Study for a Master Drainage Plan

Nueces County, Texas

THE STATE OF TEXAS
COUNTY OF NUECES

STATE OF TEXAS
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81549
LICENSED
PROFESSIONAL ENGINEER

07-15-11
FIRM #355

March, 2010

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Study for a Master Drainage Plan Nueces County, Texas Table of Contents

PART I

EXECUTIVE SUMMARY

A. PROJECT SCOPE AND BACKGROUND

This Executive Summary presents a condensed discussion of the Nueces County Drainage Master Plan authorized by the Nueces County Commissioners Court. The following sections of this report, together with accompanying watershed maps, computer models, calculations, and exhibits, present the detailed report and supporting information resulting from the study of the County's major drainage systems which is the focus of this report.

Nueces County is susceptible to flooding because some if its defined drainage ways and creeks are constricted by inadequate channel capacities and man-made barriers such as road and railroad embankments, and irrigation canals, and because its flat topography and low soil permeability create poor drainage and ponding.

B. GENERAL INFORMATION

The focus of the study was on four (4) priority areas identified by Nueces County.

- The Upper Oso Area.
- The Chapman Ranch Area
- The Community of Petronila Area
- The Petronila Creek Area.

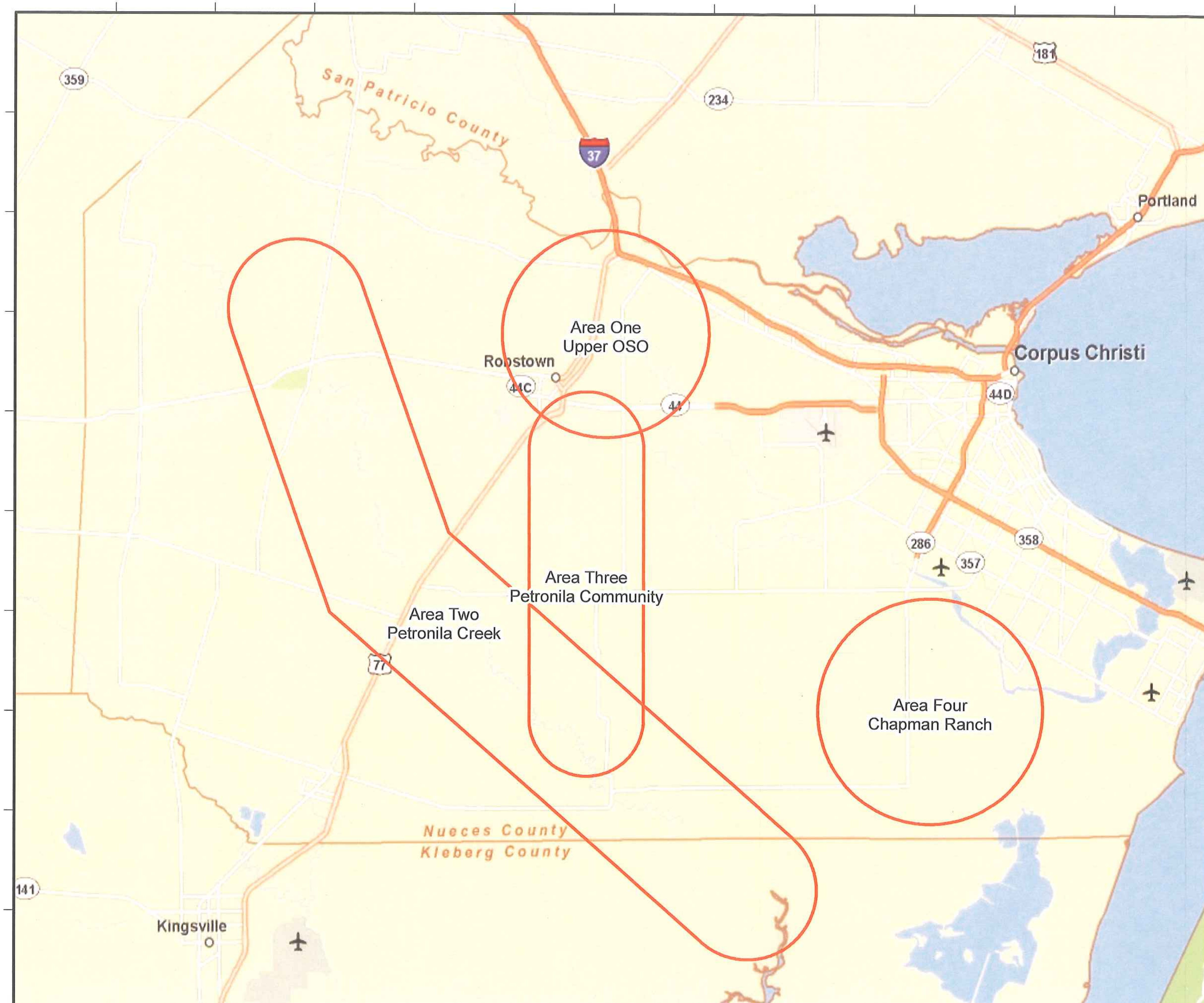
Exhibit I-01 delineates the four priority areas.

C. RECOMMENDATIONS

The recommendations in this study provide a guide for the County in implementing a plan which will reduce flood damages through both structural and non-structural measures. An implementation plan is also being issued as a separate document. Structural measures include enlarging existing channels, constructing new channels, enlarging bridge openings and constructing flood protection levees. Non-structural measures include floodplain regulation, floodproofing, flood forecasting, on-site detention of stormwater, clearing existing streams, and buyout and relocation of structures in existing floodplains.

C.1 Upper Oso

The Upper Oso Creek has historically been an area which experiences flooding. The flat terrain and lack of adequate infrastructure are the key components which impact the flooding recurrence. The existence of Irrigation levees in parts of the area makes it



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KEY MAP

MAP LEGEND

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT I-01
PRIORITY AREAS

DECEMBER 2009

difficult to efficiently drain runoff. The levees can be substantially elevated and at times can serve as a damn or diversion which re-directs water in directions which do not necessarily follow the natural terrain. At the intersection of an irrigation canal and drainage swales, special structures are required in order to efficiently drain stormwater under the irrigation canals. Exhibit I-02 depicts a special type of structure which may be utilized at these crossings.

Exhibit IV-05 depicts the recommended drainage network which would be required for the Upper Oso Area.

The following are Items which are recommended as a priority for the upper Oso. These items will have an immediate impact on the efficiency of the Upper Oso System.

1	Detention Pond One	$	10.00
2	Detention Pond Two	$	10.00
3	Drainage Swale H14-02-A	$	10.00
4	Drainage Swale H18-00 (upstream of Detention Pond Two).	$	10.00
5	Drainage Structure FM 1889 @ Swale H18-00	$	10.00
6	Drainage Swale H18-00-A (upstream of FM 1889)	$	10.00
7	Replacement Bridge – Bosquez Street @ Swale H14-00	$	10.00
8	Replacement Bridge-FM 1889 @ Swale H14-00	$	10.00
9	Replacement Bridge – Business 77 @ Swale H14-00	$	10.00
10	Replacement Bridge – Business 77 @ Swale H18-00	$	10.00
11	Drainage Swale H18-02-B (North of Detention Pond Two)	$	10.00
12	Drainage Swale H18-02-A	$	10.00
13	Other Improvements*	$	10.00

*other improvements will be constructed as development occurs.

C.2 Chapman Ranch Recommendations

The Chapman Ranch area is primarily farmland with undeveloped County Roadways and Roadside drainage swales. Drainage Improvements for this area will address two areas of concern.

1. The majority of the land in this area is very flat terrain used for farming. Surface runoff from the farms erodes top soil which has a major impact on the farming industry. At this time the drainage system consists of undersized roadside ditches which parallel the existing County Roads.

2. It is anticipated that the area immediately adjacent to and South of Oso Creek will begin to develop in the next few decades. In order to have orderly development in this area, a master plan needs to be in place to adequately drain the area and minimize the potential for flooding.

Exhibit V-02 depicts the recommended drainage network which would be required for the Chapman Ranch Area.

The following are Items which are recommended as a priority for the Chapman Ranch Area.

Chapman Ranch Area			
1	Drainage Swale H-02.	$	10.00
2	Drainage Swale H-02-02	$	10.00
3	Drainage Swale H-02-01.	$	10.00
4	Other Improvements*	$	10.00

C.3 Petronila Community Recommendations

The Petronila Community Area experiences flooding problems during flooding events. The primary reason is the flat terrain and the large drainage basin which drains across the area.

The Petronila Community includes two Colonias, San Petronila Estates Unit V and Petronila Acres. Because of the flat terrain, the recommended improvements will help alleviate some flooding but will not eliminate the flooding. The improvements will be as follows:

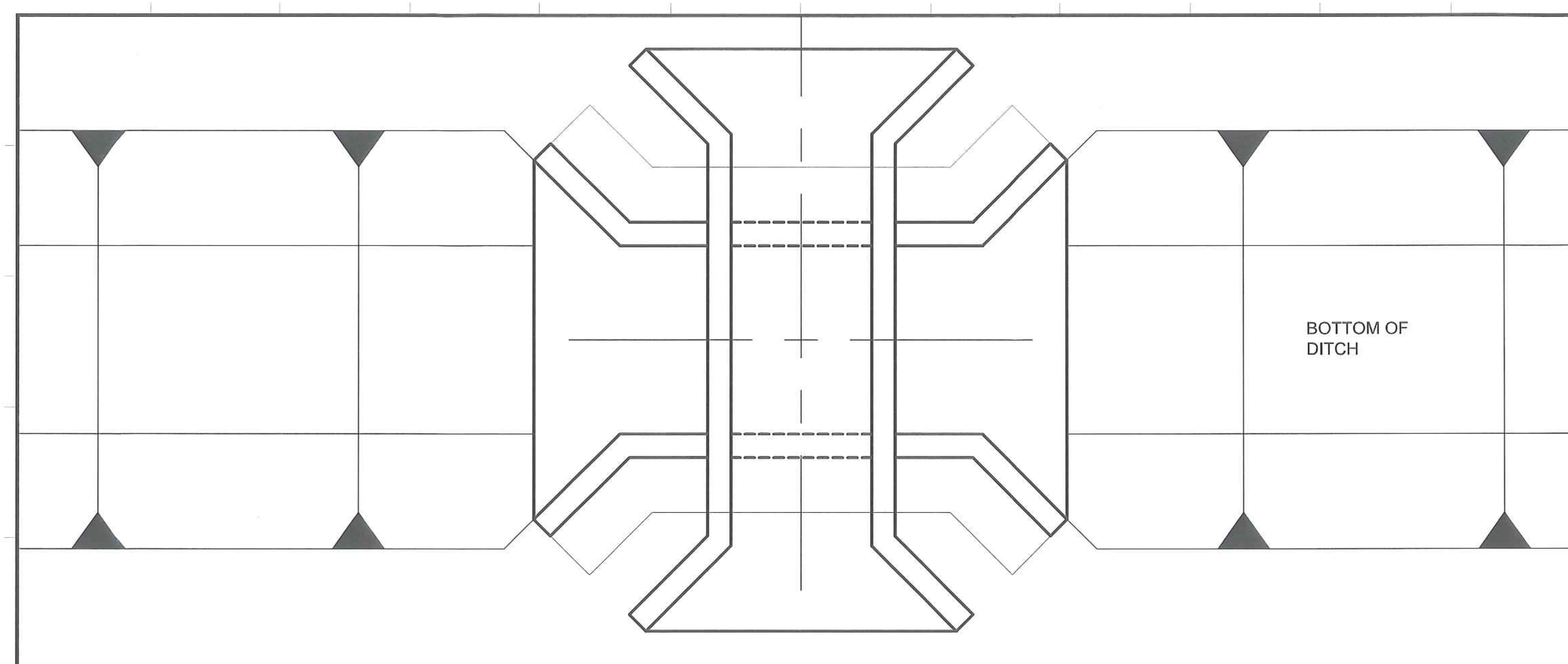
1. Construct Swales, Berms & Culverts $_________________.

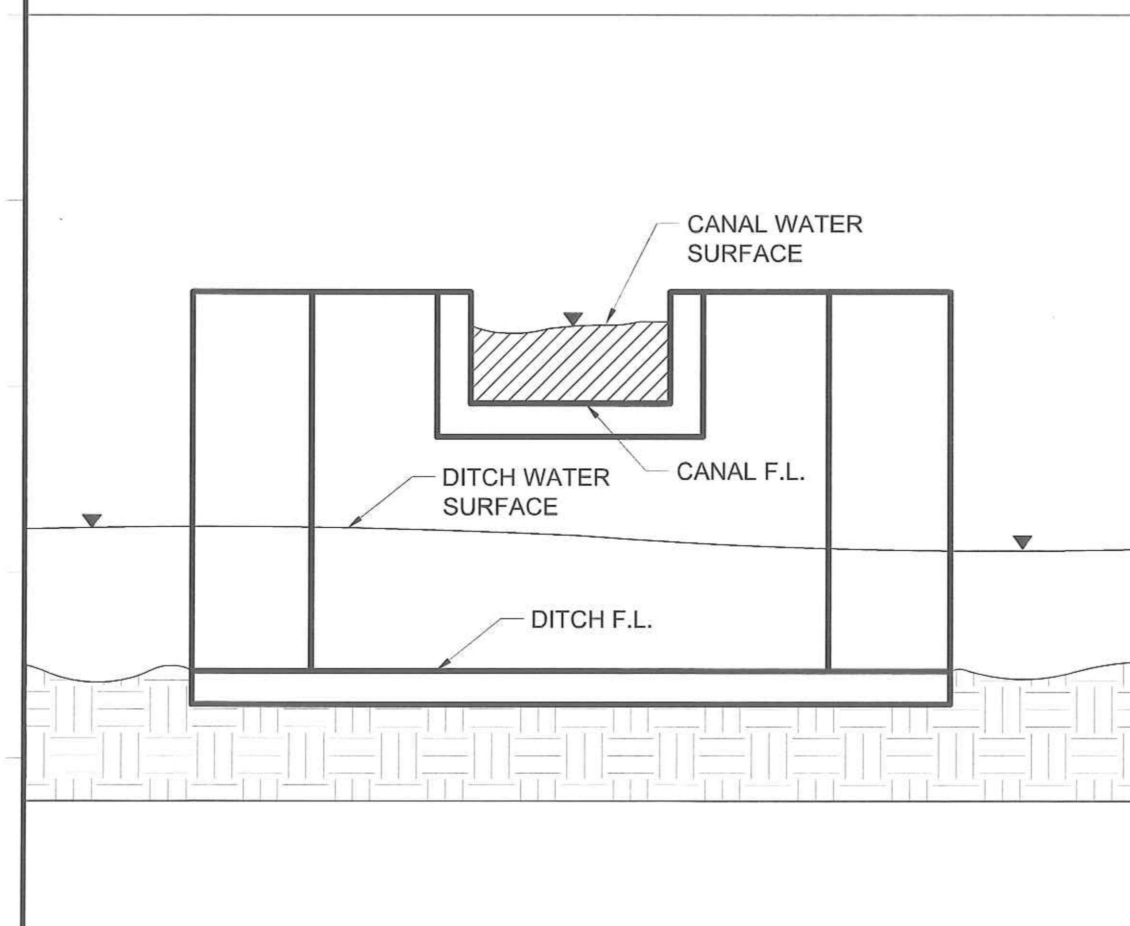
Another Colonia in the area, Petronila Estates Unit 1 & 2 was also evaluated. The recommendation is to construct some new drainage swales to divert stormwater runoff.

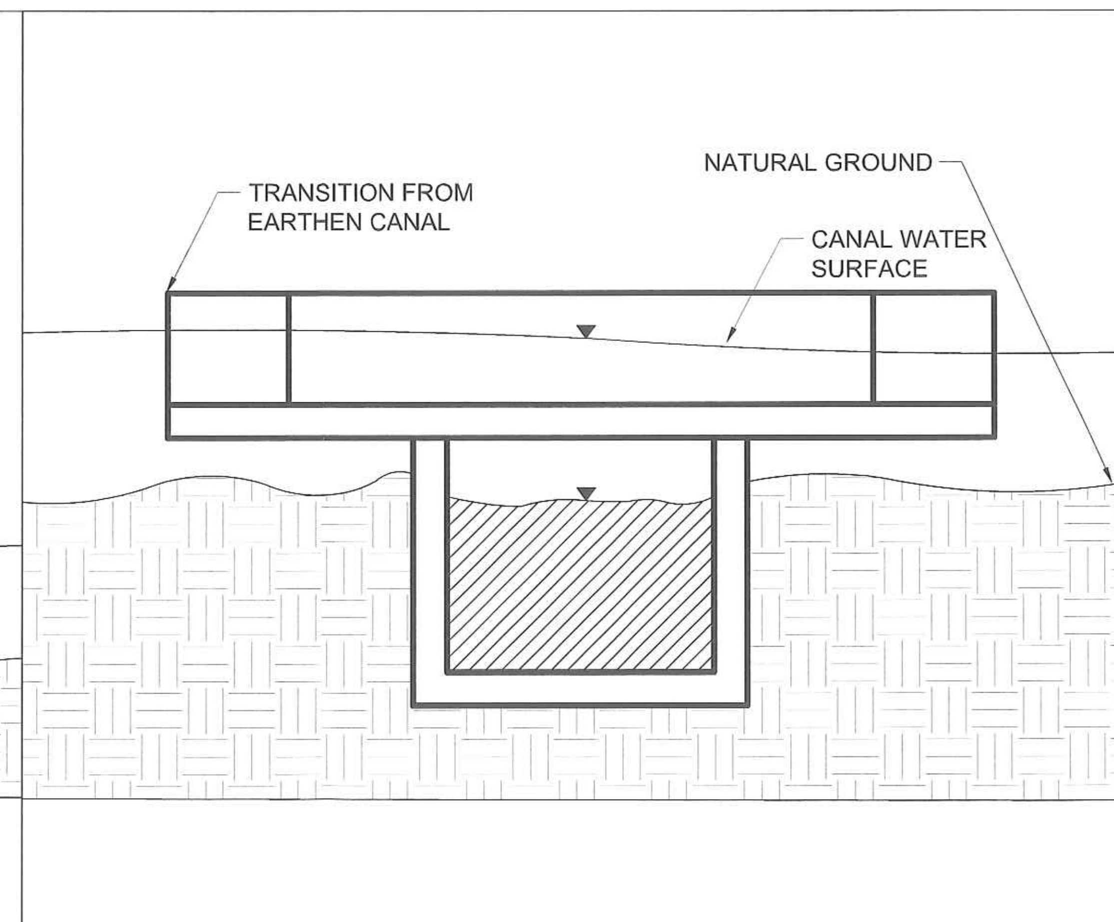
1. Construct Swales and Culverts $_________________

C.4 Petronila Creek Recommendations

Overall, the Petronila Creek system is primarily in rural areas. Although the Creek may spill outside of its banks, it is generally onto adjacent farmland or undeveloped areas. One major item is recommended for improvements associated with the Creek.







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EXISTING STRUCTURE

NOTE: A STRUCTURE SIMILAR TO THE ONE DEPICTED HERE WILL ALLOW DRAINAGE DITCHES TO FLOW UNDER THE RAISED IRRGATION CANALS.

THE STATE OF TEXAS COUNTY OF NUECES

**NUECES COUNTY
MASTER DRAINAGE PLAN**

**EXHIBIT I-02
IRRIGATION CANAL CROSSING**

DECEMBER 2009

Improve infrastructure around the Community of Driscoll $________________

D. SUMMARY

In summary, this study has developed a master plan which may be utilized as a planning tool for Nueces County. The tools available for future planning are remarkable and include the following:

1. A full County Wide GIS system.
2. A master plan for controlling and planning future development.
3. Computer Models for the major drainage systems in the County.
4. Implementation Plan.

The County may not proceed with implementing the plan and insure that the growth in Nueces County will be in an orderly, planned manner.

PART II

GENERAL INFORMATION

A. AUTHORIZATION AND SCOPE

This study was authorized by an agreement between Nueces County and Naismith Engineering, Inc. The agreement was broken up into two phases and numerous tasks. A detailed breakdown is included as Attachment B to the Agreement. In general the following tasks were approved and completed.

Phase I:

Task 1 – Plan Coordination

- Coordination with Nueces County and applicable federal, state, and local agencies, departments, and entities.
- Development of Project Management Plan

Task 2 – Data Collection and Land Use Characterization

- Literature Review of Applicable Hydrologic & Hydraulic Models, Maps, Parcel Data, Right-of-Way Data, and Existing Drainage Studies
- Performed Topographic Surveys of Channel Cross-Sections, Overbank Sections, and Physical Dimensions of all Hydraulic Structures along the Studied Streams.
- Performed Land Use Characterization Study to identify Environmental Constraints.
- Used GIS for the collection, assimilation, characterization, and illustration of technical data for the watershed.
- Completed a basic inventory of Socioeconomic Characteristics of the planning area.
- Completed an inventory of Structures in the Floodplains to assess flood damage potential in the planning area.
- Completed an inventory "critical routes" throughout the County. Critical routes would include hurricane evacuation routes and other related routes.
- Based on preliminary data, identified problems & opportunities.
- Provided a Deliverable to the County which included a DVD with all GIS layers and processed topography and a summary of available bridge inventory data (hydraulic info, photos, etc.)

Task 2A – Interim Prioritization.

Prior to commencing Task 3, the team prepared an interim prioritization of areas for the study. The prioritization was based on input from the County and also based on data which has been collected and analyzed up to that point. A decision will need to be made on whether to accept certain areas (primarily City of Corpus Christi) which overlap with other drainage master plans.

Task 3 – Hydrologic Analysis

- Performed Hydrologic Analysis with USACE HEC-HMS modeling program.
- Performed Model Calibration using historical Flood Flow Data.
- The model parameter was adjusted for lag time, curve number, Q's and to match High Water Marks (HWM).
- Performed HEC-HMS modeling to evaluate the impact of the proposed improvements under the future conditions
- Recommended 2 to 3 standard storm events which should be modeled. (i.e. 10-year, 50-year, 100-year).
- Records of the analysis are saved and are available for review in a digital format. Key components of the analysis are incorporated into the final report and recommendations.

Task 4 – Hydraulic Analysis

- Performed Hydraulic Analysis with USACE HEC-RAS modeling program on the surveyed Channel Cross-Sections and Overbank Areas, Constructed Channel Improvements, Bridge and hydraulic Structures, and other physical features along the watercourses.
- The models were assembled based on the data retrieved from the field surveys and other digital data.
- The models were calibrated to match historic High Water Marks, and stages.
- Generated Flood Profiles for various storm frequencies

Task 5 – Limited Environmental Site Investigation

- Conducted Preliminary Wetland Determination
- Identified of Permitting Requirements as related to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act.
- Conducted Protected Species Investigation
- Conducted Cultural Resources Survey in accordance with National Historical Preservation Act.

Task 6 – Inventory Basin Resources

- The majority of the data related to inventorying basin resources were completed during the Task 2 (Data Collection and Land Use Characterization).

Task 7 – Identify Problems & Opportunities (to be done in parallel with Task 2 Items)

- Identified Flooding Problems, Flood Protection Opportunities, and Flood Hazard Data.

Phase II

Task 1 – Formulate and Evaluate Alternative Drainage Plans

- Identified Potential Solutions (with Costs & Benefits) for each alternative including
- Established Design Criteria.
- Deliverables. Problems vs. Most Favored. Alternatives vs. $ vs. Benefits vs. Environmental Issues.
- Met with County to discuss Solutions.

Task 2 – Prepared the final Master Drainage Plan and Environmental Investigation Report

B. DEFINITION OF TERMS

Various technical terms are used throughout the study. They are defined as follows.

1. Detention Facility – Any structure, device or combination thereof that functions to accept inflow from surface runoff and discharge and discharge it at a controlled rate less than the peak inflow rate.

2. Developer – Any person or corporation engaged in the process of changing the use of the land.

3. Development – Any activity, including construction of a subdivision, that changes, modifies or alters the land use, generally creating additional impervious surfaces on a site including, but not limited to pavement, buildings and structures which increase stormwater runoff.

4. Enclosed Drainage System – A drainage system consisting of essentially continuous pipes and/or culverts below the ground surface. Also referred to as an Underground Storm Sewer.

5. Erosion – The removal of soil particles by the action of flowing water.

6. Freeboard – The vertical difference in elevation between the hydraulic gradient and a referenced point. An example would be the difference in elevation between the water surface at a culvert beneath the roadway and the

surface of the roadway. In a flowing channel, it may also be the height of a channel side above the water elevation.

7. Hydraulic Gradient – The elevation of the surface of the water in the drainage system at any point.

8. Hydrological Cycle: The cycle experienced by water in its travel from the ocean, through evaporation and precipitation, percolation, runoff and return to the ocean.

9. Impervious Surface (Cover) – Any surface that does not readily permit water to enter. Examples are roofs and parking lot surfaces (concrete, asphalt, etc.)

10. Improved Channel – Any channel whose characteristics are changed by either grading or construction of lining materials.

11. Level of Service – The return period for which a drainage system, or an individual element of that system has adequate hydraulic capacity.

12. Natural Channel – An existing channel that has not been appreciably altered by lining or changing its course.

13. Open System – A drainage system consisting of open channels, either natural or improved, with only comparatively short lengths enclosed by pipes or culverts.

14. Pervious Surfaces – Surfaces that readily absorb water such as yards, farm tracts or dirt roadways.

15. Reach – A specific length of the storm drainage system between two points.

16. Return Period – A statistical term for the average frequency that a given event may be expected to occur although it does not imply that the event will occur regularly at even intervals. It can also be defined as the reciprocal of the probability of an event. For example, a storm having a 10-Year return period statistically can be expected to occur once in a period of 10 years, and annual probability of occurrence of 0.10, or 10%. However, the event may happen at any time and two such events may actually occur on successive days.

17. Sediment – Soil particles eroded by flowing water either in suspension in that water or as deposited.

18. Storm Drainage System – All of the natural and constructed facilities and appurtenances, such as ditches, natural channels, pipes, culverts, bridges,

improved channels, street gutters, inlets and detention facilities, that serve to collect and convey surface drainage.

19. Surface Runoff – Water flow over the surface which reaches a stream after a storm.

20. Stream Gauging – A method of determining the velocity in an open channel.

21. Time of Concentration – The time required for water to flow from the most distant point on a runoff area to the measurement or collection point.

22. Watershed – All land draining to the storm drainage system at any given point. This term is used synonymously with the terms tributary area, drainage area, drainage basin and catchment area.

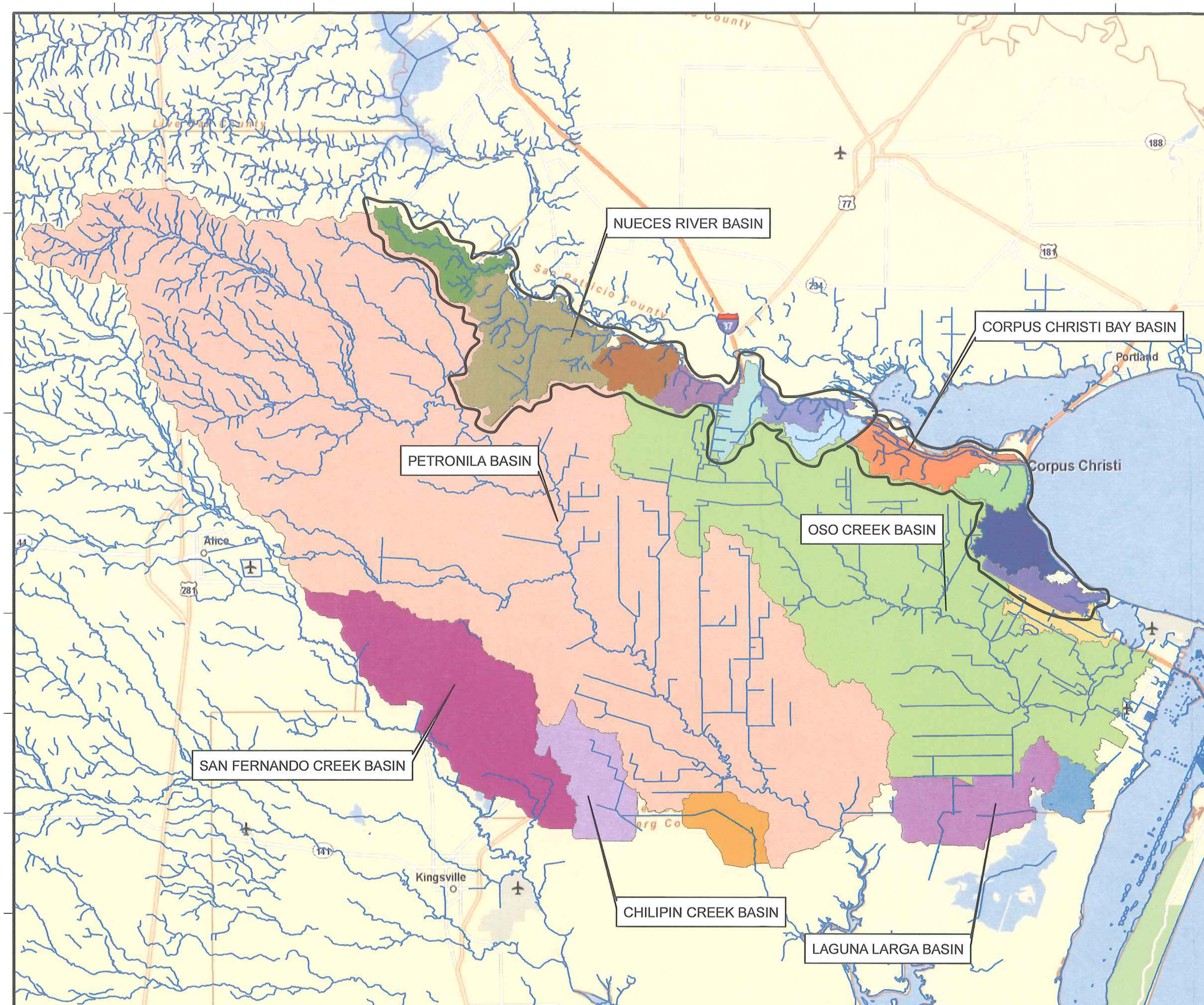
C. AREA INFORMATION

Nueces County, Texas encompasses an area of 836 square miles and is located along the Coast of the Gulf of Mexico. This area is sometimes referred to as the Coastal Bend of Texas. Major Highways through the area include Interstate Highway 37, U.S. Highway 77 and S.H. 44. Major waterways include Nueces Bay, Corpus Christi Bay, Oso Bay, the Gulf of Mexico and the Nueces River. Smaller waterways include the Oso Creek System and the Petronila Creek System.

The County seat is located in Corpus Christi, Texas. Other incorporated Cities within the County include Port Aransas, Robstown, Driscoll, Bishop, Agua Dulce, and Petronila. In addition, Banquete is a small unincorporated community in western Nueces County.

The estimated population for Nueces County in 2008 was 322,077 people based on the US Census Bureau. Of this, 285,267 people reside within the limits of the City of Corpus Christi which is by far the largest City in the County. The City of Corpus Christi is located primarily along the shores of Nueces Bay and Corpus Christi Bay with portions on a section of North Padre Island. The city is a seaport with a deep channel access to the Gulf of Mexico. The County has seven (7) primary drainage basins. See Exhibit II-01.

- The Nueces River Sub-Basin consists primarily of the land immediately adjacent to the river and contributes minimal flow to the River.
- The Corpus Christi Bay Basin consists primarily of land along the downtown area of Corpus Christi which discharges directly into Corpus Christi Bay.
- The Oso Creek Basin is completely contained within the Boundaries of Nueces County and discharges into Oso Bay.
- The Petronila Creek Basin covers the largest area of all the basins. Approximately 1/3 of the basin is within Jim Wells County to the West. Flows



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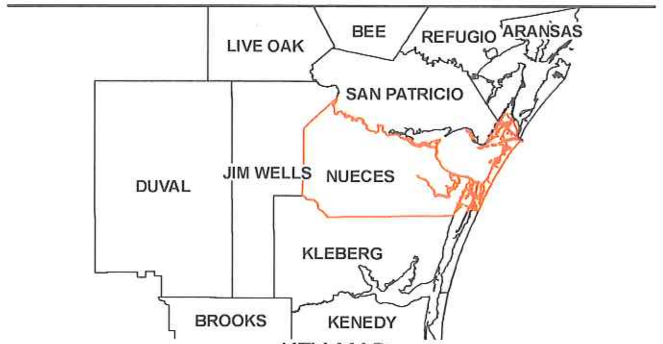


KEY MAP

MAP LEGEND

NUECES COUNTY
MASTER DRAINAGE PLAN

EXHIBIT II-01
PRIMARY DRAINAGE BASINS

DECEMBER 2009

from Petronila creek cross into Kleberg County to the South and ultimately discharge into Alazan Bay.

- The San Fernando Creek Basin in the Southwest Corner of Nueces County begins in Jim Wells County, crosses Nueces County and Discharges south in Kleberg County into the Calle del Grullo.
- The Chiltipin Creek Basin is a small basin on the Southern County Line. It crosses into Kleberg County and discharges into the Calle del Grullo.
- Laguna Larga Basin South of the Chapman Ranch Area. The basin discharges into a large fresh water lake area on the King Ranch.

Geology

Geologically, Nueces County is primarily clay soils. The Soil Survey conducted by the US Department of Agriculture identifies 44 different types of soil within the County. However, approximately 30 of the different types each compromise less than 1% of the overall county. Victoria Clay (58%) is by far the most predominant type of soil within the County. The Barrier Islands (Mustang and Padre) located on the Eastern Boundaries of the County are primarily Sand. Additional Data on Nueces County Soils may be found in the most current Soil Survey published by the US Department of Agriculture. In addition, the GIS system prepared for this Study incorporated the soil data so it can easily be accessed and evaluated for any area of interest.

Topography

Elevations in the County range from 148 feet above sea level in the Northwestern part of the county down to sea level along the coast. The County extends 25 miles from north to south and about 50 miles from the western boundary out to the barrier islands on the East. The elevation gradually rises from East to the West. Nueces County acquired LIDAR data and the data was utilized to create contours in 2' intervals for the entire County. The contour data has been incorporated into the Study's GIS system for easy access.

Climate

Average annual rainfall in the area ranges between 25 inches in the Northwestern part of the County up to 28 inches along the Coastal Areas. The highest periods of rain are normally experienced around late Spring (May) and Early Fall (September). The rainfall activity drops off during the cool winter months. Severe tropical storms occur about once every 10 years and less severe storms every 5 years. At the time of this study, Nueces County was going through an exceptional drought, and was about 13 inches below normal for the year through September.

D. JURISDICTION

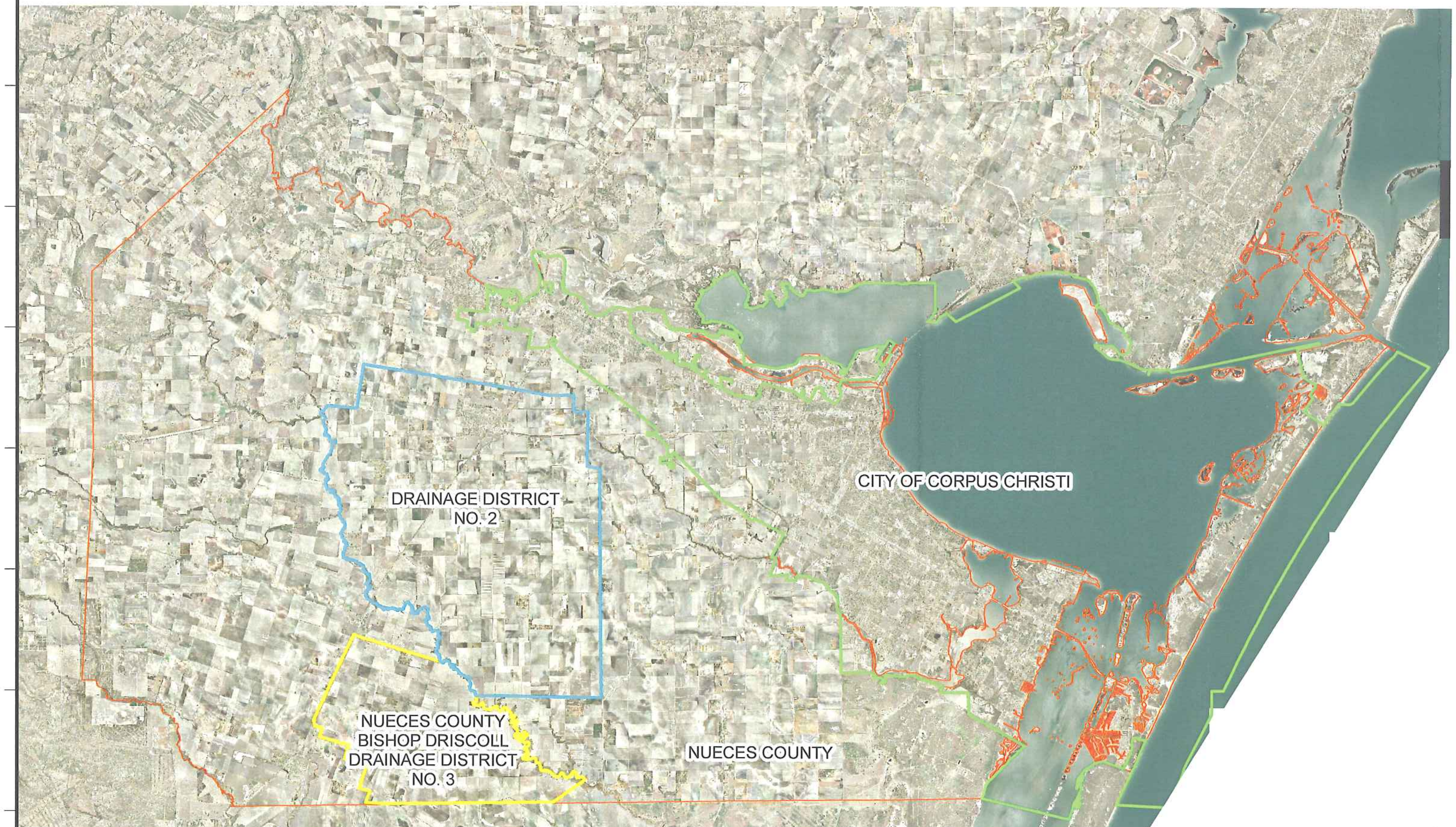
Nueces County covers an area with numerous entities that have maintenance jurisdiction. The entities include:

- City of Corpus Christi
- Nueces County
- Nueces County Drainage District #2
- Nueces County Drainage District
- Other small incorporated communities

Exhibit II-02 shows the approximate jurisdictional boundaries for the individual entities.

E. TECHNICAL METHODS AND CRITERIA

Appendix XI-1 summarizes the technical methods and criteria utilized for this project. In addition, Appendix XI-4 outlines the stormwater management policy and the minimum level of protection required for future improvements.



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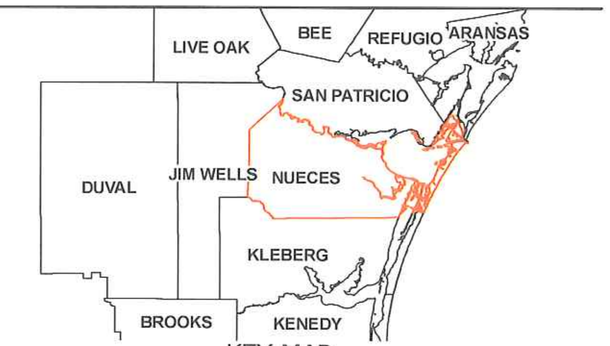
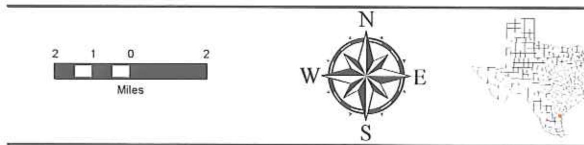


KEY MAP



MAP LEGEND

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT II-02
DRAINAGE JURISDICTIONS

DECEMBER 2009

PART III

EXISTING SYSTEM PERFORMANCE AND PROPOSED MASTER PLAN

A. GENERAL

A.1 Existing Streams

For the Purpose of this Master Plan, a coding system was established for all the major stream segments within the rural county. A stream segment can be a small stream or ditch and will typically be associated with one of the large primary streams. The coding system assigns a letter to the primary streams as outlined below.

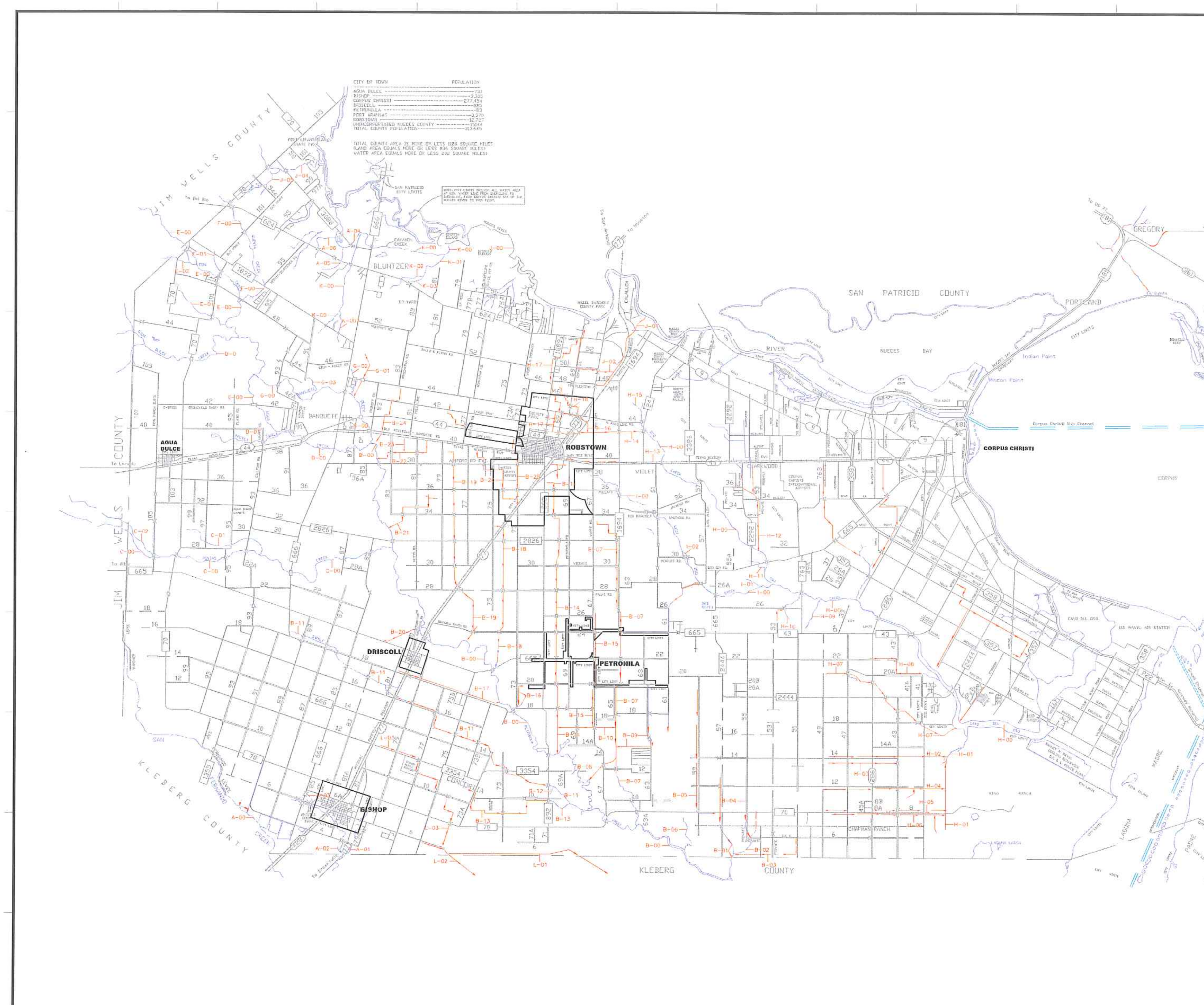
System Name	I.D.
San Fernando Creek	A
Petronila Creek	B
Pintas Creek	C
Agua Dulce Creek	D
Leon Creek	E
Quinta Creek	F
Banquete Creek	G
Oso Creek	H
West Oso Creek	I
Nueces River	J
Cayamon creek	K
Miscellaneous Border Systems	L

The smaller stream segments which discharge into the primary systems were given an extension to the system I.D. For instance D-01 is a small swale (Yackey Swale) which discharges into Agua Dulce Creek. Exhibit III-01 depicts the locations of all the stream sections and their associated I.D.

A. 2 Watershed Delineations

Nueces County has seven (7) primary basins or sub-basins which are within the limits of the County.

- The Nueces River Sub-Basin consists primarily of the land immediately adjacent to the river and contributes minimal flow to the River.
- The Corpus Christi Bay Basin consists primarily of land along the downtown area of Corpus Christi which discharges directly into Corpus Christi Bay.
- The Oso Creek Basin is completely contained within the Boundaries of Nueces County and discharges into Oso Bay.



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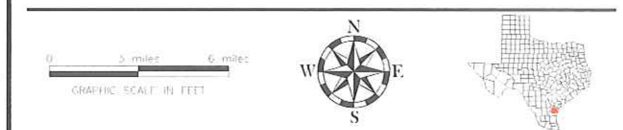
KEY MAP



MAP LEGEND

WATERWAY	DESIGNATION
SAN FERNANDO CREEK	A
PETRONILLA CREEK	B
PINTAS CREEK	C
AGUA DULCE CREEK	D
LEON CREEK	E
QUINTA CREEK	F
BANQUETE CREEK	G
OSO CREEK	H
WEST OSO CREEK	I
NUECES RIVER	J
CAYAMON CREEK	K
MISCELLANEOUS BORDER	L

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT III-01
EXISTING STREAMS

DECEMBER 2009

- The Petronila Creek Basin covers the largest area of all the basins. Approximately 1/3 of the basin is within Jim Wells County to the West. Flows from Petronila creek cross into Kleberg County to the South and ultimately discharge into Alazan Bay.
- The San Fernando Creek Basin in the Southwest Corner of Nueces County begins in Jim Wells County, crosses Nueces County and Discharges south in Kleberg County into the Calle del Grullo.
- The Chiltipin Creek Basin is a small basin on the Southern County Line. It crosses into Kleberg County and discharges into the Calle del Grullo.
- Laguna Larga Basin South of the Chapman Ranch Area. The basin discharges into a large fresh water lake area on the King Ranch.

In addition to basins, sub-basins were delineated for the Oso and Petronila Creek systems. The sub-basins can be viewed on the GIS system.

A.3 Priority Areas Analyzed

Sections IV, V, VI, VII, and VIII present the results of the hydrologic and hydraulic analysis for the Priority Areas identified for Nueces County. Early in the study process, it was determined through meetings with the team preparing this report and numerous team members that the focus of the plan would be in four primary areas of the County.

- The Upper Oso Area.
- The Chapman Ranch Area
- The Community of Petronila Area
- The Petronila Creek Area.

A.4 Hydrologic and Hydraulic Analysis

In order to develop a realistic master plan, certain parameters need to be established for developing recommendations for future improvements. A policy for adequately sizing different types of structures must first be established. This study was prepared with the understanding that Nueces County would be adopting similar parameters as the City of Corpus Christi. At the time of this study, the City of Corpus Christi was in the process of adopting a new Storm Water Master Plan and Drainage Criteria Manual. Appendix XI-4, Storm Water Management Policy, outlines the minimum level of protection which was utilized in our analysis and recommendations. The rainfall data utilized for specific storm events is outlined in section III of this study.

Other considerations include the future land use and population densities within the limits of the watershed. Population projections were taken from the Metropolitan Planning Organization, through the year 2035. In addition, the future land use maps were acquired from the City of Corpus Christi for areas that impacted the Upper Oso. Once these parameters were established, then the systems could be analyzed under existing conditions as well as the anticipated future conditions.

Models were developed for the systems based on the anticipated land use as well as the minimum parameters established for design. The models were utilized to develop an improved network of ditches, bridges, and stream sections which would efficiently drain the planning area. Key improvements including:

- Constructing new drainage swales.
- Improving/widening existing drainage swales
- Providing Detention Facilities
- Constructing Roadway Crossings (Bridges and Culverts)

PART IV

UPPER OSO SYSTEM

A. GENERAL

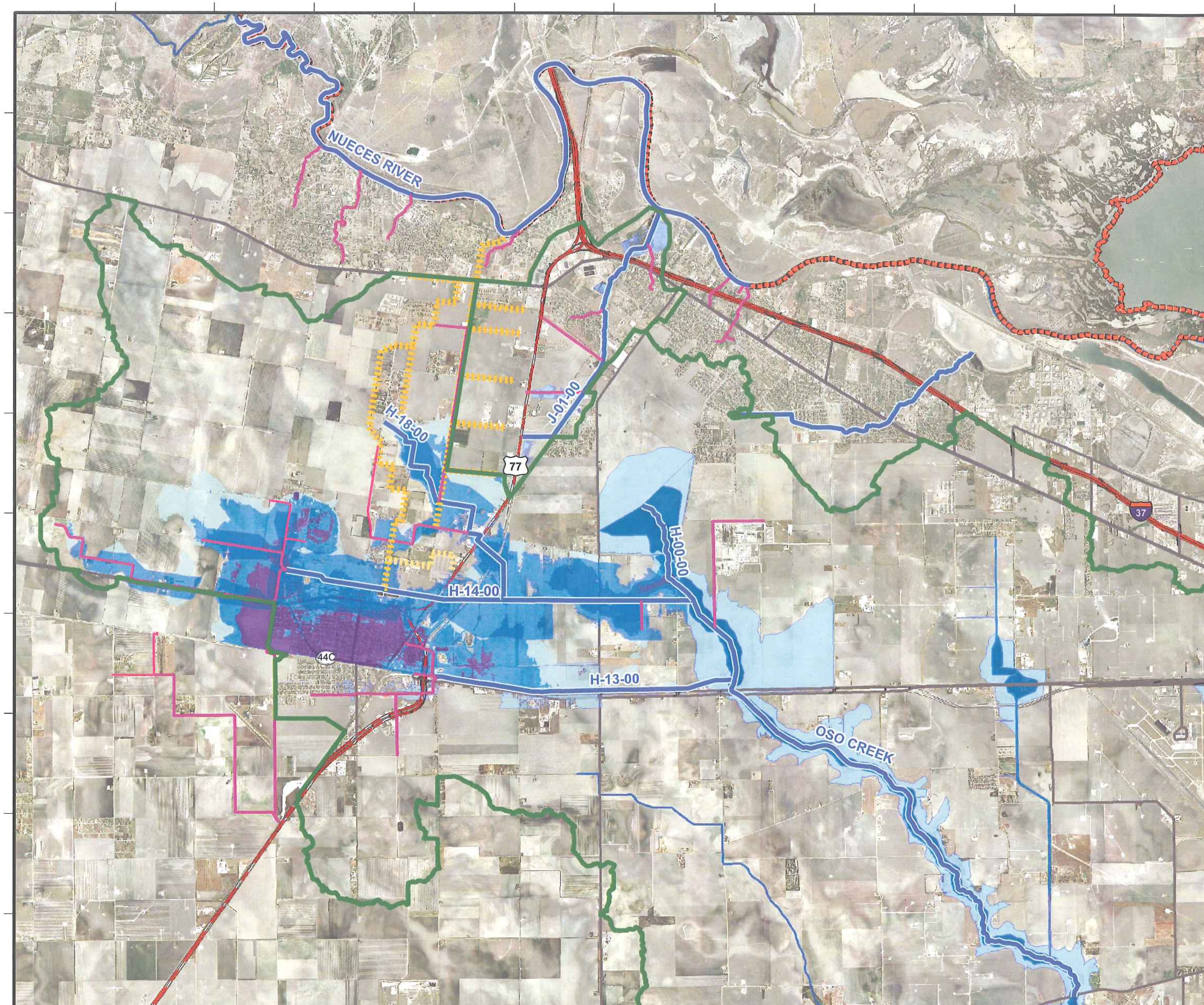
The Upper Oso Area is anticipated to be a fast growing area during the early 21st Century. The primary area of interest is bound by FM 624 on the North, the City of Robstown on the South, County Road 73 on the West, and FM 24 (Violet Road) on the East.

The existing drainage system within this area consists primarily of open ditches, culverts and bridges. Exhibit IV-01 delineates the basic existing drainage infrastructure in the area.

B. MODELING

Computer models were developed for the Upper Oso watershed for the existing conditions. The Upper Oso was divided into sub-basins and stream sections, and the required parameters of drainage area and slopes were computed. Exhibit IV-02 shows the existing topography of the Upper Oso Area. The land just east of Robstown is at elevation 68 and the land northwest of Robstown at the upper end of the basin is close to 90. This is very flat terrain having slopes less than 0.07%. This equates to a drop of roughly 8 inches every 1000'. In order to properly adjust the computer modeling, field topographic surveys were completed to compliment the Lidar data. Lidar data is great on most surfaces but it can sometimes be inaccurate on waterways. Especially if water was present at the time the Lidar data was acquired. Exhibit IV-03 delineates some of the areas throughout the County where supplemental topographic surveys were completed.

A new HEC-HMS model was created for the Oso Creek System in order to evaluate the impacts on the Upper Oso. Exhibit IV-04 depicts the basic schematic. The intent of the model was to have a tool available to analyze that Upper Oso. It is not intended to be used as a comparison for other detailed models which may have been developed by FEMA or the City of Corpus Christi. Table IV-A summarizes the flows at key locations along stream sections in the Upper Oso System.



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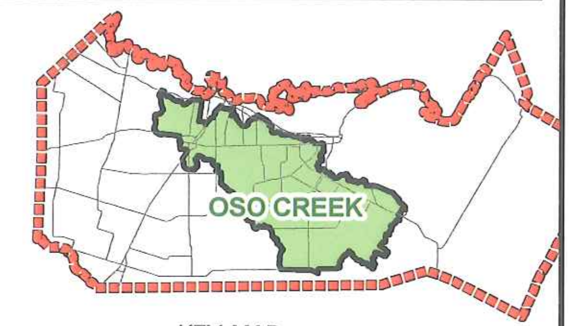


KEY MAP

MAP LEGEND

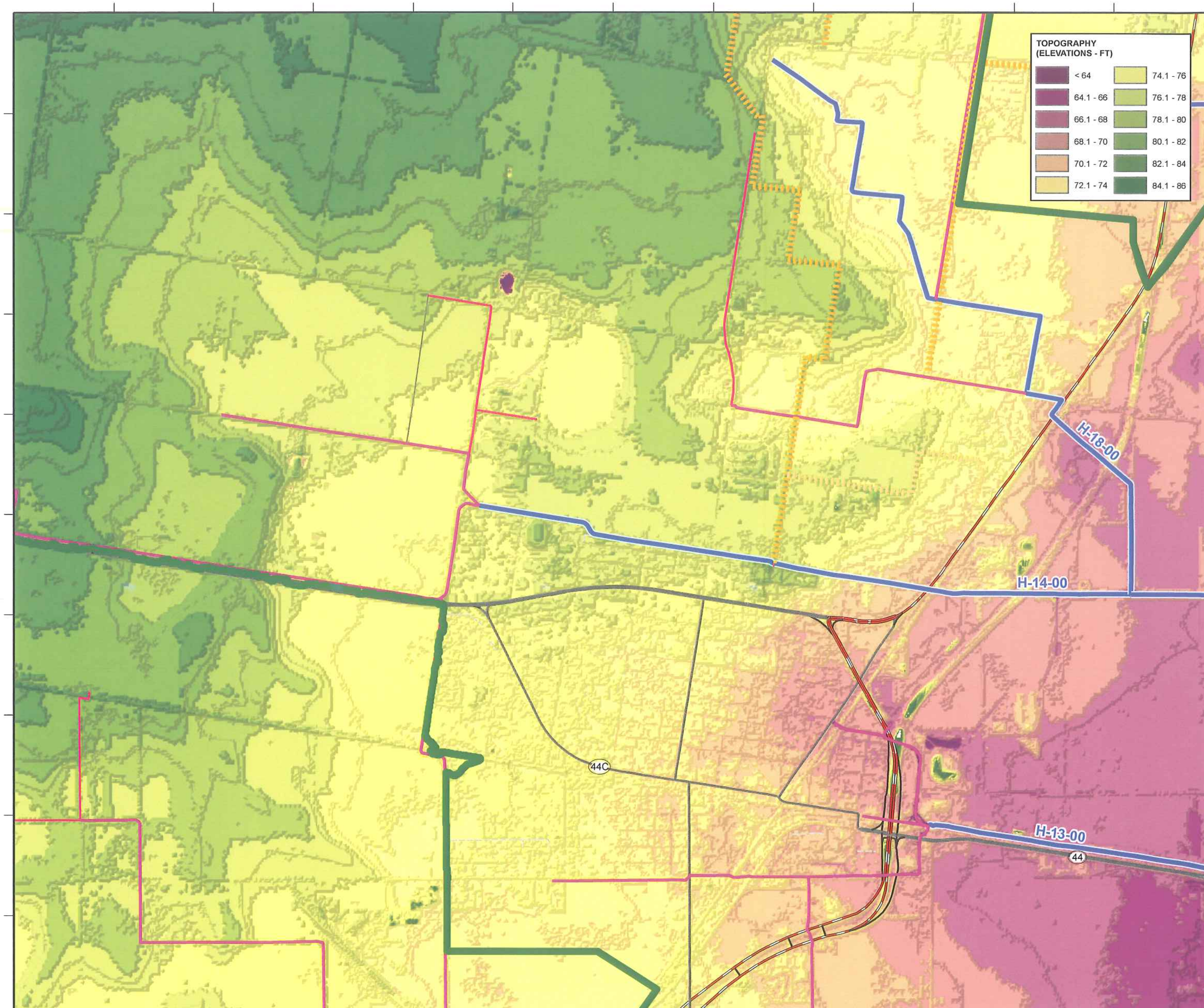
LEGEND
- NUECES COUNTY
- ROBSTOWN AREA - WATERSHEDS
- MODELED 100-YR FLOODPLAIN

STREAM/ DITCH TYPES
- DITCH-TRIB
- CHANNEL
- CANAL
- ROADSIDE
- UNKNOWN-CANAL

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-01 UPPER OSO PRIORITY AREA DRAINAGE NETWORK

OCTOBER 2009



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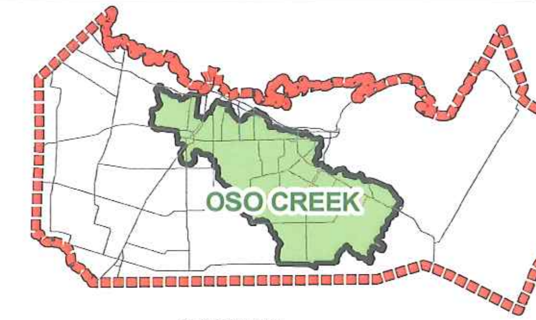


KEY MAP

MAP LEGEND

LEGEND

- NUECES COUNTY
- ROBSTOWN AREA - WATERSHEDS

ROBSTOWN_STREAMS

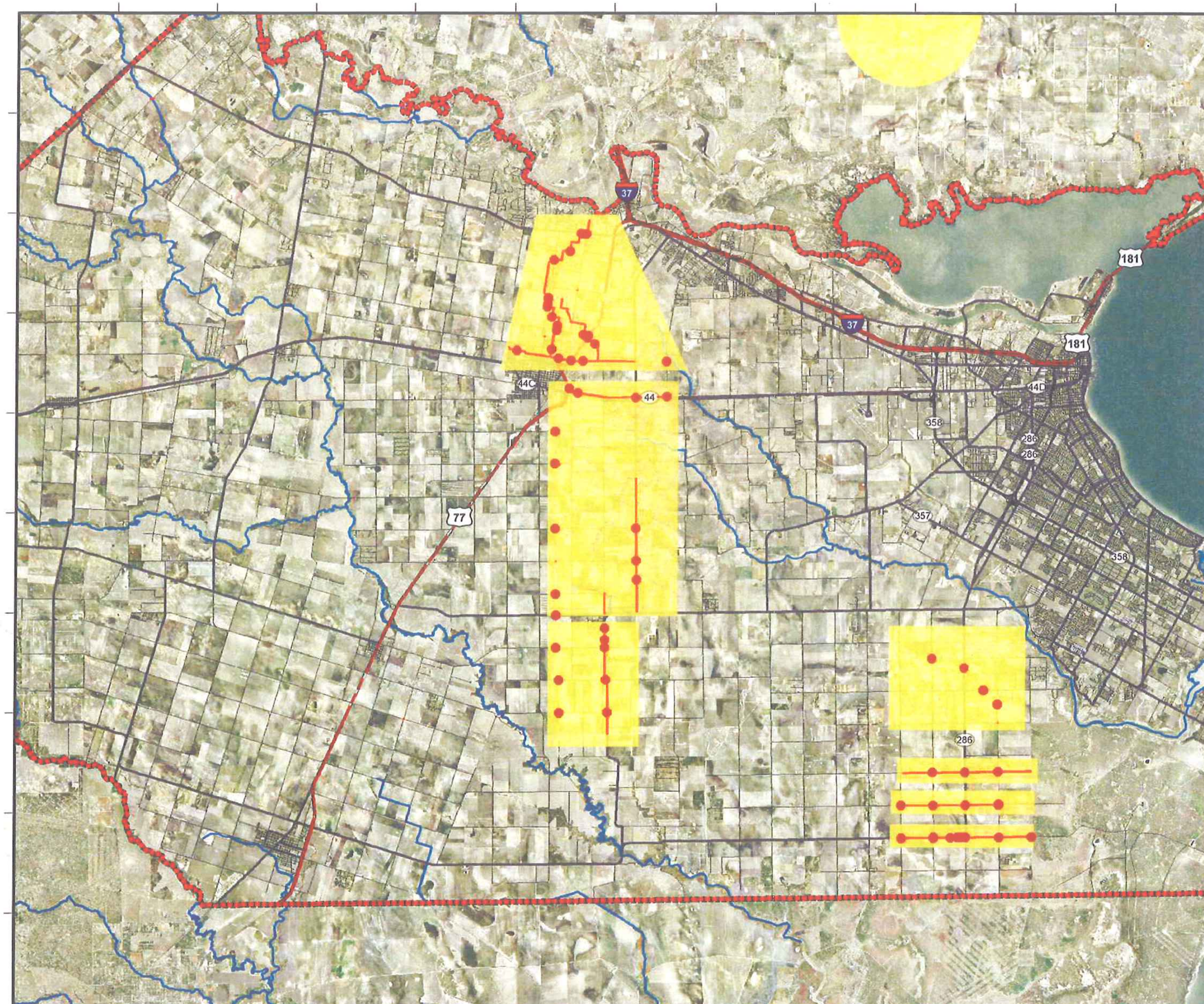
STREAM/ DITCH TYPES

- DITCH-TRIB
- CHANNEL
- CANAL
- ROADSIDE
- UNKNOWN-CANAL

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-02
UPPER OSO PRIORITY AREA TOPOGRAPHY

OCTOBER 2009



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NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-03
FIELD SURVEYING AREAS

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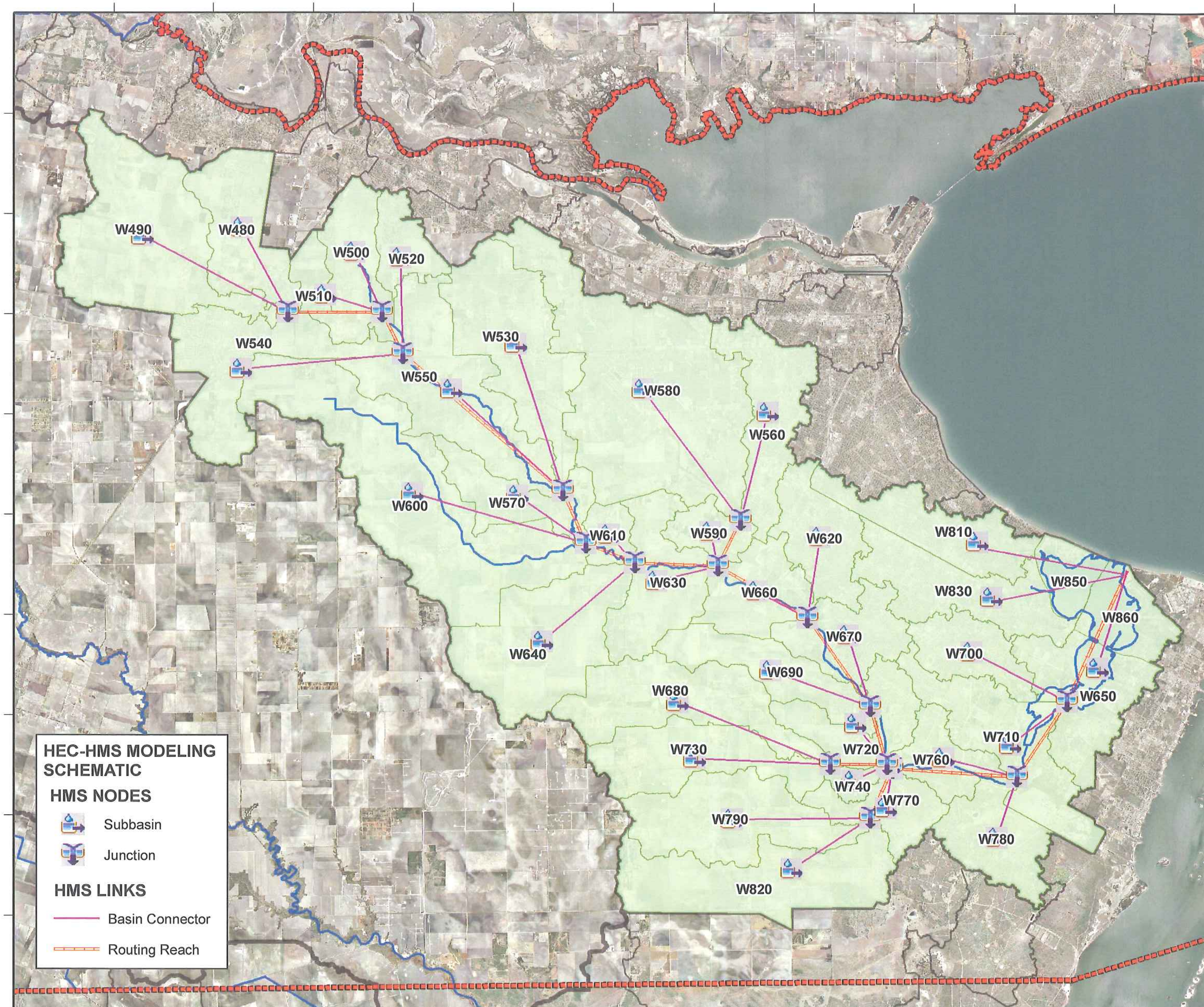

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KEY MAP

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MAP LEGEND

LEGEND

- NUECES COUNTY
- OSO CREEK SUBAREAS
- STREAMS

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-04
OSO CREEK WATERSHED
HEC-HMS MODEL SCHEMATIC

OCTOBER 2009

Table IV-A Peak Discharges
Existing Stream Sections

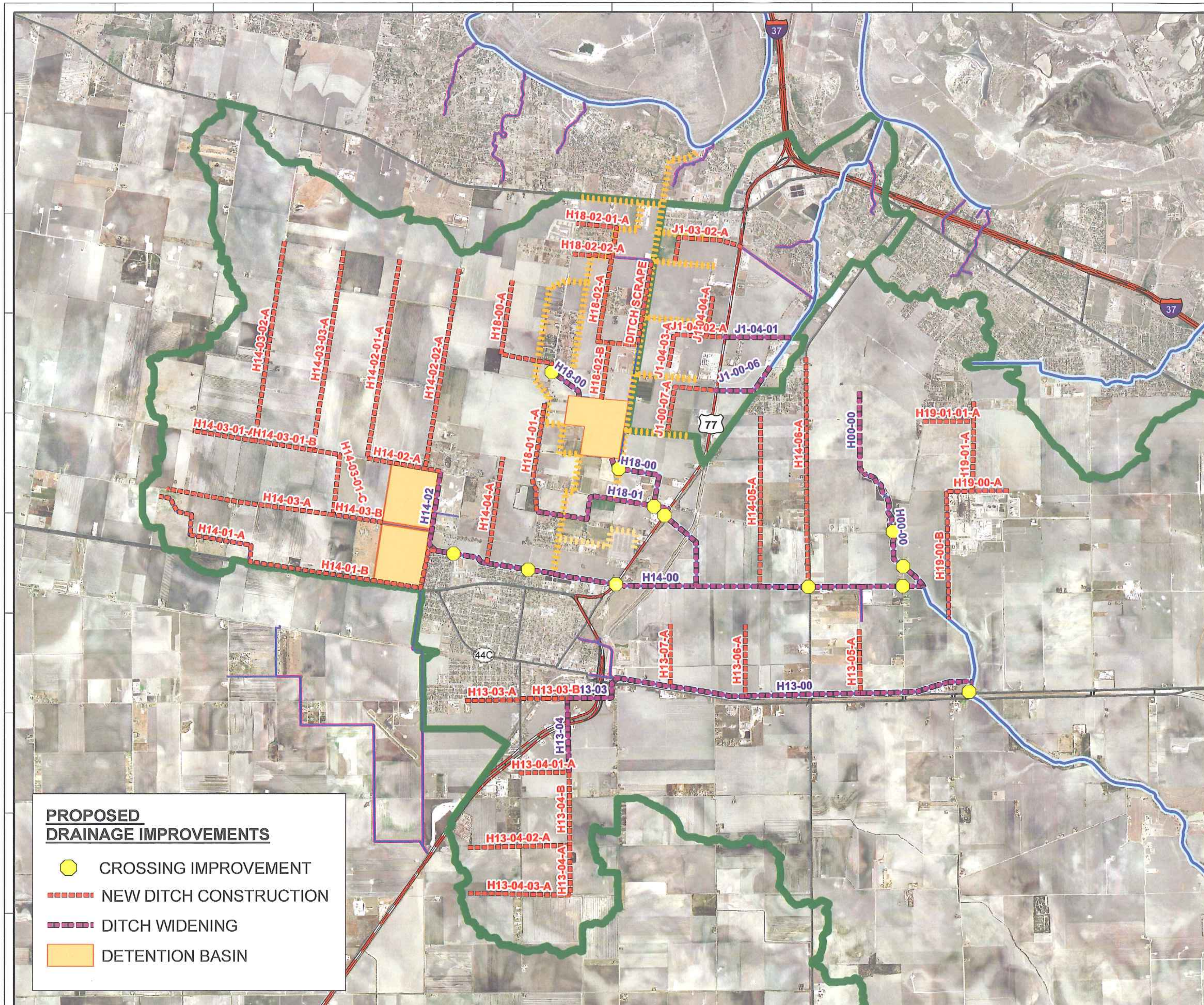
STREAM ID	REACH	LOCATION DESCRIPTION	CONTRIB AREA (ac)	2-YEAR (cfs)	5-YEAR (cfs)	10-YEAR (cfs)	25-YEAR (cfs)	50-YEAR (cfs)	100-YEAR (cfs)
H00-00	H-00	Upstream of Hwy 44	24282	4378	4661	4877	5170	5414	6430
H00-00	H-00	At Confluence of H-14-00	16678	819	1701	2387	3320	4098	4970
H13-00	H-13	At Confluence with H00-00	5250	250	410	570	820	980	1150
H14-00	H-14E	At Confluence with H00-00	14212	890	2000	2660	3780	4660	5550
H14-00	H-14D	Upstream of H18-00	8332	520	1170	1560	2210	2730	3250
H14-00	H-14C	Upstream of BS 77	8332	520	1170	1560	2210	2730	3250
H14-00	H-14A	At Bosquez Street	7971	500	1120	1490	2120	2620	3110
H18-00	H-18D	At Confluence with H14-00	3964	310	620	810	1110	1360	1670
H18-00	H-18C	Upstream of BS 77	3476	270	540	710	980	1190	1470
H18-00	H-18B	Upstream of CR 69	2501	200	390	510	700	860	1060
H18-00	H-18A	At FM 1889	1145	90	180	230	320	390	480
H18-01	H-18-01A	At Confluence with H-18	781	60	120	160	220	270	330
H18-01	H-18-01B	At FM 1889	517	40	80	110	150	180	220
H19-00	H-19A	At Confluence with H-00	1525	60	120	160	230	280	330

Table IV-A Peak Discharges Cont'd
Existing Stream Sections

STREAM	REACH	LOCATION DESCRIPTION	CONTRIB AREA (ac)	2-YEAR (cfs)	5-YEAR (cfs)	10-YEAR (cfs)	25-YEAR (cfs)	50-YEAR (cfs)	100-YEAR (cfs)
J1-00	J1-00-01	Outfall To Nueces River	3345	151	224	308	424	519	629
J1-00	J1-00-01A	Downstream of J1-01	3247	144	218	298	408	498	602
J1-00	J1-00-02	Downstream of IH-35	2925	147	187	255	348	428	513
J1-00	J1-00-02A	Upstream of IH-35	2654	147	150	207	286	351	426
J1-00	J1-00-03	Downstream ofJ1-02	2341	99	138	189	259	316	380
J1-00	J1-00-03A	Upstream ofJ1-02	2141	94	126	175	240	293	351
J1-00	J1-00-04	Downstream of J1-03	2005	88	123	169	232	284	340
J1-00	J1-00-04A	Upstream of J1-03	1697	68	95	131	181	221	268
J1-00	J1-00-05	Downstream of J1-04	1617	50	94	131	180	220	267
J1-00	J1-00-06	Upstream of CR 48	610	23	47	65	90	110	133
J1-00	J1-00-07	Upstream of US 77	494	19	39	55	76	93	113
J1-01	J1-01-01	Confluence w/ J1-00	193	19	24	35	49	63	78
J1-01	J1-01-01	Upstream of IH-35	123	13	25	35	47	58	70
J1-02	J1-02-01	Confluence w/ J1-00	201	18	34	46	63	76	92
J1-03	J1-03-01	Confluence w/ J1-00	308	21	33	45	60	73	88
J1-03	J1-03-01	Upstream of US 77	235	14	25	34	45	55	66
J1-04	J1-04-01	Confluence w/ J1-00	806	19	36	50	67	84	102
J1-04	J1-04-01	Upstream of US 77	546	10	20	28	39	49	59

C. MASTER PLAN

The master plan was developed with the use of the modeling programs and the established criteria. The existing system was not capable of meeting the drainage criteria requirements; therefore a new network was developed and analyzed. The resulting master plan for the Upper Oso area is depicted on Exhibit IV-05. In addition, Exhibit IV-06 outlines the recommended right-of-way widths for the proposed improvements. The recommended improvements also include the use of detention basins. Exhibits IV-07, IV-08 and IV-09 provide some basic details on the recommended detention basins. Actual location, dimensions and capacity will need to be worked out during final design. Table IV-B summarizes the channel improvements recommended for the Upper Oso Watershed.



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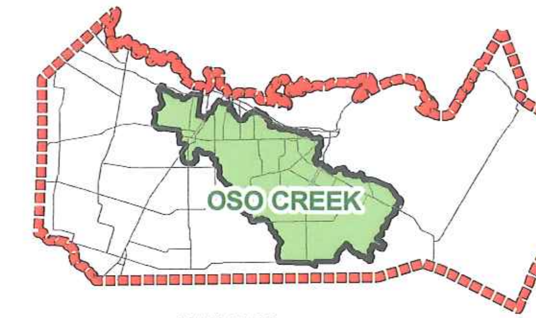

KEY MAP

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MAP LEGEND

LEGEND

ROBSTOWN AREA - WATERSHEDS

EXISTING DITCH TYPE

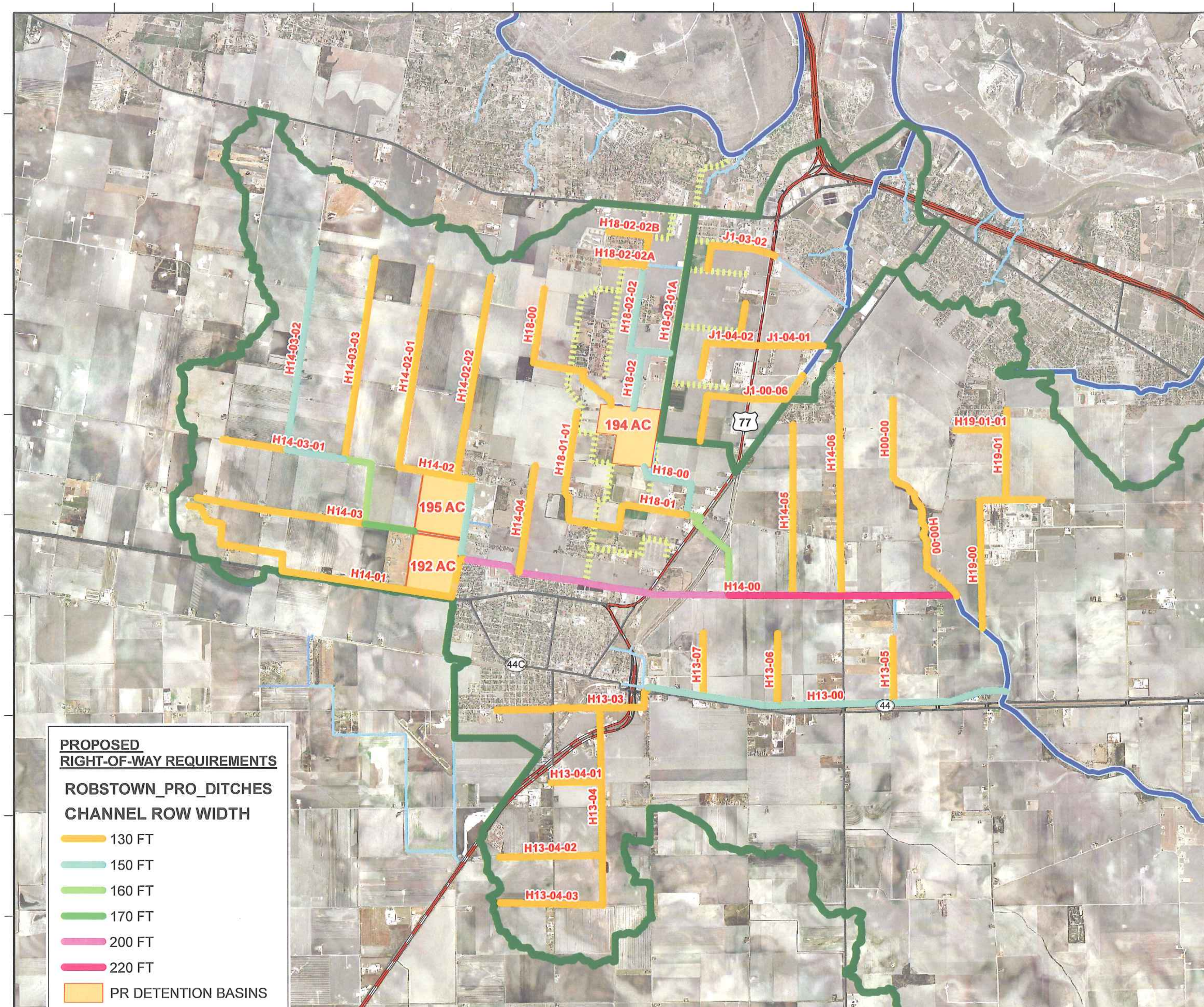
- DITCH-TRIB
- CHANNEL
- CANAL
- ROADSIDE
- UNKNOWN-CANAL?

THE STATE OF TEXAS COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-05
UPPER OSO PRIORITY AREA
DRAINAGE IMPROVEMENTS

OCTOBER 2009



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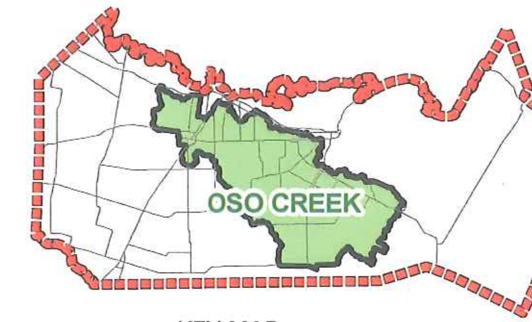


KEY MAP

MAP LEGEND

LEGEND
ROBSTOWN AREA - WATERSHEDS
ROBSTOWN_STREAMS
STREAM/ DITCH TYPES
DITCH-TRIB
CHANNEL
CANAL
ROADSIDE
UNKNOWN-CANAL

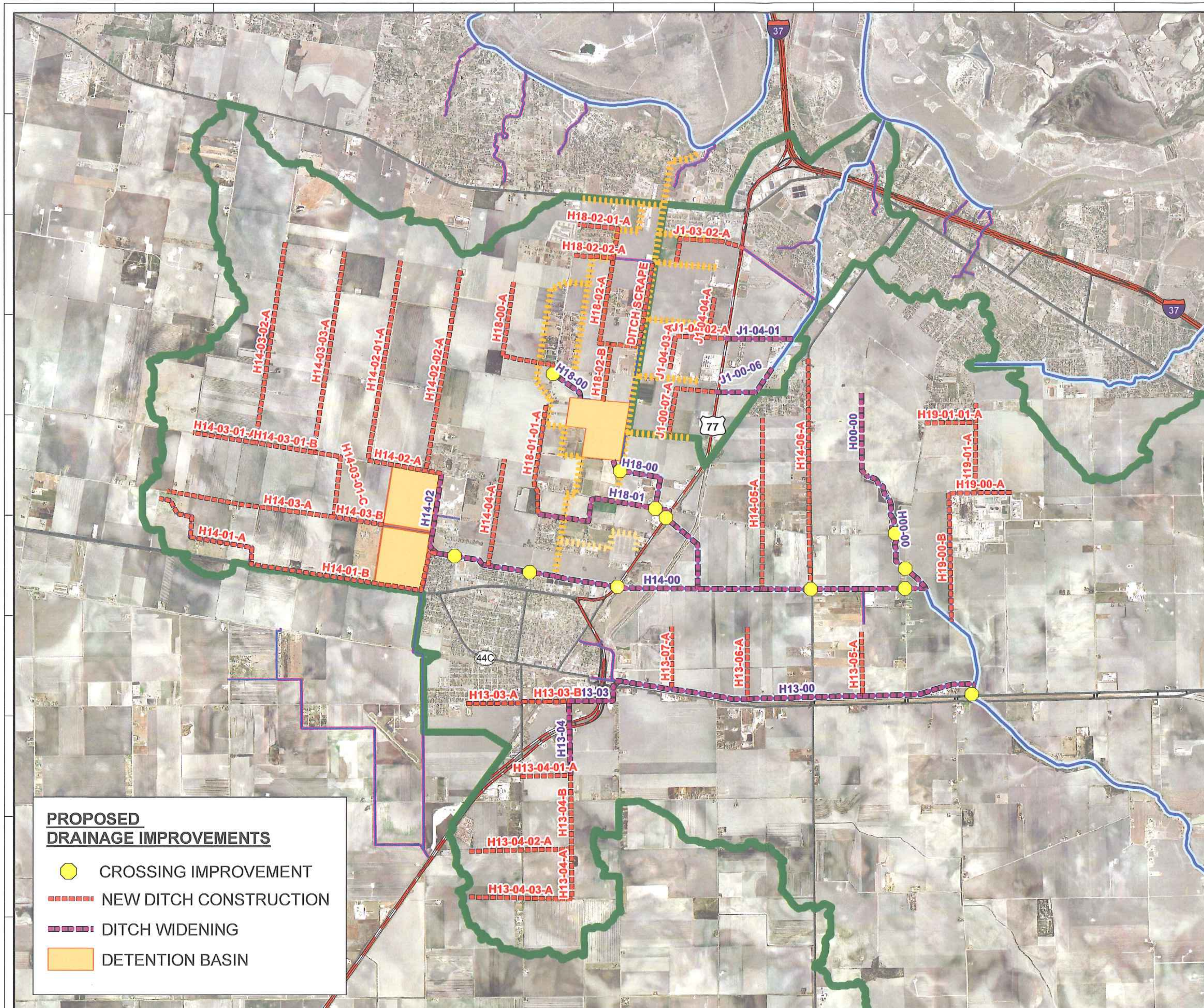
NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-06
UPPER OSO PRIORITY AREA
PROPOSED RIGHT-OF-WAY

OCTOBER 2009

TABLE IV-B
RECOMMENDED DRAINAGE WAYS - UPPER OSO

REACH	CONTRIB AREA (ac)	PROPOSED CHANNEL (1=NEW, 0=EX)	REACH LENGTH (ft)	CHANNEL TYPE	REACH SLOPE (FT)	REACH SS (H:V)	REACH DEPTH (FT)	REACH BW (FT)	REACH TW (FT)	ROW WIDTH (FT)
H00-00-B	1710	0	7559	EARTHEN	0.0008	4	8	6	70	130
H00-00-A	1051	0	4515	EARTHEN	0.0008	4	8	6	70	130
H13-00-E	5488	0	6149	EARTHEN	0.0008	4	10	10	90	150
H13-00-D	5180	0	6324	EARTHEN	0.0008	4	10	10	90	150
H13-00-C	4613	0	4081	EARTHEN	0.0008	4	10	6	86	150
H13-00-B	4092	0	3043	EARTHEN	0.0008	4	10	6	86	150
H13-03-C	2599	0	3574	EARTHEN	0.0008	4	8	6	70	130
H13-03-B	588	0	1212	EARTHEN	0.0008	4	8	6	70	130
H13-03-A	588	0	4361	EARTHEN	0.0008	4	8	6	70	130
H13-04-C	1839	0	4007	EARTHEN	0.0008	4	8	6	70	130
H13-04-B	1402	1	3953	EARTHEN	0.0008	4	8	6	70	130
H13-04-A	675	1	2702	EARTHEN	0.0008	4	8	6	70	130
H13-04-01-A	231	1	2735	EARTHEN	0.0008	4	8	6	70	130
H13-04-02-A	550	1	5458	EARTHEN	0.0008	4	8	6	70	130
H13-04-03-A	455	1	5562	EARTHEN	0.0008	4	8	6	70	130
H13-05-A	177	1	3445	EARTHEN	0.0008	4	8	6	70	130
H13-06-A	402	1	3886	EARTHEN	0.0008	4	8	6	70	130
H13-07-A	254	1	3395	EARTHEN	0.0008	4	8	6	70	130
H14-00-H	15352	0	3377	EARTHEN	0.0008	4	16	30	158	220
H14-00-G	15178	0	2862	EARTHEN	0.0008	4	16	30	158	220
H14-00-F	14806	0	2688	EARTHEN	0.0008	4	16	30	158	220
H14-00-E	13296	0	3463	EARTHEN	0.0008	4	16	20	148	210
H14-00-D	9352	0	4432	EARTHEN	0.0008	4	14	20	132	200
H14-00-C	9131	0	3378	EARTHEN	0.0008	4	14	20	132	200



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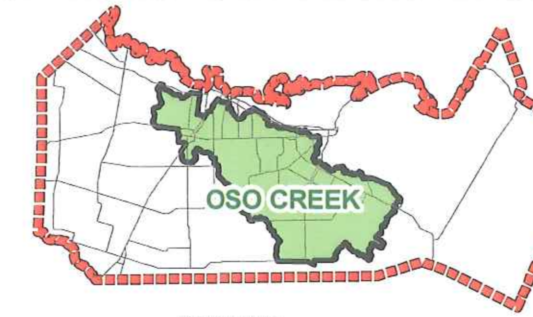

KEY MAP

N
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MAP LEGEND

LEGEND

ROBSTOWN AREA - WATERSHEDS

EXISTING DITCH TYPE

- DITCH-TRIB
- CHANNEL
- CANAL
- ROADSIDE
- UNKNOWN-CANAL?

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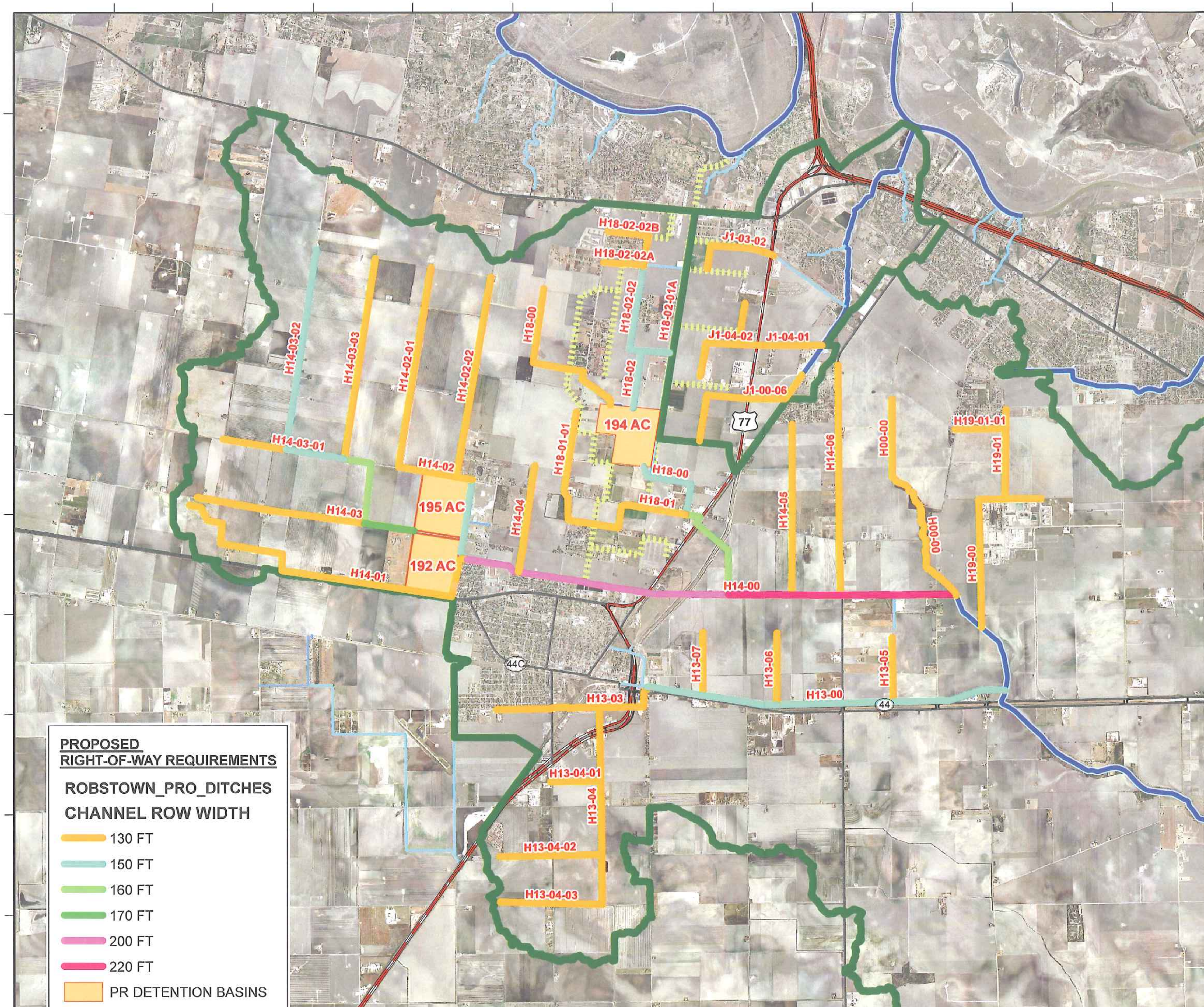
NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-05
UPPER OSO PRIORITY AREA
DRAINAGE IMPROVEMENTS

OCTOBER 2009



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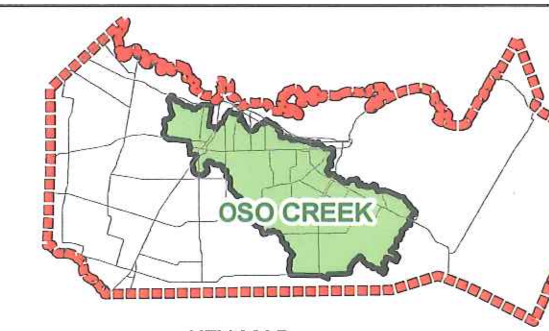


KEY MAP

N W E S

MAP LEGEND

LEGEND

- ROBSTOWN AREA - WATERSHEDS

ROBSTOWN_STREAMS

STREAM/ DITCH TYPES

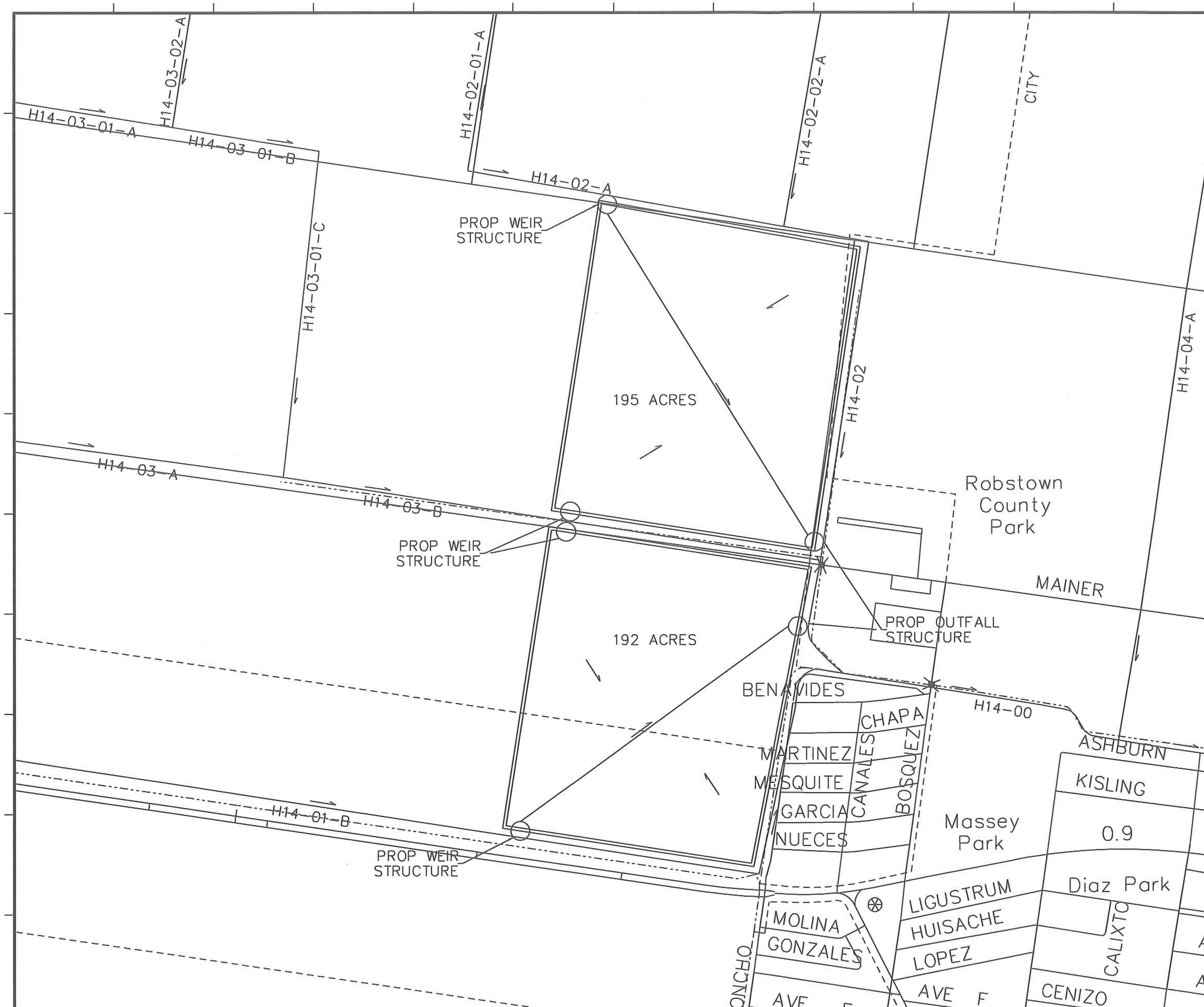
- DITCH-TRIB
- CHANNEL
- CANAL
- ROADSIDE
- UNKNOWN-CANAL

THE STATE OF TEXAS · COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-06
UPPER OSO PRIORITY AREA
PROPOSED RIGHT-OF-WAY

OCTOBER 2009



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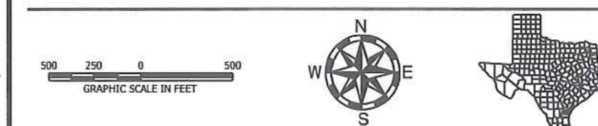
KEY MAP



MAP LEGEND

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-07
PROPOSED DETENTION BASIN FOR H14-02

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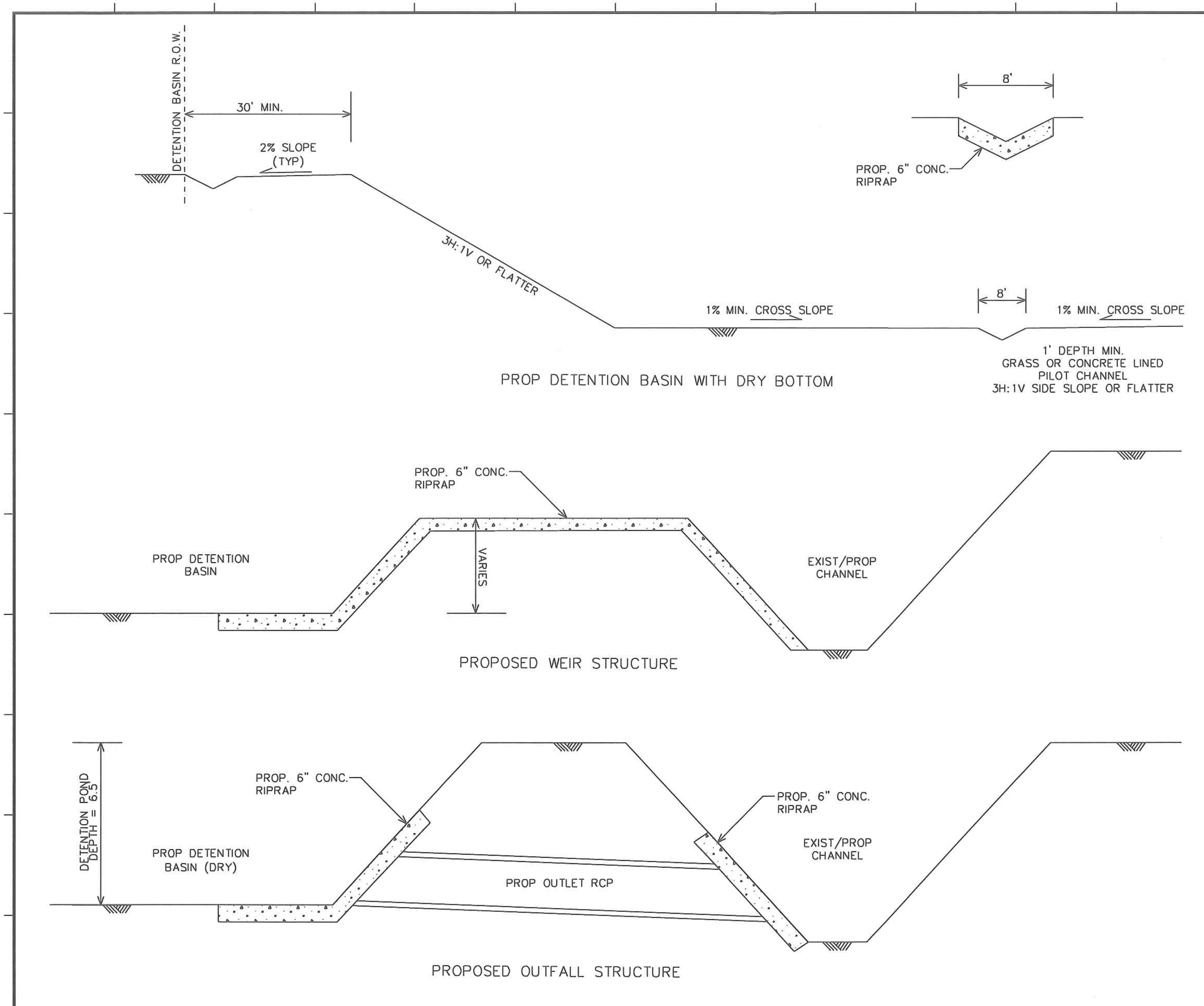

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KEY MAP

SCLAE: N.T.S.

MAP LEGEND

NUECES COUNTY
MASTER DRAINAGE PLAN

EXHIBIT IV-08
DETENTION POND
TYPICAL SECTIONS

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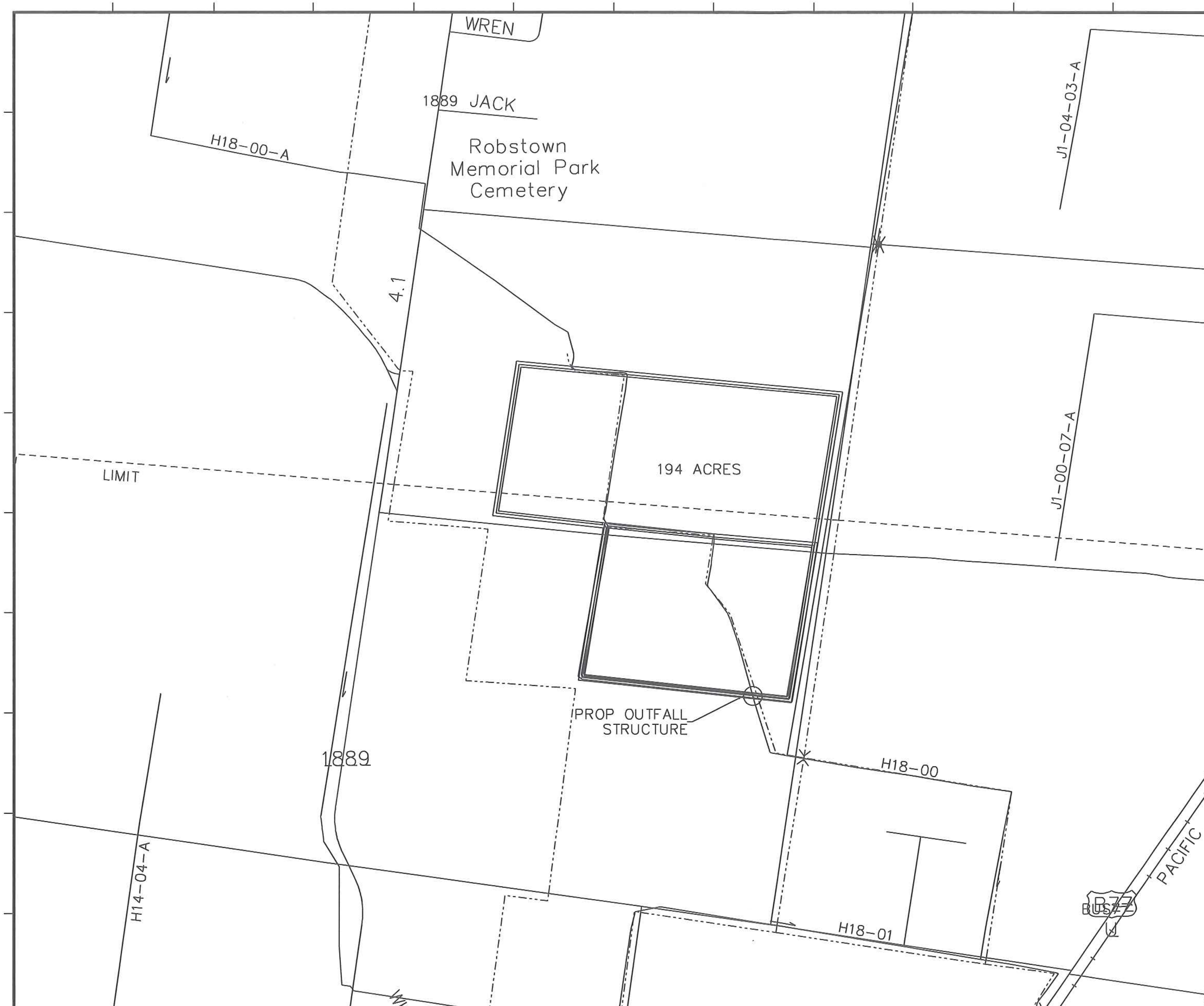

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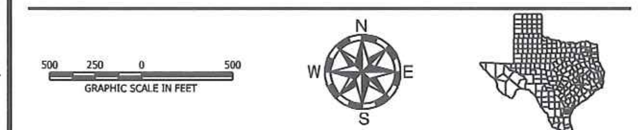
KEY MAP



MAP LEGEND

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IV-09 PROPOSED DETENTION BASIN FOR H18-00

OCTOBER 2009

TABLE IV-B
RECOMMENDED DRAINAGE WAYS - UPPER OSO (Continued)

REACH	CONTRIB AREA (ac)	PROPOSED CHANNEL (1=NEW, 0=EX)	REACH LENGTH (ft)	CHANNEL TYPE	REACH SLOPE (FT)	REACH SS (H:V)	REACH DEPTH (FT)	REACH BW (FT)	REACH TW (FT)	ROW WIDTH (FT)
H14-00-B	8869	0	3668	EARTHEN	0.0008	4	14	20	132	200
H14-00-A	8194	0	2906	EARTHEN	0.0008	4	14	20	132	200
H14-01-B	919	1	10915	EARTHEN	0.0008	4	8	6	70	130
H14-01-A	433	1	8530	EARTHEN	0.0008	4	8	6	70	130
H14-02-C	2866	0	1281	EARTHEN	0.0008	4	10	10	90	150
H14-02-B	2246	0	3216	EARTHEN	0.0008	4	10	6	86	150
H14-02-A	989	1	4074	EARTHEN	0.0008	4	8	6	70	130
H14-02-01-A	989	1	10913	EARTHEN	0.0008	4	8	6	70	130
H14-02-02-A	791	1	10975	EARTHEN	0.0008	4	8	6	70	130
H14-03-B	3541	1	5436	EARTHEN	0.0008	4	11	14	102	170
H14-03-A	421	1	9175	EARTHEN	0.0008	4	8	6	70	130
H14-03-01-C	3797	1	4767	EARTHEN	0.0008	4	11	10	98	160
H14-03-01-B	2384	1	3167	EARTHEN	0.0008	4	10	6	86	150
H14-03-01-A	400	1	3453	EARTHEN	0.0008	4	8	6	70	130
H14-03-02-A	1984	1	10942	EARTHEN	0.0008	4	10	6	86	150
H14-03-03-A	958	1	10949	EARTHEN	0.0008	4	8	6	70	130
H14-04-A	551	1	5807	EARTHEN	0.0008	4	8	6	70	130
H14-05-A	799	1	9223	EARTHEN	0.0008	4	8	6	70	130
H14-06-A	711	1	12425	EARTHEN	0.0008	4	8	6	70	130
H18-00-D	3944	0	5832	EARTHEN	0.0008	4	11	12	100	160
H18-00-C	2618	0	3975	EARTHEN	0.0008	4	10	6	86	150
H18-00-B	1175	0	7670	EARTHEN	0.0008	4	8	6	70	130
H18-00-A	533	1	7424	EARTHEN	0.0008	4	8	6	70	130
H18-01-A	963	0	7504	EARTHEN	0.0008	4	8	6	70	130

TABLE IV-B
RECOMMENDED DRAINAGE WAYS - UPPER OSO (Continued)

REACH	CONTRIB AREA (ac)	PROPOSED CHANNEL (1=NEW, 0=EX)	REACH LENGTH (ft)	CHANNEL TYPE	REACH SLOPE (FT)	REACH SS (H:V)	REACH DEPTH (FT)	REACH BW (FT)	REACH TW (FT)	ROW WIDTH (FT)
H18-01-01-A	574	1	5909	EARTHEN	0.0008	4	8	6	70	130
H18-02	1261	1	2191	EARTHEN	0.0008	4	9	10	82	150
H18-02-02	760	1	11409	EARTHEN	0.0008	4	9	10	82	150
H18-02-01A	320	0	4551	RS DITCH	0.0008	3	4	2	26	30
H18-02-02A	380	1	2201	EARTHEN	0.0008	4	8	6	70	130
H18-02-02B	193	1	3881	EARTHEN	0.0008	4	8	6	70	130
H19-00-B	1525	1	6896	EARTHEN	0.0008	4	8	6	70	130
H19-00-A	1216	1	3385	EARTHEN	0.0008	4	8	6	70	130
H19-01-01-A	240	1	2706	EARTHEN	0.0008	4	8	6	70	130
H19-01-A	850	1	4835	EARTHEN	0.0008	4	8	6	70	130
J1-00-06-A	554	0	2175	EARTHEN	0.0008	4	8	6	70	130
J1-00-07-A	438	1	4574	EARTHEN	0.0008	4	8	6	70	130
J1-03-02-A	319	1	4785	EARTHEN	0.0008	4	8	6	70	130
J1-04-01-A	894	0	3747	EARTHEN	0.0008	4	8	6	70	130
J1-04-02-A	634	1	2587	EARTHEN	0.0008	4	8	6	70	130
J1-04-03-A	140	1	1830	EARTHEN	0.0008	4	8	6	70	130
J1-04-04-A	88	1	2256	EARTHEN	0.0008	4	8	6	70	130

In addition, the models identified several structures which need to be upgraded, Table IV-C outlines the structural improvements required on Bridges or Culvert Crossings.

TABLE IV-C
RECOMMENDED IMPROVEMENTS AT EXISTING DRAINAGE STRUCTURES - UPPER OSO

STREAM	STATION	CROSSING LOCATION	EXISTING STRUCTURE	PROPOSED STRUCTURE	PR. LENGTH
OSO CREEK					
H00-00	134720	CR 44	EX 3- 20'X6.5' RCB	--	30
H00-00	132653	FM 24/ VIOLET ROAD	EX 5- 10'X5' RCB	--	40
H00-00	124225	RAILROAD	RAIL TRESTLE BRIDGE	REPLACE RAILROAD BRIDGE	40
H00-00	124225	AGNES ST/ SH 44 WESTBOUND	3-SPAN CONCRETE BRIDGE	--	60
H00-00	123658	AGNES ST/ SH 44 EASTBOUND	3-SPAN CONCRETE BRIDGE	--	60
H14-00 DITCH					
H14-00	1125	FM 24/ VIOLET ROAD	SINGLE SPAN BRIDGE	NEW BRIDGE - 150 FT	50
H14-00	6187	FM 1694	SINGLE SPAN BRIDGE	NEW BRIDGE - 130 FT	90
H14-00	14737	US 77	4-12' X 8' RCB	--	540
H14-00	16791	BS 77	5- 9'X6' RCB	NEW BRIDGE - 370 SF	90
H14-00	18824	BAUER RD	SINGLE SPAN BRIDGE - 55FT	--	30
H14-00	21599	FM 1889	3- 10'X10' RCB	NEW BRIDGE - 120 FT	80
H14-00	25820	BOSQUEZ	4- 10'X10' RCB	NEW BRIDGE - 100FT	40
H18-00 DITCH					
H18-00	2985	US 77	3- 9' X 6' RCB	--	350
H18-00	4611	BS 77	7- 4'X4' RCB; 2- 3' RCP	NEW BRIDGE - 80FT	100
H18-00		CR 44	8' X 8' RCB	NEW BRIDGE - 80FT	30
H18-00	9761	CR 69	3-SPAN WOODEN BRIDGE	NEW BRIDGE - 75FT	30
H18-00		CR 46	2-SPAN WOODEN BRIDGE	NEW BRIDGE - 75FT	30
H18-02	3000		--	NEW CULVERT: 3- 8'X6' RCB	30
H18-02	6700		--	NEW CULVERT: 2- 8'X6' RCB	30
H18-02	9900		IRRIGATION CANAL SIPHON	NEW SIPHON - 30FT	50
H-13 DITCH					
H13-00	3788.3	VIOLET ROAD	CONCRETE BRIDGE	--	50
H13-00	8883.8	FM 1694	CONC. BRIDGE W/ CONC VERT. WALL CHANNEL	--	50
H13-00	19000	PRIVATE	WOODEN BRIDGE	REMOVE/REPLACE BRIDGE	20
H13-02	772.5	E MAIN AVE / CR 40	2 BOX CULVERTS	NEW BRIDGE - 70FT	80
H13-02	2239.4	US 77	2 BOX CULVERTS	--	340

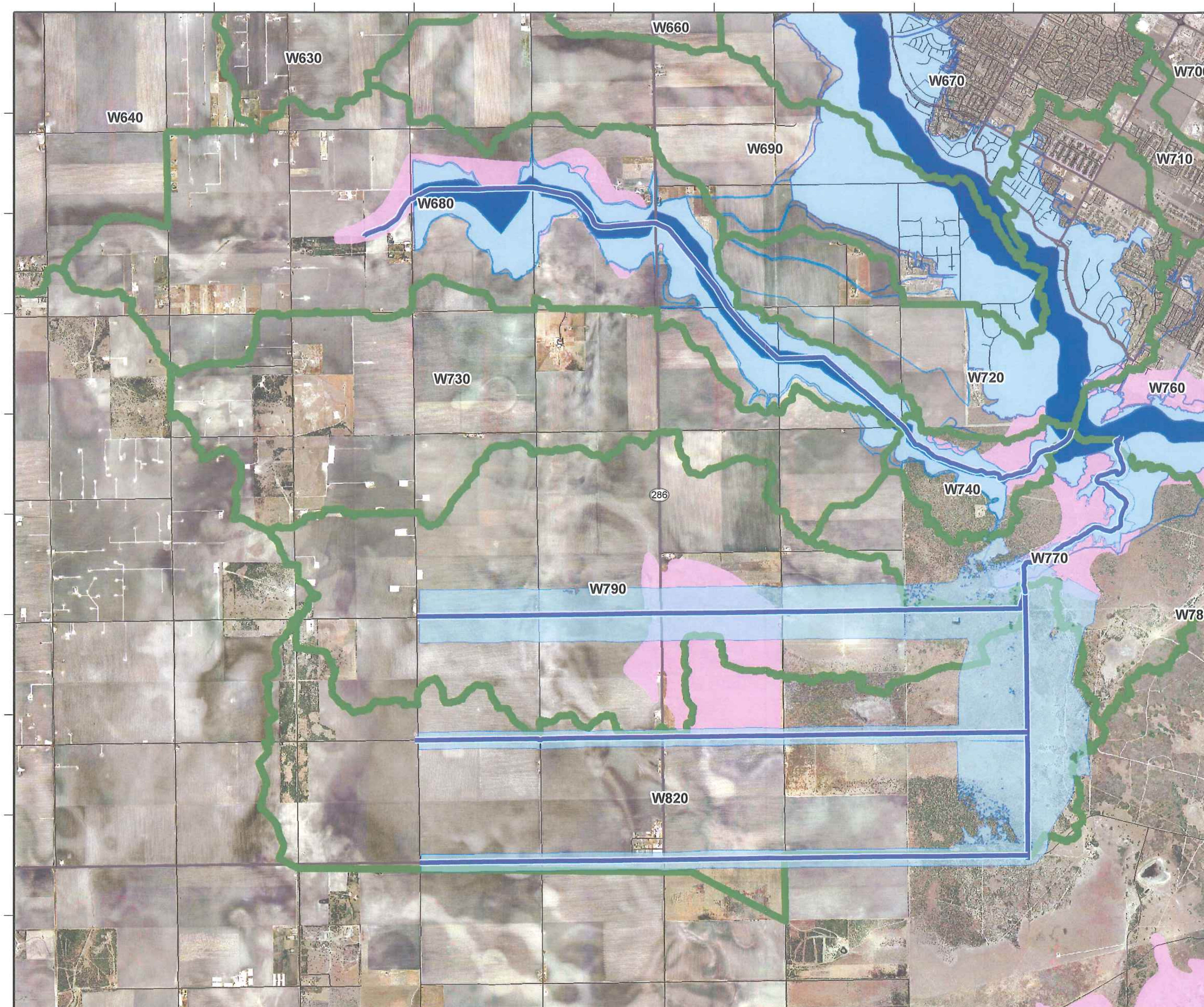
PART V
CHAPMAN RANCH SYSTEM

A. GENERAL

The Chapman Ranch Area is anticipated to be a fast growing area during the next few decades. The primary area is bound by FM 2444 on the North, King Ranch on the East, County Road 8 on the South and County Road 49 on the West. The majority of the area is primarily open farmland with some ranch area on the eastern boundary. The existing drainage system within this area consists primarily of open ditches, culverts and bridges. The ditches primarily run from West to East along County Roads and then discharge into a small tributary onto Oso Creek. Exhibit V-01 delineates the basic existing drainage infrastructure in the area. Maintenance on the existing system is completed primarily by the adjacent land owners, farmers, and ranchers. Very little maintenance is completed by Nueces County on the drainage system.

B. MODELING

Computer models were developed for the Chapman Ranch watershed for the existing conditions. The area was divided into sub-basins and stream sections, and the required parameters of drainage area and slopes were computed. Table V-A summarizes the flows at key locations along stream sections in the Area.



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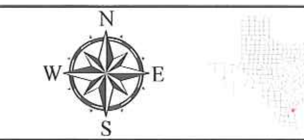
KEY MAP



MAP LEGEND

LEGEND

- OSO CREEK SUBAREAS
- CHAPMAN RANCH AREA STREAMS

LEGEND

FEMA EFFECTIVE

- 100-YEAR FLOODPLAIN

PRELIM. MAP MOD DATA

- FLOODWAY
- 100-YEAR FLOODPLAIN

NUECES CO MDP FLOODPLAIN

- EXISTING HEC-RAS 100-YEAR

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT V-01 CHAPMAN PRIORITY AREA DRAINAGE NETWORK

OCTOBER 2009

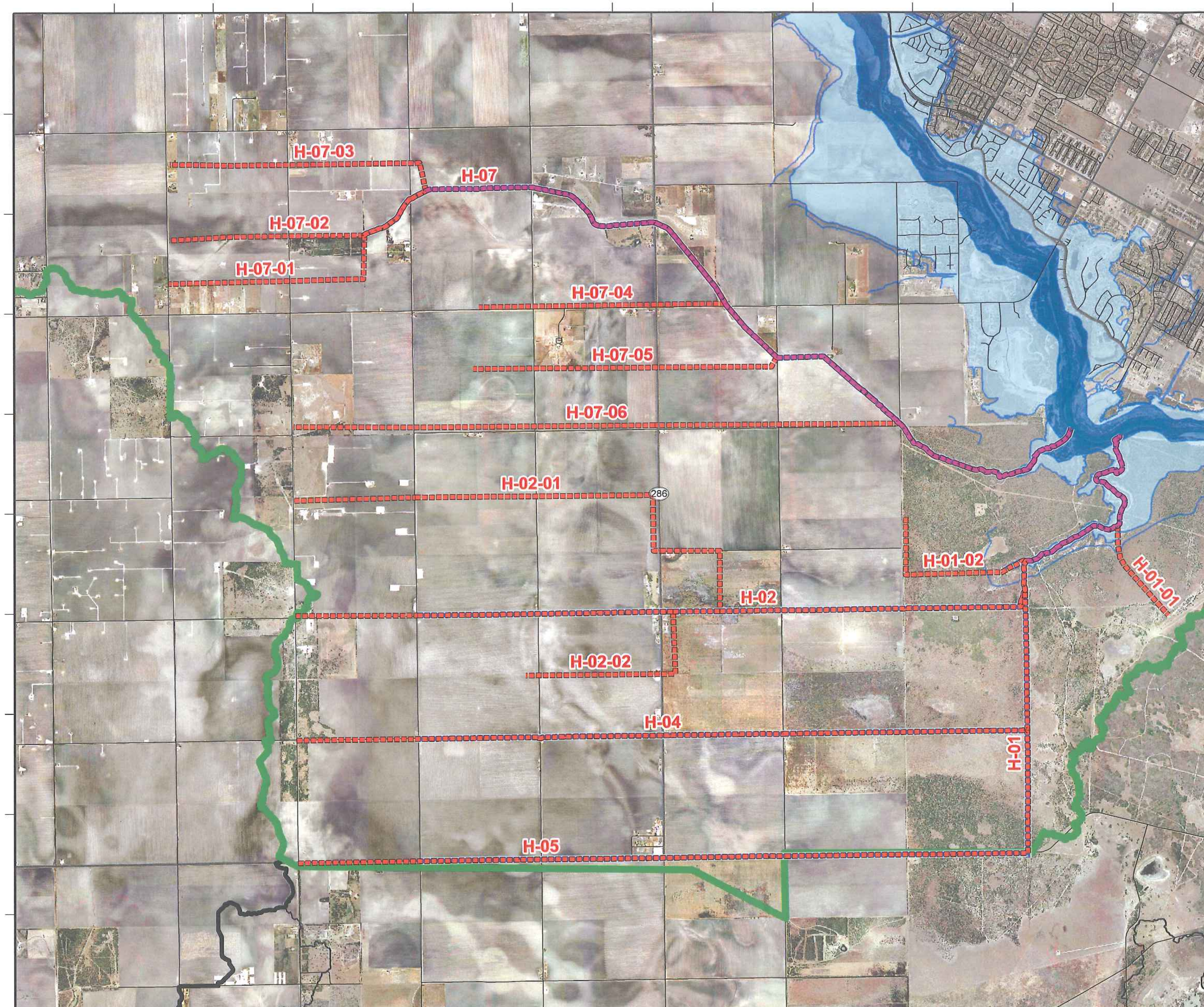
Table V-A Peak Discharges
Existing Stream Sections
Chapman Ranch Area

STREAM ID	REACH	HEC-RAS STATION	LOCATION DESCRIPTION	CONTRIB AREA (ac)	2-YEAR (cfs)	5-YEAR (cfs)	10-YEAR (cfs)	25-YEAR (cfs)	50-YEAR (cfs)	100-YEAR (cfs)
H01-00	H-01-E	6158	H01-01 TO CONFLUENCE WITH OSO CREEK	15120	709	1654	2363	3071	3780	4725
H01-00	H-01-D	10697	H01-02 TO H01-01	13756	645	1505	2149	2794	3439	4299
H01-00	H-01-C	12124	H02-00 TO H01-02	12845	602	1405	2007	2609	3211	4014
H01-00	H-01-B	18123	H04-00 TO H02-00	6547	307	716	1023	1330	1637	2046
H01-00	H-01-A	23430	H05-00 TO H04-00	2536	119	277	396	515	634	793
H01-01	H-01-01-A			743	35	81	116	151	186	232
H01-01	H-01-02-A			615	29	67	96	125	154	192
H02-00	H-02-E	11135	CR43 TO CONFLUENCE WITH H01-00	6298	295	689	984	1279	1575	1968
H02-00	H-02-D	13841	H02-01 TO CR43	5349	251	585	836	1087	1337	1672
H02-00	H-02-C	15896	SH286 TO H02-01	2829	133	309	442	575	707	884
H02-00	H-02-B	26978	CR49A TO SH286	1319	62	144	206	268	330	412
H02-00	H-02-A	32258	CR51 TO CR49A	555	26	61	87	113	139	173
H02-01	H-02-01-C		SH286 TO CONFLUENCE WITH H02-00	2188	103	239	342	444	547	684
H02-01	H-02-01-B		CR49A TO SH286	1540	72	168	241	313	385	481
H02-01	H-02-01-A		CR51 TO CR49A	536	25	59	84	109	134	168
H02-02	H-02-02-A		CR47 TO CONFLUENCE WITH H02-00	1510	71	165	236	307	378	472
H04-00	H-04-C		CR43 to CONFLUENCE with H01-00	3550	166	388	555	721	888	1109
H04-00	H-04-B		CR47 to CR 43 - CROSSES SH286	2171	102	237	339	441	543	678
H04-00	H-04-A		CRR49A to CR 47	1033	48	113	161	210	258	323

Table V-A Peak Discharges										
Existing Stream Sections										
Chapman Ranch Area										
H05-00	H-05-D	10548	CR43 to CONFLUENCE with H01-00	2255	106	247	352	458	564	705
H05-00	H-05-C	21129	CR47 to CR 43 - CROSSES SH286	1816	85	199	284	369	454	568
H05-00	H-05-B	28355	CRR49A to CR 47	1050	49	115	164	213	263	328
H05-00	H-05-A	31707	CR51 to CR 49A	319	15	35	50	65	80	100
H07-00	H-07-F	9374	CR41/ CR18 (H07-06) TO OSO CREEK	9721	456	1063	1519	1975	2430	3038
H07-00	H-07-E	15833	CR43 (H07-05) TO CR41	6326	297	692	988	1285	1582	1977
H07-00	H-07-D	19071	FM2444 (H07-04) TO CR43 (H07-05)	5728	269	627	895	1164	1432	1790
H07-00	H-07-C	26807	2650' E. OF CR47 TO FM2444 (H07-04)	4650	218	509	727	945	1163	1453
H07-00	H-07-B	34437	H07-03 (D/S OF CR49A) TO 2650' E. OF CR47	3888	182	425	608	790	972	1215
H07-00	H-07-A	37855	H07-01/ H07-02 TO H07-03 (D/S OF CR49A)	1917	90	210	300	389	479	599
H07-01	H-07-01-A		CR53 TO H07-00	715	34	78	112	145	179	223
H07-02	H-07-02-A		CR53 TO H07-00	1202	56	131	188	244	301	376
H07-03	H-07-03-A		CR53 TO H07-00	864	41	95	135	176	216	270
H07-04	H-07-04-A		CR47 TO H07-00	299	14	33	47	61	75	93
H07-05	H-07-05-A		U/S CR47 TO H07-00	779	37	85	122	158	195	243
H07-06	H-07-06-C		CR51 TO CR49A	2816	132	308	440	572	704	880
H07-06	H-07-06-B		CR49A TO SH286	1932	91	211	302	392	483	604
H07-06	H-07-06-A		SH286 TO H07-00	1204	56	132	188	245	301	376

C. MASTER PLAN

The master plan was developed and proved that the existing system was not capable of meeting the drainage criteria requirements, therefore a new network was developed and analyzed. The resulting master plan for the Chapman Ranch area is depicted on Exhibit - V-02. In addition, Exhibit V-03 summarizes the recommended right-of-way widths to support the proposed drainage ways. Table V-B summarizes the channel improvements recommended for the Area.



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OSO CREEK

KEY MAP

N W E S

LEGEND

- CHAPMAN RANCH AREA STREAMS
- OSO CREEK WATERSHED

CHANNEL IMPROVEMENTS

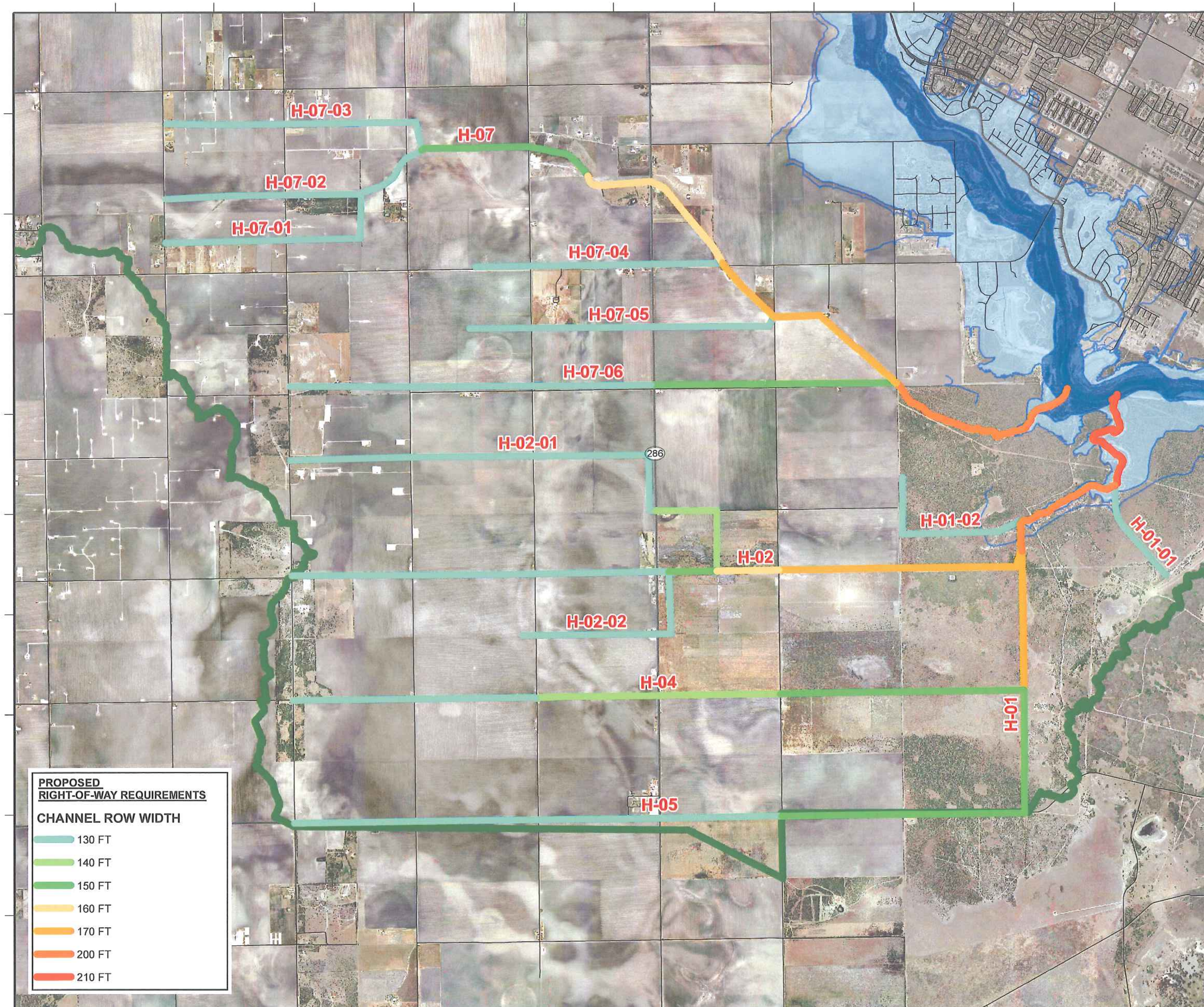
- DITCH WIDENING
- NEW DITCH CONSTRUCTION

THE STATE OF TEXAS COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT V-02 CHAPMAN PRIORITY AREA DRAINAGE IMPROVEMENTS

OCTOBER 2009



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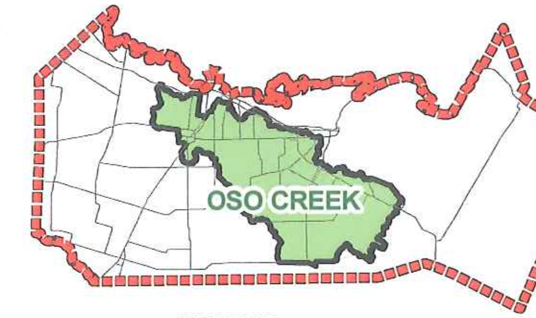


KEY MAP

N
W E
S

LEGEND

OSO CREEK WATERSHED

THE STATE OF TEXAS · COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT V-03
CHAPMAN PRIORITY AREA
PROPOSED RIGHT-OF-WAY

OCTOBER 2009

TABLE IV-B

RECOMMENDED DRAINAGE WAYS - CHAPMAN RANCH

REACH	CONTRIB AREA (ac)	DESIGN Q100Y (cfs)	PROPOSED CHANNEL (1=NEW, 0=EX)	REACH LENGTH (ft)	CHANNEL TYPE	REACH SLOPE (FT)	REACH SS (H:V)	REACH DEPTH (FT)	REACH BW (FT)	REACH TW (FT)	ROW WIDTH (FT)
H-01-E	15120	4725	0	6158	EARTHEN	0.0008	4	16	20	148	210
H-01-D	13756	4299	0	4539	EARTHEN	0.0008	4	15	20	140	200
H-01-C	12845	4014	1	1427	EARTHEN	0.0008	4	15	20	140	200
H-01-B	6547	2046	1	5999	EARTHEN	0.0008	4	12	10	106	170
H-01-A	2536	792	1	5307	EARTHEN	0.0008	4	10	6	86	150
H-01-01-A	743	232	1	4640	EARTHEN	0.0008	4	8	6	70	130
H-01-02-A	615	192	1	7834	EARTHEN	0.0008	4	8	6	70	130
H-02-E	6298	1968	1	11135	EARTHEN	0.0008	4	12	10	106	170
H-02-D	5349	1672	1	2706	EARTHEN	0.0008	4	11	10	98	160
H-02-C	2829	884	1	2055	EARTHEN	0.0008	4	10	6	86	150
H-02-B	1319	412	1	11082	EARTHEN	0.0008	4	8	6	70	130
H-02-A	555	173	1	5280	EARTHEN	0.0008	4	8	6	70	130
H-02-01-C	2188	684	1	5250	EARTHEN	0.0008	4	8	10	74	140
H-02-01-B	1540	481	1	12993	EARTHEN	0.0008	4	8	6	70	130
H-02-01-A	536	168	1	5237	EARTHEN	0.0008	4	8	6	70	130
H-02-02-A	1510	472	1	9103	EARTHEN	0.0008	4	8	6	70	130
H-04-C	3550	1109	1	10599	EARTHEN	0.0008	4	10	10	90	150
H-04-B	2171	678	1	10650	EARTHEN	0.0008	4	8	10	74	140
H-04-A	1033	323	1	10518	EARTHEN	0.0008	4	8	6	70	130

TABLE IV-B

RECOMMENDED DRAINAGE WAYS - CHAPMAN RANCH

H-05-D	2255	705	1	10548	EARTHEN	0.0008	4	10	6	86	150
H-05-C	1816	568	1	10581	EARTHEN	0.0008	4	8	6	70	130
H-05-B	1050	328	1	7226	EARTHEN	0.0008	4	8	6	70	130
H-05-A	319	100	1	3352	EARTHEN	0.0008	4	8	6	70	130
H-07-F	9721	3038	0	9374	EARTHEN	0.0008	4	14	20	132	200
H-07-E	6326	1977	0	6459	EARTHEN	0.0008	4	12	10	106	170
H-07-D	5728	1790	0	3238	EARTHEN	0.0008	4	12	10	106	170
H-07-C	4650	1453	0	7736	EARTHEN	0.0008	4	11	10	98	160
H-07-B	3888	1215	0	7630	EARTHEN	0.0008	4	10	10	90	150
H-07-A	1917	599	1	3418	EARTHEN	0.0008	4	8	6	70	130
H-07-01-A	715	223	1	10342	EARTHEN	0.0008	4	8	6	70	130
H-07-02-A	1202	376	1	8449	EARTHEN	0.0008	4	8	6	70	130
H-07-03-A	864	270	1	12083	EARTHEN	0.0008	4	8	6	70	130
H-07-04-A	299	93	1	10687	EARTHEN	0.0008	4	8	6	70	130
H-07-05-A	779	243	1	13416	EARTHEN	0.0008	4	8	6	70	130
H-07-06-C	2816	880	1	10648	EARTHEN	0.0008	4	10	6	86	150
H-07-06-B	1932	604	1	10507	EARTHEN	0.0008	4	8	6	70	130
H-07-06-A	1204	376	1	5177	EARTHEN	0.0008	4	8	6	70	130

It is anticipated that new roadway structures will be required at every roadway which is intersected with drainage ways. At the time they are built, each new structure should be sized to accommodate the anticipated flow along the drainage way.

PART VI
PETRONILA CREEK SYSTEM

A. GENERAL

The Petronila Creek Watershed system is the largest watershed system in Nueces County. The Petronila Creek System originates in Jim Wells County and Discharges into Kleberg County. The 543 square miles that contribute to Petronila Creek System are primarily rural.

B. PETRONILA CREEK SYSTEM MODELING

A complete Hydrologic Model of the Petronila Creek Watershed System was completed using the methodology established in Appendix H-1. The watershed system contributing to Petronila Creek was divided into sub-basins and the required parameters such as area, drainage slope, curve number and lag times were computed. Locations of interest such as large bridge crossings also served as locations were basins were subdivided. Table VI-A summarizes peak discharges at key locations along stream sections along the Stream

Table VI-A
Existing Stream Flows

Reach	Location	XS ID	Contributing Area (Acres)	Type *	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
B-00	US Extent of Model	194151.3	169,178.2	2	4,856	8,135	10,685	14,452	17,725	21,398
B-00	48000 ft US of US 77	178703.92	173,862.8	2	5,034	8,444	11,095	15,016	18,423	22,245
B-00	34000 ft US of US 77	164596.72	185,905.4	2	5,034	8,444	11,095	15,016	18,423	22,245
B-00	14000 ft US of US 77	144845.45	231,439.9	2	5,417	9,084	11,933	16,146	19,805	23,911
B-00	20000 ft DS of US 77	110856.1	245,046.8	2	6,286	10,505	13,780	18,609	22,803	27,509
B-00	26000 ft DS of SR 665	76794.74	259,132.2	2	6,842	11,433	14,994	20,246	24,808	29,926
B-00	26000 ft DS of FM 892	41239.08	277,987.7	2	7,439	12,494	16,417	22,213	27,255	32,908
B-00	14000 ft DS of FM 70	13403.28	320,273.3	2	7,838	13,174	17,317	23,433	28,754	34,773
B-00	DS Extent of Model	293.8	333,372.2	2	8,183	13,810	18,190	24,673	30,321	36,675

* 1-Grass Swale 2-Creek 3-Concrete Swale

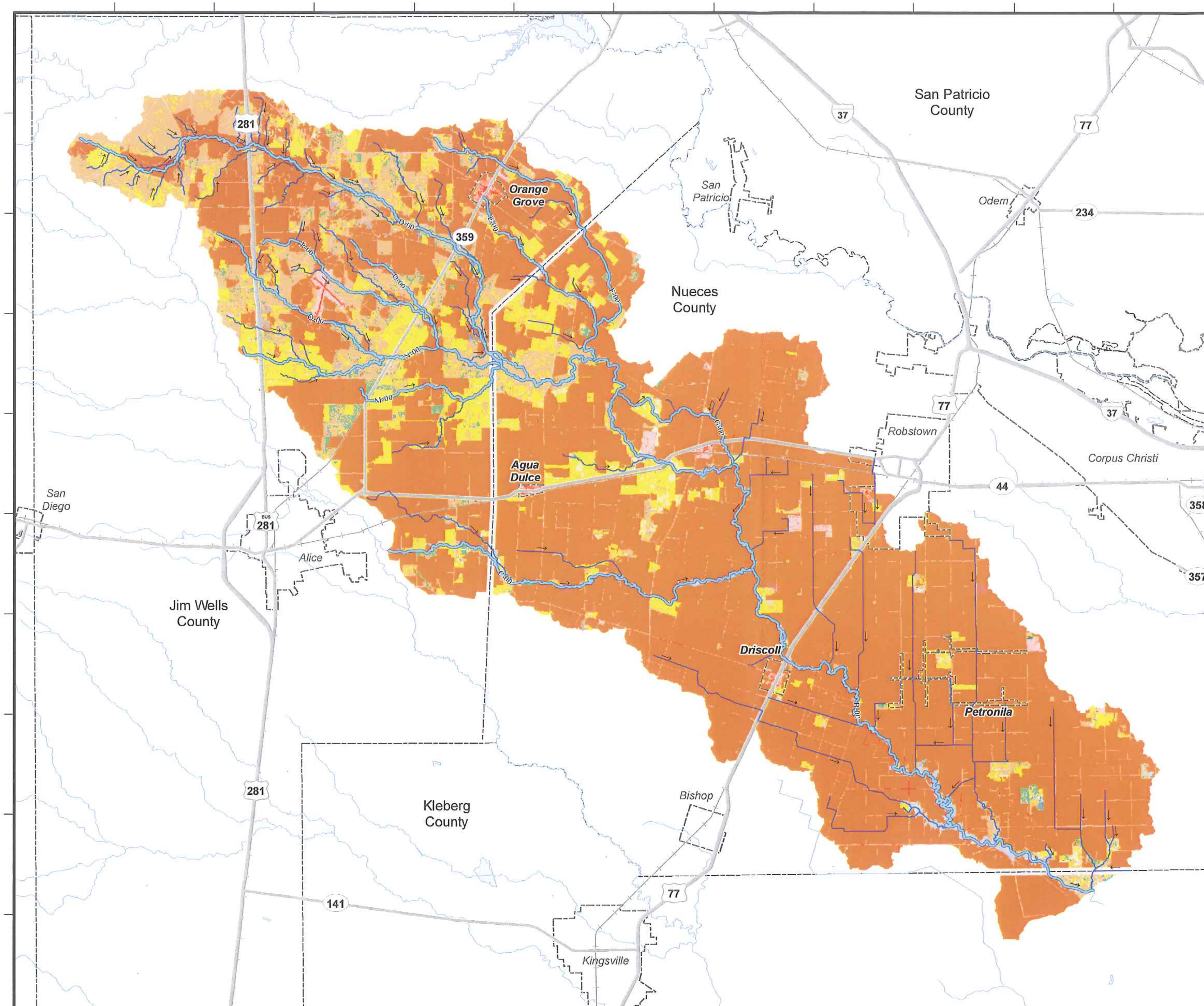
The flows are in cubic feet per second (cfs)

A complete hydraulic model was also created for the main stem of Petronila Creek. The inputs to the hydraulic model were created as part of the hydrology analysis. The upstream model limit is just south of S.H. 44 where Banquete Creek converges with Aqua Dulce Creek. The downstream limit of the hydraulic model is the Nueces County boundary. The model was completed using the HEC-RAS simulation software. Some of the land use data and soil group data are depicted on exhibits VI-01 and VI-02. The existing drainage system is depicted on Exhibit VI-03. Several stream sections which indicate wide floodplains that impact large areas were identified as part of this analysis. Table VI-B summarizes the notable cross sections and their capacities. A "Yes" designates that the location can handle the year storm event. A "No" designates that it cannot handle that particular storm event.

Table VI-B
System Capacities

Reach	Location	XS ID	Overtops					
			2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
B-00	US Extent of Model	194151.3	Yes	Yes	Yes	Yes	Yes	Yes
B-00	48000 ft us of US77	178703.92	Yes	Yes	Yes	Yes	Yes	Yes
B-00	34000 ft us of US77	164596.72	Yes	Yes	Yes	Yes	Yes	Yes
B-00	14000 ft us of US77	144845.45	Yes	Yes	Yes	Yes	Yes	Yes
B-00	20000 ft ds of US77	110856.1	No	No	Yes	Yes	Yes	Yes
B-00	26000 ft ds of SR665	76794.74	No	No	No	Yes	Yes	Yes
B-00	26000 ft ds of FM892	41239.08	No	No	No	No	No	No
B-00	14000 ft ds of FM70	13403.28	No	No	No	No	No	No
B-00	DS Extent of Model	293.8	No	No	No	No	Yes	Yes

In addition, the analysis identified possible deficiencies in major drainage structures located on the main stem of Petronila Creek. Table VI-C summarizes these structures.



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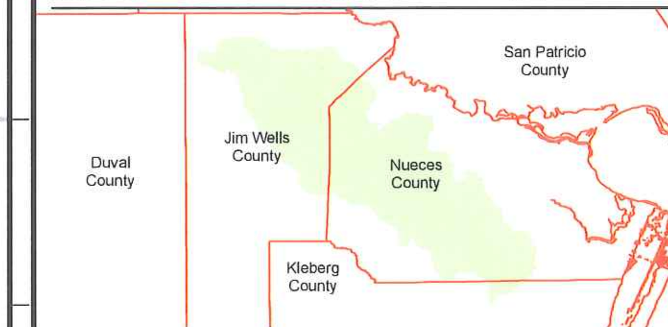


KEY MAP

0 2 4 Miles

MAP LEGEND

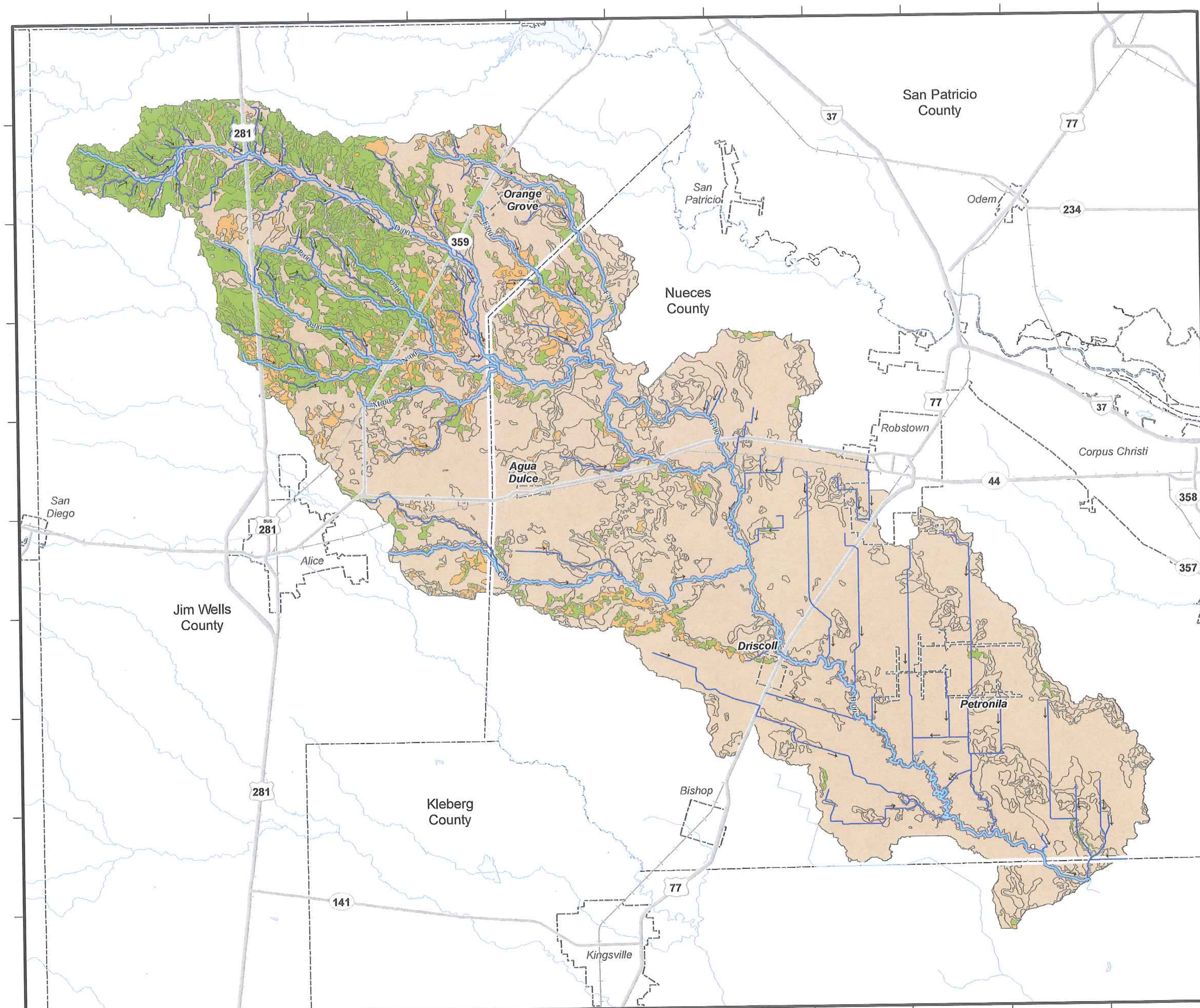
Land Use
- Open Water
- Developed - Open Space
- Developed - Low Intensity
- Developed - Medium Intensity
- Developed - High Intensity
- Barren Land - Rock/Clay/Sand
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Scrub/Shrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

- Major Road
- Railroad
- Streamline
- Water Body
- Municipal Boundary
- County Boundary
- Stream Network - Major
- Stream Network - Minor
- Flow Direction

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VI-01
Land Use Map

DECEMBER 2009



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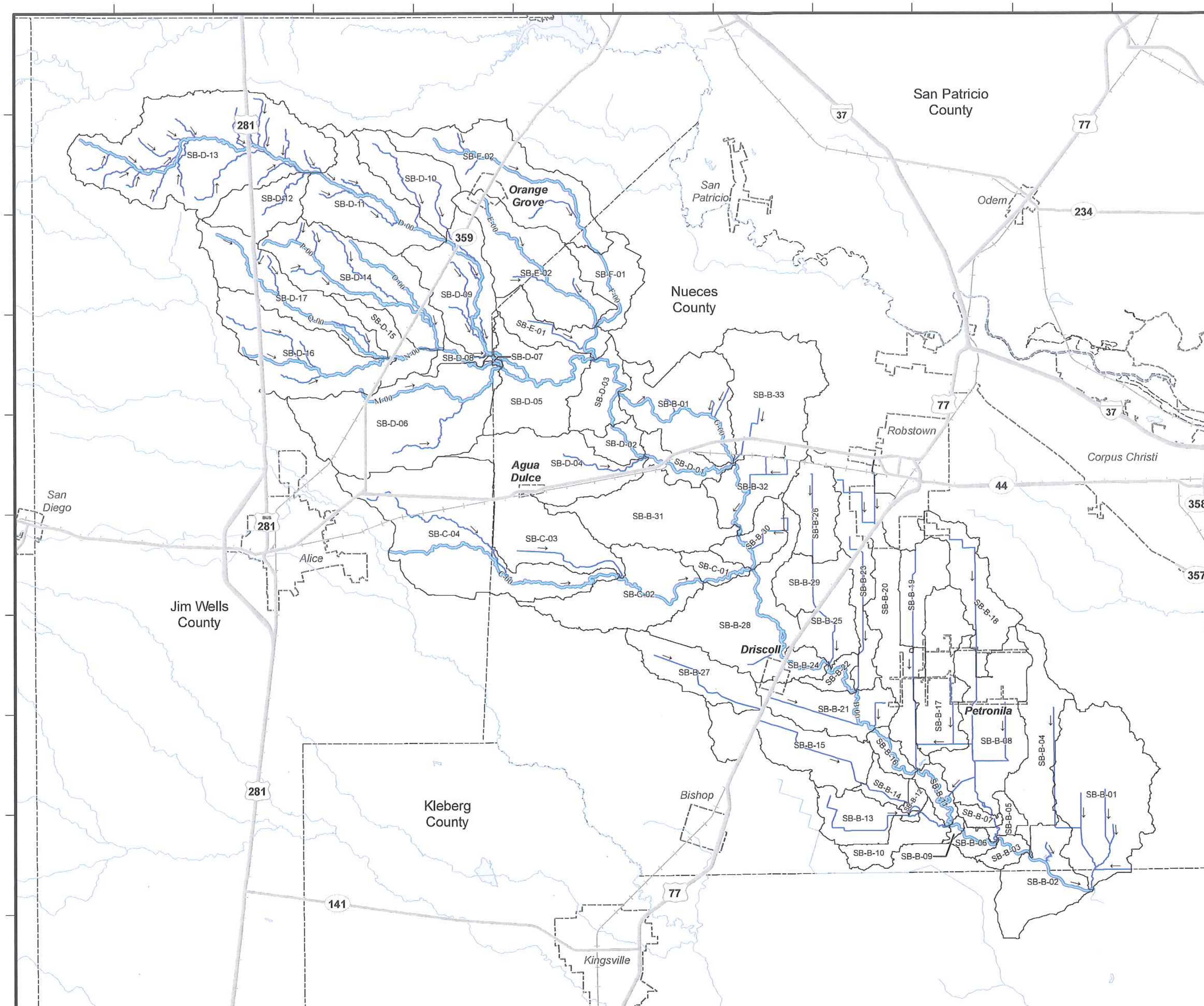
NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VI-02
Hydrologic Soil Groups Map

DECEMBER 2009



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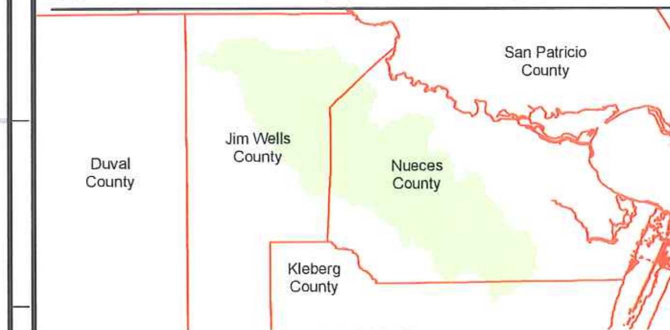


KEY MAP

0 2 4 Miles

N W E S

MAP LEGEND

- Stream Network - Major
- Stream Network - Minor
- Flow Direction
- Watershed
- Major Road
- Railroad
- Streamline
- Water Body
- Municipal Boundary
- County Boundary

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VI-03
Existing Drainage Systems

DECEMBER 2009

Table VI-C

DEFICIENT STRUCTURES

Station	Bridge	TOR ft	WS 2-Year ft	OT	WS 5-Year ft	OT	WS 10-Year ft	OT	WS 25-Year ft	OT	WS 50-Year ft	OT	WS 100-Year ft	OT	Last Modified	Capacity 100 Yr	Model Flows 2 Yr (cfs)	Model Flows 5 Yr (cfs)	Model Flows 10 Yr (cfs)	Model Flows 25 Yr (cfs)	Model Flows 50 Yr (cfs)	Model Flows 100 Yr (cfs)	Notes
130698.6BR U	US 77	62.06	54.97		56.23		56.92		57.72		58.29		58.88		1987		6268.7	10472	13733.1	18540.8	22713.8	27397	Complete removal of the bridge and embankment results in a drop of 0.8 ft in WSE at the two upstream cross sections
103080.9BR U	SR 665	52.51	46.56		48.58		49.96		49.96		52.73	YES	52.89	YES	1981		6449.1	10794.2	14169.9	19154.2	23488.6	28352.8	FM 665 is a main road that runs east through US 77 until it becomes FM 43. Complete removal of the bridge and embankment results in a drop of 1.9 ft in WSE at the upstream cross section and a drop of around 1.8 to 0.5 feet for about 1.5 miles upstream
85121.83BR U	CR 18	41.02	41.24	YES	43.74	YES	44.89	YES	46.28	YES	46.93	YES	47.38	YES	2006	24,555	6841.7	11432.6	14994.4	20246.2	24807.7	29925.8	CR 18 runs east through US 77 and ends at FM 665. It runs past a small housing development east of US 77 that is in the 100 yr floodplain. There are no foreseeable benefits that will result from improvements to bridge other than it may not be overtopped. Complete removal of the bridge from the model results in a 0.08 ft drop in WSE upstream.
67285.53BR U	FM 892	44.01	30.64		33.36		35.02		36.96		38.16		39.47		1955	20,015	6874.1	11499.4	15087.1	20378	24975.1	30132.4	Complete removal of the bridge and embankment results in a drop of 0.6 ft in WSE at the upstream cross section and a drop of around 0.3 to 0.1 feet for about 1.5 miles upstream
27109.63BR U	FM 70	33.63	20.82		24.22		26.32		27.43		28.85		28.95		1998	921.6	7865	13206.4	17352.2	23471.1	28793.8	34773.1	FM 70 is a main road that runs east through US 77 and eventually ends in FM 43. It does not appear that it is causing any problems and that there would be any benefit to removing it. Complete removal of the bridge and embankment from the model results in a 0.04 ft drop in WSE upstream.

It is anticipated that new roadway structures will be required at every roadway which is intersected with drainage ways. At the time they are built, each new structure should be sized to accommodate the anticipated flow along the drainage way.

PART VII
DRISCOLL COMMUNITY

A. GENERAL

The town of Driscoll is located southwest of the Hwy 77 and the Petronila Creek crossing. The town is located upstream of Hwy 77 in an area that is comprised primarily of farmland with rural subdivisions. The community is affected by both the backwater from Petronila Creek and discharge from adjacent watersheds which try and enter the Petronila Creek through an undersized drainage system. This drainage system travels through the town of Driscoll and causes severe flooding during large storm events. The existing drainage system within the Driscoll Community consists of roadside ditches, culverts and earthen channels.

Driscoll Community Modeling Efforts

The system drains water through adjacent watersheds and conveys the water through a series of undersized culverts and channels. The hydraulic analysis was completed using the rational method. This method was used to calculated flows for watersheds less than 500 acres. Exhibit VII-01 shows the areas where flows were calculated for the analysis, and Table VII-A summarizes the flows at these locations.

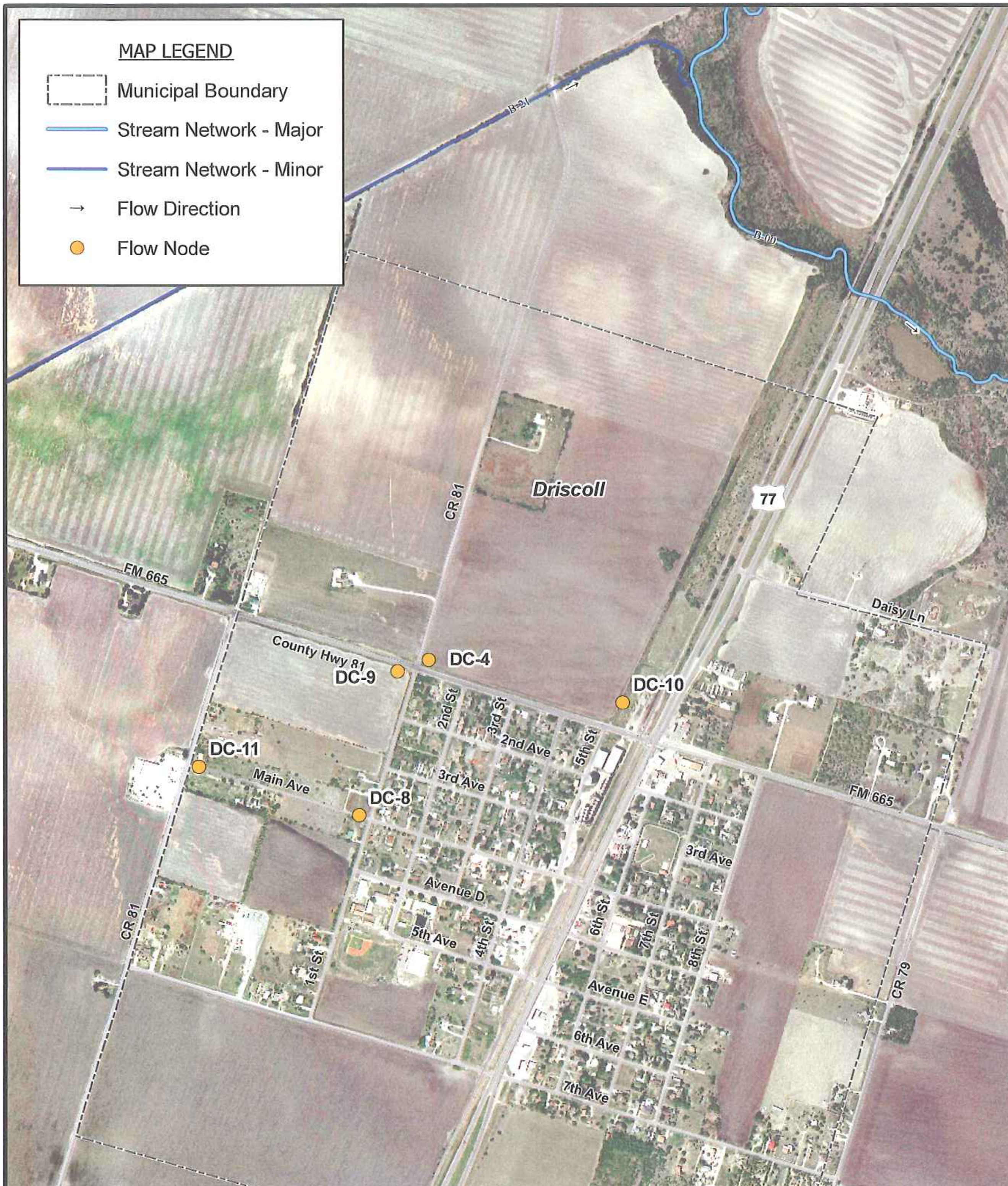
Table VII-A Peak Discharges Summary of Flows at Key Locations							
Flow Node ID	Contributing Area (Acres)	Type*	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
DC-11	192.92	1	14.59	17.66	20.71	24.32	26.75
DC-9	471.77	1	139.98	164.95	192.96	223.31	242.80
DC-8	25.96	1	26.33	30.13	35.15	40.00	42.88
DC-4	61.36	1	57.06	65.46	76.38	87.05	93.45
DC-10	557.91	2	206.95	242.32	283.29	326.66	354.15

* 1-Grass Swale 2-Creek 3-Concrete Swale

During the analysis through a series of site investigations and review of historical data, it was determined that an analysis of each existing culvert and channel would not be required. The goal of this analysis is to develop a storm drainage system that would provide different levels of protection for the town of Driscoll.

Driscoll Community Master Plan

A master plan was developed and proved that the existing system was not capable of meeting the drainage criteria requirements, therefore a new network was developed and analyzed. Multiple storm event protection levels were analyzed to provide the community a variety of flood protection options. Layouts for the 10 yr, 25 yr, 50 yr, and 100 yr protection levels are shown in Exhibits VII-02, VII-0-3, VII-04 and VII-05. Table VII-B summarizes the channel improvements recommended for the Area. In addition, Table VII-C outlines the structural improvements required on Bridges or Culvert Crossings.



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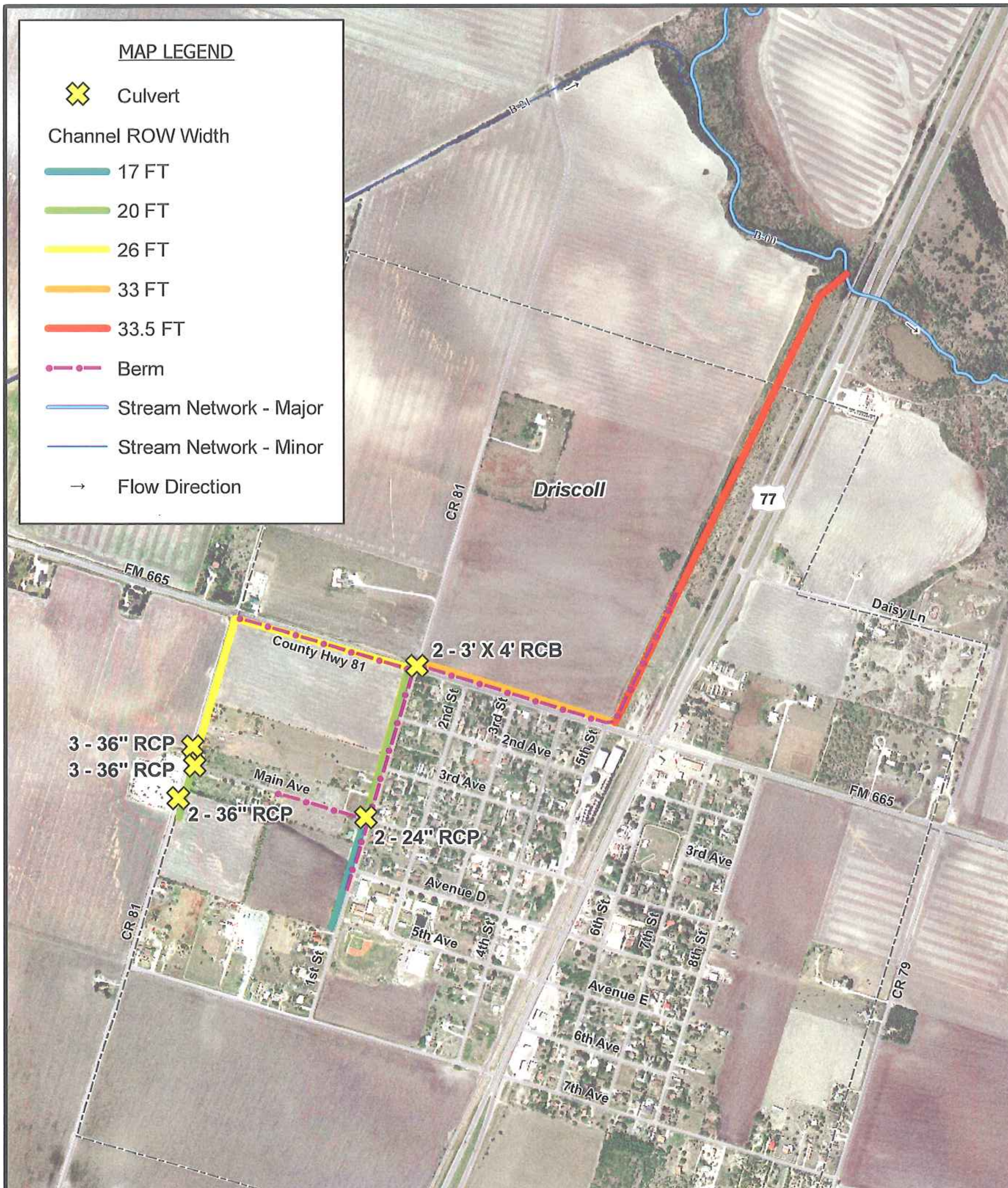
NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VII-01
Existing Drainage System for
The Town of Driscoll

DECEMBER 2009



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N S W E

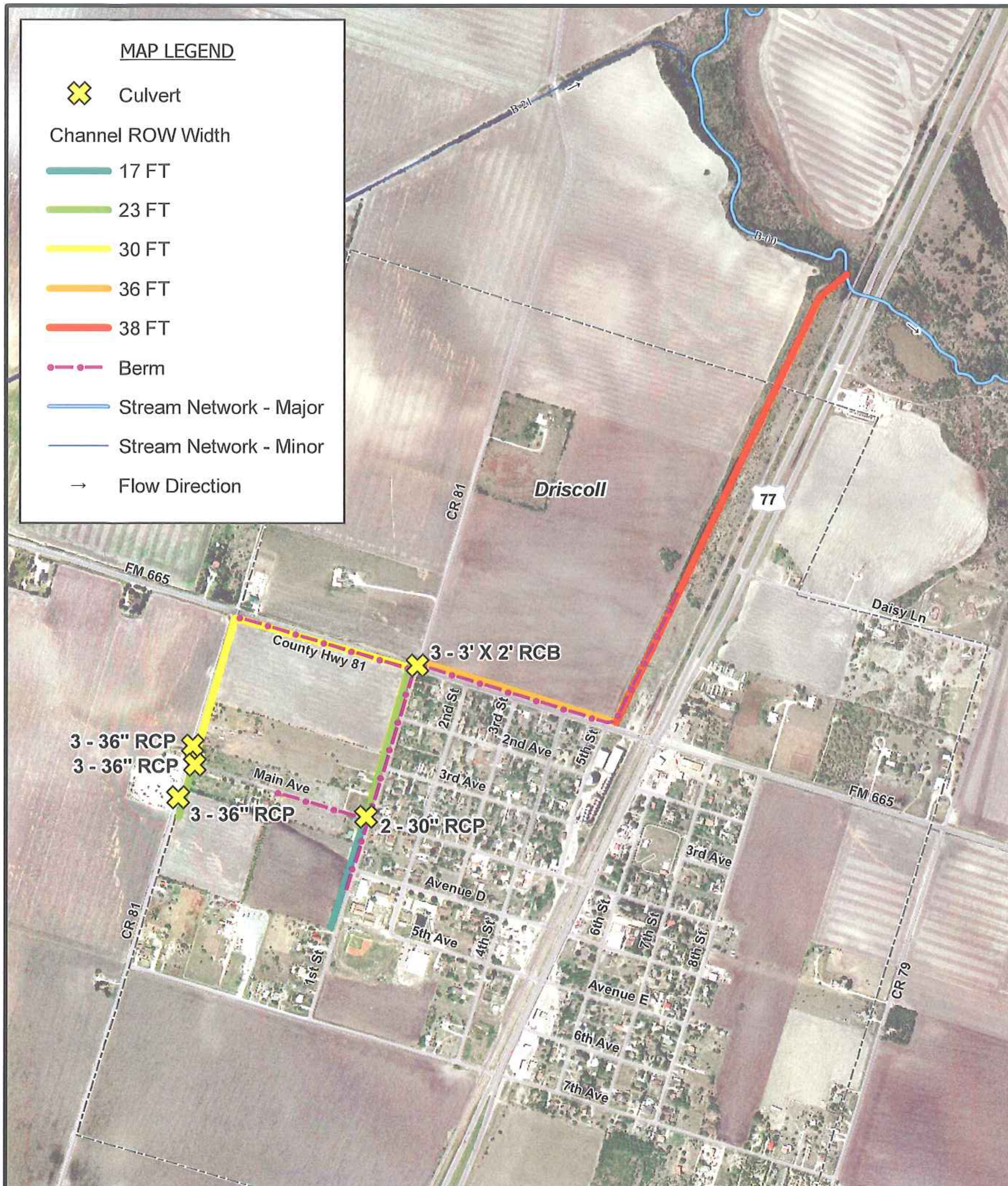
0 500 1,000 Feet

THE STATE OF TEXAS · COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VII-02
Proposed Channel & Culvert Network for
The Town of Driscoll
10 YR Protection Plan

DECEMBER 2009



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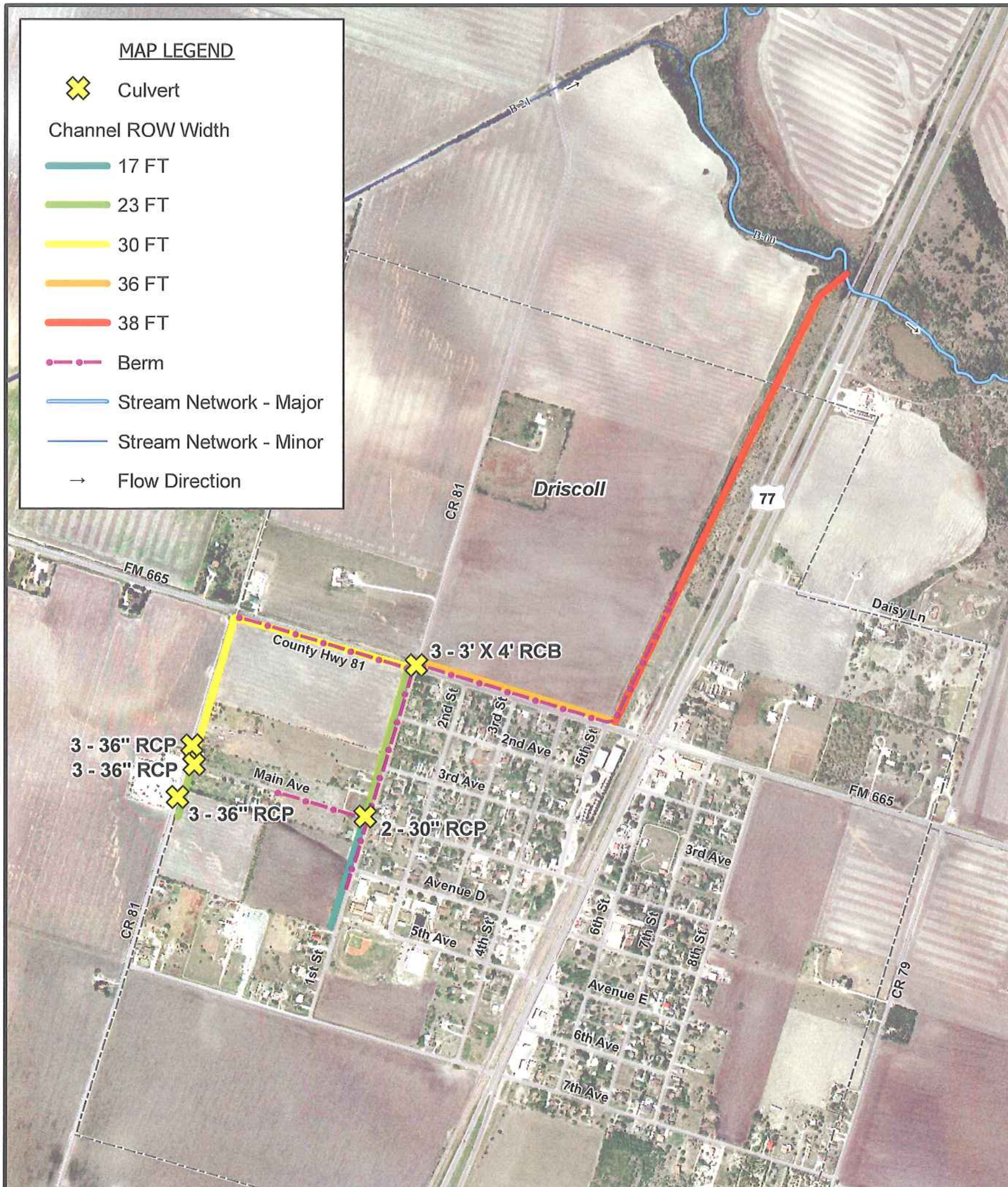
NUECES COUNTY
MASTER DRAINAGE PLAN

EXHIBITVII-03
Proposed Channel & Culvert Network for
The Town of Driscoll
25 YR Protection Plan

DECEMBER 2009



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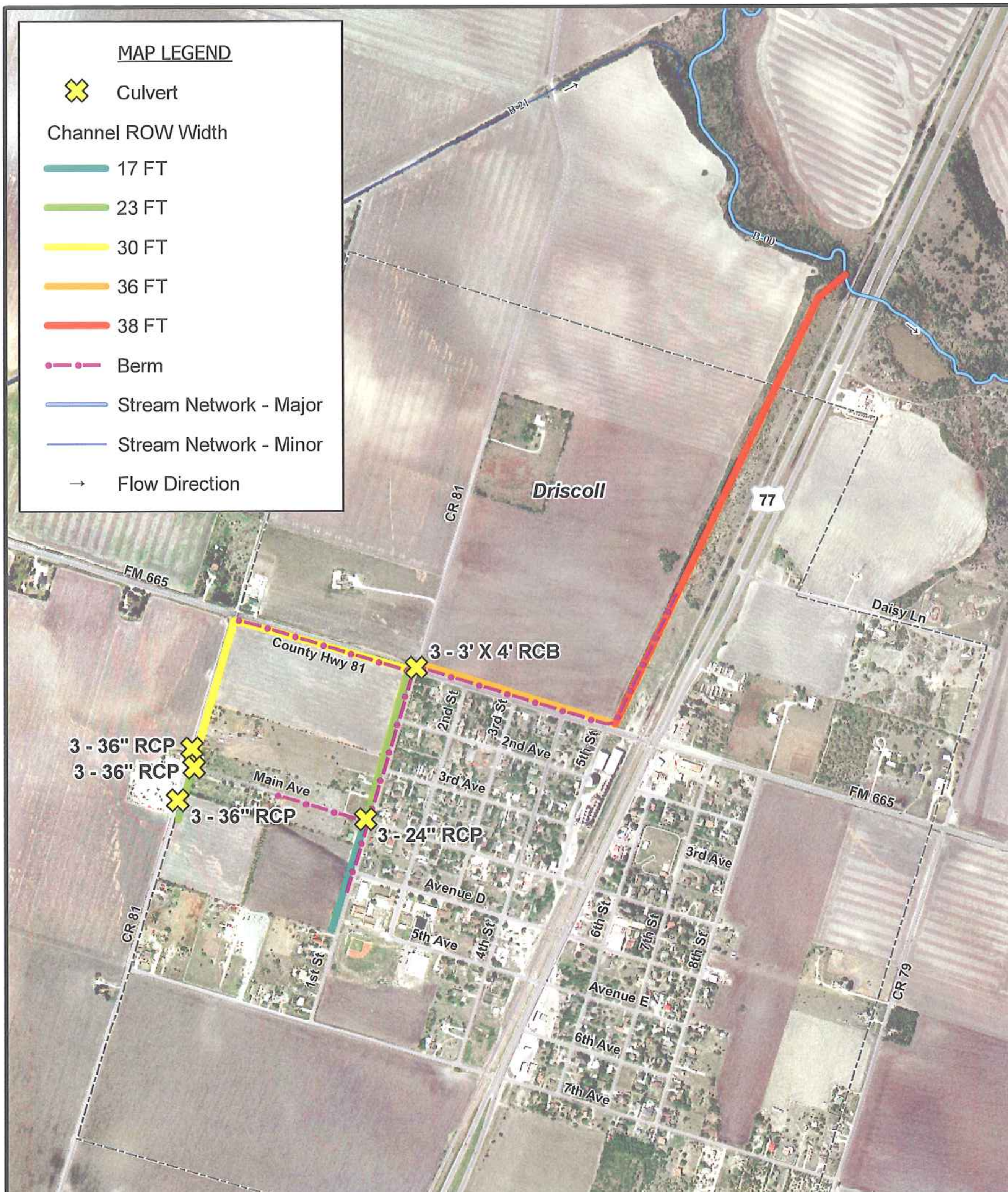
NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VII-04
Proposed Channel & Culvert Network for
The Town of Driscoll
50 YR Protection Plan

DECEMBER 2009



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N S W E

0 500 1,000 Feet

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VII-05
Proposed Channel & Culvert Network for
The Town of Driscoll
100 YR Protection Plan

DECEMBER 2009

Table VII-B

Channels

Alternative and Protection Level	Channel-Id	Location	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Slope	Description
5-yr		Upstream of Upland Intersection						
	A	South of the intersection of CR-18 and Main Ave; west side.	No Well Defined Channel	b = 2', d = 3', z = 3	Earthen	376	0.00253	
	B	North of the intersection of CR-18 and Main Ave; West side.	No Well Defined Channel	b = 5', d = 3.5', z = 3	Earthen	1062	0.00148	
	C	Between CR-18 and S. 1st St, running along Ave A; south side.	b = 7', d = 4.5', z = 3	b = 5', d = 3.5', z = 3	Earthen	1287	0.00148	
	D	South of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 2', z = 3	Earthen	807	0.00291	
	E	North of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 3', z = 3	Earthen	1101	0.00521	
	F	Between S. 1st St and S.H. 77, running along Ave. Al north side.	b = 7', d = 4', z = 3	b = 5', d = 4.5', z = 3	Earthen	1451	0.00182	
	G	Running north from the intersection of Ave A and S.H. 77; Running along the rail road tracks terminating in Petronila Creek.	b = 7', d = 7', z = 3	b = 6', d = 4.5', z = 3	Earthen	3627	0.00182	
10-yr	A	South of the intersection of CR-18 and Main Ave; west side.	No Well Defined Channel	b = 2', d = 3', z = 3	Earthen	376	0.00253	
	B	North of the intersection of CR-18 and Main Ave; West side.	No Well Defined Channel	b = 5', d = 3.5', z = 3	Earthen	1062	0.00148	
	C	Between CR-18 and S. 1st St, running along Ave A; south side.	b = 7', d = 4.5', z = 3	b = 5', d = 3.5', z = 3	Earthen	1287	0.00148	
	D	South of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 2.5', z = 3	Earthen	807	0.00291	

Table VII-B

Channels								
	E	North of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 3', z = 3	Earthen	1101	0.00521	
	F	Between S. 1st St and S.H. 77, running along Ave. Al north side.	b = 7', d = 4', z = 3	b = 6', d = 4.5', z = 3	Earthen	1451	0.00182	
	G	Running north from the intersection of Ave A and S.H. 77; Running along the rail road tracks terminating in Petronila Creek.	b = 7', d = 7', z = 3	b = 6.5', d = 4.5', z = 3	Earthen	3627	0.00182	
25-yr	A	South of the intersection of CR-18 and Main Ave; west side.	No Well Defined Channel	b = 2', d = 3.5', z = 3	Earthen	376	0.00253	
	B	North of the intersection of CR-18 and Main Ave; West side.	No Well Defined Channel	b = 6', d = 4', z = 3	Earthen	1062	0.00148	
	C	Between CR-18 and S. 1st St, running along Ave A; south side.	b = 7', d = 4.5', z = 3	b = 6', d = 4', z = 3	Earthen	1287	0.00148	
	D	South of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 2.5', z = 3	Earthen	807	0.00291	
	E	North of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 3.5', z = 3	Earthen	1101	0.00521	
	F	Between S. 1st St and S.H. 77, running along Ave. Al north side.	b = 7', d = 4', z = 3	b = 6', d = 5', z = 3	Earthen	1451	0.00182	
	G	Running north from the intersection of Ave A and S.H. 77; Running along the rail road tracks terminating in Petronila Creek.	b = 7', d = 7', z = 3	b = 7', d = 5', z = 3	Earthen	3627	0.00182	
50-yr	A	South of the intersection of CR-18 and Main Ave; west side.	No Well Defined Channel	b = 2', d = 3.5', z = 3	Earthen	376	0.00253	

Table VII-B

Channels								
	B	North of the intersection of CR-18 and Main Ave; West side.	No Well Defined Channel	b = 6', d = 4', z = 3	Earthen	1062	0.00148	
	C	Between CR-18 and S. 1st St, running along Ave A; south side.	b = 7', d = 4.5', z = 3	b = 6', d = 4', z = 3	Earthen	1287	0.00148	
	D	South of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 2.5', z = 3	Earthen	807	0.00291	
	E	North of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 2', d = 3.5', z = 3	Earthen	1101	0.00521	
	F	Between S. 1st St and S.H. 77, running along Ave. Al north side.	b = 7', d = 4', z = 3	b = 6', d = 5', z = 3	Earthen	1451	0.00182	
	G	Running north from the intersection of Ave A and S.H. 77; Running along the rail road tracks terminating in Petronila Creek.	b = 7', d = 7', z = 3	b = 7', d = 5', z = 3	Earthen	3627	0.00182	
100-yr	A	South of the intersection of CR-18 and Main Ave; west side.	No Well Defined Channel	b = 4', d = 3.5', z = 3	Earthen	376	0.00253	
	B	North of the intersection of CR-18 and Main Ave; West side.	No Well Defined Channel	b = 7', d = 4.5', z = 3	Earthen	1062	0.00148	
	C	Between CR-18 and S. 1st St, running along Ave A; south side.	b = 7', d = 4.5', z = 3	b = 7', d = 4.5', z = 3	Earthen	1287	0.00148	
	D	South of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 3', d = 2.5', z = 3	Earthen	807	0.00291	
	E	North of the intersection of S. 1st St and Main Ave.; west side.	b = 2', d = 2', z = 3	b = 3', d = 3.5', z = 3	Earthen	1101	0.00521	
	F	Between S. 1st St and S.H. 77, running along Ave. Al north side.	b = 7', d = 4', z = 3	b = 7', d = 6', z = 3	Earthen	1451	0.00182	

Table VII-B

Channels								
	G	Running north from the intersection of Ave A and S.H. 77; Running along the rail road tracks terminating in Petronila Creek.	b = 7', d = 7', z = 3	b = 7', d = 6', z = 3	Earthen	3627	0.00182	

Table VII-C
Culverts and Bridges

Alternative and Protection Level	Culvert-ID	Location	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Description
5-yr		Upstream of Upland Intersection					
	P-Cul_01	S of the intersection of CR-18 and Main Ave.	N/A	3 - 30IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_02	N of the intersection of CR-18 and Main Ave.	N/A	3 - 30IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_03	Intersection of CR-18 and Main Ave. East side of CR-18	N/A	3 - 30IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_04	Intersection of Main Ave and S 1st St., West side.	2 - 18IN RCP	2 - 24IN	RCP	40	The existing structure is too small to handle the flows generated by any of the storm events.
	P-Cul_05	Intersection of Avenue A and S. 1st St. Cross culvert from the south west side of the intersection to the north east side	5 - 24IN RCP	2 - 4FT X 3FT	RCB	100	The existing structure is too small to handle the flows generated by any of the storm events.
10-yr	P-Cul_01	S of the intersection of CR-18 and Main Ave.	N/A	2 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_02	N of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_03	Intersection of CR-18 and Main Ave. East side of CR-18	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.

Table VII-C
Culverts and Bridges

	P-Cul_04	Intersection of Main Ave and S 1st St., West side.	2 - 18IN RCP	2 - 24IN	RCP	40	The existing structure is too small to handle the flows generated by any of the storm events.
	P-Cul_05	Intersection of Avenue A and S. 1st St. Cross culvert from the south west side of the intersection to the north east side	5 - 24IN RCP	2 - 4FT X 3FT	RCB	100	The existing structure is too small to handle the flows generated by any of the storm events.
25-yr	P-Cul_01	S of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_02	N of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_03	Intersection of CR-18 and Main Ave. East side of CR-18	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_04	Intersection of Main Ave and S 1st St., West side.	2 - 18IN RCP	2 - 30IN	RCP	40	The existing structure is too small to handle the flows generated by any of the storm events.
	P-Cul_05	Intersection of Avenue A and S. 1st St. Cross culvert from the south west side of the intersection to the north east side	5 - 24IN RCP	3 - 3FT X 2FT	RCB	100	The existing structure is too small to handle the flows generated by any of the storm events.
50-yr	P-Cul_01	S of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_02	N of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_03	Intersection of CR-18 and Main Ave. East side of CR-18	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.

Table VII-C

Culverts and Bridges

	P-Cul_04	Intersection of Main Ave and S 1st St., West side.	2 - 18IN RCP	2 - 30IN	RCP	40	The existing structure is too small to handle the flows generated by any of the storm events.
	P-Cul_05	Intersection of Avenue A and S. 1st St. Cross culvert from the south west side of the intersection to the north east side	5 - 24IN RCP	3 - 4FT X 3FT	RCB	100	The existing structure is too small to handle the flows generated by any of the storm events.
100-yr	P-Cul_01	S of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_02	N of the intersection of CR-18 and Main Ave.	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_03	Intersection of CR-18 and Main Ave. East side of CR-18	N/A	3 - 36IN	RCP	40	There is no structure in this location. Proposed structures will provide relief through conveyance.
	P-Cul_04	Intersection of Main Ave and S 1st St., West side.	2 - 18IN RCP	3 - 24IN	RCP	40	The existing structure is too small to handle the flows generated by any of the storm events.
	P-Cul_05	Intersection of Avenue A and S. 1st St. Cross culvert from the south west side of the intersection to the north east side	5 - 24IN RCP	3 - 4FT X 3FT	RCB	100	The existing structure is too small to handle the flows generated by any of the storm events.

PART VIII
PETRONILA COMMUNITY SYSTEM

A. SAN PETROLINA ESTATES UNITS 1 & 2

San Petronila Estates Units 1 & 2 are Colonias located in an area which has been documented on numerous occasions to have flooding problems during large storm events. The contributing watershed is bounded to the north by CR.20 and CR.14A to the south. The area is primarily open farmland with a rural subdivision (Colonias). The existing drainage system within the Colonia consists of roadside ditches, culverts and earthen channels. Maintenance on the existing system falls within the jurisdiction of the Nueces County Drainage District No.2

B. SAN PETRONILA ESTATES UNIT 1 & 2 MODELING EFFORTS

The system drains water through adjacent watersheds and conveys the water through a series of undersized culverts and channel. The hydraulic analysis was completed using the rational method. This method was used to calculated flows for watersheds less than 500 acres. Exhibit VIII shows the locations where flows were calculated for the analysis, and Table VIII-A summarizes the flows at these locations.

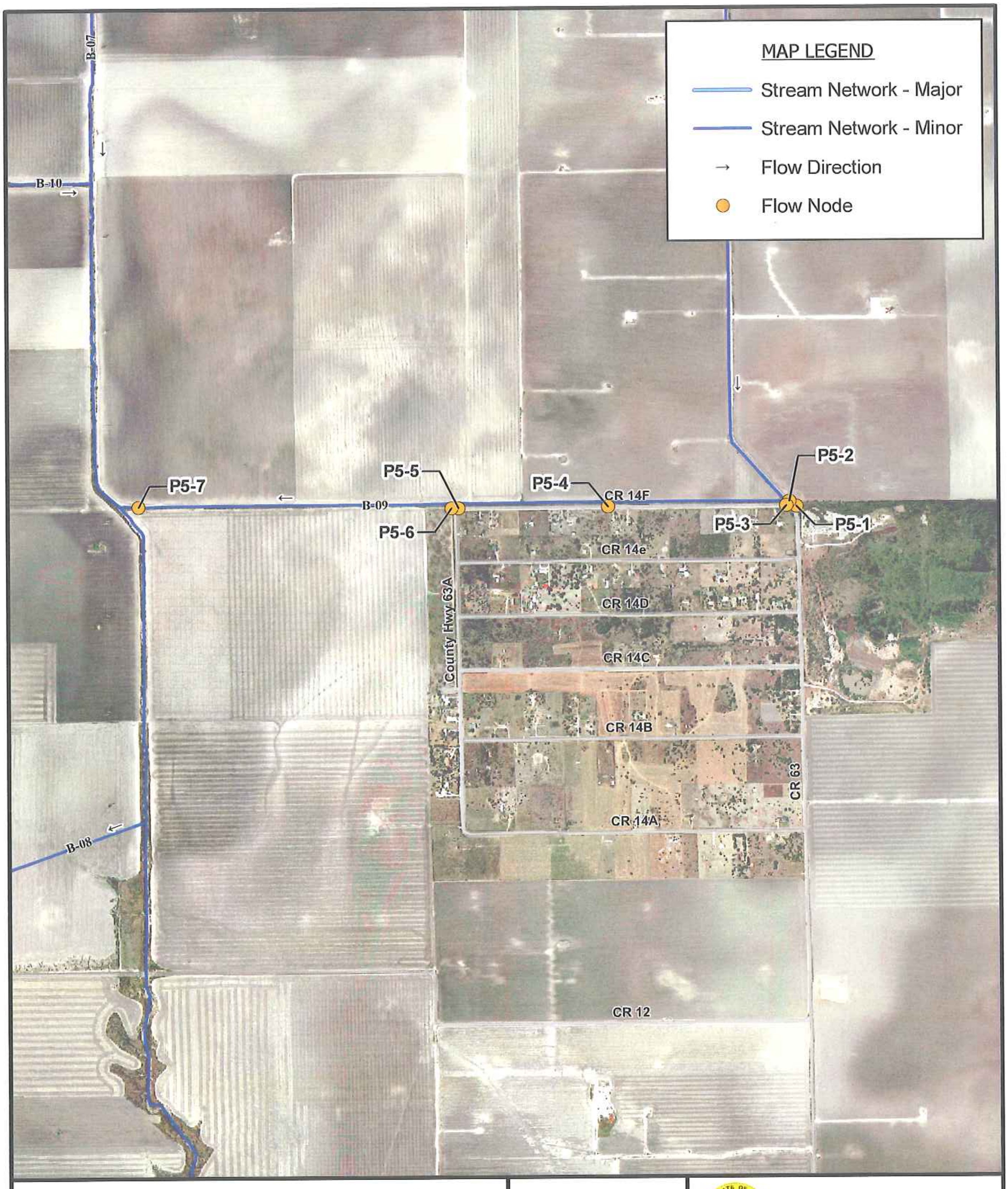
Table VIII-A

Flow Node ID	Intersection	Contributing Area (Acres)	Type*	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
P5-1		215.4	1	28.9	34.9	40.9	48.0	52.7
P5-2		3,292.9	1	194.9	250.3	328.5	398.0	472.4
P5-3		26.0	1	6.4	7.7	9.0	10.5	11.5
P5-4		13.4	1	6.0	7.0	8.2	9.5	10.3
P5-5		13.4	1	3.3	4.0	4.7	5.5	6.0
P5-6		13.9	1	5.7	6.7	7.9	9.1	10.0
P5-7		4,375.3	1	324.2	415.5	544.7	659.4	782.1

During the analysis through a series of site investigations and reviewing of historical data, it was determined that an analysis of each existing culvert and channel would not be required. The goal of this analysis is to provide an analysis that would provide different levels of protection for the Colonia. This allowed the engineer to create solution of analyzing existing conditions which were already known to be inadequate.

C. SAN PETRONILA ESTATES UNIT 1&2 MASTER PLAN

A master plan was developed and proved that the existing system was not capable of meeting the drainage criteria requirements, therefore a new network was developed and analyzed. Multiple storm event protection levels were analyzed to provide the community a variety of flood protection options. Layouts for the 10yr, 25yr, 50yr and 100yr protection levels are shown in



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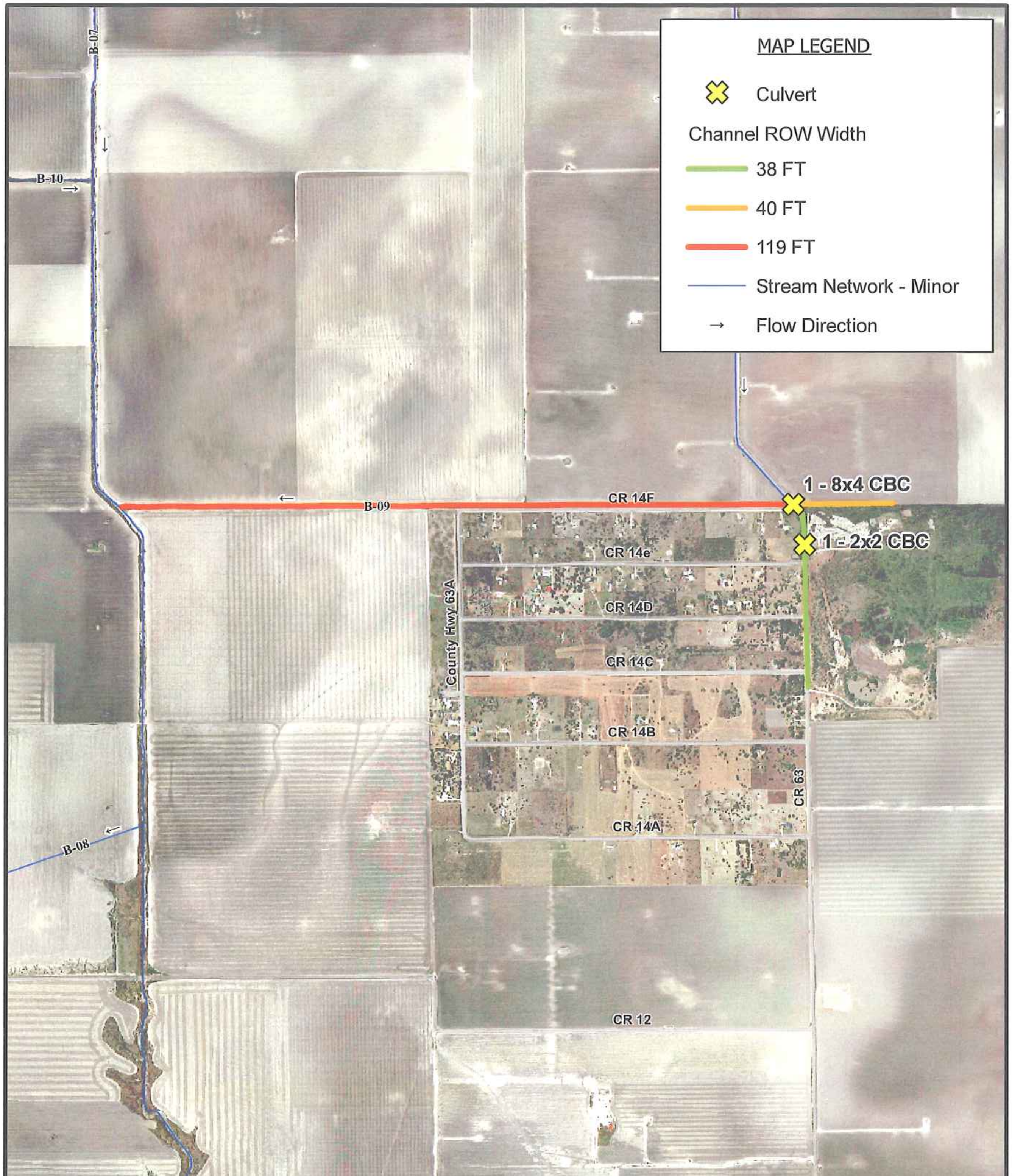
W E
S

0 750 1,500 Feet

NUECES COUNTY
MASTER DRAINAGE PLAN

EXHIBIT VIII-01
Existing Drainage System for
San Petronilla
Units 1 & 2

DECEMBER 2009



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NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VIII-02
Proposed Channel & Culvert
Network for San Petronilla
Units 1 & 2
10 YR Protection Plan

DECEMBER 2009

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NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VIII-03
Proposed Channel & Culvert Network for San Petronilla Units 1 & 2
25 YR Protection Plan

DECEMBER 2009

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NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VIII-04
Proposed Channel & Culvert Network for San Petronilla Units 1 & 2
50 YR Protection Plan

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NUECES COUNTY
MASTER DRAINAGE PLAN

EXHIBIT VIII-05
Proposed Channel & Culvert
Network for San Petronilla
Units 1 & 2
100 YR Protection Plan

DECEMBER 2009

Table VIII-B
Recommended Channel Improvements

Alternative and Protection Level	Channel-Id	Location	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Slope (ft/ft)	Description
5-yr	P5-1	South of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 11, z = 4, d = 2.25 - 3	Earthen	1954	0.001	
	P5-2	East of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 0, z = 4, d = 5 - 0	Earthen	967	0.004	
	P5-3	West of Intersection of CR-63 and CR14f	b = 4, d = 6, z = 2	b = 13, z = 4, d = 6.5 - 13	Earthen	7230	0.0005	
10-yr	P5-1	South of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 14, z = 4, d = 2.25 - 3	Earthen	1954	0.001	
	P5-2	East of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 0, z = 4, d = 5 - 0	Earthen	967	0.004	
	P5-3	West of Intersection of CR-63 and CR14f	b = 4, d = 6, z = 2	b = 15, z = 4, d = 6.5 - 13	Earthen	7230	0.0005	
25-yr	P5-1	South of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 16, z = 4, d = 2.25 - 3	Earthen	1954	0.001	
	P5-2	East of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 0, z = 4, d = 5 - 0	Earthen	967	0.004	
	P5-3	West of Intersection of CR-63 and CR14f	b = 4, d = 6, z = 2	b = 22, z = 4, d = 6.5 - 13	Earthen	7230	0.0005	
50-yr	P5-1	South of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 20, z = 4, d = 2.25 - 3	Earthen	1954	0.001	
	P5-2	East of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 0, z = 4, d = 5 - 0	Earthen	967	0.004	
	P5-3	West of Intersection of CR-63 and CR14f	b = 4, d = 6, z = 2	b = 28, z = 4, d = 6.5 - 13	Earthen	7230	0.0005	
100-yr	P5-1	South of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 22, z = 4, d = 2.25 - 3	Earthen	1954	0.001	
	P5-2	East of Intersection of CR-63 and CR14f	No Well Defined Channel	b = 0, z = 4, d = 5 - 0	Earthen	967	0.004	
	P5-3	West of Intersection of CR-63 and CR14f	b = 4, d = 6, z = 2	b = 35, z = 4, d = 6.5 - 13	Earthen	7230	0.0005	

In addition, Table VIII-C outlines the structural improvements required on Bridges or Culvert Crossings.

Table VIII-C

Recommended Culverts and Bridges

Alternative and Protection Level	Culvert-ID	Location	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Description
5-yr	P5-1	Intersection of CR-63 and CR14f	2 - 7 x 4 CBC	2 -7 x 4	CBC	50	Existing structure could possibly be used depending upon condition and whether it could be reset at a different slope.
	P5-2	South of Intersection of CR-63 and CR14f	Unknown	2 - 2 x 2	CBC	30	
10-yr	P5-1	Intersection of CR-63 and CR14f	2 - 7 x 4 CBC	2 -7 x 3	CBC	50	Existing structure could possibly be used depending upon condition and whether it could be reset at a different slope.
	P5-2	South of Intersection of CR-63 and CR14f	Unknown	2 - 2 x 2	CBC	30	
25-yr	P5-1	Intersection of CR-63 and CR14f	2 - 7 x 4 CBC	1 -10 x 4	CBC	50	Existing structure could possibly be used depending upon condition and whether it could be reset at a different slope.
	P5-2	South of Intersection of CR-63 and CR14f	Unknown	2 - 2 x 2	CBC	30	
50-yr	P5-1	Intersection of CR-63 and CR14f	2 - 7 x 4 CBC	1 - 8 x 4	CBC	50	Existing structure could possibly be used depending upon condition and whether it could be reset at a different slope.
	P5-2	South of Intersection of CR-63 and CR14f	Unknown	1 - 2 x 2	CBC	30	
100-yr	P5-1	Intersection of CR-63 and CR14f	2 - 7 x 4 CBC	1 - 6 x 4	CBC	50	Existing structure could possibly be used depending upon condition and whether it could be reset at a different slope.
	P5-2	South of Intersection of CR-63 and CR14f	Unknown	1 - 2 x 2	CBC	30	

D. PETRONILA ESTATES UNIT V AND PETRONILA ACRES

San Petronila Estates Univ V and Petronila Acres were combined as one hydrologic system because of their close proximity to each other. These areas were referred to as Petronila North for our analysis. Petronila North has been documented on numerous occasions to have flooding problems during large storm events. The area is primarily open farmland with a rural subdivision (Colonias). The existing drainage system within the Petronila North area is comprised primarily of roadside ditches, culverts and earthen channels. Maintenance on the existing system falls within the jurisdiction of the Nueces County Drainage District No.2

E. PETRONILA ESTATES UNIV V AND PETRONILA ACRES MODELING EFFORTS

The system drains water through adjacent watersheds and conveys the water through a series of undersized culverts and channel. The hydraulic analysis was completed using the rational method. This method was used to calculated flows for watersheds less than 500 acres. Exhibit VIII-6 shows the locations where flows were calculated for the analysis, and Table VIII-D summarizes the flows at these locations.

During the analysis through a series of site investigations and review of historical data, it was determined that an analysis of each existing culvert and channel would not be required. The goal of this analysis is to develop a storm drainage system that would provide different levels of protection for the Petronila Estates Unit V and Petronila Acres areas. This allowed the engineer to look at solving flooding issues instead of analyzing existing conditions which were already known to be inadequate.

F. PETRONILA ESTATES UNIT V AND SAN PETRONILA ACRES MASTER PLAN

A master plan was developed and proved that the existing system was not capable of meeting the drainage criteria requirements, therefore a new network was developed and analyzed. The area provided very little elevation relief and only a 25 year protection level could be reasonably achieved. The resulting master plan for the Petronila North Community area is depicted on Exhibit VIII-07. Table VIII-E summarizes the bridge and culvert improvements recommended for the Area.

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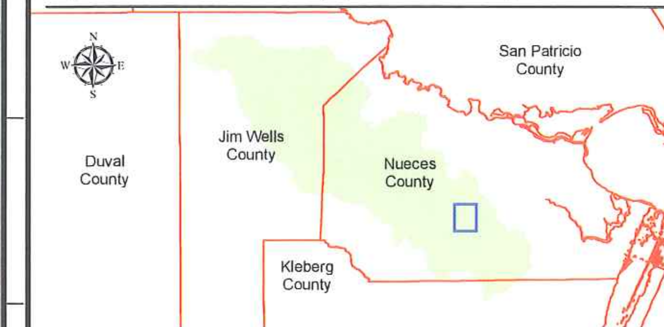
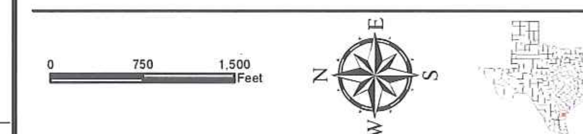


KEY MAP



MAP LEGEND

- Stream Network - Minor
- → Flow Direction

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VIII-06
Existing Drainage System for
San Petronilla Establishment No. V,
and San Petronilla Acres

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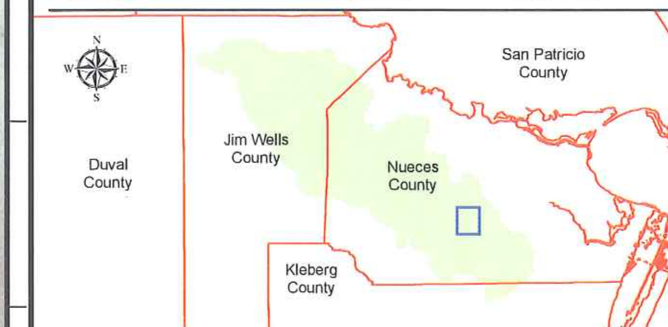


KEY MAP

0 750 1,500 Feet

MAP LEGEND

- New Culvert
- Existing Culvert
- Add Flap to Culvert
- Sediment Trap
- Berm
- Stream Network - Minor
- → Flow Direction

Note:
Clean out all culverts shown, including ditch upstream and downstream of culvert.

Channel ROW Width (25 YR)

- 20 FT
- 23 FT
- 26 FT
- 27 FT
- 45 FT

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT VIII-07
Proposed Channel & Culvert Network for
San Petronilla Establishment No. V,
and San Petronilla Acres
25 YR Protection Design

DECEMBER 2009

Table VIII-D
Existing Flows

Flow Node ID	Contributing Area (Acres)	Type*	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
NC-1	25.00	2	10.781	12.67	14.818	17.118	18.6
NC-2	392.41	2	90.396	109.63	128.59	151.21	166.43
NC-3	834.21	2	106.09	131.79	154.92	184.64	205.03
NC-4	186.95	2	41.957	50.624	59.35	69.587	76.436
NC-5	1685.51	2	209.13	260.04	305.73	364.58	404.99
NC-6	22.85	2	13.886	16.196	18.927	21.772	23.574
NC-7	323.45	2	65.141	79.433	93.217	109.95	121.26
NC-8	1717.54	2	186.13	232.71	273.73	327.42	364.43
NC-9	30.97	2	7.7348	9.2926	10.89	12.737	13.967
NC-10	145.48	2	64.688	76.404	89.393	103.56	112.77
NC-11	1067.88	2	244.77	296.93	348.28	409.59	450.84
NC-13	29.69	2	7.3961	8.8865	10.414	12.181	13.358
NC-14	16.50	2	4.5329	5.425	6.3552	7.4173	8.1213
NC-15	35.44	2	10.409	12.424	14.55	16.956	18.545
NC-17	28.32	2	7.6871	9.2044	10.783	12.589	13.786
NC-25	26.13	2	7.1661	8.5769	10.048	11.727	12.841
NC-27	38.11	2	18.03	21.243	24.849	28.746	31.268
NC-28	1695.82	2	200.73	250.08	294.06	351.04	390.22
NC-29	35.04	2	21.629	25.211	29.46	33.877	36.669
NC-30	159.72	2	47.46	56.973	66.761	78.052	85.564
NC-31	29.03	2	21.318	24.675	28.815	33.005	35.603
NC-32	156.30	2	64.269	76.148	89.121	103.43	112.78
NC-101	320.64	2	101.36	121.37	142.19	166	181.8
NC-102	262.80	2	92.075	109.8	128.58	149.77	163.75
NC-103	263.86	2	90.253	107.73	126.17	147.04	160.83
NC-104	18.64	2	6.0816	7.2282	8.4621	9.8379	10.741
NC-105	53.81	2	14.204	17.027	19.949	23.304	25.532
NC-106	23.73	2	5.2001	6.2804	7.3636	8.6383	9.4921
NC-107	4.03	2	1.6547	1.9486	2.2793	2.6361	2.8668
NC-108	6.07	2	2.1907	2.5932	3.0347	3.52	3.8366
NC-109	295.01	2	66.714	80.974	94.983	111.74	123.01
NC-110	637.22	2	184.96	222.25	260.45	304.66	334.11
NC-111	26.63	2	7.2357	8.6635	10.149	11.848	12.975
NC-112	2084.18	2	212.3	266.09	313.07	375.01	417.77
NC-113	13.79	2	5.496	6.5201	7.6317	8.8633	9.6695

* 1-Grass Swale 2-Creek 3-Concrete Swale

Table VIII-E
Recommended Culverts and Bridges

Alternative and Protection Level	Culvert-ID	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Description
5-Yr	NC-101	1 - 48IN	2 - 48IN	RCP	20	Add Flap Gate
5-Yr	NC-11	2 - 42IN	2 - 4'x4'	CBC	30	
5-Yr	NC-110	No Existing Culvert	2 - 48IN	RCP	27	Add Flap Gate
10-Yr	NC-28	2 - 6' x 2.5'	No New Culvert Proposed	CBC	35	This culvert is under a driveway.
25-Yr	NC-10	No Existing Culvert	2 - 36IN	RCP	50	Add Flap Gate
25-Yr	NC-4	2 - 18IN	3 - 24IN	RCP	60	Add Flap Gate
25-Yr	NC-102	4 - 30IN	2 - 4'x3'	CBC	28	This culvert is under a driveway.
25-Yr	NC-9	No Existing Culvert	1 - 18IN	RCP	30	Add Flap Gate

Table VIII-E Cont'd
Recommended Culverts and Bridges

Alternative and Protection Level	Culvert-ID	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Description
25-Yr	NC-29	3 - 18IN	3 - 18IN	RCP	35	Upstream channel is being improved, so new culverts of same size will need to be repositioned at outlet of new channel.
25-Yr	NC-111	1 - 18IN	1 - 18IN	RCP	35	Add Flap Gate
25-Yr	NC-17	1 - 18IN	1 - 18IN	RCP	35	Add Flap Gate
25-Yr	NC-103	2 - 30IN	4 - 30IN	RCP	30	This culvert is under a driveway.
25-Yr	NC-3	6 - 3'x2.5'	No New Culvert Proposed	CBC	36	
25-Yr	NC-13	1 - 18IN	No New Culvert Proposed	RCP	30	Add Flap Gate
25-Yr	NC-7	6 - 24IN	No New Culvert Proposed	RCP	96	
25-Yr	NC-31	3 - 30IN	No New Culvert Proposed	RCP	35	Capacity not analyzed, assumed to pass 25-Yr

Table VIII-E Cont'd

Recommended Culverts and Bridges

Alternative and Protection Level	Culvert-ID	Existing Structure Dimensions	Proposed Dimensions	Type	Length	Description
25-Yr	NC-32	8 - 36IN	No New Culvert Proposed	RCP	40	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-105	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-15	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-14	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-108	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-107	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-104	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-106	2 - 24IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-30	4 - 36IN	No New Culvert Proposed	RCP	35	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-25	2 - 60IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-117	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr

Table IV-8-E Cont'd
Recommended Culverts and Bridges

25-Yr	NC-27	3 - 18IN	No New Culvert Proposed	RCP	30	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-109	5 - 18IN	No New Culvert Proposed	RCP	50	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-112	4 - 5' x 5'	No New Culvert Proposed	CBC	40	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-114	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-115	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-116	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-120	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-119	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
25-Yr	NC-118	2 - 30IN	No New Culvert Proposed	RCP	25	Capacity not analyzed, assumed to pass 25-Yr
50-Yr	NC-8	2 - 5' x 3'	2 - 6'x4'	CBC	70	Existing culvert running north to south will be plugged and new culvert running northeast to southwest (diagonally) will replace it.
100-Yr	NC-2	4 - 4'x2.5'	No New Culvert Proposed	CBC	25	
100-Yr	NC-5	4 - 7'x3', 2 - 36IN RCP	No New Culvert Proposed	CBC	50	
100-Yr	NC-6	2 - 4'x2'	No New Culvert Proposed	CBC	88	
100-Yr	NC-1	4 - 24IN	No New Culvert Proposed	RCP	30	Add Flap Gate
100-Yr	NC-113	1 - 6' x 2.5'	No New Culvert Proposed	CBC	80	

In addition, VIII-F outlines the structural improvements required on Bridges or Culvert Crossings.

Table VIII-F

Channels							
Alternative and Protection Level	**Channel-Id**	**Location**	**Proposed Dimensions**	**Type**	**Length**	**Slope**	**Description**
25-Yr	2	Along north side of County Hwy 24, West of CR 67	b=6, z=3, d=0-3.5	Earthen	2492.6	0.0012	New Channel
25-Yr	114	Along south side of CR 22, West of CR 67	b=8, z=3, d=0.5-3	Earthen	1191.6	0.0014	New Channel
25-Yr	29	Between FM 665 and CR 22	b=0, z=4, d=2.5	Earthen	238.6	0.002	Improved Channel
25-Yr	5	Along south side of County Hwy 24 and along east side of CR 67	b=17, z=4, d=2.5-3.5	Earthen	1220.7	0.0015	Improved Channel
25-Yr	7	Along north side of FM 665, West of CR 67	b=8, z=3, d=0.5-2.5	Earthen	926.7	0.0008	New Channel
25-Yr	10	Along berm, north of Petronila Acres	b=8, z=3, d=0-3.5	Earthen	5044.1	0.0008	New Channel

PART IX

ENVIRONMENTAL REPORT

This section of the report examines some of the major regulatory and permitting conditions and processes by which projects in Nueces County must follow in order to accomplish its goals. Wetlands and Endangered Species are typically associated with our surrounding fresh, brackish, and salt water resources, including the local lakes, streams, and beaches. While drainage of flood waters is an important goal, the referenced natural resources should be protected, as they are the features that make Nueces County one of the most unique assemblages of ecosystems on the Gulf Coast.

This section covers the following aspects regarding drainage projects within Nueces County:

A. Wetlands
B. Wetland Delineations
C. Permitting and the U.S. Army Corps of Engineers
D. Threatened and Endangered Species
E. Cultural Resources
F. Receiving Waters

A. WETLANDS

The formal definition of a wetland is "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." This Clean Water Act of 1972 definition has been the basis for many refinements over the years of the definition of a wetland, including the insertion of the words "vegetation", "hydrology", and "hydric soils," the presence of which is required by the U.S. Army Corps of Engineers (USACE) to determine a jurisdictional wetland. Wetland interpretations have also been expanded recently to include mud flats, salt flats, and vegetated shallow water, all of which occur in Nueces County.

There are two regulations that define the limits by which a wetland is determined jurisdictional, Section 404 of the Clean Water Act (generally freshwater and brackish wetlands) and Section 10 of the Rivers and Harbors Act (brackish and salt water directly connected to the bay or Gulf).

Nueces County has many types of wetlands, both fresh and salt water. Different limits, impacts, and mitigation requirements are standard for either Section 404 or Section 10 Waters. Many ditches and drainages in Nueces County fall under both types as they all eventually outfall into Baffin Bay, the Laguna Madre, or Corpus Christi Bay, however the USACE does not regulate man-made drainage ditches.


(Black Mangrove swamp. Photo by Jay Gardner, Naismith Engineering)

B. WETLAND DELINEATIONS

All wetland delineations, whether for fresh or salt water areas, require that all three parameters (hydrophytic vegetation, hydric soils, and hydrology) occur in a given area to be determined as a wetland. Typically a qualified wetland delineator studies each of the three parameters at a given site, and also at adjacent upland sites. A wetland boundary between uplands and wetlands is determined by comparing the three parameters until one or more parameter fails or passes, depending on whether a delineator starts in uplands or wetlands. The results of the comparison between the parameters are the defining characteristics that distinguish uplands from wetlands.

The delineation process is the same for all parts of Nueces County, however, typically the hydrology parameter, and the presence or absence of a connection with adjacent waters determines whether a wetland is jurisdictional. Not all wetlands are jurisdictional, or fall under the purview of the USACE. While wetland delineators can provide information and opinions, only the USACE can determine legally if a wetland is jurisdictional or not.

C. PERMITTING AND THE USACE

Background - Section 404 and Section 10 requires landowners to apply for a permit in the event they want to dredge or fill any wetlands. Permits range from Regional General Permits, to the Nationwide Permit Program, to Individual Permits. An example would be the need for a permit to place footings for a bridge in a river or creek or the outfall pipes from a storm drain in the Cayo del Oso.

A permit for work in wetlands begins with identification of a specific project. A wetland determination is then performed by certified consultants or personnel. Aerial maps, a National Wetlands Inventory map, and Soils Survey maps are reviewed for potential wetlands in the area. Once it is determined that potential wetlands may exist in the area, then a field visit is scheduled by a Certified Wetland Delineator. A wetland determination should be completed before engineering plans and specs are initiated to ensure the viability and permitting requirements for a project. A wetland delineation is then prepared by field sampling at the area in question if the Delineator deems it necessary. Plants are identified in the area, soils are examined, and hydrology is determined by field marks and characteristics. The data sheets are completed, and typically a survey crew is brought on-site to work in conjunction with the delineator to survey the area. The resulting exhibits and data sheets are then submitted to the USACE for a Jurisdictional Determination (JD), typically associated with a project/impact. JD's can take from a few months to a year to receive from the USACE, depending on the proposed project impacts, endangered species, and/or avoidance and minimization.

<u>Methods and Approach to Permitting</u> – Potential or proposed project engineers should consult with a certified wetland delineator before spending time or money developing projects. Nueces County has many potential projects located in a variety of ecosystems. Almost all drainage projects will either initiate or terminate in a jurisdictional wetland area, and may require a permit from the USACE. In addition, permit applications for projects located in areas identified as critical habitat for Threatened or Endangered Species (T & E)will have to be coordinated with local resources agencies. More about T & E species and the potential permitting impacts are included in the next section.

The best approach to projects includes the early identification of projects and their potential impacts to the local environment, including both temporary and permanent impacts.

Temporary impacts - Include activities such as temporary clearing of an area to access a construction site, temporary access roads, temporary fills, dewatering activities, cofferdams, or temporary clearing and trenching. Temporary impacts are those impacts that should be restored to pre-construction condition after construction has completed within one year.

Permanent impacts - Include activities such as filling wetlands for roads or placement of footings for a bridge. A permanent loss of Waters of the U.S. requires mitigation for those impacts, typically on-site. Association with a Master Drainage Plan, however, may allow the District Engineer (USACE) to approve a "water-shed based" mitigation plan for impacts due to potential drainage projects. These types of projects should be coordinated with the USACE and resource agencies early in the project development.

<u>Types of Permits</u> – The three types of permits typically associated with a drainage project include a regional general permit, a Nationwide Permit ("nationwide"), or an Individual Permit (IP). These permits are separated by; 1) their level of impact to the environment, namely wetlands, and 2) the level of required mitigation. President H.W. Bush's vow and subsequent legislation regarding the "No-Net Loss of Wetlands" approach to our nations' resources has resulted in the adoption of the same policy by the USACE. A potential projects' level of impact (based on acres of wetlands affected) will determine the permitting process, how much coordination is required, what the mitigation requirements will be, and how long it will take to get a permit approved. Regional General Permits have specific allowable impact limits, which are usually limited to only temporary impacts, or very small permanent impacts. Nationwide Permits (the most

common type) involve impact acreage limits typically between 1/10 and 1/4 of an acre. Impacts greater than one half (1/2) an acre will include application for and coordination regarding an Individual Permit. All impacts to wetlands must be mitigated for at least at a 1 : 1 ratio, despite the type of permit applied for. A mitigation plan has to be prepared for all applications involving impacts to jurisdictional wetlands.

Ditches are not considered to be Jurisdictional according to the USACE in Nueces County. Ditches can be mowed, cleaned out, or otherwise maintained without a permit. A majority of the Nueces County Master Drainage Plan goals and objectives may involve this type of work. Each individual project will need to be examined by certified personnel before work may commence to determine the level of permitting and coordination.

D. THREATENED AND ENDANGERED SPECIES

There are fifty-five (55) rare species currently listed by the Texas Parks and Wildlife Department (TPWD) for Nueces County, which includes both Threatened and Endangered Species. This includes two amphibians, twenty bird species, four fishes, one insect, seven mammals, thirteen reptiles, and eight plants. There are sixteen (16) Federally listed Endangered or Threatened Species protected under the Endangered Species Act that exist in the Nueces County, including two mammals (the Ocelot and Jaguarundi), six birds (brown pelican, whooping crane, bald eagle, aplomado falcon, piping plover, least tern) and eight plants (black lace cactus, star cactus, walkers manioc, Johnstons' frankenia, Texas ayenia, south Texas Ambrosia, ashy dogwood, and the slender rush-pea).

Only certain members of the endangered or threatened species may potentially be affected by a typical drainage project completed in Nueces County, based on habitat. For example, a majority of the sea turtles and sea birds are located exclusively along the coast and would not likely be affected by potential projects in the western portions of Nueces County. Only projects involving the island or bay margins could potentially affect the sea turtles and pelican.

Permit applications for projects located in areas identified as critical habitat for Threatened or Endangered Species (T & E) will have to be coordinated with local resources agencies (Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), and the USACE. Inland areas will typically involve a different suite of T & E species than Padre or Mustang Island dependent on critical habitat and the proposed effects of a potential project. These effects can only be determined on a case-by-case basis, and will require field verification by a qualified biologist or consultant working with the engineer.

The GIS should be consulted for each particular project to initially determine the likelihood of T &E species within each project. The field determination should be made by certified and approved personnel or staff before a project is developed past initial stages in order to prevent wasteful spending, potential effects to T & E species, or cumbersome permitting processes. Please see the following for the list of T & E and rare species for Nueces County.

NUECES COUNTY

PLANTS		Federal Status	State Status
Plains gumweed	*Grindelia oolepis*		

coastal prairies on heavy clay (blackland) soils, often in depressional areas, sometimes persisting in areas where management (mowing) may maintain or mimic natural prairie disturbance regimes; 'crawfish lands'; on nearly level Victoria clay, Edroy clay, claypan, possibly Greta within Orelia fine sandy loam over the Beaumont Formation, and Harlingen clay; roadsides, railroad rights-of-ways, vacant lots in urban areas, cemeteries; flowering April-December

Slender rushpea *Hoffmannseggia tenella* LE E

Texas endemic; coastal prairie grasslands on level uplands and on gentle slopes along drainages, usually in areas of shorter or sparse vegetation; soils often described as Blackland clay, but at some of these sites soils are coarser textured and lighter in color than the typical heavy clay of the coastal prairies; flowering April-November

South Texas ambrosia *Ambrosia cheiranthifolia* LE E

grasslands and mesquite-dominated shrublands on various soils ranging from heavy clays to lighter textured sandy loams, mostly over the Beaumont Formation on the Coastal Plain; in modified unplowed sites such as railroad and highyway right-of-ways, cemeteries, mowed fields, erosional areas along small creeks; flowering July-November

Texas windmill-grass *Chloris texensis*

Texas endemic; sandy to sandy loam soils in relatively bare areas in coastal prairie grassland remnants, often on roadsides where regular mowing may mimic natural prairie fire regimes; flowering in fall

Welder machaeranthera *Psilactis heterocarpa*

Texas endemic; grasslands , varying from midgrass coastal prairies, and open mesquite-huisache woodlands on nearly level, gray to dark gray clayey to silty soils; known locations mapped on Victoria clay, Edroy clay, Dacosta sandy clay loam over Beaumont and Lissie formations; flowering September-November

NUECES COUNTY

AMPHIBIANS

		Federal Status	State Status
Black-spotted newt	*Notophthalmus meridionalis*		T

can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River

		Federal Status	State Status
Sheep frog	*Hypopachus variolosus*		T

predominantly grassland and savanna; moist sites in arid areas

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

		Federal Status	State Status
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

		Federal Status	State Status
Brown Pelican	*Pelecanus occidentalis*	LE-PDL	E

largely coastal and near shore areas, where it roosts and nests on islands and spoil banks

		Federal Status	State Status
Eskimo Curlew	*Numenius borealis*	LE	E

historic; nonbreeding: grasslands, pastures, plowed fields, and less frequently, marshes and mudflats

		Federal Status	State Status
Mountain Plover	*Charadrius montanus*		

breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

		Federal Status	State Status
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	LE	E

open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

		Federal Status	State Status
Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

		Federal Status	State Status
Piping Plover	*Charadrius melodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

NUECES COUNTY

BIRDS		Federal Status	State Status
Reddish Egret	*Egretta rufescens*		T

resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Sennett's Hooded Oriole *Icterus cucullatus sennetti*

often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeding March to August

Snowy Plover *Charadrius alexandrinus*

formerly an uncommon breeder in the Panhandle; potential migrant; winter along coast

Sooty Tern *Sterna fuscata* — T

predominately 'on the wing'; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July

Southeastern Snowy Plover *Charadrius alexandrinus tenuirostris*

wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats

Texas Botteri's Sparrow *Aimophila botterii texana* — T

grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses

Western Burrowing Owl *Athene cunicularia hypugaea*

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Western Snowy Plover *Charadrius alexandrinus nivosus*

uncommon breeder in the Panhandle; potential migrant; winter along coast

White-faced Ibis *Plegadis chihi* — T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

White-tailed Hawk *Buteo albicaudatus* — T

near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Whooping Crane *Grus americana* — LE — E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

Wood Stork *Mycteria americana* — T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

NUECES COUNTY

FISHES

		Federal Status	State Status
American eel	*Anguilla rostrata*		

coastal waterways below reservoirs to gulf; spawns January to February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; most aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries; diet varies widely, geographically, and seasonally

Opossum pipefish	*Microphis brachyurus*		T

brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth; southern coastal areas

Smalltooth sawfish	*Pristis pectinata*	LE	E

different life history stages have different patterns of habitat use; young found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m); in sheltered bays, on shallow banks, and in estuaries or river mouths; adult sawfish are encountered in various habitat types (mangrove, reef, seagrass, and coral), in varying salinity regimes and temperatures, and at various water depths, feed on a variety of fish species and crustaceans

Texas pipefish	*Syngnathus affinis*		

Corpus Christi Bay; seagrass beds

INSECTS

		Federal Status	State Status
Manfreda giant-skipper	*Stallingsia maculosus*		

most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk

MAMMALS

		Federal Status	State Status
Maritime pocket gopher	*Geomys personatus maritimus*		

fossorial, in deep sandy soils; feeds mostly from within burrow on roots and other plant parts, especially grasses; ecologically important as prey species and in influencing soils, microtopography, habitat heterogeneity, and plant diversity

Ocelot	*Leopardus pardalis*	LE	E

dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November

Plains spotted skunk	*Spilogale putorius interrupta*		

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf	*Canis rufus*	LE	E

NUECES COUNTY

MAMMALS		Federal Status	State Status

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

Southern yellow bat	*Lasiurus ega*		T

associated with trees, such as palm trees (Sabal mexicana) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter

West Indian manatee	*Trichechus manatus*	LE	E

Gulf and bay system; opportunistic, aquatic herbivore

White-nosed coati	*Nasua narica*		T

woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

REPTILES		Federal Status	State Status
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	LE	E

Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans, nests April through November

Green sea turtle	*Chelonia mydas*	LT	T

Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

Gulf Saltmarsh snake	*Nerodia clarkii*		

saline flats, coastal bays, and brackish river mouths

Indigo snake	*Drymarchon corais*		T

Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter

Keeled earless lizard	*Holbrookia propinqua*		

coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; eggs laid underground March-September (most May-August)

Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	E

Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback sea turtle	*Dermochelys coriacea*	LE	E

NUECES COUNTY

REPTILES		Federal Status	State Status

Gulf and bay systems, and widest ranging open water reptile; omnivorous, shows a preference for jellyfish; in the US portion of their western Atlantic nesting territories, nesting season ranges from March to August

Loggerhead sea turtle	*Caretta caretta*	LT	T

Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Spot-tailed earless lizard	*Holbrookia lacerata*		

central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Texas diamondback terrapin	*Malaclemys terrapin littoralis*		

coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches; brackish and salt water; burrows into mud when inactive; may venture into lowlands at high tide

Texas horned lizard	*Phrynosoma cornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Texas scarlet snake	*Cemophora coccinea lineri*		T

mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September

Texas tortoise	*Gopherus berlandieri*		T

open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November

PLANTS		Federal Status	State Status

Elmendorf's onion	*Allium elmendorfii*		

Texas endemic; grassland openings in oak woodlands on deep, loose, well-drained sands; in Coastal Bend, on Pleistocene barrier island ridges and Holocene Sand Sheet that support live oak woodlands; to the north it occurs in post oak-black hickory-live oak woodlands over Queen City and similar Eocene formations; one anomalous specimen found on Llano Uplift in wet pockets of granitic loam; flowering March-April, May

Lila de los llanos	*Echeandia chandleri*		

most commonly encountered among shrubs or in grassy openings in subtropical thorn shrublands on somewhat saline clays of lomas along Gulf Coast near mouth of Rio Grande; also observed in a few upland coastal prairie remnants on clay soils over the Beaumont Formation at inland sites well to the north and along railroad right-of-ways and cemeteries; flowering (May-) September-December, fruiting October-December

Mexican mud-plantain	*Heteranthera mexicana*		

wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall

(Ocelot photo courtesy of Tom Smiley, TPWD)

E. CULTURAL RESOURCES

Cultural resources such as buildings, battlefields, streets, churches, and other man-made features are literally the links to our past. Preservation of these historical icons is important in understanding what made Texas what it is today, and can provide insight to where we are heading tomorrow. There are two types of Cultural Resources, Historical Sites and Archaeological Sites.

Historical Sites are typically landmarks and buildings 50 years or older that have a clear link to our past. These include (but are not limited to) churches, government buildings, or centers of commerce from by-gone eras. These edifices or sites have typically been identified in the past and have been preserved through the Texas Historical Commission through a preservation group or committee or local government. Historical sites, entered into the GIS database, are the most common and easily recognizable Cultural Resources.

Archaeological sites, on the other hand, are not always marked with a typical bronze plaque. These sites typically pre-date recorded history and may involve resources sometimes older than 10,000 years ago. Resources of this type can only be understood through careful, controlled archaeological studies. Many of these types of sites are not marked or denoted in any way in order to prevent vandalism and amateur collection of these culturally important artifacts.

The GIS associated with this project was constructed using the Texas Historical Commissions (THC) Register of Historic Places. These places are easily denoted, and any potential drainage project should consult with the GIS database to ensure that no Historical Places or Sites are disturbed during construction. If a proposed project has the potential to affect a building or other structure, architectural historians will review the project to determine any direct or indirect effects to the site.

Some projects involve excavation for drainage features, and have the potential to affect archaeological site. For any construction projects, if any cultural articles are found during any excavation or construction, then work should cease immediately and the Texas Historical Commission should be notified immediately and investigated before work can continue.

Permitting – Some projects require coordination with the THC regardless of the apparent lack of cultural resources or historical markers due to funding requirements. For instance, the Texas Water Development Board (TWDB) requires at least some coordination with the THC on all projects funded by them, including the State Revolving Fund (SRF). Archaeologists with the THC examine new construction for potential impacts to archaeological sites, and most are concerned about sub-surface disturbance within the actual construction footprint, as well as the immediately surrounding area. Only authorized archaeologists that meet the qualifications for a principle investigator found in Chapter 26 of the Antiquities Code may conduct the examinations. A listing of authorized archaeologists can be found on the Council of Texas Archaeologists website.

(Photos from Texas Historical Commission Website http://www.thc.state.tx.us/)

The results of any investigation are submitted to the THC for review. If no cultural or archaeological resources were found, then likely the THC will not require further review. If cultural resources were found, then they will be collected and sent to the THC for examination and determination whether the materials are culturally or archaeologically important. Sites that cannot be avoided my be excavated in their entirety and removed for further study. The THC is bound by a set of Texas laws, however, which require avoidance and minimization of impacts to cultural and/or archaeological resources if at all possible. Some proposed projects may be required to re-design the project, alter the footprint, or potentially abandon the project entirely if the resources cannot be avoided and are deemed important.

A permit application with the THC should include a brief project description, a clear and concise map marked with the potential project footprint, and the request for a review of the project by the THC.

F. RECEIVING WATERS

A receiving water body is literally the body of water that receives runoff or waste-water discharge, such as rivers, streams, lakes, estuaries, and ground water. Nueces County's most conspicuous receiving water body (primary bay) is Corpus Christi Bay, as it is the bay that exchanges waters with the Gulf of Mexico through the Corpus Christi Ship Channel. All receiving waters eventually go to the Gulf of Mexico, the ultimate receiving water. Two secondary bays are associated with Corpus Christi Bay, Nueces and Oso Bays.

Nueces Bay is fed by the Nueces River, the largest in the watershed. Nueces Bay is the largest estuary for the Corpus Christi Bay system. Unless water is released from the lake or rains are heavy then Nueces Bay will become a negative estuary at times. This condition is caused by inflows lower than the evaporation rate, which results in a typically low salinity estuary becoming a hypersaline bay-system, transitioning from a nursery to a stressed environment.

Oso Bay is the receiving water for Oso Creek, which begins as a bar ditch and sewer treatment outfall in Robstown, TX. Oso Creek is influenced by two wastewater discharge plants (the Greenwood and Ennis Joslin plants) that combined add approximately 57 million gallons per day of fresh water. Oso Creek has also been lately influenced by the Barney Davis Power Plant in Flour Bluff, TX, which at full capacity discharges 502 millions gallons per day from the Laguna Madre into Oso Bay.

The Laguna Madre also receives some waters from Nueces County, and although it does not exchange directly with the Gulf of Mexico, it has secondary bay characteristics. The Laguna Madre receives water from Flour Bluff/Naval Air Station and the backside of Padre Island. The Upper Laguna Madre is a hypersaline lagoon, as the evaporation rates typically exceed the exchange rate, and salinities can widely vary.

The Baffin Bay system also receives bay waters from Nueces County. Petronila Creek empties into Alazan Bay, which is one of three secondary bay systems in Baffin Bay (including Laguna Salada and Cayo del Grullo).

Areas of Chapman Ranch and King Ranch drain into the Laguna Largo system. Laguna Larga is a land-locked playa lake with depressed salinities. It is an emphemeral body of water that will drastically reduce or increase in size proportional to rainfall amounts.

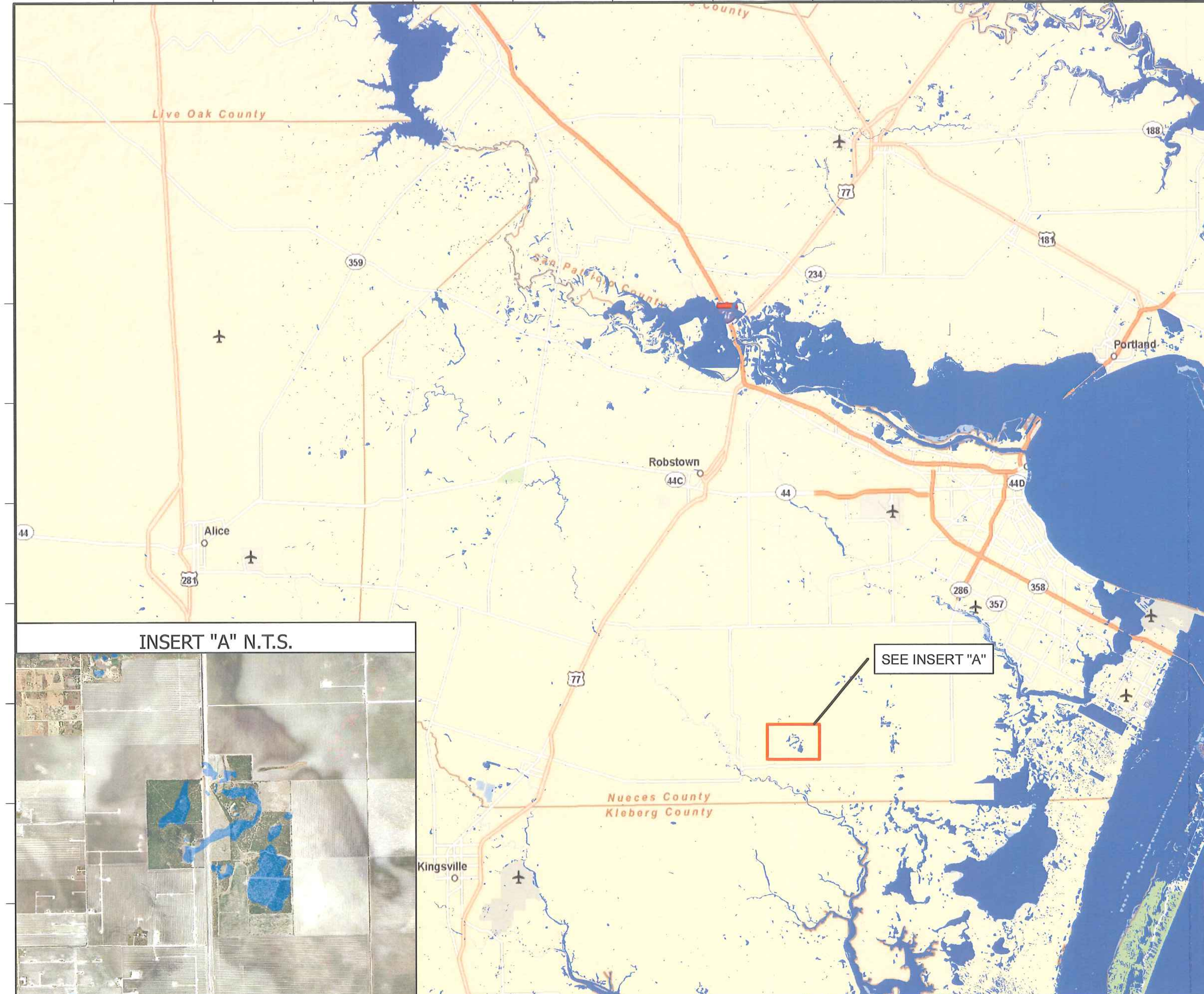
F. GIS TOOLS

The GIS system developed for Nueces County as part of this plan has some great planning environmental and cultural data available which can be utilized for quick reference. Some of the data layers available include the following:

1. Wetland Inventory listing acquired from the US Fish & Wildlife Service

2.
3. Critical Habitat acquired from the US Fish & Wildlife Service
4. Priority Protection areas identified by the GLO.
5. Areas listed as having an ecological occurrence. Data acquired from TPWD.
6. Historical Site Listing acquired from the Texas Historic Commission.

For example, if a developer approaches the County about developing a new subdivision on a specific site, the county will be capable of making a quick evaluation of the site. By zooming into the site and turning on the Aerial layer, turning on the contour layer and turning on the environmental and historical layers, a quick assessment can be conducted on the suitability of the site for development. In addition, the county can assess whether any master plan drainage improvements are planned for the area. Exhibit V-1 shows one example of a zoomed in view of an area with the wetland inventory layer turned on. The tool is very powerful.



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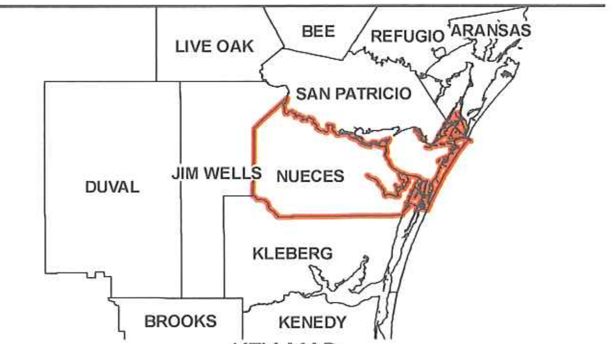


KEY MAP

2.5 1.25 0 2.5
Miles

N W E S

MAP LEGEND

NOTE: THIS EXHIBIT IS AN EXAMPLE OF THE USE OF GIS. A QUICK REFERENCE OF WETLAND INVENTORTY. THE DATA IS FROM THE INVENTORY PROVIDED BY USFWS.

THE STATE OF TEXAS — COUNTY OF NUECES

NUECES COUNTY MASTER DRAINAGE PLAN

EXHIBIT IX-01
WETLAND INVENTORY
ON GIS SYSTEM

DECEMBER 2009	EXHIBIT	

PART X
GEOGRAPHICAL INFORMATION SYSTEM

Geographic Information System (GIS)

The purpose of this project initiative was to develop a Master Drainage Plan for Nueces County. GIS technology and data were utilized to support various analytical and visualization tasks on the project. At the beginning of the project, The AIS team, lead by URS was tasked with creating a comprehensive *GIS Data Management and Implementation Plan (DMIP)* to organize and effectively mange all data acquisition and dissemination efforts during the project. A copy of the Plan is included as Appendix IV-1. Emphasis was placed on implementing an effective GIS data management approach that would avoid duplication of individual effort, eliminate redundancy in data development, and ensure accuracy of all data collected throughout the life cycle of the project.

URS conducted an initial GIS needs and requirements analysis to determine the most effective data management approach. The multi-participant GIS model was applied in the context of this initiative to acquire, assimilate, and distribute all project-related GIS data to appropriate project stakeholders. This model provided a centralized, common data resource base with distributed access and use by designated consultants on the team. The following organizations participated in the multi-participant GIS model and the data development effort:

Prime Consultant:
Naismith Engineering, Inc. (NEI)

Subconsultants:
Civil Systems Engineering, Inc. (CSE)
DOS Logistics, Inc. (DL)
URS Corporation (URS)

The DMIP defined the functional and geospatial data requirements of the project. For the purposes of all GIS-related tasks on the project, it was assumed that the ESRI ArcGIS software suite (desktop and web-enabled applications) and associated GIS data formats would be utilized. Project-specific geospatial data standards and requirements (i.e. appropriate data storage/transfer protocol, coordinate system, naming conventions, and metadata format) were provided to each of the project consultants to illustrate and guide each phase of GIS data development and implementation and identify potential data resources, opportunities, and constraints.

The data development process involved an exhaustive inventory of geospatial data available and relevant to the project in an effort to develop a comprehensive GIS for

Nueces County, Texas. The following data layers were acquired or created for integration into the project geodatabase:

- 2 foot Contours
- 2006 Imagery
- 15 Minute Rain Gages
- 1997 Flood Event Measurements
- Airports
- Banks
- Bridge Hydraulics
- Bridge Inventory (field collected)
- Channels
- Colonias
- County Boundaries
- County Grid
- Critical Habitat
- Critical Evacuation Routes
- Culvert Hydraulics
- Daily Flow Gages
- Daily Lake Gages
- Daily Rain Gages
- Demographics (2006-2035)
- Drainage Ditches
- Ecological Occurences
- Evaporation Gages
- Flow Nodes
- Flow Paths
- Hourly Rain Gages
- Hydrologic Unit Codes
- Municipal Boundaries
- 100 Year Floodplains
- Radar Grid
- Railroads
- Repetitive Loss Properties
- Roads/Highways
- Soils
- Streamline Network/Main Stems
- Sub-basins
- Tax Parcels
- Water Bodies
- 303d Streams
- Watersheds
- NWI Wetlands

During the data development process high-resolution LiDAR was geoprocessed to create the following topographic elevation data deliverables:

- 2 foot Contours
- 10 foot Contours
- 10 x 10 Grid (Raster) Dataset
- 50 x 50 Grid (Raster) Dataset
- TINs (Triangular Irregular Networks)

URS applied the following methodology to organize and process the raw LiDAR data. The grids and TINs created can then be used for hydrologic analysis such as watershed delineation and hydraulic cross-section analysis.

Data Organization and Pre-processing

Step 1: A polygon grid was created to organize the LiDAR data distribution across Nueces County. The grid was sized so that the input text files would not exceed 60 million points or 4 GB. This step helps to reduce processing time.

Step 2: Folders were then created for each grid cell or tile. A DOS based batch command then compiled the text files associated with each tile into one large text file per tile.

Step 3: ArcGIS (ArcInfo) was then used to import each cumulative text file and convert the information into point feature classes or shapefiles. A folder was created for each of the point shapefiles.

TIN Creation

Step 4: After pre-processing was completed, an ArcInfo.aml routine was created to convert the point shapefiles into coverages.

Step 5: A second .aml script is then run to convert the coverages into TINs. TINs interpolate between all known points to develop a consistent surface. TINs use the smallest weed tolerance and most detailed parameters that the data will yield.

Step 6: The TIN was then converted to a 10ft x 10ft grid to filter out similar points.

Step 7: The 10ft x 10ft grids were then converted back to point shapefiles. The new point shapefiles are uniform and incorporate no gaps.

Step 8: The new point shapefile was then converted to a TIN, and breaklines provided with the LiDAR were included. A base grid was also used to clip the extent of the TIN to incorporate areas where sufficient data was available.

Step 9: An .aml routine was then applied to create 2ft and 10ft contours for the area. URS compared the resulting contours with available USGS quadrangle maps for quality assurance of the final data product.

APPENDIX XI-1

TECHNICAL METHODS AND CRITERIA

A. SYSTEM MAPPING

Preliminary information for mapping the existing drainage system was mapping available from State Agency web states, current digital aerial photographs, USGS topographic maps and the use of LIDAR Data.

The available data was utilized to create updated system maps for this study. The basins have been incorporated as a data layer in the GIS system developed as part of this study.

B. HYDROLOGY

Normally a flood is said to occur when more water than can be conveyed by the receiving stream is introduced. Although rain causes flooding, large rain storms do not necessarily create a flooding event. The extent of a flooding event depends on several factors, including rainfall amount as well as the existing conditions of the watershed before and during the event. When rain falls on a very saturated watershed, the land is unable to absorb the water and it will runoff at a higher rate. This has been proven historically with rain events in Nueces County.

In October, 1997 a stalled cold front produced storms over a 5 day period over the Petronila Creek Watershed. The watershed is approximately 543 square miles with the extreme upper end crossing into Western Jim Wells County. On average, the rainfall over the entire watershed was only a 5-year storm. However, you cannot always analyze the watershed as a whole. In other words, sometimes it rains heavily in one part of the watershed and not in another part. This was definitely the case for the 1997 storm event.

If we isolate the most heavily hit area just southwest of the community of Petronila you will find an entirely different scenario. The estimated rainfall depths in the area were extreme events, particularly for durations of multiple days. The 5-day total of 17.8 inches was estimated to recur on average once in 500 years. The shorter duration storms, which would be more indicative of flood recurrence experienced in smaller watersheds, were estimated to have return periods that varied from 20 to 45 years.

A copy of the Technical Memorandum developed by URS Corporation analyzing the flood event is included as Appendix III-1.

Driscoll, Texas, October13, 2007

The methods for calculating the stormwater runoff can be accomplished utilizing some commonly accepted engineering methods. Typically large areas and small areas require the use of different methods.

Large Drainage Basins

For drainage areas greater than 500 Acres, three methods available to be utilized for estimating runoff are as follows:

USGS Method – This method was developed by the U.S. Geological Survey (USGS) in: "Technique for Estimating the Magnitude and Frequency of Floods in Texas (Ref. ___). In developing the method, peak discharge data from 289 sites throughout the state were incorporated using procedures which had been established by the Hydrology Committee of the U.S. Water Resource Council in 1976. Multiple regression techniques were used to develop equations for predicting the peak discharge for various return periods. Independent variables considered in the multiple regression analysis included drainage area, slope, channel length, elevation, mean annual precipitation, evaporation, and the 24-hour rainfall intensity with a 2-year recurrence interval. The state was subsequently divided into six regions on the basis of the distribution of the residuals from a single statewide regression of the 10-year flood.

SCS Method – The Soil Conservation Service (SCS) Method is described at length in the SCS National Engineering Handbook (Ref. ____). In this method, peak discharge for typical applications is estimated by the SCS method based on the following equation:

$$q_p = 484\ AQ/T_p$$

where: q_p = Peak discharge in cubic feet per second (cfs)
A = Watershed area, sq. mi
Q = Depth of effective precipitation, in.
T_p = Time to peak discharge, hr.

Cypress Creek Method – The Cypress Creek Method as applied by Stephens and Mills (Ref. ______) of the Agricultural Research Service (ARS) is a less commonly used method of peak discharge estimation considered for the area. Stephens and Mills applied the method to three rural watersheds in the Southern Florida Flatwoods major land resource area. The experimental watersheds ranged in size from 15.6 to 98.6 square miles and typically have sandy soils and slopes in the 0 to 2 percent class. Given the similarity in watershed size, topography, coastal proximity and meteorological influence, and soil type between the soil type between the experimental watersheds and the Nueces County Area, applicability of the method could have been considered.

In 1986, a Nueces County Stormwater Management Master Plan was developed through the South Texas Water Authority (Ref. ____). The plan applied all three methods to the major creeks within Nueces County and compared the calculated runoffs to some documented instantaneous peak discharges on the streams. Based on the historical points of reference, the Master Plan concluded that the USGS Method yields the most reasonable peak discharge estimates for the creeks in Nueces County.

Selected Hydrologic Method

The USGS Method will also be utilized for the current (2009) study. The Outlined below is some of the data which was utilized in the development of the HEC-HMS models. The Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems. This includes large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation.

For Nueces County HEC-HMS Model were created to determine the instantaneous peak discharge values for key points alone drainageways. Peak discharge values were calculated for return periods ranging from 2 to 500 year storms. The precipitation recurrence values shown in Table III-A were utilized in the analysis.

Table III-A

USGS Atlas of Depth-Duration Frequency of

Precipitation Annual Maxima for Texas, 2004.

Storm Event	15-min	30-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
2-yr	1.08	1.41	1.86	2.19	2.42	2.85	3.41	4.09
5-yr	1.37	1.84	2.48	2.97	3.31	3.97	4.81	5.84
10-yr	1.57	2.13	2.90	3.52	3.94	4.79	5.84	7.12
25-yr	1.82	2.52	3.49	4.29	4.85	5.97	7.30	8.94
50-yr	2.03	2.84	3.97	4.94	5.61	6.98	8.55	10.48
100-yr	2.24	3.18	4.51	5.66	6.47	8.13	9.95	12.18
500-yr	2.80	4.08	5.96	7.68	8.90	11.45	13.94	16.97

Other Key Considerations utilized during the HEC-HMS analysis were as follows:

- Unit Hydrograph: The- NRCS Dimensionless Unit Hydrograph Method.
- Peaking Rate Factor - 200 - Calculated Lag Time from NRCS Lag Time Equation should be modified by a multiplier of 484/200
- Lag Time - NRCS Lag Time Equation

$$L_p = \frac{L_W^{0.8}\lfloor(1000/CN)-9\rfloor^{0.7}}{31.67S^{0.5}}$$

Where L_p is the lag time in minutes, L_w is the length of the longest flow path in feet, S (%) is the slope of the longest flow path, and CN is the composite curve number.

- Curve Number (CN) - reflect fair conditions, open spaces, and brush cover - independent of impervious cover - NRCS Soil Data (URS) - GRID Format
- Percent Impervious Cover - (URS) - GRID format
- Zonal Statistics of Spatial Analyst were used to get composite mean CN and the Impervious cover for each of the sub-basins.
- Reach Routing - Modified Puls and Muskingum-Cunge Routing Method (8 points)

- Revised the preliminary GeoHMS modeling sub-basins according to stream crossing location.
- USGS gage data and Regression Equations were used to check model results.

Analysis of Small Drainage Basins (less than 500 acres)

The **Rational Method** was also utilized as a means of determining the discharge from drainage areas less than 500 acres. The rational method is based on the principle that the maximum rate of runoff from a given drainage area for an assumed rainfall intensity occurs when all parts of the area are contributing to the flow at the point of discharge.

$Q = C \times I \times A$

where: Q = the peak runoff rate (cubic feet per second);
C = a runoff coefficient dependent on land use (Table, A Appendix ____)
I = the rainfall intensity (inches per hour); and,
A = the drainage area (acres)

The runoff coefficient (C) is judgmental and varies with the topography, land use, and moisture content of the soil at the time the rainfall producing runoff occurs. Common Coeffecients are in included in Appendix III-2.

The intensity (I) can be determined from the formula

$I = b/(t_c+d)^e$

where: b, d, and e are constants based on Weather Bureau (NWS) Technical Paper No. 40 " Rainfall Frequency atlas of the United States"

t_c is the time of concentration in minutes required for the runoff to flow from the most hydraulically remote point in the watershed to the facility site and is estimated from the watershed characteristics.

For Nueces County the following e, b and d values apply:

Table III-B						
	2 –Year	5-Year	10-Year	25-Year	50-Year	100-Year
e	0.789	0.753	0.742	0.727	0.711	0.690
b	69	66	76	83	87	85
d	8.2	7.4	7.4	7.4	7.4	8.2

Additional examples and details of design may be found in the Nueces County Drainage Criteria Design Manual (Ref ________).

C. HYDRAULICS

Hydrologic Engineering Centers River Analysis System (HEC- RAS) is the primary hydraulic analysis tool. HEC-RAS allows you to perform one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modeling.

The key input for the programs is information on stream channel cross sections and describing the hydraulic properties of the stream and bridge and culvert geometry.

The LiDAR dataset was utilize to develop the majority of the cross-sections. Additional field reconnaissance surveys were completed for some of the streams and structures.

Hydraulic models were created for sections of the Upper Oso Creek and sections of Petronila Creek. The flood studies were performed as a planning study, and not performed with the level of ground and channel survey and other detail necessary to submit as a Flood Insurance Study (FIS). The design/study team are confident that the results are accurate enough to reflect the anticipated approximate water surface elevations within the watershed.

Flowmaster and CulvertMaster are two other commercially available software programs which were utilized. The programs are capable of analyzing open channel flow and culvert flows.

Technical Memorandum

Estimation of Return Period of October 8-13, 1997 Storm in Petronilla Creek Watershed

Prepared for:

Willie Rivera
Naismith Engineering

Prepared by:

Jeff Irvin, P.E.
URS Corporation
9400 Amberglen Blvd.
Austin, TX 78729

August 11, 2009

To: Willie Rivera, Naismith Engineering

From: Jeff Irvin, P.E., URS Corporation

RE: Estimation of Return Period of October 8-13, 1997 Storm in Petronilla Creek Watershed

Date: August 11, 2009

The purpose of this memorandum is to estimate the return period (annual exceedance probability) of the series of storms in Nueces County from October 8 to 13, 1997. The data used in the analysis will be described, followed by a brief description of the analysis methodology.

Background

The return period of storms varies with storm duration. For instance, the 1-day 100-year rainfall depth for Nueces County is about 12 inches, or approximately 0.5 inch per hour. The 1-hour 100-year rainfall for Nueces County is approximately 4.5 inches, a storm of much less total rainfall depth, but much higher intensity (4.5 inches per hour). The Petronilla Creek watershed has a total area of about 543 square miles, with a time for flow to proceed from the upstream end of the watershed to the outlet on the Gulf of about 5 days. The storm duration that would typically lead to peak flow at the outlet would be a 5-day storm. Storms of lesser duration would be the critical storms for the numerous subwatersheds of Petronilla Creek. To understand the severity of the October 8 to 13 storms, it is necessary to estimate the return period of those storms for a full suite of storm durations, ranging from 1 hour to 5 days.

Source Data

Two sets of rainfall data were obtained, reviewed, and used in the analysis. Figure 1 shows the study area with the location of watershed, radar data grid, and Corpus Christi.

Hourly Rainfall Data from the Corpus Christi Airport. The Corpus Christi Airport rain gage is the only hourly rain gage in the vicinity of the Petronilla Creek watershed. Data were obtained for this gage and are plotted for the period of interest on Figure 2.

Hourly Precipitation Data per NOAA NEXRAD Stage III Data. NEXRAD Stage III hourly spatial rainfall data were obtained from NOAA. The data are provided for each grid cell shown on Figure 1. NOAA radar-based precipitation estimates are substantially less accurate than point data, such as data from rainfall collected and measured in a point gage at the Corpus Christi Airport. These data are needed, however, for analysis of storms that are focused on one part of a large ungaged watershed, as is the case of this storm and the Petronilla Creek watershed.

Technical Approach

The technical approach involved the following tasks:

- The radar data grid was overlain with the Petronilla Creek watershed, as shown on Figure 1. The area (in acres) of each grid cell within the watershed was estimated using GIS methods.
- The hourly average rainfall depth over the entire Petronilla Creek watershed was estimated by multiplying the hourly rainfall in each grid cell by its corresponding area (in acres), summing these values for the full watershed area, then dividing by the full watershed area. This calculation was performed for each hour in the period of interest. These data are shown on Figure 3. The data for the grid cell with the highest rainfall totals are shown on Figure 4.
- Consecutive summations in increments of 1 hour, 2 hours, 3 hours, 6 hours, 12 hours, 1 day, 2 days, 3 days, and 5 days were performed for the watershed aggregate rainfall and for the rainfall in each cell. The maximum summed values were then found for each duration for each analysis.
- These maxima were compared to rainfall depths for south Nueces County for 1-hour through 5-day duration storms for return periods varying from 2 years to 500 years per the "Atlas of Depth-Duration-Frequency of Precipitation Annual Maxima for Texas" (USGS Scientific Investigations Report 2004-5041, 2004) to estimate the return period of the most intense portions of the October 8 to 13 storm.

Results

Table 1 provides a summary of the maximum rainfall depths by duration averaged over the entire watershed and within the grid cell with the most intense rainfall (see Figure 1). Table 1 also provides an estimate of the corresponding return period for each rainfall depth. In general, the average rainfall over the entire watershed was a relatively frequent depth, with the exception of the 5-day total which corresponded to a 10-year event (one that could be expected on average to be exceeded once in 10 years). Based upon this estimate, the flooding within the Petronilla Creek main stem that occurred in October 1997 would be estimated as a 5-year flood level.

The estimated rainfall depths in the grid cell receiving the most intense rainfall were very extreme events, particularly for durations of multiple days. The 5-day rain total of 17.8 inches was estimated to recur on average once in 500 years. The shorter duration storms, which would be more indicative of flood recurrence experienced in smaller watersheds, were estimated to have return periods that varied from 20 to 45 years.

It should be noted that the statistics for the single cell are dominated by the radar estimates for October 13, which show a total rainfall depth on that date of 6.85 inches, much greater than that measured at the nearest point gage at Corpus Christi, which measured a maximum of just over 4 inches in a 24-hour period. This inconsistency points to the likelihood that the actual rainfall depth over the lower Petronilla Creek watershed was less than that estimated by radar.

It should also be noted that a large volume rainstorm, such as the 5-day event, would lead to a particularly wide extent and duration of flooding in flat terrain pocked with depressions, as is the case with lower Petronilla Creek. The depressions, which have limited capacity outlets, would retain water for a protracted period.

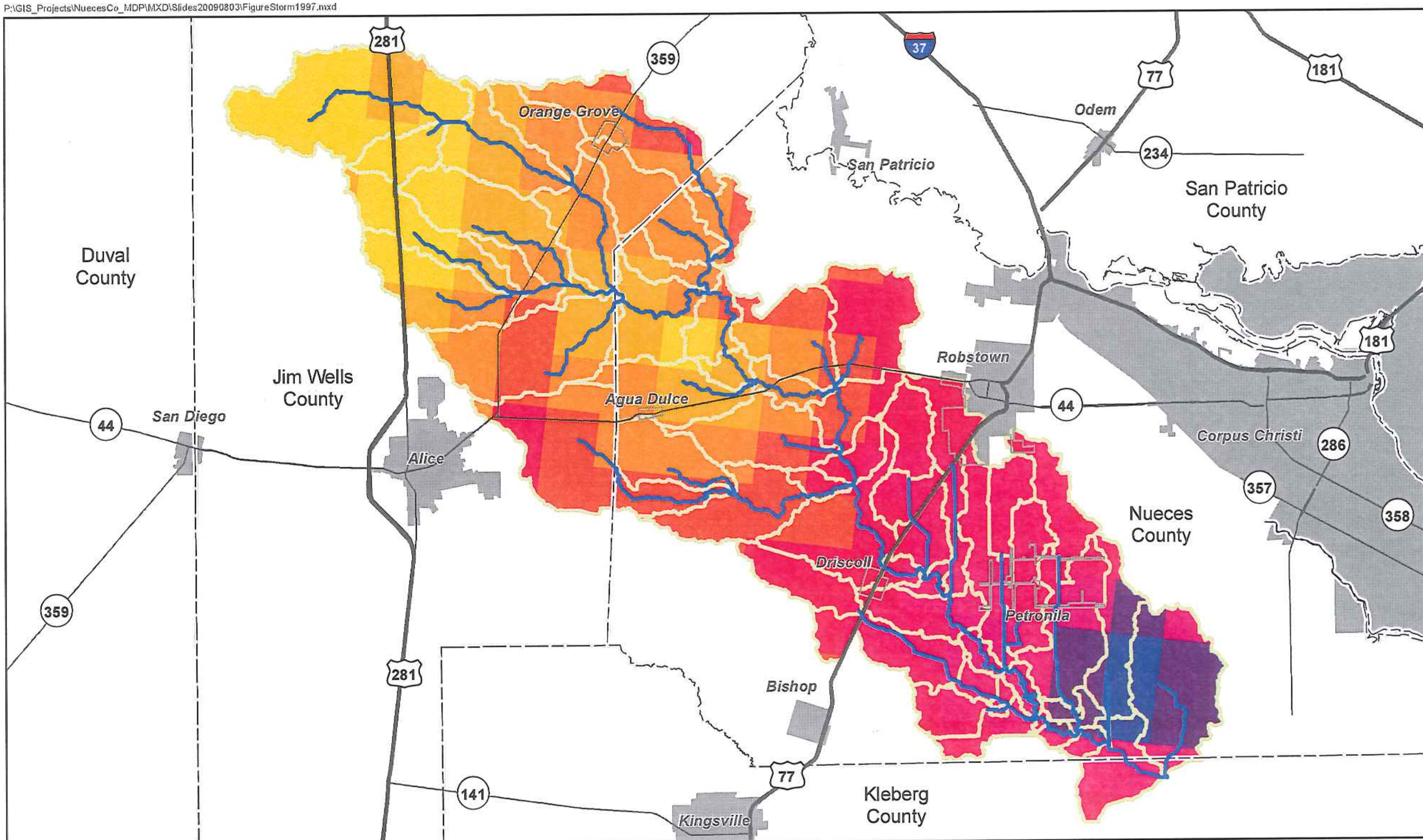
Table 1:

Oct 8-13 storm over Petronilla Creek Watershed

Duration/Return Period Values

	Grid Cell with Highest Rainfall		Entire Watershed		Corpus Christi
Duration	Precip (in)	Return Period (yrs)	Precip (in)	Return Period (yrs)	Precip (in)
1 hour	3.31	**20**	0.70	-	1.14
2 hours	4.71	**35**	1.15	-	1.34
3 hours	5.21	**40**	1.35	-	1.56
6 hours	6.65	**45**	1.89	-	2.17
12 hours	6.85	**25**	2.52	-	2.54
1 day	6.85	**10**	3.27	-	4.03
2 days	8.77	**20**	5.51	**4**	6.23
3 days	12.57	**80**	6.71	**6**	8.80
5 days	17.80	**500**	8.55	**10**	11.07

P:\GIS_Projects\NuecesCo_MDP\MXD\Slides20090803\FigureStorm1997.mxd



N
0 3 6 Miles
1 : 380,160 or 1 inch = 6 miles

URS

6-Day Total (inches)

3.20 - 4.50	10.50 - 12.00
4.50 - 6.00	12.00 - 13.50
6.00 - 7.50	13.50 - 15.00
7.50 - 9.00	15.00 - 16.50
9.00 - 10.50	16.50 - 17.80

Petronila Creek Network
Watershed
City
County

Petronila Creek Watershed Storm Event

October 8-13, 1997
6-day total Precipitation

Date: 08/11/2009

Figure 1

Figure 2:
Corpus Christi Hourly Rainfall
October 1 - 20, 1997

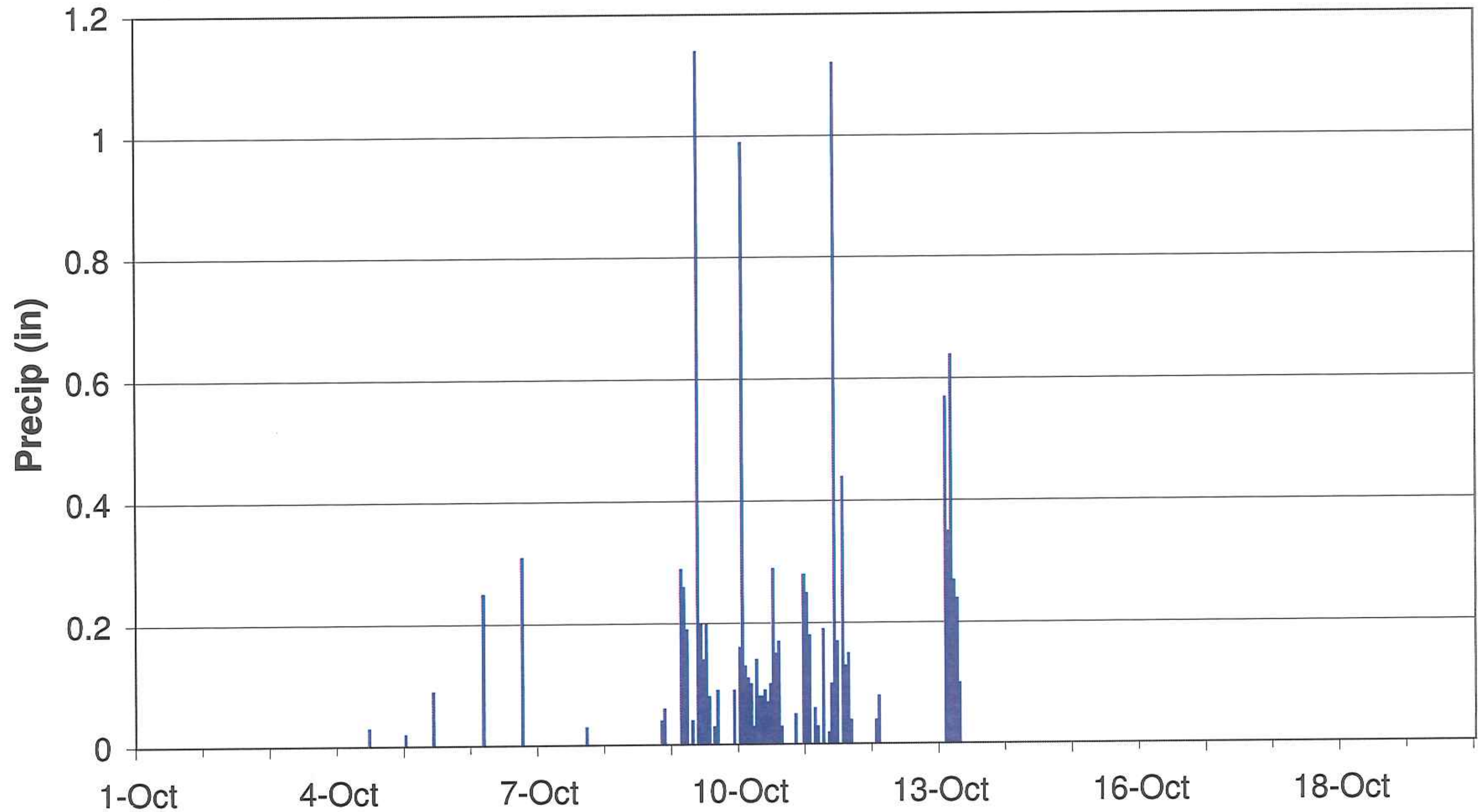


Figure 3:
Petronilla Creek Watershed Hourly Aggregate Rainfall
October 8-13, 1997
Over the Entire Watershed

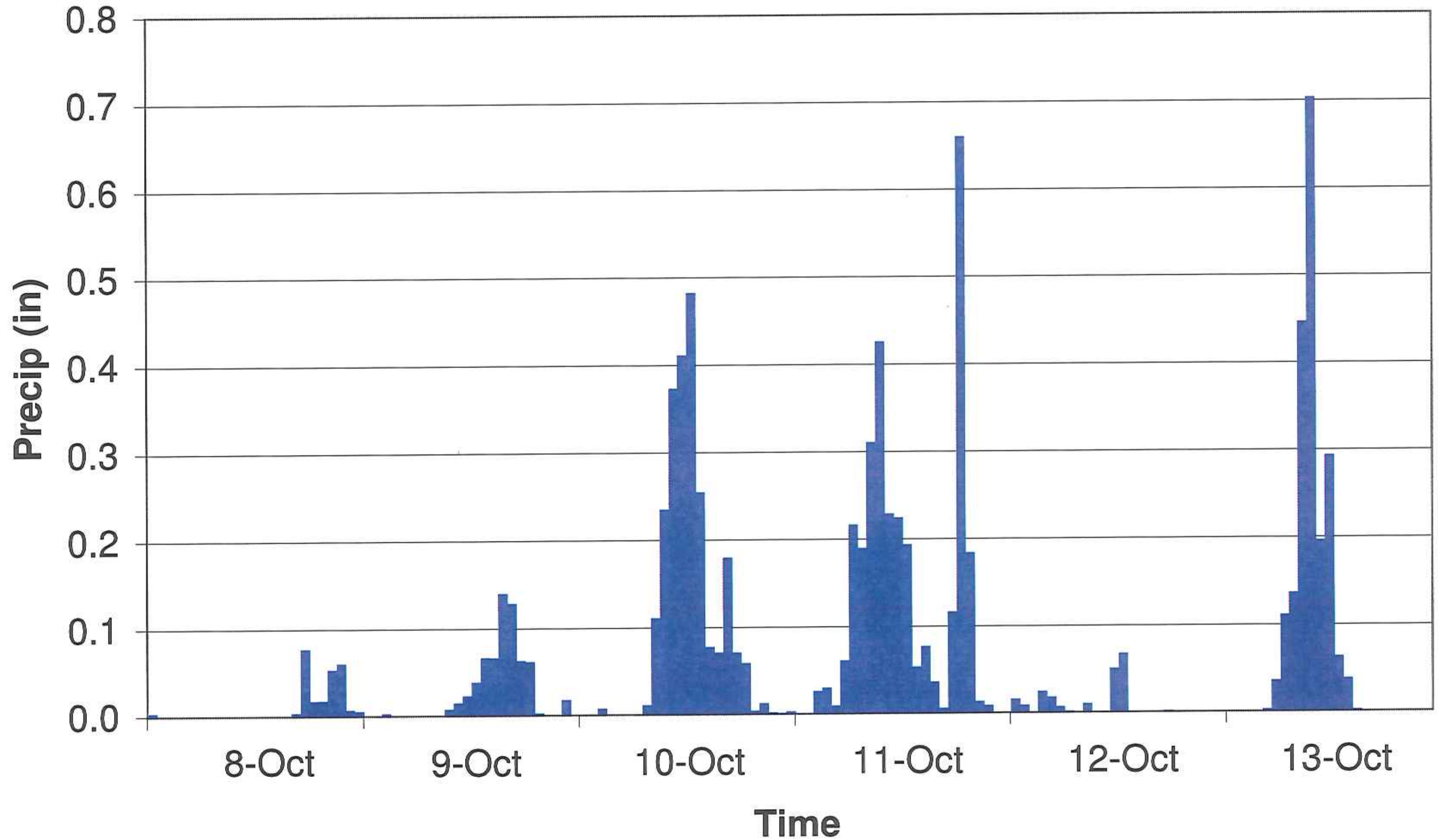
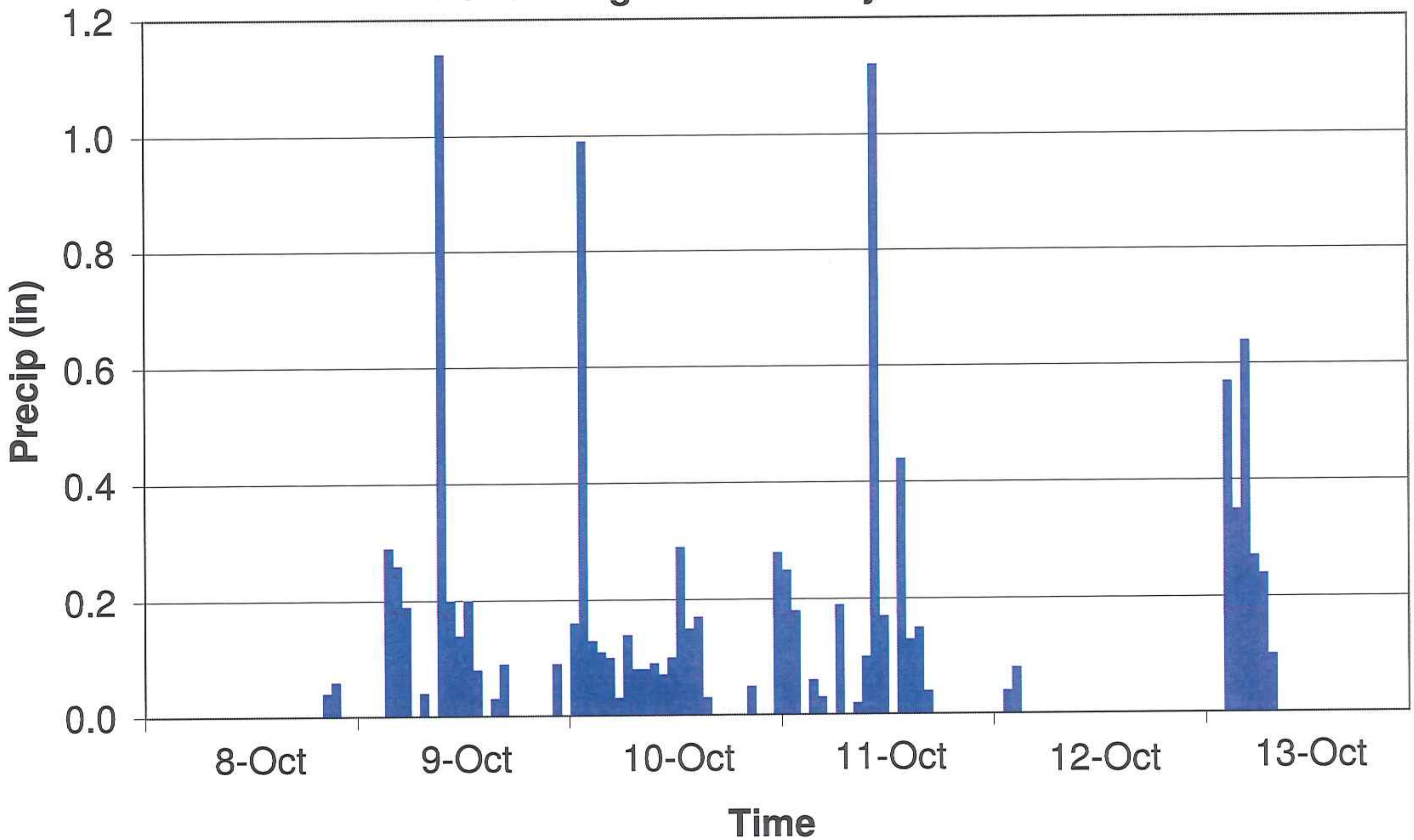


Figure 4:
Petronilla Creek Watershed Hourly Rainfall
October 8-13, 1997
For the Highest Cell Only



Appendix XI-3

Runoff Coefficients (C) for Urban Watersheds

Type of Drainage Area	Runoff Coefficient
Business:	
♦ downtown areas	0.70-0.95
♦ neighborhood areas	0.30-0.70
Residential:	
♦ single-family areas	0.30-0.50
♦ multi-units, detached	0.40-0.60
♦ multi-units, attached	0.60-0.75
♦ suburban	0.35-0.40
♦ apartment dwelling areas	0.30-0.70
Industrial:	
♦ light areas	0.30-0.80
♦ heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.30-0.40
Railroad yards	0.30-0.40
Unimproved areas:	
♦ sandy or sandy loam soil, 0-3%	0.15-0.20
♦ sandy or sandy loam soil, 3-5%	0.20-0.25
♦ black or loessial soil, 0-3%	0.18-0.25
♦ black or loessial soil, 3-5%	0.25-0.30
♦ black or loessial soil, >5%	0.70-0.80
♦ deep sand area	0.05-0.15
♦ steep grassed slopes	0.70
Lawns:	
♦ sandy soil, flat 2%	0.05-0.10
♦ sandy soil, average 2-7%	0.10-0.15
♦ sandy soil, steep 7%	0.15-0.20
♦ heavy soil, flat 2%	0.13-0.17
♦ heavy soil, average 2-7%	0.18-0.22
♦ heavy soil, steep 7%	0.25-0.35
Streets:	
♦ asphaltic	0.85-0.95
♦ concrete	0.90-0.95
♦ brick	0.70-0.85
Drives and walks	0.75-0.95
Roofs	0.75-0.95

Appendix XI-4
Storm Water Management Policy
Minimum Level of Protection (Recurrence Interval)

It is the intent of this study to follow as closely as possible the policies being implemented by the City of Corpus Christi in its Draft Drainage Criteria Manual (Ref. _____). The County may opt to modify some of these requirements in rural areas which do not have a major impact on the City of Corpus Christi or other rural communities. In addition, the county has some minimum drainage standards required as part of the Subdivision Ordinance. The County Engineer and the Commissioners Court have final say on the requirements for new developments.

A. Streets and Roadways

<u>Local/Rural Roads (Outside of City of Corpus Christi City Limits):</u>

- 5-Year* Storm water contained within adjacent roadside ditches
- 100-Year Storm Water shall be below adjacent habitable structures.

<u>Collector Road (Outside of City of Corpus Christi City Limits):</u>

- 10-Year * Storm water contained within adjacent roadside ditches
- 100-Year Storm Water shall be below adjacent habitable structures.

<u>Arterial Streets (Outside of City of Corpus Christi City Limits):</u>

- 25-Year Storm water contained within adjacent roadside ditches
- 100-Year Storm Water shall be below adjacent habitable structures.

<u>Major Highways and Freeways:</u>

- 50-Year Conveyance system and inlet design
- 100-Year Storm Water shall be below adjacent habitable structures.

*Note: If the contributing drainage area is greater than or equal to 200 acres, the level of protection shall be for a 25-Year event.

B. Drainage Systems**

Channel requirements

Minor Channels (0-200 acres contributing Area)

- 5-Year — At least 1 foot of freeboard below top of bank
- 100-Year — Take measures to insure that adjacent habitable structures are not impacted by flooding.

Intermediate Channels (200-500 acres contributing Area)

- 25-Year — Design objective is 3 feet of freeboard with 1 foot of freeboard Minimum, when necessary
- 100-Year — Take measures to insure that adjacent habitable structures are not impacted by flooding.

Major Channels (greater than 500 acres contributing Area)

- 25-Year — Design objective is 3 feet of freeboard with 1 foot of freeboard Minimum, when necessary
- 100-Year — **Water Surface Elevation below top of banks**

Bridge Requirements

Minor Channel Crossings

- 5-Year — At least 1 foot of freeboard below bottom of low chord

Intermediate Channel Crossings

- 25-Year — At least 1 foot of freeboard below bottom of low chord
- 100-Year — Take measures to insure that adjacent habitable structures are not impacted by flooding.

Major Channels Crossings

- 50-Year — At least 1 foot of freeboard below bottom of low chord ear
- 100-Year — **Water Surface Elevation below bottom of low chord and measures shall be taken to ensure that street ponding remains below habitable living space.**

**additional system requirements for areas within the City of Corpus Christi may be found in the City's Drainage Criteria Manual (Ref. _______).

APPENDIX XI-5

Nueces County Master Drainage Plan

GIS Data Management and Implementation Plan

Prepared for:

Naismith Engineering, Inc.

Prepared by:

URS
9400 Amberglen Blvd
Austin, TX 78729

April 2008

Table of Contents

1.0 INTRODUCTION

The purpose of this project initiative is to develop a Master Drainage Plan for Nueces County. GIS technology and data will be utilized to support various analysis and visualization tasks on the project. This document details a comprehensive GIS Data Management and Implementation Plan to organize and effectively mange all data acquisition and dissemination efforts during the project. The primary goal is to implement an effective GIS data management approach that avoids duplication of individual effort, eliminates redundancy in data development, and ensures accuracy of data throughout the life cycle of the project. Effective implementation of this plan will result in significant reductions in time and costs associated with GIS data development tasks and will ultimately preserve the integrity of the project geodatabase.

URS conducted an initial GIS needs and requirements analysis to determine the most effective data management approach. The multi-participant GIS model will be applied in the context of this initiative to acquire, assimilate, and distribute all project-related GIS data to appropriate project stakeholders. This model will provide a centralized, common data resource base with distributed access and use by designated consultants on the team. The following organizations will participate in the multi-participant GIS model and the data development effort:

Prime Consultant:
Naismith Engineering, Inc. (NEI)

Subconsultants:
Civil Systems Engineering, Inc. (CSE)
DOS Logistics, Inc. (DOS)
URS Corporation (URS)

This plan will define the functional and data requirements of the project. For the purposes of all GIS-related tasks on the project, it is assumed that the ESRI ArcGIS software suite (desktop and web-enabled applications) and associated GIS data formats will be utilized.

2.0 ROLES AND RESPONSIBILITIES

The number, type, specific technology needs (frequency of use and applications), and responsibilities of potential GIS users involved with the project are defined below as GIS User Level Definitions. Each potential GIS user can be classified as a Manager, Analyst, or Stakeholder.

2.1 GIS User Level Definitions

2.1.1 Manager

A *Manager* from the perspective of GIS data management has ultimate access, control, and authority over the data development efforts of the project. Three individuals will be classified in this category and specific responsibilities of each individual are described below.

Project Manager – Willie Rivera, Jr., PE (NEI)

- Guides the development of a comprehensive GIS data management approach and approves final plan for implementation.
- Redistributes GIS data management responsibilities in the event that the data management effort is not effectively executed or data standards are not achieved.

GIS Task Leader – Kristi Teykl, GISP (URS)

- Develops and executes the GIS data management plan.
- Responsible for developing and monitoring the implementation of project-specific GIS data standards and responsibilities.
- Provides support as requested by the Project Manager to execute GIS data development/mapping/analysis/training.

Geodatabase Coordinator – Julia Presas (URS)

- Responsible for primary control and maintenance of all GIS data integrated into a centralized project geodatabase.
- Coordinates data acquisition, access, exchange, and updates for GIS stakeholders and analysts.
- Communicates data updates regularly to the project team.
- Provides technical guidance to GIS stakeholders and analysts as requested.

2.1.2 Analyst

An *Analyst* can be defined as an intermediate level GIS user. Analysts will use geospatial data and technology to acquire and process data, conduct spatial analysis, and interpret results to gain a better understanding of flood and drainage issues in Nueces County. These individuals will use GIS applications to prepare maps, tables, charts, and graphs to communicate project issues and findings.

2.1.3 Stakeholder

A *Stakeholder* is an introductory level GIS user and will use geospatial technology to visualize geospatial data and review maps to gain an enhanced understanding of project-related phenomena or patterns and support decision making.

3.0 GIS DATA STANDARDS AND SPECIFICATIONS

Project-specific GIS standards and requirements are defined below to illustrate and guide each phase of GIS data development and implementation and identify potential data resources, opportunities, and constraints.

3.1 Data Acquisition and Assimilation

This project employs a concerted data collection effort to be executed by NEI, DOS and URS. Specific assignments have been made to maximize the data collection effort and utilize existing relationships and current GIS offerings/resources. Table 1 describes specific data to be acquired and each partner responsible for collecting the information.

Table 1. Data to be Collected and Partner Responsible for Acquisition

Data	Source	Partner Responsible for Acquisition
Scoping Report and Current TSDN Data and Damage Reports	FEMA	URS
High Water Marks	TxDOT	DOS
Stage Q	USGS	URS
Rainfall and Radar	NOAA	URS
Flood Prone Areas (frequency/level of flood event)	City of Corpus Christi	NEI
Flood Prone Areas (frequency/level of flood event)	Port of Corpus Christi	NEI
Flood Prone Areas (frequency/level of flood event)	Robstown	NEI
Flood Prone Areas (frequency/level of flood event)	Bishop	NEI
Flood Prone Areas (frequency/level of flood event)	Driscoll	NEI
National Wetlands Inventory	USFWS	URS
Critical Habitat	USFWS	URS
Ecological Occurrence Data	TPWD	URS
Storm Reports (2005)	USGS	URS
Rainfall Atlas (2005)	USGS	URS
County Complaints	Nueces County	NEI
Aerial Imagery	TBD	NEI
Current and Projected Land Use/Zoning	City of Corpus Christi	NEI
Tax Parcels	Nueces County Appraisal District	NEI
LiDAR Data Points	FEMA via Nueces County	URS
Topography	Standard Source?	NEI
Structure Inventory (Repetitive Loss)	FEMA	URS
Population and Demographics	US Census Bureau	URS
Stream Segment Quality	EPA/TCEQ/USGS NHD	URS
Roads/Highways	TxDOT/TNRIS	URS
Emergency Response/Evacuation Plans	City of Corpus Christi	NEI

It is imperative that all GIS data developed during the course of the project be mapped and delivered to the Geodatabase Coordinator in a uniform coordinate system and in accordance with a consistent naming convention. The following specifications should be applied to all GIS data developed in support of project goals and tasks.

3.1.1 Coordinate System

Texas State Plane South (FIPS 4205) - NAD 83, Feet

3.1.2 Naming Convention Example

NuecesCoMDP_DataLayer_Source_Partner_Date_Version.shp

3.1.3 Naming Convention Specifications

- Title case will be implemented to distinguish multiple words in naming a data layer, source, or partner responsible for creating or acquiring the GIS data.
- Do not use spaces or punctuation other than the underscore symbol when naming GIS data. Grammatical symbols such as commas, semi-colons, colons, and asterisks will corrupt the geodatabase.
- *NuecesCoMDP* will always serve as the prefix for each GIS shapefile.
- *DataLayer* will describe the content of the shapefile (i.e. NWI, TaxParcels, RoadsHighways, HighWaterMarks).
- *Source* identifies the original source or creator of the data (i.e. TPWD, FEMA, TxDOT).
- *Partner* references the project consultant that acquired and delivered the data to the Geodatabase Coordinator.
- *Date* should reference the actual date the geospatial information was acquired or developed by the Partner.
- *Version* indicates the iteration of the data as it is updated and its geospatial or attribute components are modified (i.e. v1, v2, v3).
- *.shp* – All data will be delivered to the Geodatabase Coordinator in ESRI shapefile format for integration into the project geodatabase.

3.1.4 Metadata

Metadata identifies and documents GIS data source, vintage, and spatial accuracy and details any usage or distribution constraints associated with the data. Every project analyst or stakeholder submitting GIS data to the Geodatabase Coordinator for integration into the project geodatabase will be required to create FGDC-compliant metadata using ESRI ArcCatalog templates and completing all required fields. Refer to Appendix A for examples of FGDC-compliant metadata, ArcCatalog templates, and required fields.

3.1.5 Map Templates

URS has developed custom map templates for the project. These templates will be made available to all members of the project team. These templates provide a standard format for all map products developed during the course of the project and will ensure consistency in map content and communication of project-related data and results of analysis.

3.2 Data Storage

All project-specific GIS data will be integrated in one centralized project geodatabase and hosted on URS data servers. The ESRI *File Geodatabase* repository format will be utilized to manage and maintain all GIS data developed during the project. Proposed schema of the project geodatabase will be provided to the project team to reference and document data organization. This schema is by no means static and may evolve over time as we proceed through the various tasks included in the scope of work to accommodate additional data that were not identified in the initial scoping process. Any updates to geodatabase schema or structure will be communicated to the team as necessary. The Geodatabase Coordinator will be responsible for the integrity and periodic maintenance of this comprehensive project geodatabase.

3.3 Data Access and Exchange

Exchange of project-related GIS data will operate under the assumption that URS provides distributed access and use of a comprehensive, centralized data resource. Project consultants will utilize the URS Secure Folder data exchange portal to access and exchange all GIS data developed during the course of the project. Appropriate access and use permissions have been established for each GIS data user relative to your anticipated data needs and previously assigned GIS User Level (*Manager, Analyst, or Stakeholder*).

During the initial GIS data collection effort (Phase I - Task 2), each consultant will upload any data (shapefiles, TIFF images, PDF files, etc.) they acquire or create to their company's respective folder housed in the URS Secure Folder portal. An email notification should be sent to the Geodatabase Coordinator to communicate and document the data transfer. The Geodatabase Coordinator will download the data within one (1) business day for validation and integration into the comprehensive project geodatabase.

In each subsequent task as defined in the scope of work, all GIS users will be instructed to access and query the centralized project geodatabase for data to be used in their respective analyses and reports. This will minimize duplication of individual effort, eliminate redundancy in data development, and ensure each consultant on the team utilizes the most current and complete data throughout all phases of the project.

3.4 Data Updates

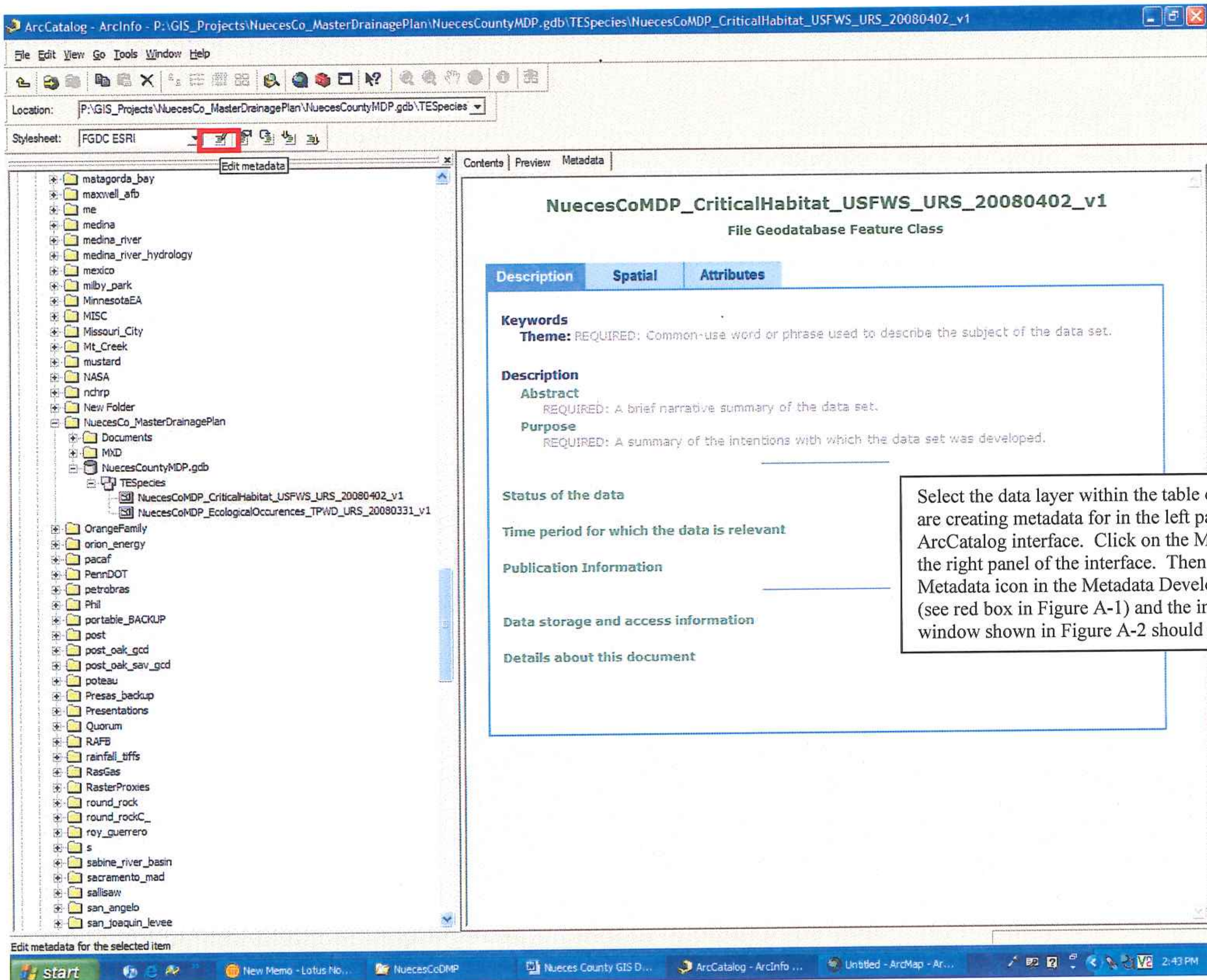
At various time throughout the project, certain GIS data will need to be updated or modified. It is important to track these changes and ensure this information is integrated into the project geodatabase and distributed to the entire team in an efficient and effective manner. When editing project-specific GIS data, be sure to upload the modified version of the data to the URS Secure Folder portal, employing the appropriate naming convention to indicate and reference an updated version of the data (i.e. v1, v2, v3).

Send an email notification to the Geodatabase Coordinator to communicate and document the data transfer, and provide a brief description or summary of the changes that were made to the data.

Within one (1) business day, the Geodatabase Coordinator will review and validate the content of the data transmission before integrating the data into the project geodatabase.

Appendix A

Metadata Examples



Select the data layer within the table of contents you are creating metadata for in the left panel of the ArcCatalog interface. Click on the Metadata tab in the right panel of the interface. Then click the Edit Metadata icon in the Metadata Development toolbar (see red box in Figure A-1) and the interactive window shown in Figure A-2 should appear.

Figure A-1. Example of FGDC-compliant metadata to be created and edited within an ESRI ArcCatalog template.

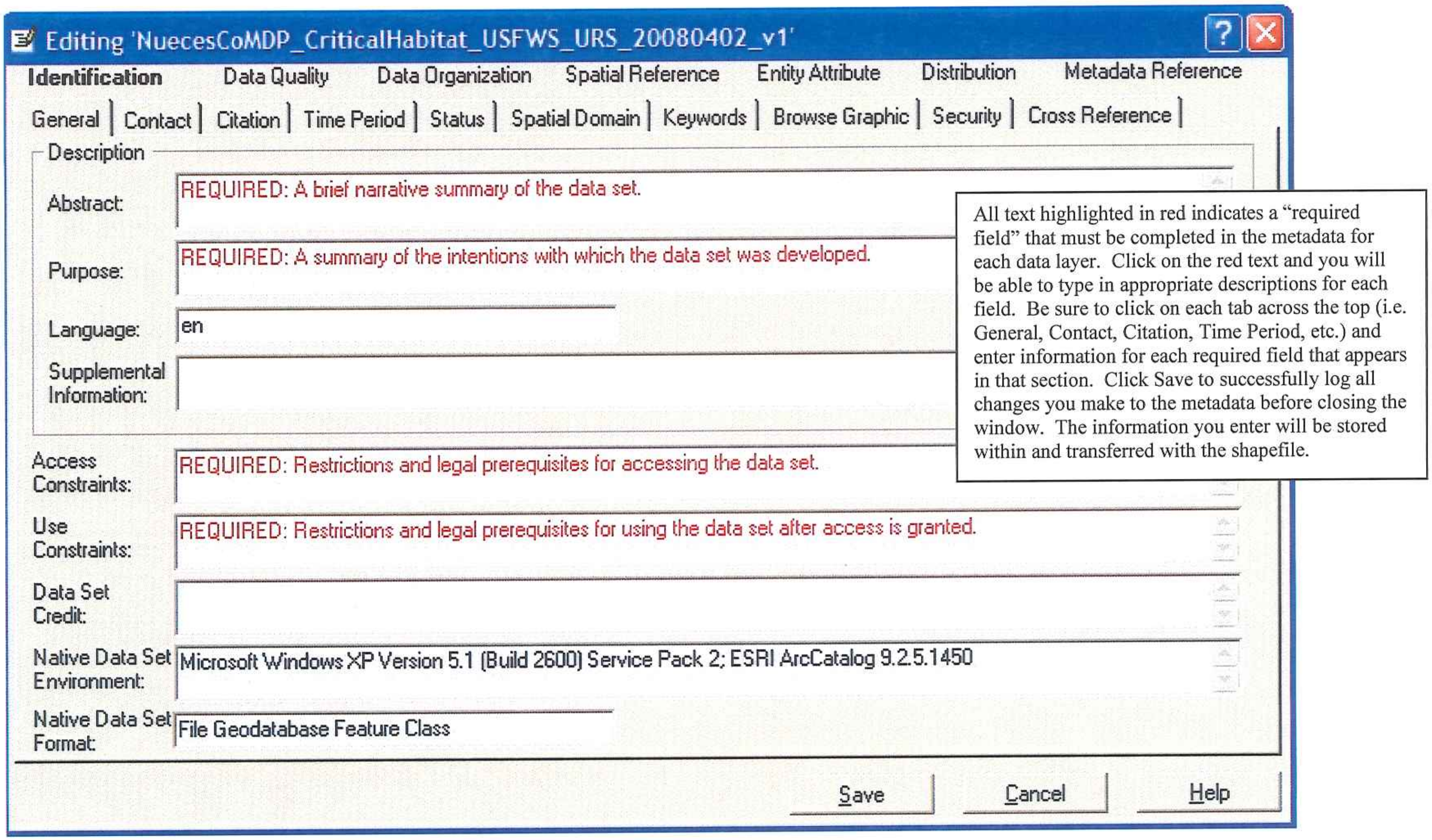


Figure A-2. Example of required fields that must be completed within the metadata template.

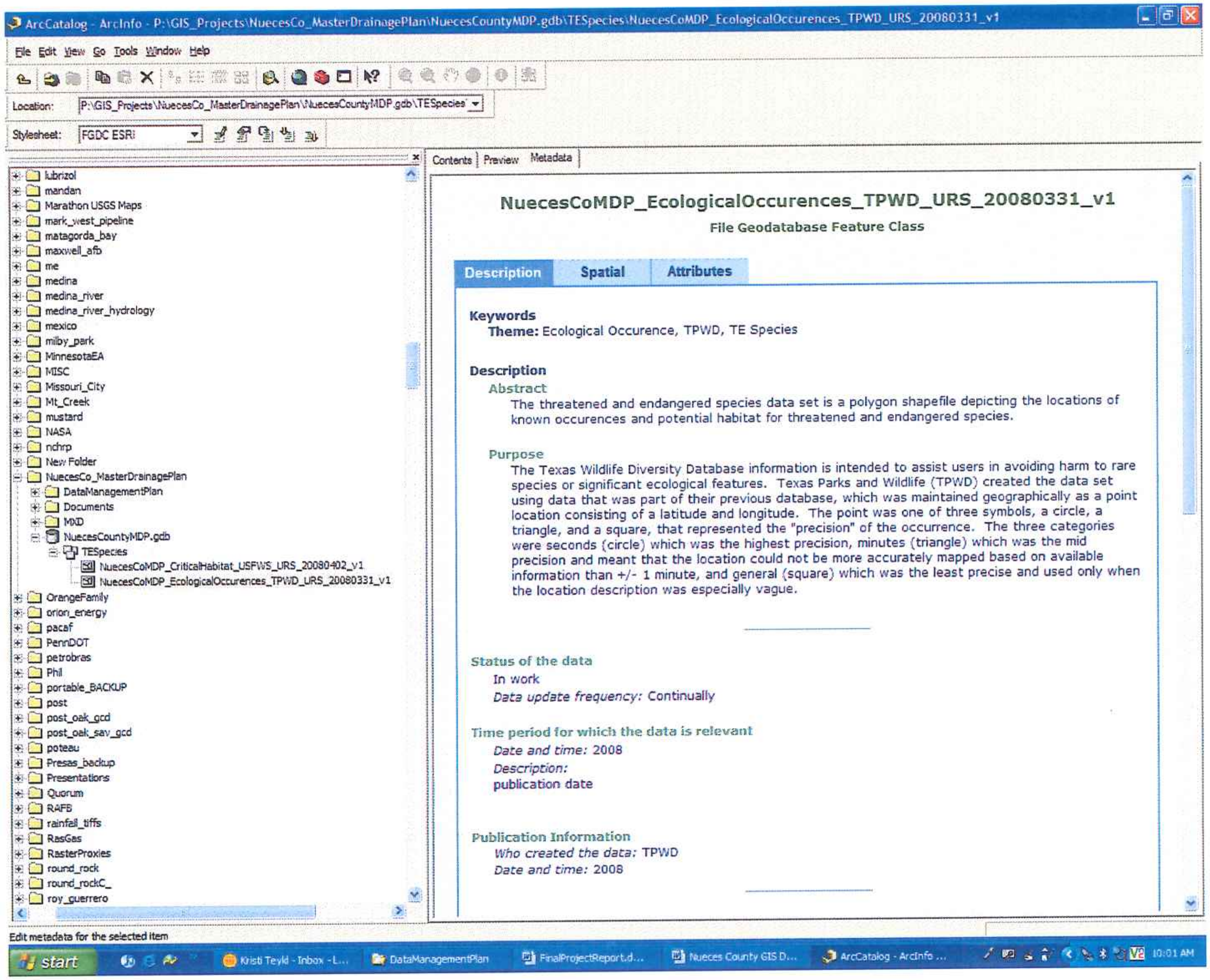


Figure A-3. Example of metadata created for Ecological Occurrence data acquired by URS from TPWD. This image illustrates the required fields that were completed for a general description of the content (Abstract, Purpose, Status, Time Period, etc.).

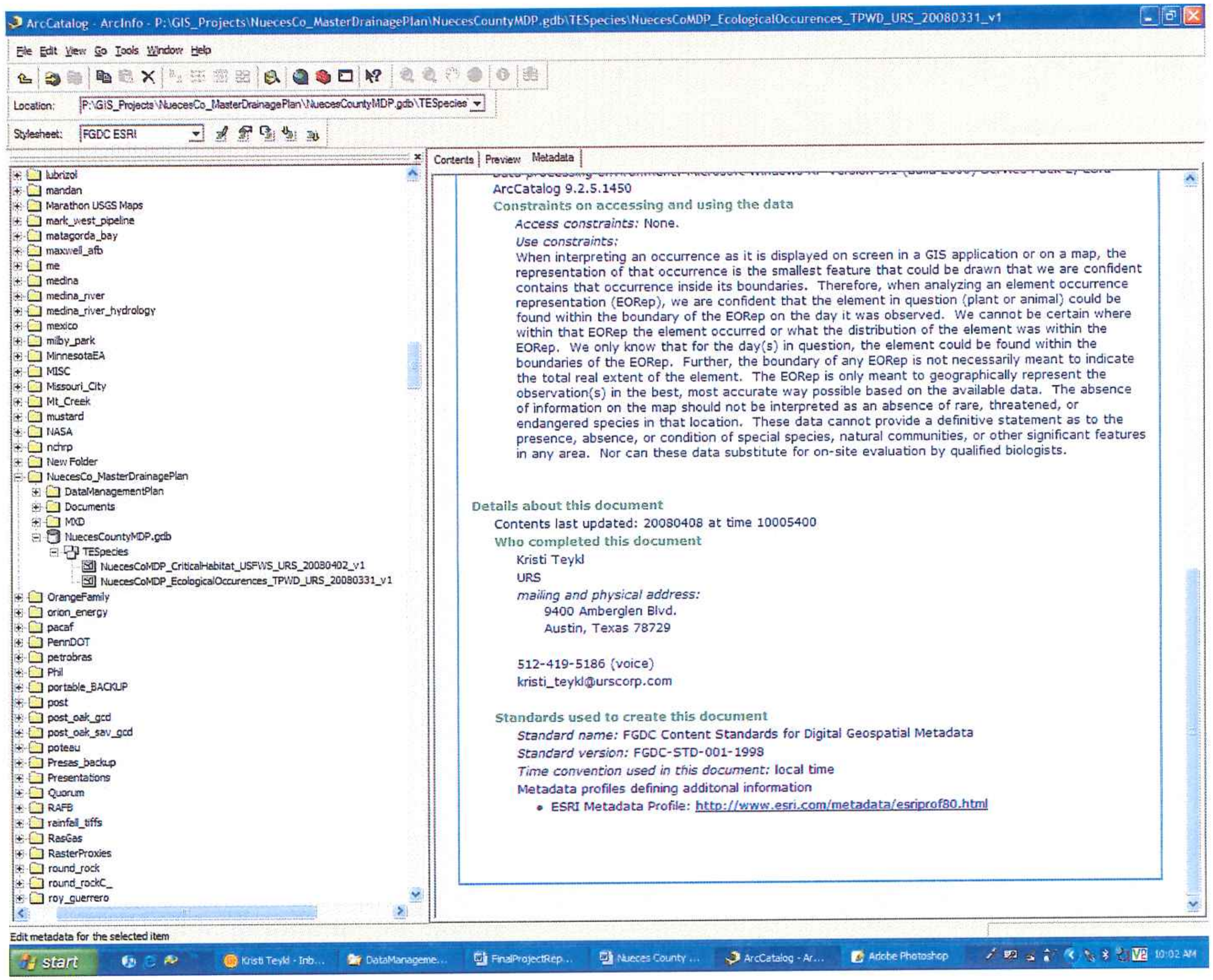


Figure A-4. Second example of metadata created for Ecological Occurrence data acquired by URS from TPWD. This image illustrates the required fields that were completed to convey constraints on accessing and using the data as well as providing contact information of the partner that created the data.

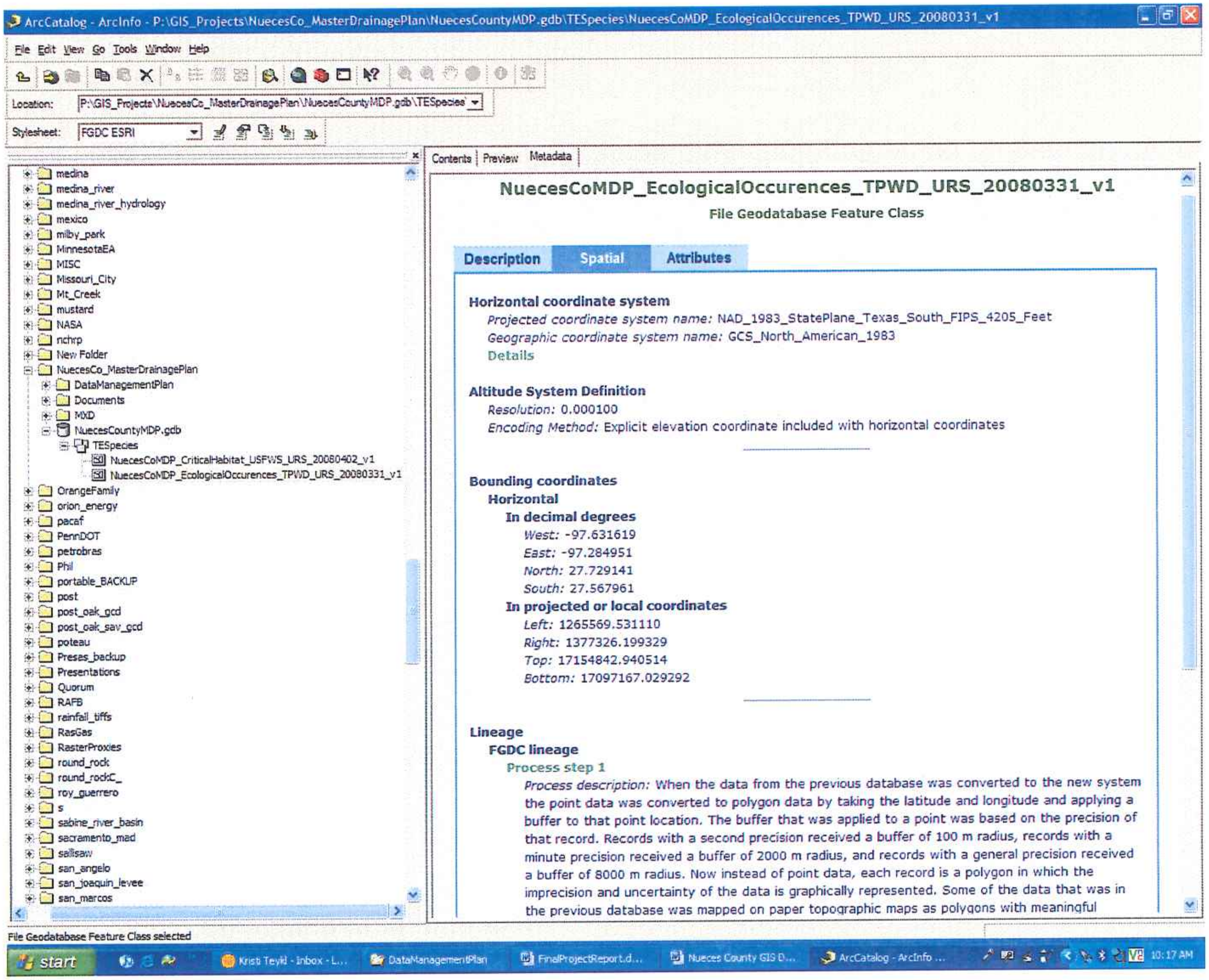


Figure A-5. Third example of metadata created for Ecological Occurrence data acquired by URS from TPWD. This image illustrates the required fields that were completed to convey spatial and process details (i.e. coordinate system and data processing steps) associated with the data layer.