Tule Creek Watershed Project Report

Hydrologic, Hydraulic, Water Quality and Ecological Assessment and Analysis with Project Recommendations

Aransas County Stormwater Management Plan

Tule Watershed Project Team

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June 2010 - FINAL DRAFT

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EXECUTIVE SUMMARY

This Tule Creek Watershed Project Report is a priority component of the Aransas County Stormwater Management Plan Project which was started in early 2009. The Tule Creek Watershed is a priority watershed within Aransas County due to its large watershed and extensive drainage area in the heart of Rockport and the Town of Fulton, damages to structures during previous storm events, and the outfall to Little Bay which is a priority ecological and community resource in Aransas County. The purpose of the County Stormwater Plan and Tule Creek Watershed Project Report is to use an integrated approach to help protect and enhance public and private properties from poor drainage and flooding, and to protect and enhance wetlands, estuaries, bays and other ecological resources through water quality and ecological improvements. These goals are to be accomplished through the development of stormwater best management practices (BMP's) that help guide land development and drainage improvements, and also through development and implementation of stormwater projects such as those recommended in this Tule Creek Watershed Project Report. This project report presents the hydrologic, hydraulic, water quality and ecological/habitat analysis performed for the Tule Creek Watershed along with recommended improvements. The remaining watersheds in Aransas County are also being evaluated using this integrated approach. This stormwater planning process and recommendations involving the Tule Creek Watershed have been developed based on comments from the Stormwater Management Advisory Committee, Technical Committee, Water and Ecological Resources Advisory Group, stakeholders, the public, and agencies.

These recommended stormwater projects largely involve property owned by Aransas County, the City of Rockport, and the Town of Fulton. There will be U.S. Army Corps of Engineers (USACE) permits and agency coordination involved to varying degrees with the different projects, and different grants to Aransas County are helping project funding. The USACE has indicated that Tule Ditch between Little Bay and Hwy 35 is tidally influenced and jurisdictional, and above Hwy 35 much of the Tule Ditch is also jurisdictional (work may require permits). Project implementation plans are considering final design on approved priority projects to begin during the summer of 2010. Project construction could begin before the end of 2010 or early 2011 on priority projects.

A detailed hydrologic and hydraulic model was created to closely simulate existing conditions and determine existing peak flows and water levels for three design storms, 5-yr, 25-yr, and the 100-year 24-hour storms. Information about historical flood levels was used to calibrate the model and a map was produced showing areas inundated for each of the storms. The map served as a guide for a three pronged approach to stormwater management that the project team has tried to integrate: (1) evaluate and identify alternatives to mitigate flood conditions; (2) identify areas for possible water quality best management practices (BMP's); and (3) identify opportunities for ecological/habitat enhancement.

TABLE 1: IMPACT OF RECOMMENDED PROJECTS

Recommended Improvement Project	Improves Water Quality	Reduces Flood Levels	Increases Flood Levels
1. Mesquite Bypass	√	√	
2. Tule Creek West Sediment Pond and Habitat Enhancement	√		
3. Upper Tule Creek West Widening/Enhancement	√		
4. Tule Creek East Detention Pond and Marsh Enhancement	√		√
5. Tule Creek North Retention Pond and Habitat Enhancement	√		
6. Lower Tule Creek Park, Picton and Sorenson Roads		√	

* Increases level on Tule at Henderson by 0.2ft, decreases levels on Cedar Ridge by 0.5ft.

All of the improvements have water quality components, except for lowering the roads. However, lowering the roads near the outfall of Tule Ditch has a significant effect of lowering flood levels, and is necessary to offset the minor increases in water levels caused by some of the upstream water quality improvements. Therefore, since improved water quality along with flood mitigation and improved drainage is desired, a combination of these projects will be needed.

The recommended improvements were arrived at based on the optimum combined benefit for flood mitigation, water quality and ecological/habitat. The aforementioned recommended alternatives to address drainage, stormwater quality, and ecology were studied and the five sites recommended, are described in more detail throughout the report.

The Aransas County Project Team has recommended the following projects:

1. *Mesquite By-Pass* (3200 LF box culverts diverting drainage to Aransas Bay along Mesquite St., drainage control, Cost = $1,600,000).
2. *Tule Creek West Sediment Pond and Habitat Enhancement (several acres of pond/old lake restoration, drainage control, sediment reduction, invasive removal, protect existing forested wetlands, TCEQ Grant, Cost = $650,000).*
3. *Upper Tule Creek West Widening/Enhancement (widen 1000 LF ditch, improved slope, re-vegetation, reduces erosion/sand loss discharging to Little Bay, possible hike-bike trail re-alignment, Cost = $650,000).*
4. *Tule Creek East Detention Ponds and Marsh Enhancement improved "detention ponds", maintain/enhance existing park, drainage control, sediment removal, Cost = $650,000).*
5. *Tule Creek North Retention Ponds and Habitat Enhancement (300 LF /42" RCP, several acre ponds, drainage control, sediment reduction, habitat protection/enhancement, Cost = $1,325,000, CMP grant).*
6. *Lower Tule Creek Pond Picton/Sorenson Overflow (lower roads, no culvert adjustment, improves drainage, removes Little Bay Shore from 100 yr. floodplain, Cost = $100,000).*

SECTION 1.0 - INTRODUCTION

1.1 BACKGROUND AND PURPOSE – AN INTEGRATED APPROACH

In the early stages of the Aransas County Regional Stormwater Management Plan (ACSMP), it was determined that an integrated approach to stormwater management, to include not only drainage and flood control but also integrating water quality and ecological considerations, was necessary to achieve the County purpose and approach. This Tule Creek Watershed Project Report utilizes the same integrated approach and is the first priority watershed to be addressed under the ACSMP.

The purpose of the ACSMP is to help the County administer stormwater services for the protection of public and private properties from poor drainage and flooding, and the enhancement of the local wetlands, estuaries, bays, other water bodies, and protection of these ecological resources from the potential damage resulting from uncontrolled stormwater releases and non-point source pollution.

The planning approach included developing a framework to help guide land development and stormwater requirements, provide a Capital Improvement Plan prioritized to areas of immediate concern, educate the public of the benefits from water quality and quantity management, help implement priority structural and non-structural stormwater best management practices (BMP's), and provide the County with the tools needed to protect the character, quality of life, environment, and ecological integrity, and public/private infrastructure of Aransas County.

The ACSMP, to include the Tule Creek Watershed Project, is being completed in three (3) phases. The First Phase includes the Project Planning and Needs Assessment including Initial BMP Implementation. The Second Phase includes the Modeling, Evaluation and Alternative Analysis, and Continued BMP Implementation including development of this Report; and the Third Phase includes Preparation and Implementation of the overall Master Plan and Final BMP Implementation. Aransas County has developed a Stormwater Management Advisory Committee and Technical Advisory Committee composed of representatives from Aransas County, the Cities of Rockport, Aransas Pass and Fulton, and the Aransas County Navigation District to assist in guiding the performance of the ACSMP. The ACSMP and Tule Watershed Project Report share similar goals and objectives as follows:

- Decrease flooding impact on present and future citizens and infrastructure;
- Decrease siltation, pollutants and nutrient loading to the surrounding bays;
- Preserve ecological integrity of Aransas County and the Live Oak Peninsula;
- Develop standards to accommodate quality growth;
- Introduce a regional long term and low maintenance approach toward the water quantity and quality issues;
- Continue to identify local issues and concerns, potential water quality programs;
- Identify and implement immediate and continued stormwater best management practices;
- Acquire public grants for the implementation of stormwater improvements;
- Integrate stormwater management planning into the existing permitting process for the County, Cities of Rockport, Fulton, Aransas Pass including cohesive design criteria and accepted storm vent frequencies;
- Create flexible and practical standards that can be used by County staff;
- Identify and cultivate collaborative efforts with all partners within the region;
- Use a planning process that is transparent with opportunities for public participation and education;
- Identify alternative funding methods for the procurement of easements and infrastructure improvements.

While the ACSMP includes the entire County, the priority Tule Creek watershed was chosen for more comprehensive and immediate attention study using this same integrated approach, goals and objectives.

Tule Creek watershed is the highest priority watershed due to the extensive area connected by existing drainage infrastructure, the amount of drainage issues existing within the watershed, the limited resource areas for mitigation (and decreasing daily), and the possible detrimental effects the watershed is contributing to the water quality and habitat within Little Bay. Therefore, the initial focus was to prepare the Tule Creek Watershed Project Report to provide Aransas County with a detailed model, an in-depth analysis, and site-specific conceptual recommendations to be used as an initial Capital Improvement Plan for this watershed. Modeling and similar, but less involved, planning, analysis, and recommendations are also planned for the remaining portions of Aransas County. This report will focus on those studies and recommendations for the Tule Creek Watershed

1.2 PROJECT SCOPE AND LOCATION

The project team was managed by Naismith Engineering, Inc. (NEI), who also handled the ecological assessment, the hydrologic and hydraulic analysis was completed by Lippke, Cartwright, and Roberts Consulting Engineers (LCR), and the stormwater quality analysis was completed by LDP Consultants, Inc. A Geographic Information System (GIS) and data base was developed by NEI and URS Inc. The project team's scope for the Tule Creek Report included:

- Coordinate with the County's Stormwater Management Advisory Committee (SWMAC) and the Technical Advisory Committee
- Identify Existing Conditions, Features, Resources and Constraints and Opportunities for stormwater improvements.
- Coordinate with the County's consultant (URS, Inc.) that analyzed surrounding watershed delineations and determine consistent, compatible hydrologic and hydraulic analysis methodology.
- Develop existing condition model and floodplain map for the 5-year, 25-year, and 100-year 24-hour storms.
- Assist with grants solicitation and proof of development
- Development of a hydraulically similar model for evaluation of more frequent events for use in water quality models.
- Develop proposed condition model and floodplain map with all proposed flood mitigation, water quality features, and ecological enhancement opportunities.
- Prepare exhibits and literature for public meetings and help facilitate public meetings and stakeholder/agency coordination.
- Make recommendations for stormwater BMP concepts and development criteria.
- Prepare and present this report summarizing analysis and recommendations for stormwater quantity and quality controls and incorporating ecological protection, restoration, and enhancements.
- Participate with Aransas County's strategy for project implementation

The Tule Creek watershed occupies approximately 2,340 acres on the Live Oak Peninsula, and includes the cities of Rockport and Fulton. State Highway 35 Business runs north to south through the watershed, FM 3036 runs east-west to the north, and FM 2165 runs east-west to the south. The Rockport County Club with golf course and residential areas is located in the middle of the watershed. There are four main drainage ways which confluence upstream of the crossing at Business 35, and runoff from the entire area discharges to Little Bay. To account for overflow during less frequent storm events, the adjacent watershed of Long Reach, which discharges to Little Bay through Canoe Lake, is also included in the modeling. The location of the project and a project map are shown in Exhibits 1 and 2.

SECTION 2.0 – EXISTING CONDITIONS, CONSTRAINTS AND OPPORTUNITIES

The first phase of stormwater planning is the needs assessment and establishing factors and priorities that influence the project goals and objectives unique to Aransas County. This starts with identifying the existing conditions, drainage issues land features, natural resources, public and agency comments, regulatory requirements and the opportunities and constraints related to drainage and flood control, stormwater quality, and ecological protection, restoration, and enhancement. This was accomplished through literature review, considering comments from stakeholders and partnerships, numerous site visits, public open house, project team workshops, advisory groups and project committees and agency consultation. In addition, stormwater related criteria were established based on available technical, professional, regulatory, and other available resources and documents. Although information was sought for the entire County, the initial focus was on the priority Tule Creek Watershed.

2.1 EXISTING CONDITIONS, FEATURES, AND ECOLOGICAL RESOURCES

A literature review and data compilation utilizing feedback and comments from the project team partnership and stakeholders was performed to identify issues and priorities. These issues and data were also compiled into a Geographic Information System (GIS) data base for not just the Tule Watershed but also the entire Aransas County.

From April 2009 to January 2010, the project team conducted more than a dozen site visits to the specific sites included in this report along with many more sites countywide. Integrated into these site visits were full day field trips that included walking tours of the entire length of the Tule Ditch section from Pearl Street to the confluence at Tule Lake, the Tule Lake area including the forested wetland area, the East Tule Marsh area including the undeveloped marshy area downstream toward the Rockport park/baseball field, the Henderson Tract (recently approved under a CMP grant for purchase), the Processing Facility near the Airport and several other areas considered prime candidates for possible water quality BMP's and point solutions.

There are numerous habitat and environmental considerations associated with this project. These biological systems were assessed by team members involved in other aspects of this project. That information was incorporated herein and accepted as providing a guiding context and a factor for establishing limitations and constraints for BMP placement.

Site visits were necessary to observe the seasonal changes, existing conditions, wet weather/post storm event results, surrounding properties and other constraints and opportunities that would prove vital the assessment of the varied solutions for each site individually and the combined result throughout the Tule Creek Watershed.

2.2 PUBLIC AND AGENCY INVOLVEMENT

The County approach believed that public and stakeholder participation and interaction is the cornerstone for a successful stormwater management plan. With this in mind, two Open Houses have been held and comments were also requested from agencies as well as an established Water and Ecological Resource Advisory Group. The first Open House, planned to introduce the project scope and team members to the public and elicit initial public comments and general sentiments, took place at Paws and Taws in Fulton on June 18, 2009. Additionally, the project team dispersed a project Fact Sheet and a Stormwater Flyer meant to assist in the public's education of not only the project's scope but also the County's stormwater intentions. The project team produced exhibits and elicited public comments for a variety of project topics including hydrology and hydraulics, drainage and flooding problem areas, water quality and ecological considerations, GIS database information, and specific discussions about Tule Creek and Lake and Little Bay. The first Open House concluded with a presentation from the project team and Q/A session.

The second Open House was held on March 8, 2010. It followed a similar format to the first with stations and opportunities to interact with engineers and environmental specialists. At both Open Houses, one of the noteworthy topics surrounding water quality was Little Bay and its major tributary, the Tule Creek Watershed. Public and agency comments were summarized and presented to the SMAC and Technical Committee for further comments and feedback regarding incorporation into the project development process.

2.3 OPPORTUNITIES AND CONSTRAINTS

This section discusses those issues and factors from this inventory which became the constraints and approaches associated with that information. This section consolidates key features that emerged. To develop a plan of the type at hand, the various couplings of opportunities and constraints with selected technologies are evaluated, and each potential solution is adjusted to achieve an acceptable project. Over all, opportunities, constraints and risks are balanced to define acceptable solutions that promote drainage control, water quality and our valued resources. In terms of prioritization, the over-arching goal is to define sustainable solutions. The basic requirements which were based on the project goals and objectives were that:

- Safety and avoidance of property damage were first considerations. While this aspect largely is a factor more fully assessed in the design stage, care was taken to avoid planning solutions that would constitute a major threat to safety or property that could not be mitigated or moderated.
- Maintenance of the water balance to reduce disturbance of the hydrologic cycle (precipitation, runoff, evapotranspiration and ground water storage) should be a consideration,
- Solutions requiring artificial energy (pumps etc.) to maintain the BMP systems are to be avoided.
- The O&M resources necessary for system functionality should be considered.
- Proven techniques, or those currently accepted in peer practice, should be emphasized.

The primary focus is to identify locations where structural systems can be placed that respect these requirements and maintain/protect the ecological resources. Acceptable solutions must also address any applicable regulations. The constraints and opportunities that emerged from the inventory of existing conditions, features ecological resources and the feedback from public, agencies and stakeholders included the following issues, considerations and requirements:

2.3.1 REGULATORY

The technical requirements to be addressed in this work will be constrained by the regulatory limitations imposed by State and Federal agencies. These are numerous, and include:

FEDERAL AND STATE

- TPDES General Permits - These permit include the "Multi-Sector General Permit" (MSGP), the Construction General Permit (CGP) and the Phase 2 Municipal Separate Storm Sewer System (MS4) General Permit. Texas Commission on Environmental Quality Construction General Stormwater Permit under the Texas Pollutant Discharge Elimination System (TPDES) and Section 401 of the Clean Water Act.
- USACE – The US Army Corps of Civil Engineers is a major regulating agency and have asserted jurisdiction in some of the areas contained in this plan. U.S. Army Corps of Engineers (USACE) Permits under the Federal Clean Water Action (Section 10 and Section 404).
- Texas General Land Office Coastal Lease for Structures on State-Owned Lands (bay bottom and shorelines)

- Texas Commission on Environmental Quality Section 401 Water Quality Certification (related to facilities requiring USACE permits)
- Texas Coastal Management Program Consistency Review (related to USACE projects requiring an individual permit)
- Migratory Bird Treaty Act
- Water quality standards – These typically identify a designated use, water quality criteria to protect the designated use, and an antidegradation policy. Sections 101(a) and 303(c) of the Clean Water Act are among the regulations that address this.
- Areas identified as not meeting designated use standards – These are specified in section 303(d) of the Clean Water act
- TMDL - The Clean Water Act also requires that a total maximum daily load (TMDL) be developed for parameters affecting the 303(d) listed waters from meeting the state water quality standards.
- City of Rockport Stormwater Ordinance and Drainage Design Manual
- City of Rockport Tree Ordinance
- Aransas County Construction Site Stormwater Guidelines
- City of Rockport Construction and Building Permits

All of these and other regulations and permits may apply. The source agencies responsible will need to be contacted directly for details on the demands and processes that are outcomes of this involvement. The principal regulatory, permitting and ***local*** ordinances/codes influencing stormwater management are related to the construction of structural stormwater improvements and include:

U.S. ARMY CORPS OF ENGINEER PERMIT

The most commonly used USACE permits involving stormwater are: Nationwide Permits which can require 6-10 months to obtain approval from the time the application is submitted. The most common nationwide permits used for stormwater projects are as follows:

Nationwide Permit No. 27 – Aquatic Habitat Restoration, Establishment, and Enhancement Activities. Activities in waters of the United States associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas and the restoration and enhancement of non-tidal streams and other non-tidal open waters, provided those activities result in net increases in aquatic resource functions and services. To the extent that a Corps permit is required, activities authorized by this NWP include, but are not limited to: the removal of accumulated sediments; the installation, removal, and maintenance of small water control structures, dikes, and berms; the installation of current deflectors; the enhancement, restoration, or establishment of riffle and pool stream structure; the placement of in-stream habitat structures; modifications of the stream bed and/or banks to restore or establish stream meanders; the backfilling of artificial channels and drainage ditches; the removal of existing drainage structures; the construction of small nesting islands; the construction of open water areas; the construction of oyster habitat over unvegetated bottom in tidal waters; shellfish seeding; activities needed to reestablish vegetation, including plowing or discing for seed bed preparation and the planting of appropriate wetland species; mechanized land clearing to remove non-native invasive exotic or nuisance vegetation; and other related activities. Only native plant species should be planted at the site. This NWP authorizes the relocation of non-tidal waters, including non-tidal wetlands and streams, on the project site provided there are net increases in aquatic resource functions and services.

Nationwide Permit No. 41 – Reshaping Existing Drainage Ditches. Discharges of dredged or fill material into non-tidal waters of the United States, excluding non-tidal wetlands adjacent to tidal waters, to modify the cross-

sectional configuration of currently serviceable drainage ditches constructed in waters of the United States, for the purpose of improving water quality by regarding the drainage ditch with gentler slopes, which can reduce erosion, increase growth of vegetation, and increase uptake of nutrients and other substances by vegetation. The reshaping of the ditch cannot increase drainage capacity beyond the original as-built capacity nor can it expand the area drained by the ditch as originally constructed (i.e., the capacity of the ditch must be the same as originally constructed and it cannot drain additional wetlands or other waters of the United States). Compensatory mitigation is not required because the work is designed to improve water quality. This NWP does not authorize the relocation of drainage ditches constructed in waters of the United States; the location of the centerline of the reshaped drainage ditch must be approximately the same as the location of the centerline of the original drainage ditch.

Nationwide Permit No. 43 – Stormwater Management Facilities. Discharges of dredged or fill material into non-tidal waters of the United States for the construction and maintenance of stormwater management facilities, including the excavation of stormwater ponds/facilities, detention basins, and retention basins; the installation and maintenance of water control structures, outfall structures and emergency spillways; and the maintenance dredging of existing stormwater management ponds/facilities and detention and retention basins. The discharge must not cause the loss of greater than ½ acre of non-tidal waters of the United States, including the loss of no more than 300 linear feet of stream bed, unless for intermittent and ephemeral stream beds this 300 linear foot limit is waived in writing by the district engineer. This NWP does not authorize discharges into non-0tidal wetlands adjacent to tidal waters. This NWP does not authorize discharges of dredged or fill material for the construction of new stormwater management facilities in perennial streams.

Nationwide Permit No. 46 – Discharges in Ditches. Discharges of dredged or fill material into non-tidal ditches that are: (1) Constructed in uplands, (2) receive water from an area determined to be a water of the United States, prior to the construction of the ditch, (3) divert water to an area determined to be a water of the United States prior to the construction of the ditch, and (4) are determined to be waters of the United States. The discharge must not cause the loss of greater than one acre of waters of the United States. This NWP does not authorize discharges of dredged or fill material into ditches constructed in streams or other waters of the United States, or in streams that have been relocated in uplands. This NWP does not authorize discharges of dredged or fill material that increase the capacity of the ditch and drain those areas determined to be waters of the United States prior to construction of the ditch.

Individual Permits (IP). The IP is the more involved permitting process and is us for projects that cannot qualify for a Nationwide Permit since the project involves more issues and impacts. The IP is a more involved process and requires a Public Notice process and more agency and public involvement. An IP for the type stormwater projects envisioned may require 12-18 months to obtain approval from the time an application is submitted.

TPDES CONSTRUCTION GENERAL PERMIT

A construction project must comply with TCEQ's Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit (CGP) if greater than 1 acre is disturbed during construction. Stormwater Pollution Prevention Program (SW3P) would be required and implemented and a construction site notice would be posted on the construction site. A Notice of Intent (NOI) would also be required to be submitted if the project disturbed greater than 5 acres.

The SW3P would include temporary erosion and sedimentation controls (such as silt fencing, rock filter dam) to be used as directed by the engineer in response to changing field conditions and by the contractor for construction activities. Where appropriate, these temporary erosion and sedimentation control structures will be in place prior to initiation of work and will be maintained throughout the duration of the project. All materials being removed

and/or disposed of by the contractor are required to be done in accordance with State and Federal laws and by approval of the project engineer.

A Stormwater Pollution Prevention Plan (SW3P) would be prepared before construction and followed during construction. Pollution from stormwater would be minimized through adherence to measures in the project's SW3P. Table 2 lists erosion control measures available for this project.

TABLE 2. ANTICIPATED BEST MANAGEMENT PRACTICES

TCEQ-Water Quality Permit BMP Category	BMPs ** Available for Use
Erosion Control	Temporary Vegetation/Mats/Mulch/Sod
Sedimentation Control	Silt Fences/Hay Bale Dikes/Rock Berm
Post Construction TSS* Control	Detention/Retention Ponds/Booms/ Sediment Traps

*TSS – Total Suspended Solids
**BMP's – Best Management Practices

Section 401 of the Clean Water Act: Texas Pollutant Discharge Elimination System, *Municipal Separate Storm Sewer System (MS4).* This project is not located within the boundaries of a regulated MS4 at this time. However, the projects envisioned for the Tule Creek Watershed are all within the City of Rockport. The City is expected to come under the MS4 for populations of 10,000 which may be required after the 2010 census results. Currently such construction projects must comply with the City Stormwater Ordinance.

TEXAS GENERAL LAND OFFICE COASTAL LEASE AND TEXAS COASTAL MANAGEMENT PROGRAM (TCMP)

Projects located within Aransas County are within the Texas Coastal Management Program (TCMP) boundary. Projects requiring a USACE permit may be required to show consistency with the TCMP goals and policies in accordance with the regulations of the Coastal Coordination Council: it has been determined that the proposed action is consistent with the applicable TCMP goals and policies, and would not have a direct and significant adverse effect on the Coastal Natural Resource Area (CNRA's), identified in 31 TAC Chapter 501.31.

MIGRATORY BIRD TREATY ACT

During construction in woodland and native grassland areas compliance under the Migratory Bird Treaty Act is necessary to avoid impact to nesting migratory birds. The migratory bird nesting under the Migratory Bird Treaty Act is necessary to avoid impact to nesting migratory birds. The migratory bird nesting period in this area is from February 15th to September 1st. A Migratory Bird Treaty Act (MBTA) Compliance Program should be developed with the construction plans to identify steps to avoid impacts to nesting and migratory birds during project construction. This program will identify time periods when work could be performed without impacts to nesting birds, measures that can be taken to avoid impacts even when nests may occur, and opportunities to clear, survey, or perform other project-related activities (in the woodland areas) during non-nesting season. In addition, providing professional environmental oversight to assure that the construction is consistent with the Migratory Bird Treaty Act can optimize the construction schedule while complying with the MBTA. Such a compliance program can help ensure compliance during the nesting period.

ESSENTIAL FISH HABITAT

The issue of Essential Fish Habitat (EFH) can, by the Natural Marine Fisheries Service (NMFS), be triggered during any construction work in tidal waters subject to a USACE individual permit. Only the Tule Creek section downstream from where Tule Creek crosses below Business SH35 is tidally influenced.

2.3.2 ENERGY

The flat grades in this area make it tempting to consider energy intensive solutions such as pumps or forced flow devices as solutions. The consequences of such solutions are a transfer of environmental impact from one sector (e.g. Tule Creek) to another (e.g. the power provider). It was concluded that all solutions of this type should be avoided unless a specific determination is made and direction received from the County.

2.3.3 WATER BALANCE

The coastal aquifer and Little Bay are both sensitive to fresh water flows, and a diversion from one to the other by stormwater constitutes a potential damage for each. As a basic principle, solutions that adversely affect water balance (i.e. change it) are avoided in all stormwater quality planning. It is understood that similar constraints will be observed in stormwater quantity planning and that the governing assumption in this work is that water balance will be maintained.

2.3.4 OPERATION AND MAINTENANCE

Some BMPs require extensive O&M intervention to continue effective functioning in the long term. This is an undesirable outcome and is avoided to the extent possible in this program. Point solutions are placed so as to enable access for O&M purposes, and complex devices (such as those systems requiring real time control) are avoided.

2.3.5 ECOLOGICAL RESOURCES FUNCTIONS AND VALUES

The systems in this area have numerous instances of valued resources and eco-communities. Opportunities for BMP placement are limited, and some of the locations where this might be contemplated have inherent value as natural resources in their existing form. A good example of this is the Tule Marsh West Area, which has a well established community that provides a dual function as habitat and as a de facto water quality BMP. This plan was designed on the basis that preservation of existing values is a requirement. Cases where changes may be needed are minimized to the extent possible, and are identified and flagged where they occur.

2.3.6 ACHIEVABLE SOLUTIONS

It has been made clear that solutions that are actionable and effective in a reasonable time frame are desired so that continued degradation and loss of opportunity in the watershed area and in receiving waters does not continue. This does not affect the analysis or opportunities which exist in this area, but it does affect the staging and planning which might be considered. Where applicable, all plans presented here will be addressed in a way which to the extent consistent with proper practice leads to effective results in the short term.

2.3.7 HYDRAULIC CONSTRAINTS

There are numerous areas where the system is hydraulically sensitive. In this plan, care was taken to look for hydraulic considerations that ruled out some solutions, using the results of the modeling made available by the hydrologic/hydraulic team members. This is adequate for planning purposes, but final hydraulic analysis will be required at a design stage in areas where net decreases in water surface elevations are not expected in the proposed conditions model and to verify that conflicts will not arise from this factor.

2.3.8 PERFORMANCE TARGETS

It is known, as a result of the basic physical investigations of this location, that the hydraulic limitations in this area are such that the volume to detain large flows without adversely affecting habitat, flooding or other constraints is not readily available, and proprietary, high energy or high maintenance solutions were to be avoided. Hence, the focus for quality control was on high frequency events (in the range of the 1-yr return period or more frequent event) and on basic controls (coarse sediment capture, floatables control and sediment transport fluid energy) was emphasized in locations where Structural BMP solutions are proposed. This provides a valuable degree of improvement, and balances the other factors constraining solutions. It also makes it clear that control of the land surface and of water quality discharges from future development will need to be carefully managed if added degradation is to be avoided. The future of water quality associated with Tule Creek will be enhanced by the point devices identified in this report, but will hinge on the adoption of control measures across the watershed at large. In converse, the focus for the water quantity (flood/drainage) control was on peaks flows and water surfaces from low frequency events (5-yr, 25-yr, and 100-yr) and on volume control.

SECTION 3.0 – HYDROLOGY AND HYDRAULICS

This section describes the hydrologic and hydraulic (H&H) analysis performed for the Tule Creek Watershed, and includes the approach, process, and recommendations for the integrated quantity or drainage/flood control solutions.

The purpose of the H&H study is to identify existing areas which are subject to flooding, and to produce a floodplain map and an H&H data set that would serve as tools for regulating future development. The existing condition map and model also assist in identifying and evaluating favorable locations for water quality features.

There are two sources of elevation information used in this H&H study. LiDAR topography was provided by Aransas County, which is on the NAVD88 datum. Ground shots of streams, culverts and roadway crossings within Tule Creek Watershed were provided by Griffith & Brundrett Engineering and Surveying, Inc., which are also on NAVD88. However, according to the surveyor, there are errors in some of the existing NAVD88 benchmarks which were not corrected for the LiDAR. The ground shots provided by the surveyor are based on corrected benchmarks. As the error varies across the County, there is no single adjustment factor that could be used to convert one to the other. The use of both corrected and non-corrected datum for a project as broad as a watershed analysis, both H&H and water quality, is considered an acceptable practice but for specific designs and future construction plans a consistent survey datum and specific project control should be required.

The Tule watershed area is shown on FEMA Flood Insurance Rate Map (FIRM) panels 485504-0001D and 0002D for City of Rockport, and Panels 485452-0018C and 0047C for Aransas County. The watershed boundary is overlaid onto the FIRMs in Exhibit 3.

Of the whole watershed, only a small portion along Sorenson and Picton on Lower Tule Ditch is in Zone B, which is described as being between the 100-year and 500-year floodplain or areas where the 100-year depth is less than 1ft. The rest of the watershed is in Zone C, which is described as areas of minimal flooding. The floodplain shown on the FIRMs is limited to the first ridgeline and does not include areas inundated by riverine affects, as in this study.

3.1 HYDROLOGIC AND HYDRAULIC METHODOLOGY

The following is a description of the methodology used for the hydrologic and hydraulic (H&H) analysis of Tule Creek watershed. The Tule Creek watershed is highly developed with substantial impervious cover and closer streets with a more intricate drainage system. This requires a more detailed analysis with smaller Sub-basins and finer topographic resolution.

3.1.1 WATERSHED DELINEATION

With a processed LiDAR grid, the following was performed to delineate a surface watershed:

- The Tule Creek watershed will be divided into approximately 20-acre Sub-basins
- Use 1-meter grid LiDAR topography
- The ArcHydro module will be used to aid in the determination of flow direction, watershed slope, and other hydrologic metrics.
- Aerial photographs were reviewed. Linear structures that potentially alter watershed boundaries (highways, railroads) were identified, and watershed boundaries altered as appropriate. Delineation of watersheds by different consultants must be coordinated for agreement at the boundaries.

It is important that this process be performed for surrounding watersheds simultaneously (URS, Inc.), as otherwise boundaries between watersheds will not properly match. The Tule Creek watershed boundary was based on the original boundary created for the previous drainage plan (Urban Engineering, December 2000), and modified with current methods and topography described above. Most of the boundary between Tule Ditch watershed by Lippke, Cartwright, and Roberts and adjacent watersheds by URS, Inc. were adjusted to match. The exception is the area to the south-east, which is not in URS' scope.

3.1.2 ASSIGNMENT OF WATERSHED PARAMETERS

The NRCS (formerly SCS) unit hydrograph method will be used for all watersheds. Developing curve numbers required estimation of land use, soil type, and impervious area parameters. To assign land use parameters needed for Curve Number Estimation, the following was performed:

- Impervious areas were identified using ERDAS, using most recent 1m resolution aerials;
- The land use for remaining land will be assigned categories per TR55. These categories will be related to common land uses in Aransas County and specifically Tule Creek Watershed. Existing SSURGO soil polygons are imported into ArcHydro based on NRCS Soil Series maps for Aransas County. A matrix was developed that relates the defined land use category/soil type combinations to a specific curve number. GeoHMS was then run to 1) develop a raster which assigns a curve number per watershed pixel; 2) developed a single curve number per sub-watershed; and 3) developed a percent impervious per watershed.

3.1.3 TIME OF CONCENTRATION

Developing time of concentration for each sub-watershed required 1) estimation of longest flow path, slope of longest flow path, and centroidal longest flow path; 2) estimation of lag times using 2 separate methods; 3) application of professional judgment to choose between the two methods, 4) multiplication by a factor to estimate time of concentration. These analyses were performed using one-meter grids. The estimation of flow path lengths for the longest flow path, slope of longest flow path, and centroidal longest flow path was done in ArcHydro, following the tasks above. The estimation of lag time was performed using the following two methods:

- *NRCS Method* (per Eqn 15.4, Chapter 15, NRCS NEH-4). Slope of ongest flow path to be used for "average watershed slope"; the length of the longest flow path was used for "hydraulic length of the watershed".
- *Burec Method* (per Design of Small Dams (Burec, 1987), equation on page 35. L, Lca, and S derive directly from the ArcHydro values derived above. Two values will be used for Kn: 0.017 and 0.024 per the Houston values in Table 3-6, P43. This produced a set of three potential values for each watershed. The values were compared, and engineering judgment applied in choice of results to use in further modeling.

To estimate times for concentration, the chosen lag times were divided by 0.4 (for predominantly urban watersheds), per page 13 of "Time-Parameter Estimation For Applicable Texas Watersheds" (Research Report 0-4696-2 for the TXDOT), Lamar University, August 2005.

3.1.4 STREAM ROUTING - RAINFALL – TIME STEP

Stream routing was performed with the Interconnected Pond Routing (ICPR) Model V3 to perform an unsteady (time varying) analysis. ArcGeoRAS was used to create stream sections from the LiDAR data. The frequency storm was created using 2004 USGS Atlas, storm duration, 24-hour. The time step used was fifteen (15) minutes

3.2 HYDROLOGIC ANALYSIS

This section describes the rainfall data, the runoff hydrograph method, and the existing hydrologic conditions in the Tule watershed that result in the parameters used to develop the runoff hydrographs. The Tule watershed is approximately 1 mile wide by 3.7 miles long. The model has 96 Sub-basins for the 2,340-acre watershed, with an average size of 24 acres, depending on hydrologic conditions. The delineation of the boundary and Sub-basins is shown on Exhibit 4.

3.2.1 TOPOGRAPHY

The Tule watershed lies on the east side of the Live Oak Peninsula, which runs mostly north to south. The peninsula is high in the middle and slopes to the bays on the east and west. The western portion of the watershed near the middle of the peninsula has a high elevation of 17 and 18, and drops to the roads along the bays to the east at approximate elevation of 4. Typical slopes are 1ft per 1,000ft, or 0.1%. Typical elevations along Business 35 are from 10 to 12.

An important hydrologic feature of the area is the presence of many natural depressions located throughout the watershed. There are perhaps two dozen of 1 to 5 acres with depths from 3 to 8 ft. There are also countless smaller "potholes" depressions. The depressions can be seen on the aerial as the dark, treeless areas. Most of the depressions have a dark water line on the bottom 1 or 2 ft, which indicates they hold water for a long period of time. These depressions provide a significant amount of runoff storage, which helps to mitigate flooding in the area. Development of the area may result in their being filled in and increasing storm runoff to adjacent areas.

3.2.2 HYDROGRAPH METHOD

The SCS Runoff Curve Number Method was used to produce runoff hydrographs. The hydrographs represent a time series of runoff flow which is computed for each Sub-basin. The hydrographs are routed through the streams in the hydraulic computation, and combine with hydrographs from adjacent areas where they confluence. To accurately compute runoff hydrographs from each Sub-basin, a separate set of parameters and curve number was determined for each.

The Tule Creek watershed is highly developed with substantial impervious cover and closer streets with a more intricate drainage system. This requires a more detailed analysis with smaller Sub-basins and finer topographic resolution than for the rural watersheds in Aransas County. The model used was chosen for its ability to simulate complex systems. Each Sub-basin area is treated separately with its own set of hydrologic parameters resulting in a curve number and runoff hydrograph. The parameter spreadsheet is included in Appendix 1.

CURVE NUMBER

Runoff, Q is computed by:

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S}$$

Where: Q = runoff (cfs)
P = rainfall (in)
S = potential maximum retention after runoff begins (in)
Ia = Initial abstraction (in)

For this study the initial abstraction, Ia is 0.2S for average runoff conditions, per TR-55. The above equation can be simplified as:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

The term S is related to the curve number, CN by:

$$S = \frac{1000}{CN} - 10$$

The curve number, CN is determined based on soil type and ground cover for urban watersheds from Table 2-2a of TR-55, Appendix 4. Curve numbers for this project range as follows:

Low: 63 **High: 91** **Average: 72**

SOIL TYPE

Soil data from the area was obtained from the existing SSURGO soil polygons, the soil map is included as Exhibit 5. The soil types present in the Tule Creek watershed are Mustang fine sand and Galveston-Mustang Association. Both are listed as hydrologic **soil group A**, which concurs with observations of the soils in the area. Soil Group A has a high degree of absorptive capacity and provides effective mitigation for storm runoff. New development would typically replace some of the sandy cover with impervious cover, or less absorptive turf, all of which would result in increased runoff to adjacent areas.

TIME OF CONCENTRATION AND LAG TIME

The time of concentration (TC) is the time it takes runoff from the furthest point in the watershed to reach the discharge location, and indicates a time at which runoff from all areas are contributing to the discharge to the outfall stream. Initially, in accordance with the Methodology, the time of concentration was computed from the lag time per the NRCS method. The NRCS lag time was then divided by 0.4 for as recommended for urban watersheds, per Reference 2 (Lamar Univ., 2005), to determine the TC. However, the resulting times of concentration were considered excessive and the corresponding runoff rates were very low. So a more direct method was used to determine the TC.

The TC was computed using distance and estimated velocity for estimated lengths of sheet and channelized flow before entering the streams or ditches. The equation for travel time, Tt is given below. This method was found to yield more reasonable results. The time of concentration is the sum of travel times of individual flow segments.

$$Tt = \frac{L}{3600V}$$

Where: Tt = travel time (hr)
L = length travelled (ft)
V = velocity (fps)

The assumption was made that for the first 300ft, flow is sheet flow at 0.25 fps, and the remaining distance to the receiving stream is based on a velocity computed by the Manning equation for a swale with 100:1 sides 1ft deep. The stream slope is based on the LiDAR map and Manning roughness factor is taken from ground cover as indicated by the aerial maps. A Sub-basin Parameter spreadsheet is included in the appendix.

IMPERVIOUS COVER

Impervious cover for each Sub-basin was measured using AutoCAD with an aerial image. Coverage ranges from 0% to 90%. The overall impervious cover for the 2,340-acre Tule watershed is approximately 24%, or 562 acres.

RAINFALL DISTRIBUTION PATTERN

Aransas County is in Region III of the TR-55 rainfall distribution map, included in the appendix. Region III covers most of the U.S. gulf coast, and the entire Texas gulf coast. The cumulative rainfall curve is shown in Figure 1 (Figure B-1, TR-55). The Region III curve (dashed) shows a sudden increase and decrease in intensity centered on hour 12 of the 24-hour storm. Approximately half of the total rainfall depth occurs within a couple hours in the middle of the storm. This is a symmetric distribution which produces hydrographs with sharp rising and falling limbs.

Figure B-1 SCS 24-hour rainfall distributions

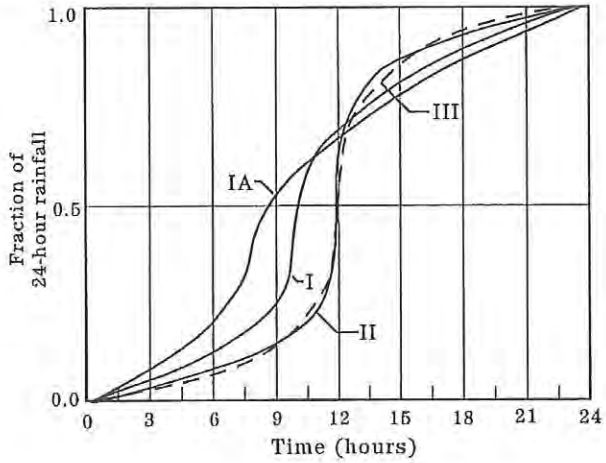


FIGURE 1. 24-HOUR RAINFALL DISTRIBUTION FOR REGION III (TR-55)

RAINFALL DATA

Rainfall data for Aransas County and the Rockport area was taken from the website for the National Climatic Data Center. Depths and durations for standard storms are shown in Table 3.

TABLE 3. DEPTH DURATION FOR STANDARD STORMS IN ARANSAS COUNTY

DURATION	Duration (Hr)	2-YEAR	5-YEAR	10-YEAR	25-YEAR	100-YEAR
5-minute	0.08					
10-minute	0.17					
15-minute	0.25	1.10	1.40	1.60	1.90	2.30
30minute	0.50	1.60	2.00	2.30	2.70	3.40
60-minute	1	1.90	2.50	2.90	3.50	4.50
2-hour	2	2.50	3.30	3.80	4.50	5.80
3-hour	3	2.80	3.60	4.20	5.00	6.70
6-hour	6	3.20	4.40	5.20	6.50	9.00
12-hour	12	3.60	5.00	6.00	8.00	10.50
24-hour	24	4.60	6.50	8.00	10.00	13.50

DESIGN STORMS

The standard storms used in this analysis are the 5-year, 25-year, and 100-year, 24-hour storms, as shown in Table 3. The 2-year storm was also run for coordination with the water quality consultants in development of their model which uses more frequent events.

CALIBRATION STORMS

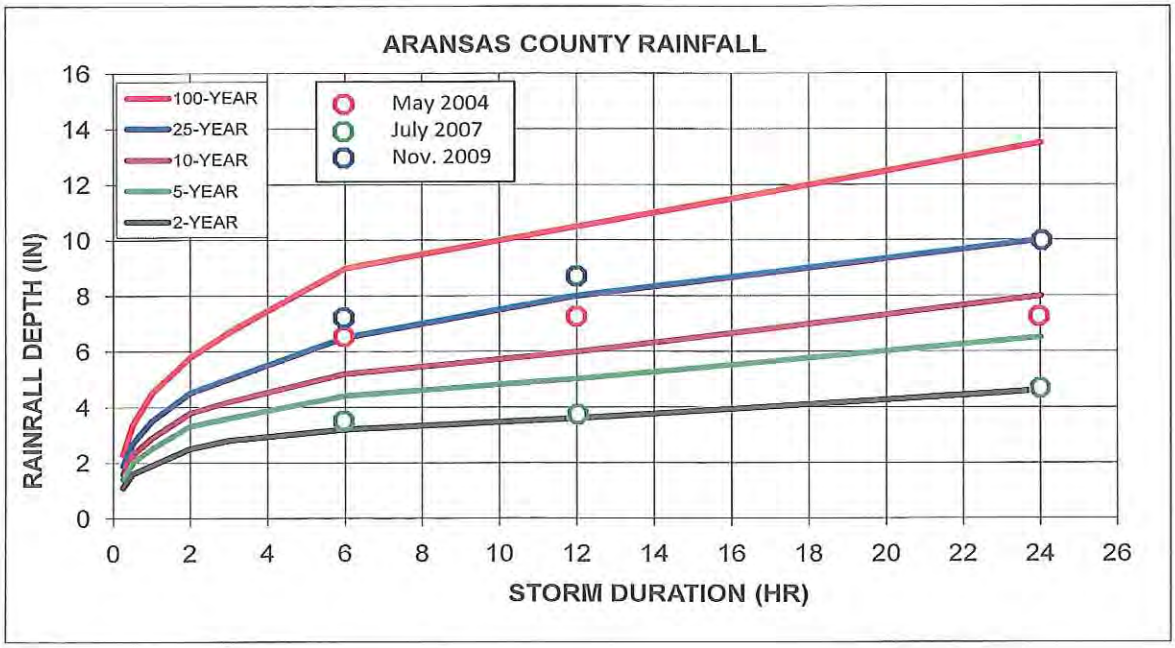
Historical water levels were determined available from three storms which were used to calibrate the existing condition model. The storms occurred in May 2004, July 2007, and November 2009. A summary of depths and durations for the storms is shown in Table 4. Figure 2 shows a plot of the standard storms with the calibrating storms at certain durations for comparison. On a 24-hour basis, the 2004 storm is approximately a 7-year storm, the 2007 storms was as 2-year, and the 2009 storm was a 25-year.

TABLE 4. CALIBRATION STORM DEPTHS AND DURATIONS

EVENT DATE	RAINFALL DEPTH (INCHES)*				24HR FREQ. (YEAR)
	6-HOUR	12-HOUR	24-HOUR	TOTAL	
May 2004	6.61	7.25	7.29	7.29	7
July 2007	3.66	3.80	4.57	5.67	2
Nov. 2009	7.13	8.75	9.94	9.99	25

* Source: Aransas County Airport, National Climatic Data Center

FIGURE 2. DESIGN STORMS AND CALIBRATION STORMS



COORDINATION WITH WATER QUALITY CONSULTANTS

The water quality and hydrologic consultants used different models for the same physical system. To ensure accuracy and consistency, the models were run for the same storm events to check if they produce similar results, and adjusted as necessary. For this check, the 2-year and 5-year 24-hour storms were used, as well as incremental rainfall data for specific events used by the water quality team. All hydrologic and hydraulic data established in the H&H analysis was provided to the water quality consultants.

3.3 HYDRAULIC ANALYSIS

The ICPR (Interconnected Pond Routing) model, version 3.2 by Streamline Technology, was used for both the hydrology and hydraulics because it conveniently integrates both in a single model. ICPR also provides a dynamic analysis (time variable) which is important in understanding how components of a complicated system like Tule behave. For example, the ICPR model allows flow to reverse direction in a pipe or ditch, which may actually happen, as upstream and downstream head conditions vary throughout the storm.

The hydraulic computation is performed with ICPR by routing the SCS hydrographs through the streams and basins. The hydraulic models are comprised of a series of links and nodes. Hydrographs are combined at nodes and routed through links, which may be a ditch, pipe, weir, bridge, drop structure, etc.

The starting water surface elevation was prescribed as the mean high water (MHW) elevation in Little Bay of 0.9.

3.3.1 THE MODELS

This section describes the particular model software that was used for the hydrologic and hydraulic analysis, and the individual models that were produced.

Three models were produced: the existing condition, the updated existing condition, and the proposed condition. The first existing condition model was created because historical flood information was available for storms in 2005 and 2007, which were used to calibrate the model. Since some drainage improvements have been made since 2007, it was necessary to create a model of the system as it was during those storms. After an accurate model was arrived at, the recent existing improvements were added to produce the updated existing condition model. This model serves as the baseline for the proposed work. The proposed condition model looks at adding alternatives for water quality and flood protection purposes.

MODEL CALIBRATION

The first existing condition model was calibrated using rainfall data from storms in July 2005 and May 2007. Photos of flooding at known locations allowed a survey to determine good estimates of those elevations. Most of the photos were taken along Business 35 and in the residential areas of the golf course. The locations are shown on the Contour and Sub-basin exhibit. These photos are included in the appendix.

During this study, a large storm in November of 2009 provided some additional flood level information, although no photos were available to obtain surveyed elevations from.

The results show that the existing condition model was able to simulate observed elevations to within +/- 0.4ft, which is a good level of accuracy for an area this large and of this complication. Observed and computed water levels from the calibration process are shown in Table 5.

TABLE 5. CALIBRATION RESULTS

ID	LOCATION	*C*	OBSERVED WSE	COMPUTED WSE	DIFF (FT)	EVENT DATE	APPROX. FREQUENCY	PHOTO NO.
1	Colonial and Olympic Drive		14.84	14.51	-0.3	July 2007	2-yr	2,3,4,8
2	108 Cedar Ridge		12.6	12.49	-0.1	May 2004	5-10 yr	7
3	112 Peach Tree	1	12.4	10.32	NA	May 2004	5-10 yr	6
4	113, 116 Cedar Ridge	2	11.8	11.83	0.0	July 2007	2-yr	1
5	113, 116 Cedar Ridge	2	12.5	12.68	0.2	May 2004	5-10 yr	1
6	SH35 & Palmetto	3	10.49	10.06	-0.4	May 2004	5-10 yr	5A
7	SH35 & Broadway	3	10.0	10.06	0.1	May 2004	5-10 yr	5B
8	SH35 & Tule Ditch	4	< 8.2	8.24		Nov. 2009	25-yr	none

C-COMMENTS

1. Observed water level likely caused by hydraulic gradient on storm system not included in this model; nearest computed water level not expected to accurately estimate this location.
2. Water levels based on discussion with owners, August 2009.
3. Photo copyright by Linda Pechaceck.
4. Observation reported by Navigation District personnel, Tule Ditch never overtopped SH35

EXISTING CONDITION MODEL

The existing condition model is based on the calibration model, and was modified to include recent drainage improvements. These additions resulted in only minor changes water levels. The flood map for the existing condition is shown in Exhibit 7, which provides the base condition for comparison of proposed improvements.

Peak flows and maximum water surface elevations for the 5-year, 25-year, and 100-year storms for key locations are summarized in Table 4. The locations are indicated on Sub-basin exhibit.

The Tule watershed is comprised of 96 Sub-basins which make up nine major hydraulic systems, as shown on Exhibit 6. Exhibit 6 shows the location of the nodes used for this study. Exhibit 7 shows an ICPR schematic of all the links and nodes.

Since the study area is fairly flat and Sub-basin boundaries are somewhat arbitrary, runoff is not necessarily restricted within a Sub-basin boundary. To allow spill from one to the other links were created between multiple adjacent Sub-basins. The Long Reach watershed was added to the Tule study to allow spill from the Business 35 area to the Long Reach ditch. Generally, for Sub-basins that are not connected by a well-defined stream, a broad swale is assumed.

EXISTING DITCHES

Most of the drainage ways in the Tule watershed are earthen ditches. However, most of Ditch 2 is concrete-lined, as is a segment of Ditch 3 between FM 3036 and Chapparel. Below is a discussion of the major reaches of each ditch. Representative photos of each are included in the appendix. Plots of typical sections of the ditches are included in the appendix.

- Ditch 1 upstream of FM 2165
- Ditch 1 downstream FM 2165 to the confluence with Ditch 4
- Ditch 2
- Ditch 3 to the confluence with Ditch 4
- Ditch 4 upstream of the confluence with Ditch 3
- Ditch 4 downstream of Ditch 3
- Ditch 4 downstream of confluence with Ditch 1 upstream of Bus. 35.
- Ditch 4 downstream of Bus. 35 to outlet at Little Bay

The profiles shown in Exhibits 9A-9E, show flowline, bank and hydraulic gradeline for the three design storms, as well as the crossing structures.

Stream sections in the model are based on a combination of GIS data from the LiDAR topography and surveyed ground shots. The ArcGeoRAS (GIS) module was used to create the overbank sections from the LiDAR data. The ground shots were considered more accurate and so were inserted in the GIS sections where available.

PEAK FLOWS

The 100-year peak discharge to Little Bay from the Tule ditch is 1,411 cfs (Node TN-OUT). Additional flow reaches Little Bay from the Long Reach area with a 100-year peak flow of 257 cfs (Node LR-E) The peak flow at key points in the watershed are shown in Table 6. Because of the sharp rise and fall of the hydrograph limbs, the timing of combined hydrographs plays an important role in the resulting peak flows and water levels. Peak flows and times to peak at all nodes for each storm are included in Appendix __.

TABLE 6. EXISTING CONDITION PEAK FLOWS AT KEY NODES

Node Label	Node Name	Existing Conditions Inflow, cfs		
		5-Year	25-Year	100-Year
A	LR-E	105	180	257
B	TN-EE	504	833	1,409
C	TN-OUT	506	833	1,411
D	TN-O2	95	177	269
E	TN-S1	98	113	117
F	TN-U2	73	129	183
G	TN-U6	89	251	424
H	TN-Y	588	946	1,531
I	TS-L1	18	23	26

The maximum water surface elevations at key points in the watershed are shown in Table 7. These levels are shown graphically in the flood map of Exhibit 9. The map shows that for the 5-year storm, areas that are subject to flooding are a portion of the residential areas in the golf course around Cedar Ridge, Bus. 35 near Palmetto, and the Lower Tule area on both sides of Bus. 35. The Lower Tule area is an area of interest for detention and water quality storage.

Areas subject to 100-year flooding are along the north Bus. 35 corridor, although the road itself appears to be passable, an area between Prairie and Lone Star toward the airport, the Lady Clair – Colorado area, and the areas in the far south of the watershed along Maple, Rose, Cedar.

TABLE 7. EXISTING CONDITION WATER LEVELS AT KEY NODES

Node Label	Node Name	Existing Conditions WSE, ft		
		5-Year	25-Year	100-Year
A	LR-E	3.66	5.23	5.53
B	TN-EE	3.38	6.83	8.02
C*	TN-OUT	0.90	0.90	0.90
D	TN-O2	12.50	13.17	13.64
E	TN-S1	8.86	10.16	10.80
F	TN-U2	14.85	15.29	15.60
G	TN-U6	12.24	12.67	12.94
H	TN-Y	6.60	8.56	9.26
I	TS-L1	12.64	12.71	13.19

* Starting Water Level at Mean High Water

PROPOSED CONDITION MODEL

The proposed condition model is based on the existing condition model, revised to simulate several flood mitigation and water quality improvements. The recommended improvements are shown on Exhibit 10. The hydraulic characteristics of the recommended stormwater quality improvements are included in the proposed condition model.

The sandy soils and common natural depressions in the Tule watershed provide effective storage for storm runoff. New development would normally fill in some of the depressions and cover some of the sand with impervious material, which would result in increased runoff to adjacent areas.

Several CIP improvements with water quality and flood mitigation components were analyzed for their hydraulic impact. Some projects improve flood levels and some increase them, so if both objectives are to be achieved, a combination of projects will be needed. The water quality and ecological assessment of alternatives structural and non-structural stormwater BMP's are provided in Section 4. While Section 7 of this report discusses the recommended improvements, a summary of the drainage flood control benefits of the recommended improvements is included below.

OVERALL COMBINED PROPOSED CONDITION MODEL

The proposed condition model includes all the improvements discussed above. Together, the improvements result in lower water levels at several locations and reduced discharge volume to Little Bay. Table 8 shows the resulting reduction in water levels at commonly know locations shown on the Improvement Exhibit.

TABLE 8. WATER SURFACE ELEVATIONS FOR COMBINED IMROVEMENTS

ID	Node Name	Comparison of Water Surface Elevations (ft)								
		5-Year			**25-Year**			**100-Year**		
		Exist	Prop	**Diff**	Exist	Prop	**Diff**	Exist	Prop	**Diff**
A	LR-E	3.66	3.66	**0.00**	5.23	5.23	**0.00**	5.53	5.53	**0.00**
B	TN-EE	3.38	2.44	**-0.94**	6.83	5.40	**-1.43**	8.02	6.76	**-1.26**
C	TN-O2	12.50	11.68	**-0.82**	13.17	12.72	**-0.45**	13.64	13.29	**-0.35**
D	TN-S1	8.86	8.21	**-0.65**	10.16	9.87	**-0.29**	10.80	10.70	**-0.10**
E	TN-U2	14.86	14.86	**0.00**	15.29	15.29	**0.00**	15.60	15.60	**0.00**
F	TN-U6	12.24	11.41	**-0.83**	12.67	12.22	**-0.44**	12.94	12.40	**-0.54**
G	TN-Y	6.61	5.90	**-0.71**	8.56	8.24	**-0.32**	9.26	9.02	**-0.25**
H	TS-L1	12.64	12.64	**0.00**	12.71	12.71	**0.00**	13.19	13.19	**-0.01**

3.4 PROPOSED STORMWATER QUANTITY IMPROVEMENTS

AREA 1 - MESQUITE BYPASS. The principal objectives are to lower the flood water surface in the northern reaches of the Tule Creek Watershed and improve water quality in Little Bay by diverting storm runoff from the area north of FM 3036 to Aransas Bay. The flow would be conveyed by 5'x5' box culvert in the Mesquite ROW from Ditch 3 to Aransas Bay, approximately 3,200ft. The diverted area is 541 acres, which is 24% of the total Tule Creek watershed area. For storms greater than approximately a 5-year storm not all runoff would be diverted. When water levels in the ditches are high a pair of box culverts each under FM 3036 on Ditches 3 and 4 allows considerable flow to pass to the south and to Little Bay.

To improve the amount of flow diverted, Ditch 3 along Railroad would be reverse graded to the north to Mesquite, as would a portion of Ditch 4 from Chaparral to Mesquite. Ditch 4 from FM 3036 to Chaparral is concrete-lined, so it would not be modified. Conceptual drawings of the box culvert and re-graded ditches are shown in Exhibit 11. Table 6 shows the volume and associated percentage of runoff diverted to the three analyzed storm events. The actual design features for this project are to be developed during the design phase. Additional explanation of

water quality and ecological components were developed during the water quality and ecological analyses further described in Section 4, Stormwater Quality and Ecological Protection and Section 5, Ecological Resources Plan.

TABLE 9. 100-YEAR STORM RUNOFF VOLUME WITH MESQUITE BYPASS

Condition	Discharge Volume to Little Bay (ac-ft)		
	5 Year	25-Year	100-Year
Existing Condition	441	959	1,384
Mesquite Bypass	368	729	1,180
Reduction	73 (17%)	230 (24%)	204 (15%)

AREA 2 AND 3- TULE CREEK WEST AND UPPER TULE CREEK WEST. The greatest benefit is for water quality and has little effect on flood levels. The project involves widening and deepening an approximate 1-2-acre area upstream of Business 35 just east of where the north and south branches of Tule Creek confluence. This would allow velocities to drop and sediment to settle out before passing on to Little Bay. The pond would reduce steep side slopes and thereby reducing erosion and additional sediment loading to Little Bay. There is no weir planned for this project and a boom is being proposed to collect floatables. The actual design features for this project are to be developed during the design phase. In conjunction with this sediment pond would be the widening of the Upper Tule Creek West ditch to lessen the severe 2:1 side slopes to reduce the overall amount of sediment entering the system. Additional explanation of water quality and ecological components were developed during the water quality and ecological analyses further described in Section 4, Stormwater Quality and Ecological Protection and Section 5, Ecological Resources Plan.

AREA 4 - TULE CREEK NORTH RETENTION POND. This project involves excavating a 5-acre pond on the Church Tract north of Ditch 4 between Henderson and Palmetto, and running a new 42" pipe from the existing inlet on Hole 8 of the Rockport Country Club golf course. Also, Ditch 3 along the west side of Palmetto is severely restricted by a single drive culvert, so a diversion ditch is proposed to be cut from upstream of the culvert to the new pond. The pond would provide water quality polishing for low flows and approximately 24 ac-ft of flood mitigation storage.

This improvement has an additional water quality benefit. Depth in the receiving stream allows the new 42" pipe to be placed approximately 18" below the existing pipe, providing that the first flush will be diverted to the new pond for retention and polishing before being released to the Tule system and out to Little Bay. A conceptual drawing of this improvement is shown in Exhibit 12.

The new 42" pipe from the Rockport Country Club golf course would double the capacity of the existing 42" pipe, which discharges to Ditch 3 downstream of Henderson. This has a benefit of reducing the 100-year water level on Cedar Ridge, which is known to have flooded previously, by approximately 0.5ft. The actual design features for this project are to be developed during the design phase. Additional explanation of water quality and ecological components were developed during the water quality and ecological analyses further described in Section 4, Stormwater Quality and Ecological Protection and Section 5, Ecological Resources Plan.

AREA 5 - TULE CREEK EAST. This involves creating two water quality ponds on the south side of Lower Tule (below Bus. 35). The ponds are separated by Tule Park Road, and are linked by a 24-inch equalizer pipe. The ponds are excavated below elevation 0 to hold water for wading birds. Hydraulically, the ponds are separated from the channel by a side-flow weir that runs along the existing ditch, and allows spill over from the ditch at elevation 5.5.

A weir placed in the existing ditch with a crest elevation of 2.0 will prevent low flows from upstream passing to Little Bay. The weir may be earthen or sluice gate type. A 24-inch pipe upstream of the weir diverts runoff from the ditch to the water quality ponds for polishing before release. The most notable hydraulic affect of this improvement is to raise the 100-year water level upstream of Bus. 35 by approximately 0.2ft. To avoid a negative impact on flood levels, this project would need to be built in conjunction with another that would offset its impact. A conceptual drawing of the weir and ponds is shown in Exhibit 13. The actual design features for this project are to be developed during the design phase. Additional explanation of water quality and ecological components were developed during the water quality and ecological analyses further described in Section 4, Stormwater Quality and Ecological Protection and Section 5, Ecological Resources Plan.

LOWERING OF PICTON LANE AND SORENSON ROADS. This improvement provides a large amount of flood mitigation benefit by reducing the damming effect of the roads on Lower Tule. Table 9 shows the existing and proposed roadway centerline elevations. A conceptual drawing of the improvements is shown in Exhibit 14. The incorporation of ecological components into this project and a small pond is addressed in Section 4, Stormwater Quality and Ecological Protection, and Section 5, Ecological Resources Plan. The actual design features for this project are to be developed during the design phase. Additional explanation of water quality and ecological components were developed during the water quality and ecological analyses further described in Section 4, Stormwater Quality and Ecological Protection and Section 5, Ecological Resources Plan.

TABLE 9. EXISTING AND PROPOSED ROADWAY ELEVATIONS, IMPROVEMENT 5.

Development Condition	Tule Park	Picton	Sorenson
Existing	5.85	6.24	6.04
Proposed	4.85	4.74	4.54
Difference	1.00	1.50	1.50

SECTION 4.0 - STORMWATER QUALITY AND ECOLOGICAL PROTECTION

This section discusses the areas which are known to be candidate sites for central BMP approaches within the Tule Creek watershed, and the development of alternative structural BMP projects what included the integration of the hydrology and hydraulic analysis, water quality, and ecological analysis. This includes locations where a BMP might be placed to serve a wider area, and locations where a specific land use or condition merits specific consideration for BMP placement.

4.1 WATER QUALITY AND ECOLOGY ASSESSMENT CRITERIA

While this section focuses on the results of the functional analysis of specific stormwater management solutions in the Tule Creek Watershed, it is important to consider the overall process that was used to arrive at these conclusions. Included in the process were numerous site visits, two public Open House forums, the development of strategic guidelines and initial water quality design criteria that focused on future development, project team workshops held to consolidate the data and information and develop conceptual projects and integration of this analysis into the Tule Creek recommendations. These efforts are addressed in other sections of the Tule Creek Report.

In all, a total of five locations were identified which might constitute opportunities for consideration for Structural BMP placement in the watershed. These locations for structural BMP facility design were developed considering the influences of the existing conditions, features and resources described in Section 2, including the constraints and opportunities that influence project design and implementation. Other parts of the watershed will be addressed by means of distributed BMPs that can be identified, planned, designed and placed as development proceeds. The five project areas which are potential Structural BMP candidates within the Tule Creek Watershed are generally labeled:

- Area 1: Tule Creek West Forested Wetlands and Woodlands
- Area 2: Upper Tule Creek West
- Area 3: The Tule Creek North
- Area 4: The Tule Creek East Detention Pond and adjacent properties including lower Tule Creek area near Picton Street/Sorenson Street
- Area 5: The Transfer Station near the airport (included as an example of industry stormwater improvements)

In addition, one of the first tasks of the ACSMP was to prepare and implement non-structural BMP improvements including: The Interim Site Development and Construction Management Guidelines and the Interim Stormwater Quality Design Criteria. These non-standard BMP's reiterate the County's Stormwater Policy, provide planning and engineering-level guidance as well as design-level information for the stormwater quality requirements, and an initial discussion about Low-Impact Development techniques along with an introduction into stormwater credits available through the practice of these techniques. These non-structural BMP rules were implemented throughout the County but outside the City of Rockport which is regulated by City stormwater codes.

While it is not necessary to reiterate the entire non-structural BMP stormwater quality requirements in this report, it should be noted that the requirements included both a presumptive and demonstrative requirement. The presumptive requirement is to contain the volume equivalent to the first inch (1.00") of every runoff event on-site to be released over a period of not less than 36 hours. The engineer can also demonstrate the development activities will not increase the runoff, erosive activities or pollutants, or further add to any other water quality

problems. In all cases, Best Management Practices (BMP's) shall be employed to eliminate surface (floatable) contaminants, to eliminate settleable material (discrete settling) and to reduce other pollutants to the maximum extent practicable. All BMP's should be designed according the Interim Stormwater Quality Design Criteria or other applicable criteria.

WATER QUALITY BMP DESIGN WORKSHOPS

With the information and data gathering nearing completion and after numerous site visits, interviews and discussions it was concluded that a 2 or 3 day workshop would be necessary to help finalize the functional analysis and conceptual design of the proposed stormwater quality BMP's within the Tule Creek Watershed. The project team gathered together in early January 2010 to listen to the technical stakeholders and identify, evaluate, and analyze the specific site solution presented in this report along with another field trip to each site. The results of this workshop were utilized to further develop recommended plans.

The results of the steps above were consolidated and presented at an open meeting of the Water Quality Committee on March 4th, 2010. At that meeting, members of the project team including the hydrologic/hydraulic, water quality and general project elements, members of the public, Aransas County and the City of Rockport discussed the draft water quality plan in detail. Significant input was received, and has been added to this plan. The end result constitutes a result that blends known technical requirements, input from key stakeholders, known regulatory preferences or requirements and available information on planning and stormwater control constraints. Further decisions and information will be necessary as design calculations on sizing and hydraulic details are established and as the resulting plans are circulated, but the present result is anticipated to be generally complete and ready for design and decision. Continued coordination with the SMAC, Technical Committee, and other agency/advisory/stakeholders further refined the development of project alternatives and incorporating water quality and ecological components to the water quality projects.

HYDRAULIC AND BMP CAPACITY ANALYSIS

Size restrictions and hydraulic capacities for the system were developed in a separate analysis completed by the project team using the ICPR model, and the water quality analysis relied on this supporting information to determine elevations and limitations for hydraulic features of the system. Added information will be necessary at a design stage, but this information was accepted as the best available and effective for present purposes.

Although detailed quantitative analysis is reserved for the design stage of this project, a preliminary model of the system was set up using the QUALHYMO model. This is a continuous quantity/quality model suitable for sizing BMPs of the type considered in Aransas County. Since results are only preliminary, they are not included here except in synoptic form; more definitive assessments will be included in the final analyses conducted at the design stage of this project.

DESIGN FACTORS AND ASSUMPTIONS

As well as the elements discussed above, there are other factors that have an impact on the potential for design of BMPs and for water quality control options. These include such things as operational preferences, land ownership uncertainty, and so on. The most important of these factors are:

- Operating Practice. It was assumed that changes in operating practice associated with BMP maintenance could be absorbed by the existing County/City infrastructure support staff. To reduce the chance that an extraordinary burden would not be placed on these staff, highly complex and maintenance intensive solutions (for example those requiring sophisticated real time control) were eliminated from consideration after input from City and County representatives. This was confirmed at the Second Workshop described

above. Details of operating requirements will emerge during design, and this can be dealt with further at that time after consultation with those who will be vested with this responsibility.

- Land Ownership. Property maps were available and were used to guide solutions that were likely achievable with minimum need for property acquisition. Open areas (those without significant structures or infrastructure coverage) were sought, and lands owned by the County or City were emphasized. Some land acquisition may be required in the course of this plan, and where this has been encountered at least anecdotally, indications that this may be possible were obtained. However, it is noted that some adjustment of this plan may occur as land acquisition needs and opportunities are confirmed. To the extent possible, the elements of this plan have been devised so that they can be potentially implemented and adjusted in the event that potential land acquisitions contemplated in this plan are eventually found to be problematic. The principal landowner of lands where structural stormwater BMP's are recommended in the City of Rockport. There has been continued coordination during this entire project with the City of Rockport. In addition, initial coordination of recommended projects has been initiated with the Rockport City Council. Approvals from the City of Rockport have not yet been established and will be required for project implementation.

- Regulatory Preferences. Although the details of implementation are specific to this project, all the practices suggested in this plan have ample precedents in peer practice. Further, there has been input from various relevant agencies throughout this project, and existing regulatory guidance or requirements have been consulted. It is therefore anticipated that there will be little difficulty in obtaining suitable approvals for the plan in principle. Circulation and comment associated with regulatory demands as design details become available will confirm regulatory requirements, and adaptations will be made if necessary in accordance with whatever further needs are made known.

- Uncertainty. There are a number of factors which are only generally quantified in this watershed. The tolerance and response of the natural systems to changes in water quality or quantity associated with stormwater is understood in principal, but there are few measurements that enable a firm understanding of cause and effect for existing problems. There are no local gauges or monitoring stations that have provided data adequate for calibration of continuous simulation tools (or any other) for BMP analysis. There is no firm plan for future development in the watershed. Therefore, it was necessary to use available data and develop plans that are robust in the face of uncertainty. This factor is not a major issue at the present stage of analysis, but will become more important as the design stage is pursued. For now, it is noted that the plans are all predicated on the notion of adaptive management, in that key features will be planned in ways that help to enable adjustment in the future as the response of the system to BMP implementation becomes visible. As a specific example, rigid weirs will be avoided, and adjustable weirs will be preferred. Similarly, conveyance structures will be sized and placed to emphasis flexibility in the face of uncertain future inputs.

- Future Development. A significant assumption was that future development elsewhere in the watershed would adhere to the plans developed in this project over all, such that conditions will not worsen (quality and quantity relationships will not be adversely affected by development). If future development proceeds unchecked, and if water balance is not preserved, the Structural BMPs identified in this plan will still function, but their performance will likely be adversely affected. It should be understood, therefore, that all elements of this plan will need to be adhered to; the Structural BMPs by themselves will not assure water quality improvement or control.

The final plan, was evaluated within the ICPR model to determine overall compatibility with the hydraulic constraints within the Tule Creek system, both point and distributed solutions were considered, along with a

combined results plan. This water quality assessment was created so as to mesh with other analyses being carried out as a part of this project. A key aspect that was integrated with the water quality analysis was the hydraulic and hydrologic analyses. An in depth hydrologic and hydraulic analysis using the Interconnected Pond Routing (ICPR) software has been completed for the Tule Creek Watershed, and this information became the primary basis for assessing hydraulic constraints and opportunities in the water quality analysis. The water quality analysis itself included a functional analysis and conceptual plans for water quality BMP's for several specific sites within the watershed. In addition, the ecological analyses was also integrated and the water quality analysis was being performed.

4.2 STORMWATER BMP ALTERNATIVE ANALYSIS

4.2.1 AREA 2: TULE CREEK WEST FORESTED WETLANDS AND WOODLAND

LOCATION

This site is located on Tule Creek immediately upstream (north) of US 35, as shown below, extending between the old Wal-Mart location to the north, the current Wal-Mart location to the south, and along the backs of several lots in the Rockport Country Club subdivision to the west.

FIGURE 3 AREA 2 (TULE MARSH WEST) LOCATION

CHARACTERISTICS

The overall Tule Marsh West area is over 22 acres. The present marsh area is a stable resource that is the outcome of a continuing natural process in the area, and it now contains a forested wetland area with Tule Creek running through it. The western extend is heavily over-grown with brush and trees on the western margins, and has an open bank on the east margin. The west bank is only slightly above low flow elevation, while the east bank is several feet above this elevation, so flood waters tend to move overland on the west side. Human passage through this area is presently very limited, because of the density of brush and the lack of positive motivators to access this area, but signs of human activity are detectable. The area is profusely strewn with anthropogenic litter and debris, possibly resulting from direct human incursion but more likely interpreted as the result of flood waters traveling over land and leaving deposits behind.

The Tule Marsh West area has not experienced modifications over the course of several decades, and, as such, has become naturalized in terms of vegetative communities and associated topographic features. This forested

wetland area currently provides important ecological functions and values as well as roles in water quality improvement. It is not known, however, whether any unique species or habitats occur at the Tule Marsh West site (such as Federal or State listed species) that would preclude intrusive solutions.

The canopy vegetation in the lakebed is dominated by native black willow (Salix nigra) trees and non-native Chinese tallow (Triadica sebifera) trees. Other vegetative species include native sugar hackberry (Celtis laevigata) and some understory species such as shin oak (Quercus virginiana), yaupon, and American beautyberry (Callicarpa americana). The site also contains a variety of native and non-native forbs as well as some non-native Brazilian pepper (Schinus terebinthifolius) trees particularly in the area where Tule Ditch enters the central marsh area.

A portion of the central marsh area (near the old Wal-Mart facility) does currently contain open water features fringed by black willow, sugar hackberry, and Chinese tallow trees. The flow through the open water portion (which extends from Traylor Boulevard to SH 35), is maintained by excavating excess sediments, cat-tails, and water hyacinths.

The forested (upland) woodlands located immediately adjacent and contiguous to the central marsh area are characterized as a mosaic of live oak woodlands and coastal grasslands. The dominant tree species include live oak and sweetbay with understory species such as yaupon, coral bean, lime prickly-ash, and wax myrtle. Forb layers include bushy bluestem (Andropogon glomeratus), little bluestem (Schizachyrium scoparium), three awns (Aristida spp.), lovegrass (Eragrostis spp.), paspalum (Paspalum setaceum), greenbrier (Smilax spp.), and Virginia creeper (Parthenocissus quinquefolia).

OPPORTUNITIES AND CONSTRAINTS

Over all, this site may then be viewed as a substantial wetland and woodland resource, but also one which appears to be a candidate for multi-purpose uses and enhancements, such as nature trails and public access.

THREATENED AND ENDANGERED SPECIES

According to the Texas Parks and Wildlife Department's Natural Diversity Database Check and Federal and State Listed Threatened/Endangered Species List for Aransas County, the County contains a total of 47 listed endangered, threatened, and rare species. The vast majority of these plant and animal species would not likely occur in the Tule Marsh West area due the lack of appropriate habitat. A few species, however, could occur in the Tule Marsh West vicinity and should therefore be considered in the early planning stages for projects in this area. These species include the State listed threatened black-spotted newt, State listed threatened white-faced ibis, State listed rare American eel, and State listed threatened opossum pipefish. The adjacent oak motte dominated woodland habitat may contain the State listed rare Aransas short-tailed shrew, State listed rare Plains spotted skunk, State listed threatened Texas horned lizard, and State listed threatened Texas scarlet snake.

EXISTING QUALITY CONTROL BENEFITS

The site is in essence already functioning as a BMP that has a well developed plant community as its base. This interpretation is made based on observations of the site itself. The site has been seen during rain events to capture substantial quantities of detritus when overland flow occurs. The range of litter and debris deposited among the trees and bushes across this area, typical of the urban context, attests to that. This accumulation of waste does not appear to constitute impairment from the perspective of the ecology of the area. The accumulation of waste materials in this area clearly co-exists with the habitat that also covers this area, and that habitat has grown to its present state in the face of this kind of deposition.

The water quality benefits of this area are not a coincidence. The bushes and undergrowth that cover the area provide effective natural filters that catch and retain the debris. Removing that vegetation would diminish the

ability of this area to capture debris, and therefore act to the detriment of the waters below. So the site has value in its present form, not just as habitat area, but as a protective feature for the creek.

This relationship constitutes a basic constraint. Removal of the vegetation is appropriate given its inherent habitat value and given its value as a water quality improvement area. A solution in this area that would diminish either value would not be a positive outcome. For example, replacing the treed area with an open expanse would be a negative step. This does not mean that changes are inherently bad. On the contrary, changing the composition of the treed area such that a new sustainable community (which offers water quality benefits and habitat) emerges would be a neutral change from a water quality control perspective and a positive change from a wider ecological perspective.[1]

A POTENTIAL ECONOMIC RESOURCE

Stakeholders in the area have determined that this site has the potential to be a value added ecotourism feature. The potential for birding and wildlife viewing is significant if the area can be sustained and preserved. Perspectives communicated during the workshop indicate that this area is not seen as a manicured and intensely used area, but as a semi-wild area that affords limited access and promotes passive recreation such as bird viewing. This supports the need to maintain the habitat, and to maintain the associated ecosystem, in a form that supports birds and other wildlife but that allows non-intrusive viewing.

HYDRAULIC CONSTRAINTS

As with other areas in this watershed, the site is intimately hydraulically connected with areas upstream. Increasing water elevation in this location propagates changes in elevation upstream, because the whole region is so flat. Further, the crossing at US 35 downstream is one which needs to be viewed with care since increases in flow caused by changes in this area might lead to adverse effects at that location or downstream.

In addition, the Wal-Mart property adjacent to this site may pose a challenge. Discharges from the Wal-Mart property join Tule Creek near the bottom of this area. If the Wal-Mart discharges are impaired because prevailing water levels in this area differ from present conditions, consequences could be negative. This should be avoided.

MASS BALANCE

Maintaining flow and groundwater behavior in this area is a key requirement, given the interest in birding and ecology based uses. Changes in hydroperiod could adversely impact these effects, and from that perspective needs to be avoided. Consequently, solutions that lead to wide open water surfaces are questionable because of the potential changes in evapotranspiration and the resulting changes in net recharge.

COMPETITIVE USES

The City of Rockport WWTP effluent provides the bulk of the non-runoff flow in Tule Creek above this area. It appears that in dry weather, the only significant flows through this location are from the Plant. Given the interest in maintaining a thriving wildlife community, this is an important consideration. If plans call for the WWTP effluent to reduce flows in Tule Creek substantially, there will be drawbacks from the perspective of the Creek. This kind of use change is not within the scope of a stormwater quality study, but is a physical reality that will need to be addressed if the Tule Creek systems are to be maintained.

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[1] It is noted that this conclusion is based on a performance perspective and on what is known now. Other factors, such as regulatory requirements, may further constrain the site and may become evident in the future.

PERMITTING

The U.S. Army Corps of Engineers (USACE) has determined that the Tule Creek West area is subject to their agency's jurisdiction within the stream and forested wetlands areas. The Tule Creek West stream area is also considered adjacent to the tidal waters east of SH 35. Therefore, projects proposed in this area should be coordinated with the USACE and commenting natural resource agencies early in the planning process, especially if filling or placement of structures is involved. Provided in Section 2.3.1 are additional discussions of permitting issues.

SOLUTIONS

The overall picture which has emerged is that part of this area constitutes a useful on-line water quality BMP and habitat. It can be substantially modified based on what is known now provided that the essential habitat and quality protection character of the area is preserved.

The most profitable way to enhance the water quality protective value of this area would be to increase volumes by excavating along the general alignment of the existing major conveyance alignment, to minimize hydraulic complexity and to reduce the need to excavate. The degree to which this is possible depends on the need to maintain access by maintenance vehicles and the degree to which existing ecosystem elements in this area are a priority for preservation. The total live volume that can be captured this way will depend on the final design, but based on presently available information will amount to about 1.0 acre feet because of the vertical constraints imposed by flooding that would propagate upstream if water elevations at this location are substantially increased. Further, the need to preserve maintenance access and the need to provide reasonable bank slopes (e.g. flat enough to prevent slumping) reduces the ability to generate added volume over the undeveloped area in this location. However, it is possible to add a significant treatment volume within the current system by excavating downward, which can provide a sediment capture volume without markedly increasing flow resistance and increasing flooding.

The opportunity to provide new treatment volume in this area is limited. It is possible to increase conveyance and to sculpt the area margins to enhance flow patterns. It is also possible to inject new features into the area if needed for other purposes, for example to enable walkways for birding, provided that appropriate safety and environmental constraints are respected. However, these have little direct water quality treatment benefits and should not be implemented solely on the basis of water quality control benefits. .

In order to protect the integrity of this stabilized ecosystem, potential water quality/water quantity improvement projects should be designed to avoid/minimize actions which would disrupt the current stability and ecological integrity of this site. Some measures may be appropriate, such as removing non-native invasive Chinese tallow and Brazilian pepper trees, however an over-arching goal should be to maintain the area's current water quality improvement (sediment and coarse solids trapping, nutrient uptake, etc.) and ecological (wildlife habitat and wetland) functions. Another goal should be to avoid project designs and features which could result in conditions that are conducive to the establishment of non-native invasive species such as Brazilian pepper and Chinese tallow trees, water hyacinths, California bulrush, and cat-tails.

Whatever is done, it needs to be recognized that the stability of the ecosystem is a significant value, as is the structure (including hydro period, geomorphic characteristics, and existing communities) that reduces the tendency for undesirable invasives to take hold at this site. This structure should be preserved to retain the desirable characteristics and value in this area.

Finally, it is also noted that the area has an intimate hydraulic connection with the reach immediately below US 35, in the form of a backwater effect propagating upstream from the lower area. As a result, increases or decreases in

water elevation below US 35 may have an impact on conditions in Area 1. It appears based on present information that this kind of manipulation may be permissible provided that the constraints in this area are still met. This opens up the possibility of implementing changes downstream of US 35 (see Area 5 below) even though some impacts will be felt above US 35.

Figure 2 illustrates the net result of the above considerations. Four zones are shown that consolidate the major development constraints within this area. These will need to be verified by field survey before further development is pursued, and there will need to be final confirmation with applicable permitting agencies. For the present, however, these zones provide a good indication of what may be possible and preferable stormwater quality management uses of these areas.

Zone A: In this area, hydraulic conveyance improvements can be implemented if needed, and there may be some sculpting and margin modification along the banks to facilitate habitat maintenance and viewing.

Zone B: In this area, extensive re-development is possible, subject to three constraints. First, the nearby areas may need to use some of this space for BMP placement to protect the Creek from highway drainage or from adjacent area re-development. Second, development within this zone may prompt the need to implement BMPs to protect the Creek from that development. Third, parts of this wooded area constitute ecologically important native live oak woodlands and thus may need to be protected in their own right.

FIGURE 4
AREA 2 PLANNING OPTIONS

Zone C: This area has little ecological value due to the significant amount of disturbance that has occurred at this site. Most of the area can be fully re-developed provided that neither hydraulic limitations nor contamination of the Creek result.

Zone D: This area functions as habitat and as a BMP protecting the creek and should not be disturbed except as necessary to add a pool as described below. There may also be steps taken to strengthen the ecosystem, for example to remove exotic invasives such as Chinese tallow trees and to replace them with equivalent more desirable species or habitat types.

It is understood that bicycle paths and passive viewing areas may require minor deviations from this general plan, but they can be countenanced provided that the general principles outlined above are respected.

PREFERRED WATER QUALITY CONTROL MEASURES

At a design stage subsequent to this report, the final details of an installation that will take advantage of this area while preserving the ecological integrity of the area can be determined. At this time, a basic plan has been developed as a guide for consideration at the design stage. As noted above, departures from this basic plan are entirely acceptable provided that the general principles outlined above are respected. This is particularly the case where agency input and/or new data provide more definitive indications of what should be preserved in this area. Overall, the factors that were considered in developing this plan are:

- preservation of valued habitat,
- avoidance of habitat isolation or habitat area segregation,
- emphasis on sediment and floatables control to reduce discharges to the Creek and BMPs below Highway 35,
- retention of amenity value (bike paths or birding potential), and
- avoidance of installations that lead to major maintenance challenges

Measure 1: Creek Corridor Restoration: Along Zone A, the creek should be stabilized to reduce the potential for erosion. This can be achieved by structural measures or by other means such as flattening side slopes and encouraging stabilizing vegetative growth, but the details that are preferred can be identified as costs and other factors are considered at a design stage. Consideration should be given to re-alignment to avoid the artificial sudden bend in the channel to the northwest. A low flow meandering channel should be encouraged. It is noted that a careful blend to existing conditions will be needed in the vicinity of the confluence of the two branches of Zone A, to avoid a difficult and/or disruptive transition.

Measure 2: Sediment Trap installation: Along Zone A, between Zones B and D, or possibly B and C, a sediment containment feature should be placed. This will need to be developed by digging down rather than by elevating the water elevation. Placement should be finalized at design time, but it is noted that the location should be along the main channel, and placed to balance cost of excavation, access difficulty for maintenance, and disruption of adjoining land areas with value. The south bank currently has value as a BMP by filtering overland flows, and this should be preserved. The north bank has areas that are already highly disturbed and these can be re-aligned as needed. The lands in Zone C, near the highway, may be a preferred location if ownership and access are possible. There is flexibility in the design at this location provided that sufficient volume for capture is available, flooding is not increased, and maintenance access is preserved.

4.2.2 AREA 3: UPPER TULE CREEK WEST WIDENING/ENHANCEMENT

LOCATION

This site is located upstream of Area 2, extending along the creek channel to the location of the City of Rockport WWTP outfall, as shown below.

FIGURE 5 AREA 3 (WEST TULE CREEK) LOCATION

CHARACTERISTICS

Tule Creek is an earthen steep bank creek subject to high stormwater flows and erosion. The creek receives water as effluent from the City of Rockport Wastewater Treatment Plant as well as stormwater runoff. The stormwater runoff comes from nearby urban developed lands including residential subdivisions, mobile home subdivisions, and street and highway runoff. The water in this ditch is normally effluent dominated except after major rainfall events. As a result of these hydrologic influences, the wetland features within Tule Creek West are largely influenced by wastewater effluent.

The creek is routinely excavated for maintenance purposes to remove vegetation, debris and sediment. The flow in Tule Creek is continual and the creek contains a variety of freshwater wetland plants including umbrella sedges (Carex spp.), cat-tail (Typha spp.), frog fruit (Phyla lanceolata), water hyssop (Bacopa monnieri), largeleaf water pennywort (Hydrocotyle bonariensis), rattlebush (Sesbania drummondii), and a variety of spikerush (Eleocharis spp.) species.

The west bank of the Tule Creek West contains native riparian habitat including wax myrtle, coral bean, shin live oak, yaupon, and sweetbay. The forb layer occurring in this riparian area is comprised of native coastal prairie grasses. This native tree, shrub, and forb layer appears to effectively stabilize the steep banks of the ditch and eliminate/minimize erosion in many areas of the creek. The east side of the creek is maintained through periodic mowing. This maintained section of the creek is typically devoid of vegetation, or contains invasive grasses and other forbs that typically colonize disturbed sites.

The non-maintained side of the creek currently contains native riparian vegetation which extends all the way down the side of the ditch. This dense vegetation provides excellent ecological and wildlife benefits. These riparian habitats are known to provide important habitat and movement corridors for numerous species of birds and other wildlife. This vegetation also plays a very important role in water quality improvement by stabilizing the banks, preventing erosion, trapping sediments and coarse solids in stormwater runoff, and taking up nutrients. Efforts should be made to protect the integrity of this native riparian habitat, and to restore native vegetation where ever possible.

OPPORTUNITIES AND CONSTRAINTS

The area is sited where it is tempting to consider it as a potential BMP location, but has characteristics that work against this kind of use.

CONVEYANCE

The creek in this area does not have a lot of surplus capacity. It is quite flat and is constrained by crossings. It is therefore not able to withstand substantial hydraulic losses without potentially causing inundations or other negative impacts.

VOLUME

The existing alignment is maintained at a very steep side slope, visually estimated at approximately 60-70 degrees. This means that the channel section itself is relatively small, and there is no overbank area to take advantage of unless major events are considered. The ability to provide added volume for routing is therefore very limited.

BANK STABILITY

The existing banks are not only steep, they are relatively unprotected along the large part of the east bank north of Enterprise. This means that there is little ability to withstand added stresses. During a recent large storm event (December of 2009), the site experienced significant erosive losses with rills and gullies evident along the whole length of the reach. The interpretation of this is that the bank cannot be assumed to be a candidate for addition of BMP features without a significant geotechnical engineering investigation and potentially without substantial geotechnical stabilizing works added to prevent further losses.

THREATENED AND ENDANGERED SPECIES

According to the Texas Parks and Wildlife Department's Natural Diversity Database Check and Federal and State Listed Threatened/Endangered Species List for Aransas County, the County contains a total of 47 listed endangered, threatened, and rare species. The vast majority of these plant and animal species would not likely

occur in the Tule Ditch West area due the lack of appropriate habitat. A few species, however, could occur in the Tule Ditch vicinity and should therefore be considered in the early planning stages for projects in this area. These species include the State listed threatened black-spotted newt, State listed threatened white-faced ibis, State listed rare American eel, and State listed threatened opossum pipefish. The adjacent oak motte dominated woodland habitat may contain the State listed rare Aransas short-tailed shrew, State listed rare Plains spotted skunk, State listed threatened Texas horned lizard, and State listed threatened Texas scarlet snake.

RIGHT OF WAY

The land immediately adjacent to the area and available for development is limited. There is some potential for adding BMPs, but this is not a situation where there is room to add a substantial wetlands or control system.

PERMITTING

The U.S. Army Corps of Engineers (USACE) has determined that the Tule Marsh West area is subject to their agency's jurisdiction. Therefore, projects proposed in this area should be coordinated with the USACE and commenting natural resource agencies early in the planning process. Provided in Section 2.3.1 are additional discussions of permitting issues.

SOLUTIONS

This site is not suitable for modification to add features whose primary purpose is water quality control. The lack of available volume, the potential problems with bank stability, and the hydraulic constraints all combine to argue against addition of BMPs. Consequently, the site may be viewed as an opportunity for landscaping and amenity value rather than a water quality control opportunity. The site does not display substantial limitations for landscaping and other uses (provided the geotechnical and safety limitations are addressed), so it appears that enhancements of this type may be considered. However, this does not mean that water quality consequences can be ignored in the event that such enhancements are implemented. It will still be necessary to ensure that adverse consequences do not result from this kind of activity.

FIGURE 6 AN ILLUSTRATIVE SOFT CHANNEL FORM

It is known that one option of interest in this reach of Tule Creek is to add pools and riffles. This could be accomplished but initial findings are that the grade and structural constraints of the system would work counter to this type of amenity. It is suggested that in contrast, an alternative form be considered. A softer meandering form of the main channel could be placed to provide high flow capacity. Within that modified main channel, a finder sinuosity low flow channel could be encouraged. The result could be as or more stable than the current situation, and far more attractive. The figure below provides an example of such a configuration found elsewhere in the watershed. This is for illustrative purposes only, but is indicative of a possibly preferable form that is consistent with the need to maintain water quality values and limit erosive

potential. As this does not constitute a point water quality control measure, further evaluation of this option is beyond the scope of this investigation, but the principles noted here should be born in mind if and when channel enhancements are considered.

Whatever else is done, this creek should not be adjusted or modified, for example with crossings, without a detailed geotechnical and sediment transport analysis. Creek crossings in particular should be implemented as fully non-intrusive crossings (such as bridges) rather than covered or intrusive solutions (such as culverts) unless it can be demonstrated that alternatives will not have adverse effects. It is understood that evolving plans may involve a hike and bike trail along the banks and/or crossing the Creek; this specifically should not be implemented in any form unless a comprehensive evaluation of erosive impacts is undertaken and protective steps implemented as needed. Further, care must be taken to ensure that these softer forms still preserve the conveyance needed to safely convey flood flows.

4.2.3 AREA 4: TULE CREEK NORTH RETENTION POND AND HABITAT ENHANCEMENT

LOCATION

This site is located to the west of the northern tributary of Tule Creek, extending between Henderson (to the south) and Palmetto (to the north).

FIGURE 7 AREA 4 (TULE NORTH) LOCATION

CHARACTERISTICS

The area is a wooded area that has experienced some human interaction and that is bounded on three sides by some development. A drainage ditch runs along the east margin of the property. The overland area itself has not been severely affected by human activity, and constitutes a pocket of relatively undisturbed habitat.

The Tule Creek North itself is an earthen ditch which accommodates large stormwater flows. The creek does contain some wetland vegetation such as spikerush and umbrella sedges. One side of the creek contains native live oak woodlands which also occur throughout the adjacent parcel of land. The native tree, shrub, and forb layer occurring along this side of the creek appears to effectively stabilize the creek's steep bank. The other side of the creek has been cleared and it is maintained through periodic mowing. This maintained section of the creek contains grasses and other forbs that typically colonize disturbed sites.

The non-maintained side of the creek containing the native woodland vegetation provides excellent ecological and wildlife benefits. These vegetated areas play a very important role in water quality improvement by stabilizing the creek's banks, preventing erosion, trapping sediments and coarse solids in stormwater runoff, and taking (absorbing) up nutrients. These live oak woodland and coastal prairie grassland areas also provide important habitat for numerous species and particularly for resident and migratory birds. Efforts should be made to protect the integrity of this native habitat, and to restore native vegetation where possible.

OPPORTUNITIES AND CONSTRAINTS

The area has a substantial opportunity for amendment to enable implementation of an offline or on-line BMP.

CONVEYANCE

The major limitation on this site revolves around conveyance. The grade is limited, and restrictions at Henderson combine with properties along the east margin of the area to limit flows and opportunities to increase flow. However, the adjacent lands set to be acquired with the assistance of a CMP grant provide an opportunity for an offline or on-line facility that might co-exist with these constraints if a low head requirement is maintained.

THREATENED AND ENDANGERED SPECIES

According to the Texas Parks and Wildlife Department's Natural Diversity Database Check and Federal and State Listed Threatened/Endangered Species List for Aransas County, the County contains a total of 47 listed endangered, threatened, and rare species. The vast majority of these plant and animal species would not likely occur in the Tule Creek North area due the lack of appropriate habitat. A few species, however, could occur in the Tule Creek vicinity and should therefore be considered in the early planning stages for projects in this area. These species include the State listed threatened black-spotted newt, State listed threatened white-faced ibis, State listed rare American eel, and State listed threatened opossum pipefish. The adjacent oak motte dominated woodland habitat may contain the State listed rare Aransas short-tailed shrew, State listed rare Plains spotted skunk, State listed threatened Texas horned lizard, and State listed threatened Texas scarlet snake.

The state of knowledge at this time suggests that it is reasonable to proceed with a plan that supposes this area can be fully repurposed as a BMP facility provided that the current pockets of Live Oak are preserved. For planning purposes, it is estimated that 4-7 of the 9.9 acres may be constrained, making 3-6 acres available for open water BMP uses.

LOCATION

This site is located midway down the Tule Creek North and is therefore tributary to the potential Area 1 and 5 sites downstream. This could lead to a ponds-in-series configuration if this site and Areas 1 and 5 are all developed. Should this happen, some impact on pond removal efficiency will occur (as treated waters from upstream combine with untreated waters downstream). This is not a no-go constraint, but does require consideration from an efficiency perspective.

REGULATIONS

The Tule Creek North area may be subject to the U.S. Army Corps of Engineers (USACE) jurisdiction. The USACE will be contacted to determine if this inland portion of the ditch is considered jurisdictional, and to identify which types of permits might be applicable for projects located within the ditch.

SOLUTIONS

The available volume in this area is limited both by the available area and the available depth. The total storage which may be made accessible, based on the above estimates, is taken as 5 acre-feet +/- 2 acre feet. The efficacy of this volume for control will depend on the implementation of a diversion above this location which has been recommended in the course of flooding assessments conducted in other elements of this project.

PREFERRED WATER QUALITY CONTROL MEASURES

At a design stage, details of this can be developed, dependant on the tributary area identified above. For now, it is assumed that the above noted diversion will occur. If it does not, an off line facility associated with the main channel alignment should be considered. On the assumption that the diversion proceeds, an on-line facility serving the area approaching via the golf course to the west should be implemented. This will have to be designed such that inflows do not short circuit across the bottom of the facility, by placing the inlet further north or by placing baffles in the body of the BMP. Hydraulic evaluations will need to verify the function of the facility during flood conditions.

4.2.4 AREA 5: TULE CREEK EAST DETENTION PONDS AND MARSH ENHANCEMENT AND PICTON ST POND AND PICTON STREET/SORENSON OVERFLOW

LOCATION

This site is located at the bottom of the Tule Creek, beginning below US 35 and extending (with some interruptions) to Picton Lane continually bounded by Encina Street to the northeast.

FIGURE 8 AREA 5 (TULE EAST MARSH AND PICTON PROPERTY) LOCATION

CHARACTERISTICS

Tule Marsh East is a 5-acre site that currently contains a system of "ponds" (upland areas where the vegetation was cleared and the land was lowered). The site contains native live oak motte/woodland habitat along an upland ridge. The northern portion of this site was the subject of a restoration project which involved removing extremely dense stands of non-native invasive vegetation such as Brazilian pepper trees, Chinese tallow trees, and wild bamboo. Portions of the site were excavated in an effort to create shallow ponds, and an educational pavilion was constructed to provide public access and education outreach opportunities. The Tule Marsh East site contains several native trees and shrubs such as black willow and yaupon, and a variety of native grasses (such as bushy broomsedge), vines, and other forbs that are currently colonizing the site. The site also contains a variety of non-native species such as Brazilian pepper trees, exotic grasses, and exotic vines.

The Extended Wetland area is about 3 acres located along Tule Ditch East and is situated downstream from the Tule Marsh East site. This Extended Wetland area contains a large upland area bordered by Tule Ditch on the east and a low area located along the western side of the site. A ball field/park is located on the south-eastern half of the upland property. The northern and western portions of the property contain very dense monotypic stands of non-native invasive Brazilian pepper trees. The low area does hold stormwater during rainfall events, however, it is largely devoid of any vegetation. A ridge of oak mottes occurs along the western border of the site.

OPPORTUNITIES AND CONSTRAINTS

The area is located in a place (the bottom of the watershed towards the outfall to Little Bay) that makes it a logical choice for insertion of a water quality BMP targeting protection of the Bay from watershed discharges. However, there are significant constraints that balance the opportunity provided at this location.

CONVEYANCE

The site is limited between the sea level below and the available grade to businesses along the highway and to Area 1 above. This means that the site is not able to sustain very substantial increases in hydraulic grade line.

CONFORMATION

The site is raised several feet above the low water level in the adjacent Tule Creek reach. Since the site has little opportunity for increasing hydraulic grade line, it follows that volume can only be achieved (barring energy intensive solutions like pumping) by excavation. Tule Ditch is not connected to the Tule Marsh East site. An increase in elevations between Tule Ditch and the 5-acre marsh site currently prevents ditch water from entering the marsh. A Coastal Management Program (CMP) grant was recently obtained which provided for the removal of thick monotypic stands of non-native invasive vegetation within this 5-acre area, the excavation of shallow ponds, and the construction of interpretive signage, walking paths, boardwalks, and an observation deck/pavilion area. This site may provide excellent opportunities because it currently contains many areas which are still in a somewhat disturbed state.

THREATENED AND ENDANGERED SPECIES

The Extended Wetland site does not contain native upland vegetation and it does not appear to contain wetland vegetation. The dense monotypic stands of Brazilian pepper trees at the site do not have ecological value from a wildlife standpoint. These non-native trees are extremely invasive and they will rapidly overtake native vegetative communities. Upland areas which contain dense monotypic stands of Brazilian pepper trees are considered to be ecologically disturbed sites and therefore are considered as prime areas for alteration. The low area at the site could possibly be an area of jurisdiction regulated by the USACE , however, this determination has not been established yet.

PERMITTING

The US Army Corps of Engineers has determined that Tule Ditch East (which extends from SH 35 bayward to Picton Lane) is subject to their agency's jurisdiction. The Tule East Marsh and extended wetland areas may also contain some jurisdictional wetland areas. Therefore, projects proposed in this area should be coordinated with the US ACE and commenting natural resource agencies early in the planning process. One possible constraint which should be considered is the fact that grant funds were sought and secured to perform the aforementioned habitat and education outreach site features. Although the goals and objectives of a future potential project may be the same as the goals occurring in the CMP grant, this factor should be recognized and coordinated in the early planning process to assure that there are no conflicts or constraints in utilizing the Tule Marsh East site. Provided in Section 2.3.1 are additional discussions of permitting issues.

SOLUTIONS

The preferred plan in this area is to maximize the use of the area as storage volume for small event quality control. The total area available for this is about 5.5 acres (3 acres in the west section and the remainder in the section downstream near Picton). The available depth of flow is about 1.5 feet (assuming some increased low level flow depth upstream is tolerable) or some 8.25 acre-feet of storage volume. To make this available, re-contouring and

removal will have to shift some 25 acre-feet of earth from this location. This is a substantial project, but it is noted that the opportunities for control in this area are very limited and a choice will have to be made between taking this step or accepting continued contribution of contaminants to Little Bay. Further discussions between the Little Bay community (outside the direct scope of this work) and those responsible for quality management on the land side may be necessary to establish the need for and value of this step.

PREFERRED WATER QUALITY CONTROL MEASURES

An off line facility to control high frequency events, emphasizing floatables and course sediments control, should be placed in this location. This should be designed to co-exist with the plans and existing facilities that provide recreational value (birding and passive observation) at this location. Also at a design stage, there will need to be substantial consideration of hydraulic conditions at this location. In the event that this BMP is placed, it is noted that it will require careful hydraulic design to make best use of the available volume. The 8.25 acre feet of storage that are contemplated will not be enough to have a material impact on large flows. That volume will have to be preserved at smaller events. To accomplish this, an offline facility will be needed. By placing a weir below the location, and forcing low flows through the storage volume, water quality benefits can be achieved. By designing the placement and channel configuration at the weir carefully, backwater effects during major events can be managed. Figure 9 below provides a sketch of a configuration that accomplishes this.

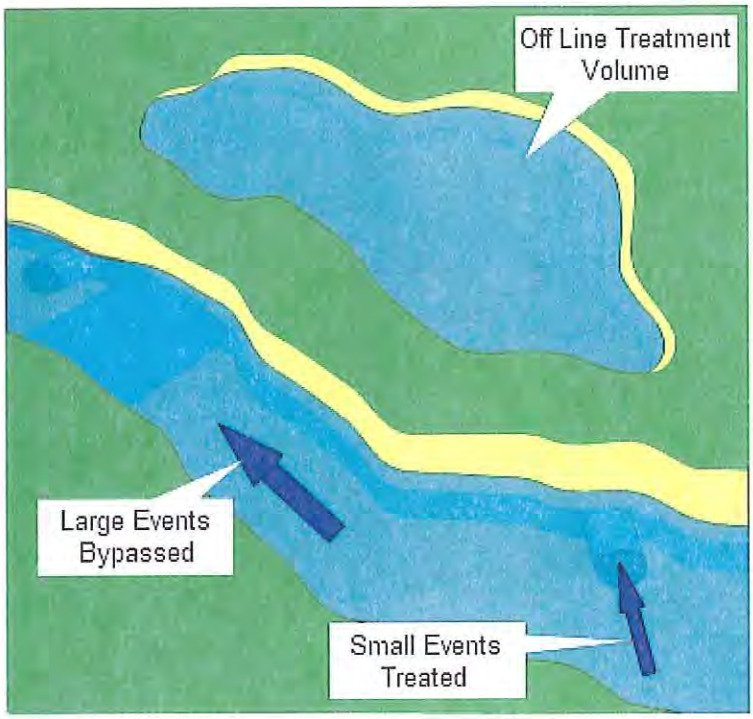


FIGURE 9 CONCEPTUAL SKETCH OF OFF LINE TREATMENT BMP

4.2.5 AREA 6: TRANSFER STATION SITE IMPROVEMENTS

LOCATION

This site is located near the northern terminus of the watershed, as shown in Figure 7. It has an area of approximately 10 acres, and situated generally west of US 35, north of Wishert Street and south of Airport Blvd.

FIGURE 10 AREA 6 (TRANSFER STATION SITE) LOCATION

CHARACTERISTICS

The area is a managed site where a range of waste handling operations occur. The site was visited by the project team on January 07, 2010. While no attempt was made to interpret or comment on the internal operations of the site as seen at that time, it was noted that the area over all appeared to be carefully maintained. Hazardous

materials (e.g. motor oil), construction waste (e.g. concrete rubble) and organic materials (e.g. vegetative debris) are all handled. Photos provided below illustrate the general nature of the site and operations. The Transfer Site is located adjacent to areas within the Tule Watershed which have been identified as being in the 5-year floodplain. The Transfer Station Site is a highly disturbed area. Although live oak woodlands and Tule Watershed wetlands do occur near the Transfer Station Site, no ecologically important habitats were found within the site itself.

The land is generally flat, and has no visible open water areas, wetlands or valuable natural communities. For the most part, it has been cleared and is covered with buildings, vehicle lanes and/or other appurtenances of the waste management operations.

FIGURE 11 SOUTHWEST TRANSFER STATION PERIMETER FENCE

FIGURE 1 GENERALLY SOUTH-EAST VIEW OF TRANSFER STATION INTERIOR

FIGURE 13 OIL COLLECTION POINT WITHIN TRANSFER STATION

What is significant from a stormwater quality perspective is that there were no visible barriers to offsite migration of potential waste by-products associated with this operation.

- On the south perimeter of the property, outside the property fence line and downwind of the site, a significant presence of windblown debris was evident. This by itself is a testament to the potential for contribution of quality impairment to stormwater, since storm flows have the potential to pick up and carry this type of debris.
- The vehicle egress point consists of a roadway with a scale. There is no washing or fall-out zone which would minimize tracking of materials picked up on the site to off-site areas by exiting vehicles. Stormwater could therefore become laden with debris that has been carried off-site, and could convey that debris into the watershed drainage system below.
- There is no positive containment system surrounding the property. There are limited swales and drainage associated with the roadways adjacent to the property, but there is no purpose-built ditch, dyke or other barrier to offsite flows. It is therefore reasonable to anticipate that offsite stormwater flows will proceed unimpeded from the site into the drainage system as a whole.
- Other than the land surface within the site, there is no visible floatables (e.g. oil) capture mechanism surrounding the oil collection point to capture losses from the system that may occur during oil transfer operations or as a result of failure of the oil collection system. This could lead to quantities of oil floating on the surface of waters drained from the site, particularly if a loss of oil were to occur during or immediately before a major storm event.

It is additionally noted that there was no information available on possible infiltration and groundwater contamination below the facility. This type of loss and water quality impairment may be happening, but is neither visible nor known to be present at this time.

Systematic measurements of offsite flows were not within the scope of this project, but a casual observation of flows in the stormwater system immediately below the site provided a compelling visual indication that some water quality impairment may be at work. The water, associated with a recent rainfall, was only slightly turbid but was very colored. This effect is consistent with high dissolved or fine suspended organic content, and may be linked to the mounds of mulch and organic material covering much of the site. Water flowing through the mulch and into the drainage system could very well become laden with organic materials and display the characteristics that were observed.

OPPORTUNITIES AND CONSTRAINTS

It does not appear that there is any Federal or State listed species, wetlands, or other ecologically sensitive areas located within the Transfer Site property. Existing woodlands and wetlands located outside of the site should be protected when possible due to their important ecological functions and values.

Whether or not the condition of flows that was observed downstream was a direct result of runoff from the site, or arose from some other cause, it is clear that site operations in this area inherently create a potential for adverse stormwater quality impacts in runoff. This in turn constitutes a potential point source of contaminants at the site location. If those contaminants are not controlled locally, they will travel through the watershed and presumably eventually be caught by controls placed lower in the system. However, because of the location of the site, in the far north end of the watershed, they will have traveled through an extensive part of the drainage system before this capture and treatment can occur. Rather than letting an untreated discharge happen and cause possible

negative impacts along the transport route/s, it is preferable to locate water quality controls immediately next to the site.

The opportunities to develop a water quality control system in this site are substantial, because there is no major identified habitat value to the location. Stormwater controls would need to be placed so as to avoid impairing facility operations, but provided they respect this need they could be added as and where they are most effective.

SOLUTIONS

The site has no major identified drainage way off site, so a perimeter containment system will be needed to capture off site drainage. A ditch will accomplish this, but such a ditch would need to be lined to avoid the potential for groundwater contamination in the event that an oil spill or other hazardous material release occurs on sit and is conveyed to the ditch. It is also possible to install a piped drainage system with capture designed to collect flows from critical points. Costs and engineering preference at the design stage should determine which method is used. Whatever the case, a detention volume suitable to collect flows and 1) remove gross solids and 2) capture floatable constituents needs to be placed so as to treat flows captured from the site.

Solids and floatables capture is a minimum necessary step. It is also important to consider reduction of dissolved constituents, which are likely to be high in BOD and/or nutrients and possibly in other contaminants. Because the off-site drainage has not been measured, it is not possible (or within the scope of this project) to design a facility that will achieve this. It is noted that there appears to be sufficient land area in the near vicinity of the facility to consider implementation of a constructed wetland to achieve this. It is also noted that amendments to the site itself may mitigate the need for such a wetland. If the mulch piles are covered, for example, primary treatment may be all that is required, and an added wetland may be unnecessary.

PREFERRED WATER QUALITY CONTROL MEASURES

For the present, this study recommends a facility management plan be developed that ensures flows from the site are captured and treated before release. There is no indication that such a facility should be developed so as to capture and treat flows other than from the transfer station. On the contrary, the unique (in this watershed) nature of flows from this area suggests that the facility treatment system should be special purpose and restricted to controlling facility discharges. However, if local preferences dictate, there could be some exploration of integrating a facility for the transfer station with other local treatment needs. In particular, the nearby airport may have needs that are aligned with the needs of the transfer station and some joint planning may be indicated if agreeable to both parties. The basic approach at this time should be to treat the transfer station as equivalent to a construction site. The open piles of material on site and the continually managed surface, coupled with the lack of surface cover, make this a close analog to that condition. Therefore, measures such as perimeter filter fabrics, cover and placement of materials, and related solutions typically implemented to contain water quality impacts associated with construction should all be considered for immediate adoption and placement around this facility.

All of these should be implemented to some degree if possible. However, several factors will need to be considered as this is done.

- The total volume available to capture flows is not large compared to the watershed as a whole. A total retained volume equivalent to about 0.1 inches can be captured. This is a consequence of the very flat grades and development constraints in this area. This volume is not enough to provide substantial improvements beyond gross solids and floatables removal. While still worth while, this kind of BMP operation should not be posed as one targeting removal of all contaminants under all conditions. Nutrient removal, for example, will be possible for perennial flows (e.g. from the wastewater treatment

plant) but will not be substantial during high (storm event) flows. Therefore, the BMPs at these locations should emphasize floatables removal and gross solids removal.

- It follows that distributed controls in the rest of the watershed must be the primary mechanism for water quality control in this system. Prevention (e.g. by maintenance of ground cover) and local control (e.g. with infiltration) will be very important parts of this program.
- The sites are all to one degree or another hydraulically sensitive. There are numerous constraints which will limit the ability to increase the elevation of the hydraulic grade line. Careful consideration of this will need to be a part of all designs.
- The sites are intimately connected with human access, and it has been communicated that increased access (e.g. as a result of birding) is a key part of the plans for this area. Careful consideration of safety will therefore need to be a part of every design.
- There are competitive ecological values to each site. A conscious decision will therefore need to be made on the tradeoffs between the value of each site as a BMP (for example to protect Little Bay) and the inherent value of the site (for example as forested and/or wetland areas). The decision on best and highest purpose of these areas is one which will have to be made by the community, in the context of regulatory imperatives, local economy and local preferences.

SECTION 5.0 – ECOLOGICAL RESOURCES PLAN FOR THE TULE CREEK WATERSHED

This section addresses the elements incorporated into the Tule Creek Report to satisfy the goals and objectives related to protecting, restoring and enhancing water and ecological resources of the Tule Creek Watershed. Accomplishing these water and ecological goals involved the following:

- Establishing a Water and Ecological Resources Advisory Group and providing project updates and seeking opinions and comments on project deliverables involving development of stormwater BMP's, but also all water and ecological resource issues within the County and Tule Creek Watershed. This advisory group of ecological professionals and scientists was comprised of the CBBEP, TPWD, MA-NERR, TAMU-CC wetland researchers and scientists.
- Compiling the water and ecological issues conveyed during the Open Houses, SMAC, Technical Committee, agency coordination, and literature review into criteria, considerations, constraints and opportunities to be evaluated and incorporated into stormwater BMP projects and other recommended County initiatives.
- Coordinating with resource agencies including agencies involved with potential permitting activities to help assess water and ecological resource functions and values.
- Developing ecological and water quality components to incorporate as riparian aquatic, buffer zone and woodland habitat enhancements with recommended stormwater BMP projects.
- Incorporate and integrate the related water and ecological resource related public, stakeholders, partnership, Advisory Group Comments and opinions into the process for developing, evaluating, and recommending stormwater BMP projects.
- Develop a list of other (not just stormwater related) ecological resource related programs, initiatives, projects and sponsorships for consideration by the County to help in ensuring County ecological resources are protected, restored and enhanced.

5.1 LIVE OAK PENINSULA ECOSYSTEM

The Live Oak Peninsula of Aransas County is part of the Texas Gulf Coastal Plains Ecoregion, which is considered to be one of the most ecologically and biologically diverse ecoregions in Texas. The Texas Parks and Wildlife Department has ranked this ecoregion as the second highest in Texas for conservation. Although the peninsula is relatively small (approximately 5 miles wide and 25 miles long), it does contain unique vegetative communities including dense scrub/shrub and oak motte forests interspersed with numerous small freshwater wetlands. The peninsula contains habitats ranging from coastal prairie grasslands to fresh, brackish, and estuarine marshes and coastal bay ecosystems. This geographic area, which also supports numerous species of fish, birds, and other wildlife, provides significant tourism, hunting, fishing, and other recreational opportunities. Although this area is becoming more urbanized, there are still large areas within the peninsula that contain non-fragmented habitats.

The coastal areas located along the Live Oak Pensinsula and surrounding coastland contain a wide array of ecologically significant and fragile habitat types such as seagrass beds, oyster reefs, and estuarine marshes. Many of these habitats are home to threatened and endangered species including whooping cranes and sea turtles. These bays and estuaries provide habitat to thousands of fish, turtles, seabirds, and mammals as well as important marine nurseries for many of these species. These natural areas provide some of the coast's greatest economic, recreational, and aesthetic assets.

The woodland areas occurring on the peninsula are comprised of a mosaic of live oak mottes and native coastal prairie grasslands. The dominant tree species include live oak (Quercus virginiana) and sweetbay (Persea

borbonia) with understory species such as yaupon (Ilex vomitoria), coral bean (Erythrina herbacea), lime prickly-ash (Zanthoxylum hirsutum), and wax myrtle (Morella cerifera). This woodland habitat most closely matches the "Live Oak Woods/Parks" vegetation type classification described by the Texas Parks and Wildlife Department in the "TPWD Vegetation Types of Texas". The associated forb layers include numerous species of native coastal prairie grasses and vines.

This particular ecoregion provides extremely important habitat for numerous species of birds, insects, reptiles, and mammals, but its' value as a stopover habitat for migratory songbirds is immeasurable. The oak motte areas occurring on the Live Oak Peninsula have historically been, and continue to be, used as important refuges for migrating passerines as they make landfall during a Circum-Gulf or Trans-Gulf migration. During a spring or fall migration stopover or fallout event, thousands of neotropical migratory songbirds will congregate in these forested areas due to the Live Oak Peninsula's juxtaposition to the Gulf of Mexico. These migrants will seek out shelter and protection from strong winds and predators, freshwater, and begin to forage before resuming their migratory trek to their Canadian and North American breeding grounds.

5.2 TULE CREEK WATERSHED ECOLOGICAL RESOURCES

BACKGROUND

The Tule Creek Watershed is approximately 2,340 acres and is located within the northeastern portion of the Live Oak Peninsula. This watershed extends from Airport Road along its northern boundary to West Orleans Street along its southern boundary. The eastern watershed boundary is located at the western shoreline of Little Bay near Picton Lane and the State Highway 35 Bypass generally represents the western boundary.

The Tule Creek Watershed contains both undeveloped rural lands as well as urbanized areas. The rural lands are comprised of pasturelands and large tracts of undeveloped live oak woodlands interspersed with numerous small freshwater wetlands that are typically in the form of small depressional wetlands. This watershed also contains some remnant coastal prairie grasslands and scrub/shrub habitats. These ecologically unique deciduous forests are dominated by live oak (Quercus virginiana) and sweetbay (Persea borbonia) trees with understory species such as yaupon (Ilex vomitoria), coral bean (Erythrina herbacea), lime prickly-ash (Zanthoxylum hirsutum), and wax myrtle (Morella cerifera) and forb layers of bushy bluestem (Andropogon glomeratus), little bluestem (Schizachyrium scoparium), three awns (Aristida spp.), lovegrass (Eragrostis spp.), paspalum (Paspalum setaceum), greenbrier (Smilax bona-nox), and Virginia creeper (Parthenocissus quinquefolia).

According to the literature, these coastal live oak trees can withstand significant climatic conditions such as high winds from tropical storms, salt spray, occasional stormwater flooding, and occasional tidal flooding. These live oak trees sprout from the root collar and their shallow roots and expand laterally forming dense stands of running oak (shin oak). These shin oaks subsequently play an important role in the succession, maintenance, and integrity of these deciduous oak forests.

The Tule Creek Watershed also contains live oak mottes that are interspersed among grassland habitats. These native grassland areas provide habitat for many wildlife species. They also serve as extremely important habitat sites for many bird species including rapidly declining populations of grassland birds such as dickcissel, eastern meadowlark, and a variety of sparrows. This watershed also contains numerous freshwater wetlands that are often in the form of small isolated, shallow depressions. These depressional wetlands, which may periodically dry out, are extremely important components of this Live Oak Peninsula deciduous forest - native grassland - depressional freshwater wetland complex. These wetland areas provide critical habitat for wildlife at every level of the food chain including insects, amphibians, reptiles, fish, birds, and mammals. This unique ecosystem, which is naturally adapted to this geographic area's harsh climatic conditions, is extremely valuable in terms of biodiversity

and habitat for wildlife and particularly for resident and migratory birds. These areas also provide important breeding and nesting habitat for many species of waterfowl, wading birds, and passerines.

Along with the hundreds of acres of relatively unfragmented parcels of native forests, grasslands, and freshwater wetlands, this watershed also supports many areas that currently function as wildlife corridors and riparian buffers. Riparian areas refer to vegetation that is located adjacent to watercourses such as streams and ditches. Riparian habitat provides a number of important ecological functions including serving as wildlife corridors and increased use (ecotone effect) by local wildlife species. Birds, for example, will occupy woodlands, grasslands, and wetland/aquatic areas. Their utilization of an area will increase significantly when these habitat types overlap or are in close proximity to each other. When Trans-Gulf and Circum-Gulf migratory birds reach the Texas Coast, they seek cover and freshwater first, and then will finally begin foraging later. This is one example illustrating why migratory birds are observed congregating within these riparian zones.

Riparian areas also serve very important water and stormwater quality improvement functions. The vegetation (tree, shrub, forb, and grass layers) will use their root systems to bind the soils and thereby stabilize the stream/ditch banks and prevent/reduce erosion. Certain plants, such as sedges, rushes, willows, grasses, and other herbaceous plants provide structural support for the streambanks while the thicker and harder root systems of woody plants (such as shin oak and yaupon) protect the streambanks from erosion. These plant species also trap sediments and other pollutants from stormwater runoff before they enter the watercourse.

THREATENED AND ENDANGERED SPECIES

The Tule Creek Watershed also provides potential habitat for a number of Federal and State listed threatened, endangered, and rare species. According to the Texas Parks and Wildlife Department's Natural Diversity Database Check and the Federal and State Listed Threatened/Endangered Species List for Aransas County, the County contains a total of 47 listed endangered, threatened, and rare species. The vast majority of these plant and animal species would not likely occur in the candidate Tule Creek Watershed BMP locations due to the lack of appropriate habitat. A few species, however, could occur in these areas and should therefore be considered in the early planning stages for projects in this area. These species include the State listed rare Aransas short-tailed shrew (Blarina hylophaga plumbea), rare Plains spotted skunk (Spilogale putorius interrupta), threatened Texas horned lizard (Phrynosoma cornutum), threatened Texas scarlet snake (Cemophora coccinea lineri), threatened black-spotted newt (Notophthalmus meridionalis), rare American eel (Anguilla rostrata), and threatened opossum pipefish (Microphis brachyurus).

Six geographic areas within the Tule Creek Watershed have been assessed in terms of existing ecological and water quality functions. These areas include the Mesquite Street By-Pass (Area 1), Tule Creek West (Area 2), Upper Tule Creek West (Area 3), Tule Creek North (Area 4), Tule Creek East (Area 5), and Transfer Station (Area 6).

5.2.1 MESQUITE STREET BY-PASS (AREA 1)

The Mesquite Street By-Pass Area 1 site is located within an urbanized setting. The Mesquite Street By-Pass Candidate BMP project involves diverting stormwater runoff from the area north of FM 3036 east to Aransas Bay. The stormwater flow would be conveyed by 5' x 5' box culverts which would be constructed within the Mesquite Street right-of-way. This roadside maintained right-of-way does not currently provide ecological water quality improvement or wildlife habitat functions (see Table 9), therefore, culvert route would not have any ecological constraints. The culvert outfall to Aransas Bay would involve an outfall structure along the shoreline. The area proposed for the outfall is primarily rock rip-rap, however, a very small amount of seagrass may be involved with the outfall construction footprint. These issue should be addressed during the design phase.

5.2.2 TULE CREEK WEST (AREA 2)

The Tule Creek West Area, which is over 22 acres in size, contains live oak dominated woodlands, a man-made ditch (Upper Tule Creek West – Area 3) that transports municipal wastewater effluent and stormwater runoff downstream, and a large forested wetland. The man-made ditch, which is approximately 1 mile in length, extends from the City of Rockport Wastewater Treatment Plant to the forested wetland.

EXISTING HABITATS

Upland Areas

A large portion of the Tule Creek West Area contains forested uplands. These live oak-dominated woodlands are characterized as a mosaic of live oak woodlands and coastal grasslands. The dominant tree species include live oak (Quercus virginiana) and sweetbay (Persea borbonia) trees with understory species such as wax myrtle (Morella cerifera), yaupon (Ilex vomitoria), coral bean (Erythrina herbacea), and lime prickly-ash (Zanthoxylum hirsutum). Forb layers include three awns (Aristida spp.), bushy bluestem (Andropogon glomeratus), little bluestem (Schizachyrium scoparium), lovegrass (Eragrostis spp.), paspalum (Paspalum setaceum), greenbrier (Smilax bona-nox), and Virginia creeper (Parthenocissus quinquefolia).

The Tule Creek West Area also contains several disturbed upland sites where the native live oak woodlands have previously been cleared. Two of these disturbed areas are located adjacent to the new Wal-Mart site. Clearing has also been performed along the southeastern and northeastern banks of the forested wetland. Disturbed upland areas are easily invaded by non-native species such as Brazilian pepper (Schinus terebinthifolius) trees and Guinea-grass (Urochloa maxima). Many of these non-native invasive species will rapidly colonize disturbed areas and form dense stands that suppress or displace local native plant species. These dense colonies of non-native plants significantly impact wildlife use and habitat values. These disturbed areas do not currently provide high quality habitat for wildlife and they provide very limited water quality improvement functions. Therefore, these areas provide excellent opportunities as candidate BMP sites.

The forested uplands located within the Tule Creek West Area are in a relatively unfragmented state. There are some wildlife trails and old senderas within these woodlands, however, these forested areas are considered to be ecologically intact. Due to the prevalence and aggressiveness of non-native invasive plant species on the Live Oak Peninsula (and within South Texas), it is vitally important to protect and maintain areas containing unfragmented native habitats. Disturbance factors, such as clearing for roadways and paths, should be avoided or limited to the perimeter (outside edges) of this native live oak woodland area to avoid habitat fragmentation and reduce opportunities for undesirable invasive plants. Appropriate project planning is critical in maintaining and preserving the ecological integrity and biodiversity of these woodlands.

Wetland and Aquatic Areas

The Tule Creek West Area currently contains a forested wetland that is dominated by native black willow (Salix nigra) trees and non-native Chinese tallow (Triadica sebifera) trees. Other vegetative species include native sugar hackberry (Celtis laevigata) and some understory species such as shin oak (Quercus virginiana), yaupon, and American beautyberry (Callicarpa americana). This site also contains a variety of native and non-native forbs. During a review of historic aerial photography, it became evident that this forested wetland area had been an open water body at one time. This open water body extended to the east side of SH 35 Business. Historic aerial photographs also reveal that several sections of this aquatic complex had been altered through filling and development over the last 40 to 50 years.

The forested wetland area itself has not experienced any man-made modifications over the course of several decades, and, as such, has become naturalized in terms of vegetative communities and associated topographic

features. A portion of the forested wetland area (near the old Wal-Mart facility) does contain open water features that are fringed by black willow, sugar hackberry, and Chinese tallow trees. The flow through this open water portion (which extends from Traylor Boulevard to SH 35 Business), is maintained by excavating and removing excess sediments, cat-tails, and water hyacinths on a regular basis. Maintenance work and equipment access are accomplished using a high grassy berm which extends from Traylor Boulevard to SH 35 Business along the northern edge of the creek.

EXISTING WATER QUALITY AND ECOLOGICAL FUNCTIONS AND VALUES

Upland Areas

The existing live oak-dominated woodlands are ecologically unique and biologically diverse providing important habitat for numerous species of insects, reptiles, and mammals, especially migratory songbirds as previously discussed.

As illustrated in Table 9, these live oak woodlands provide many important water quality and ecological functions as well. These functions include stabilizing the soils and reducing erosion, slowing water runoff and enhancing infiltration, trapping pollutants and sediments, providing habitat for wildlife, serving as a wildlife corridor, and providing greenspace and buffer areas to surrounding development. These woodlands may also provide habitat for State listed threatened, endangered, and rare species such as the rare Aransas short-tailed shrew. This area of relatively unfragmented habitat situated within an urbanized setting is rather unique. The site also serves as an important wildlife corridor within the Tule Creek Watershed and is recognized as one of the County's best areas to promote nature-based recreation such as birdwatching and nature appreciation. These woodlands also serve as an effective buffer to surrounding development and provide significant aesthetic and greenspace values.

Wetland and Aquatic Areas

The existing forested wetland area is the outcome of decades of natural succession. This area, which apparently was open water at one time, has naturalized over the course of 40+ years. Even though this area currently contains non-native plants such as Chinese tallow trees, this forested wetland eco-system has become naturalized in terms of vegetative communities and associated topographic features.

This forested wetland area appears to be stable in terms of successive plant communities and soil/site conditions. The Wastewater Treatment Plant, which has been in operation for at least 50 years, has continuously discharged its effluent into Tule Ditch which passes through this forested wetland system. It is likely that the base of this wetland has subsequently developed sediment layers that are super-nutrified as a result of decades of biofiltration activity. The wetland is also situated in a low position within the landscape and consequently plays important roles in stormwater quality improvement, retention, and groundwater recharge. This forested wetland system traps nutrients and pollutants occurring in surface runoff. Wetlands, such as this one are known to function like sponges during heavy rainfall events by slowing water runoff and enhancing infiltration. This forested wetland site appears to currently serve as an ideal BMP due to its location within the Tule Creek Watershed and ability to trap pollutants and sediments, slow stormwater runoff, enhance infiltration, provide groundwater recharge, stabilize the soils, and reduce erosion. This forested wetland also provides habitat for many species of wildlife including resident and migratory birds.

OPPORTUNITIES AND CONSTRAINTS

General Comments

The Tule Creek West Area does provide some of the best opportunities for the development of BMPs due to its location in the watershed and land entitlements, however, this geographic area also contains uplands and wetlands that currently provide numerous water quality and ecological functions (see Table 9). It is important to

site BMPs in areas that will provide more extensive and better water quality and ecological functions than what a particular site currently offers. The live oak (upland) woodlands and the forested wetlands already provide important ecological and water quality functions, however, the previously disturbed areas (such as the mowed/maintained berms along the forested wetland) do not currently provide these functions and would therefore provide the best opportunities from an ecological and water quality improvement standpoint.

It is apparent that much of the ongoing erosion and sedimentation moving downstream through the Tule Creek system originates in the Upper Tule Creek West Area 3. These sediments, which are carried downstream, ultimately enter the Little Bay ecosystem and may be contributing to seagrass loss and degradation within this small bay system. The existing forested wetland has actually been aiding in reducing the amount of sediments and pollutants moving downstream to Little Bay. In order to protect the integrity (existing water quality functions) of this forested wetland system, prioritization should be given to correcting the problem (erosion within the Upper Tule Creek West Ditch) at its source instead of attempting to replace or improve the existing naturally functioning forested wetland system located downstream.

The recommended conceptual plan involving a sediment pond can provide an opportunity for incorporating aquatic habitat features with the proposed pond and that should be evaluated during the design phase to ensure net ecological benefits with the recommended project.

Maintaining the Forested Wetland

The forested wetland contains native plants such as black willow trees, however, it is also dominated by non-native Chinese tallow trees. Chinese tallow trees are an invasive species, however, they currently represent a successive plant species at this particular site. The vegetation in this area currently provides important functions in this watershed and, most specifically, by stabilizing the soils, reducing erosion, trapping sediments, enhancing infiltration, trapping pollutants, and providing for groundwater recharge (see Table 9). This forested wetland also contains a combination of wet and dry soils that facilitate a variety of biological and chemical reactions. Research has shown that these biological and chemical reactions reduce the availability of some nutrients and decrease the toxicity of some contaminants. Several concerns have been expressed by ecologists regarding modifications to this forested wetland. This forested wetland has developed a thick humic layer over the past several decades. This current soil structure provides soil stability in an otherwise sandy and easily eroded environment. As a result, this site currently functions as a very effective sediment trap. The sediments that have accumulated over the years are also considered to be super-nutrified due to years of biofiltration and uptake of nutrients. Research has shown that high levels of organic soil material are known to capture and facilitate the degradation of contaminants. Alterations to this forested wetland could result in these super-nutrified sediments moving downstream and ultimately to Little Bay.

The forested wetland does, however, provide opportunities for habitat enhancement through the selective clearing of the Chinese tallow trees. The tallow trees do currently aid in stabilizing the site with their root systems, however, they provide little habitat value for wildlife. One of the biggest negative aspects of Chinese tallow trees is their invasive nature, often invading areas containing native vegetation and suppressing or displacing native plant communities; therefore, replacing the tallows with native species would be desirable. This selective clearing of tallow trees should be approached through a well researched and well planned effort to ensure that the site's existing water quality improvement functions are not compromised and that problems downstream (such as sedimentation) are not exacerbated. Planning efforts should also include coordination with Federal and State natural resource agency biologists who have experience with similar projects and have expressed a desire to be involved in this particular project.

Competitive Uses

The City of Rockport Wastewater Treatment Plant (WWTP) effluent provides the majority of the non-runoff flow in Tule Creek from Enterprise Boulevard to the location where the creek joins the forested wetland and other tributaries. It appears that the treated effluent is the creek's only significant source of flow during dry weather. This flow is a very important consideration in maintaining the forested wetland's existing water quality and ecological functions. If the WWTP effluent was significantly reduced or eliminated, then the wetland and aquatic systems downstream will be affected and large sections of this forested wetland may dry out and significant problems with highly aggressive non-native species such as Brazilian pepper trees and Guinea grass would likely occur. This kind of use change is not within the scope of this report, however, it is a physical reality that will need to be addressed if the Tule Creek systems are to be preserved for their existing functions and values.

5.2.3 UPPER TULE CREEK WEST (AREA 3)

The Upper Tule Creek West is a 1-mile long man-made ditch that was initially constructed at least 50 years ago to serve as an outfall for WWTP discharges. This ditch currently contains typical 2:1 side slopes and is a significant source of erosion and sedimentation downstream. Although the forested wetland (located in the Tule Creek West Area - Area 2) does evidently trap a significant amount of these sediments, some sediments do continue to pass along Tule Creek to Little Bay.

EXISTING HABITATS

Upland Areas

Despite the severe side slopes, upland vegetation has colonized and stabilized one side of the ditch along most of its length. The other side of the ditch is utilized as an access route for maintenance activities. The vegetated (non-maintained) portions of the ditch contain riparian vegetation comprised of native species such as wax myrtle (Morella cerifera), yaupon (Ilex vomitoria), coral bean (Erythrina herbacea), sweetbay (Persea borbonia), and small scrub live oak (Quercus virginiana) and native grasses such as bushy broomsedge (Andropogon glomeratus), panic grasses (Panicum spp.), horsemint (Monarda punctata), fleabane (Erigeron myrionactis), and little bluestem (Schizachyrium scoparium). The disturbed (maintained) side of the ditch contains grasses and forbs. Many of these grasses and forbs are non-native weedy species.

Wetland/Aquatic Areas

The Upper Tule Creek West Ditch does contain some wetland vegetation such as coastal bacopa (Bacopa monnieri), lesser duckweed (Lemna minor), sedges (Cyperus spp.), and spikerush (Eleocharis spp.) along its entire length. The primary source of water in this ditch is derived from the City of Rockport's Wastewater Treatment Plant effluent and stormwater runoff from the surrounding landscape. During dry periods, this ditch is typically effluent-dominated.

EXISTING WATER QUALITY AND ECOLOGICAL FUNCTIONS AND VALUES

Upland and Wetland/Aquatic Areas

The dense native riparian vegetation occurring along one side of the upper creek's length is extremely valuable in terms of providing ecological functions such as wildlife habitat (particularly for resident and migratory birds), wildlife corridors, and enhanced biodiversity (edge effect) and slope stabilization. The native wax myrtle is particularly valuable in terms of stabilizing the banks of the creek because this native plant has dense, shallow, fibrous root systems that tend to extend laterally beneath the soil. This vegetation also plays an important role in water quality functions as illustrated in Table 9.

OPPORTUNITIES AND CONSTRAINTS

The Upper Tule Creek West does experience severe erosion, however, this erosion and subsequent sedimentation is almost exclusively limited to the disturbed (maintained/mowed) bank area and from surrounding disturbed and developed areas. The native riparian vegetation along the non-maintained side of the creek is densely vegetated and, as such, currently provides excellent erosion protection, bank stabilization, and wildlife functions. Correcting the erosion problem at its source (the Upper Tule Creek West) should significantly reduce sedimentation downstream and should therefore be considered as a priority BMP solution. If re-sloping and vegetating the disturbed (maintained) side of the creek is identified as a preferred corrective action (for example, versus installing hard structure along the creek), then some amount of live oak woodlands will likely be impacted. Although the edge of the woodlands may be affected, additional ecological benefits could be realized by designing the improvements to include vegetated slope protection (possibly living shoreline / riparian habitat), wetland creation, restoring native riparian vegetation, and controlling non-native invasive plants. In addition, the downstream ecological benefits of reducing/eliminating this source of sediment loan can provide offsetting habitat benefits when combined with wetland and riparian design improvements. The existing riparian vegetation along this ditch should not be modified as this habitat already provides extremely important ecological and water quality functions and values.

5.2.4 TULE CREEK NORTH (AREA 4)

The Tule Creek North (Area 4) site is located immediately west of the northern tributary of Tule Creek extending between Henderson Street to the south and Palmetto Street to the north.

EXISTING HABITATS

Upland Areas

The Henderson Tract, is approximately 10 acres of woodland area that has experienced some amount of disturbance and is dominated by native woodland species including live oak (Quercus virginiana) yaupon (Ilex vomitoria), coral bean (Erythrina herbacea), and lime prickly-ash (Zanthoxylum hirsutum). Forb layers include three awns (Aristida spp.), bushy bluestem (Andropogon glomeratus), little bluestem (Schizachyrium scoparium), lovegrass (Eragrostis spp.), and paspalum (Paspalum setaceum). Some amount of ground disturbance has occurred in the past which may have involved clearing access roads or pedestrian corridors.

Wetland and Aquatic Areas

The Tule Creek North ditch is an earthen ditch that contains native riparian/woodland habitat along the eastern side of the tract and is maintained (mowed) along several other sections. This ditch contains a limited amount of wetland vegetation and is a fairly significant collection point of stormwater runoff from several geographic areas.

EXISTING WATER QUALITY AND ECOLOGICAL FUNCTIONS AND VALUES

Upland Areas

The existing woodland area currently provides important habitat for wildlife, and particularly for resident and migratory birds. This site is situated adjacent to a large tract of undeveloped (wooded) land which makes the Henderson Tract even more valuable in terms of being a wildlife corridor and part of a larger unit of unfragmented habitat. The dense riparian woodlands occurring along the edge of Tule Creek North currently provide excellent water quality functions such as soil stabilization, erosion reduction, and biofiltration. These riparian woodlands also provide significant ecological value in terms of wildlife use, biodiversity and edge-effect (see Table 9).

Wetland and Aquatic Areas

The existing earthen ditch contains limited amounts of wetland vegetation. This ditch does, however, currently provide an important freshwater source for wildlife including numerous species of birds.

OPPORTUNITIES AND CONSTRAINTS

The Henderson Tract woodlands and adjacent Tule Ditch North area do provide some opportunities for BMPs, however, BMPs should be situated in disturbed areas such as the previously cleared areas within the woodlands and the maintained portions of the ditch. BMP designs should also include features that mimic natural wetland and riparian ecosystems which will in turn provide numerous water quality and wildlife habitat functions. Efforts should also be made to protect the integrity of the native woodlands, limit opportunities for non-native invasive plants to take hold, and restore native vegetation where possible. Recommended conceptual plans also involve the meandering and sloping of the existing drainage channel along the eastern site boundary. This will provide opportunities for bankshaping and sloping and establishment of a riparian habitat.

5.2.5 TULE CREEK EAST (AREA 5)

The Tule Creek East Area is located at the downstream end of the Tule Creek Watershed. This area, which extends from SH 35 Business to Picton Lane, is comprised of an earthen ditch (Tule Creek Ditch along Encina Drive), the upper "Tule Creek East Marsh" site, and the Tule Park area near Picton Lane.

EXISTING HABITATS

Uplands and Wetlands/Aquatic Areas

Tule Creek East Marsh. This area is comprised of a 5-acre "marsh" site that currently contains a system of ponds. This system of ponds represents upland areas where the vegetation was cleared and the land was lowered. This small nature preserve was the subject of a restoration project which involved removing extremely dense stands of non-native invasive vegetation such as Brazilian pepper trees, Chinese tallow trees, wild bamboo, and duck potato. Portions of the site were excavated in an effort to create shallow ponds, and an educational pavilion was constructed to provide public access and education outreach opportunities. These shallow ponds do go dry during periods of low rainfall. This marsh site is not connected to Tule Ditch. This site currently contains several native trees and shrubs such as black willow and yaupon, and a variety of native grasses, vines, and other forbs that are currently colonizing the site. The site also contains a variety of non-native species such as Brazilian pepper trees, exotic grasses, and exotic vines.

Tule Creek Ditch Along Encina Drive. The Tule Creek Ditch located along Encina Drive is earthen, however, retaining walls are currently being constructed along sections of the ditch that are experiencing significant erosion. This ditch contains some amount of wetland vegetation and it is apparently tidally influenced, at least up to SH 35 Business. The bank of the ditch adjacent to Encina Drive is maintained (mowed) and is vegetated with non-native grasses. The non-maintained side of the ditch contains trees and shrubs that are dominated by non-native invasive species such as Brazilian pepper trees.

Tule Park near Picton Lane. Another significant feature of the Tule Creek East Area 5 is a site located near Tule Park and Picton Lane. Tule Park is an existing grassy ballfield/park area that is mowed on a regular basis. The northern portion of this site contains a linear-shaped low area that holds stormwater during rainfall events, however, it is largely devoid of vegetation. A ridge of oak mottes occurs along the western edge of this low area. This shallow area adjoins a large upland area that is dominated exclusively by non-native, highly invasive Brazilian pepper trees.

OPPORTUNITIES AND CONSTRAINTS

A Coastal Management Program (CMP) grant was obtained which provided for the removal of the thick monotypic stands of non-native invasive vegetation within the 8-acre Tule East Marsh site, the excavation of shallow ponds, and the construction of interpretive signage, walking paths, boardwalks, and an observation deck/pavilion area. This site may provide excellent BMP opportunities because it currently contains many areas which are still in a somewhat disturbed state. In addition, the Brazilian pepper tree forest near Picton Lane does not currently provide positive water quality improvement or wildlife habitat functions. Therefore, these areas could provide excellent opportunities for stormwater BMPs due to their lack of existing ecological and water quality functions and values (see Table 9). The planning and design of potential BMPs within the Tule Marsh East site should, however, be coordinated with Aransas First who holds management responsibilities for this small nature preserve. Coordination is also required with TxDOT and the City of Rockport who are owners of the site and have agreements with Aransas First. The area of Brazilian pepper is land also under private ownership.

The recommended conceptual plans involving the detention pond also include maintaining, enhancing the existing wetland ponds with appropriate elevations and hydrologic regimes to support and enhance their existing wetland function and attributes as a premier birding site.

5.2.6 TRANSFER STATION (AREA 6)

The Transfer Station site is located near the northern limits of the Tule Creek Watershed and is west of the SH 35 Bypass, north of Wishert Street, and south of Airport Boulevard. This site is approximately 10 acres in size and is managed as a waste handling operation. This site evidently receives hazardous materials (such as motor oil), construction wastes (such as concrete rubble), and organic materials (such as vegetative debris).

EXISTING HABITATS

The Transfer Station site is located adjacent to areas which do contain native woodlands and grasslands, however, the site itself has primarily been cleared to accommodate the buildings, vehicles lanes, and other appurtenances associated with waste management operations. As such, the site does not currently provide important wildlife habitat or water quality improvement functions.

OPPORTUNITIES AND CONSTRAINTS

The Transfer Station site is a highly disturbed area and it does not appear to contain wetlands, ecologically sensitive areas, or habitat for Federal or State listed species. The site does, however, provide opportunities for BMPs which would reduce potential point source contamination to nearby habitats and watersheds.

SECTION 6.0 – GRANTS AND FINANCING

As part of the ACSMP Project, various local, state and federal grant opportunities have been evaluated and acquired through a competitive grant solicitation effort. These grant opportunities were pursued in order to obtain added funds which could be used to fund the implementation of stormwater best management practices (BMP's). As part of the ACSMP approach there was an interest to also "implement" stormwater BMP's as soon as possible so that the benefits of stormwater management could be realized at the earliest time. With regard to the Tule Creek watershed, grant opportunities were evaluated in cooperation between the NEI Project Team and the Aransas County grant contractor, the Grants Connection. Grant opportunities were identified and recommendations were provided to the SMAC and also the Technical Committee for subsequent continued review and recommendations to the Commissioners Court. Although the primary focus of the grant opportunities was to obtain funding for stormwater BMP implementation, other grant opportunities involving ecological preservation, restoration or enhancement were also considered to aid in achieving goals of the Ecological Resources Plan.

Since the Tule Creek Watershed Project Report has a focus on stormwater BMP's and related funding grants in the Tule Creek Watershed, only those grant opportunities specifically within the watershed and related to stormwater are discussed in this section. Provided in Section 5, Ecological Resources Plan for Tule Creek Watershed is additional grant opportunities with a focus on ecological benefits. Provided in Table 1, _____ is also a summary of Stormwater Environmental Grants and Status which is more inclusive of all grants being pursued or monitored involving Aransas County.

The grant opportunities that have been successfully accomplished involving stormwater within the Tule Creek watershed are briefly summarized as follows:

6.1 TEXAS COMMISSION OF ENVIRONMENTAL QUALITY (TCEQ) NON-POINT SOURCE STORMWATER GRANT FOR TULE CREEK

Aransas County was awarded a FY2009 grant for the Tule Creek Stormwater Wetland Project. The purpose of the grant is to improve the water quality of Tule Creek by 1) Restoring wetlands with non-point source runoff treatment capability and habitat value, and 2) Improving water quality from Tule Creek discharging to Little Bay and Aransas Bay. Funds originate from the U.S. Environmental Protection Agency (USEPA), Clean Water Act 319(h) Non-Point Source Grant Program. The total project is $238,000.00 which includes the $142,800.00 grant from TCEQ, and $95,200.00 in local in-kind contribution of excavation work from Aransas County. The project originally would involve: Tule Marsh East Enhancement/Restoration, a Public Education and Outreach Program, and Tule Ditch West Bank Stabilization and Brazilian pepper invasive tree removal.

The TCEQ and Aransas County executed the Agreement in June 2010. However, the County can be making acceptable amendments to the project scope by now focusing on the West Tule Creek Sediment Pond and Habitat Enhancement Project (Phase 1). Considering expected project costs, it is expected that full completion of this project within this limited TCEQ grant budget is not feasible. Therefore, portions of Phase 1 will need to be funded through other sources. In addition, the Upper Tule Creek West Widening/Enhancement Project is recommended as a Phase 2 component of the project.

It is recommended that the TCEQ FY2009 project is moved forward into design and any necessary U.S. Army Corps of Engineer (USACE) permitting be resolved in the "West Tule Creek Sediment Pond and Habitat Enhancement Project". This project may be designed as an "excavation only" project, which would avoid the USACE permit process, and thereby allow design to be completed by fall 2010. Plans and specifications could then be prepared allowing the TCEQ construction grant and funded project be begin late 2010 or early 2011.

It is further expected to recommend that the next FY2011 TCEQ grant opportunity (due in early Fall 2010) involve construction of initial phases (funding dependent) of the Upper Tule Creek West Widening/Enhancement. Although the Upper Tule Creek West Widening/Enhancement project is a high priority since it is a "cause" of sediment loading issues to Tule Creek-Little Bay, the cost of creek slope protection techniques is a greater cost commitment

6.2 TEXAS GENERAL LAND OFFICE (TXGLO) COASTAL MANAGEMENT PROGRAM (CMP) GRANT FOR LAND ACQUISITION

Aransas County was awarded a grant from the TxGLO Coastal Management Program to acquire approximately ten (10) acres within the City of Rockport generally consisting of Live Oak woodlands and patches of cleared/disturbed areas. The project is referred to as the Tule Creek North Retention Ponds and Habitat Enhancement. These woodlands are within the Tule Creek Watershed at a location referred to as the Henderson tract. The grant will allow Aransas County to purchase the property for a combined stormwater retention pond and riparian habitat and woodland habitat protection and enhancement project. The CMP grant, a 60:40 match, is for $485,000.00 which includes a grant funded amount of $291,060.00 and a local contribution of $194,040.00.

The project will involve a Public Access and Education Component, and funds for surveys and appraisals, grants administration, title commitments, and property purchase. It is expected the County will receive a contract from the TxGLO to begin the project in fall 2010. Once the property is acquired, future grants will be considered by the County to construct the stormwater facilities, habitat improvements, and public education and access facilities.

6.3 COASTAL IMPACT ASSISTANCE PROGRAM (CIAP) LIVE OAK PENINSULA SHORELINE ENHANCEMENT PROJECT

Aransas County will be allocated $634,820.87 each year of FY2007 and FY2008. Also for FY 2009 and FY 2010, the County will also receive similar amounts each year but approximately 13-15 percent less each year. The County has thus far dedicated $584,820.87 of their FY2007 allocation and another $539,598.00 of their FY2008 allocation to the Live Oak Peninsula Shoreline Enhancement Project. This project will involve shoreline stabilization using Living Shorelines techniques along Broadway Street and Little Bay and also along Fulton Road-Aransas Bay shoreline. In addition, the project will involve wetland protection and enhancement along Little Bay. This project is not a stormwater improvement project but does address the Counties interest in protecting, restoring, and enhancing ecological and water resources within Aransas County, and the priority Tule Creek Watershed.

It is expected that the FY2007 project activities involving the assessment of shoreline enhancements, and design and permitting of improvements will commence in the fall of 2010. Construction of improvements using the FY2008 CIAP funds could then commence in early 2010.

SECTION 7.0 – SUMMARY OF RECOMMENDATIONS

This section summarizes the recommended project plans that were developed based on a combination of flood and drainage control, stormwater quality, and ecological considerations. The set of recommended plans include projects that balance these considerations and the associated constraints and opportunities. In addition, the projects recommended for grants are also identified. The data and information provided in the preceding sections are the basis for developing and recommending the project plans. Also included in the section are additional recommended policy and project implementation considerations. The drawings of conceptual plans for the recommended BMP projects are provided in Exhibits 10 through 16. The recommended alternative projects (with associated recommended prioritization) are summarized as follows:

Area 1 - Mesquite Bypass (*Priority 1A*)
Area 2 - Tule Creek West Sediment Pond and Habitat Enhancement (*Priority 1B*)
Area 3 - Upper Tule Creek West Widening/Enhancement (*Priority 2*)
Area 4 - Tule Creek North Retention Pond and Habitat Enhancement (*Priority 3*)
Area 5 - Tule Creek East Detention Pond and Marsh Enhancement (*Priority 5*)
Lowering of Picton Lane and Sorenson Roads (*Priority 4*)
Area 6 – Transfer Station (*Priority 6*)

7.1 SUMMARY OF STRUCTURAL BMP OPTIONS

The following is a brief discussion of the recommended plans including the primary basis for their selection and ranking. Provided in Table 11 is a Summary Comparison of the Recommended BMP Projects which identifies the differences between recommended plans and basis for their selection. The areas and proposed projects, described in the previous sections of this report which are the best candidates for BMP placement are also summarized below:

7.1.1 AREA 1: MESQUITE BY-PASS

The Mesquite By-Pass project is primarily a drainage and flood control plan that will divert 25 percent of the total Tule Creek Watershed area to a new Aransas Bay outfall. This project will require approximately 3,200 feet of a 5'x5' box culvert to be installed within the Mesquite Street ROW from the Railroad ROW Ditch to Aransas Bay. A significant water quality benefit is gained by diverting this flow to Aransas Bay. In addition, there will be in-line sediment traps considered in the final design stage which will further reduce sediment load to the Aransas Bay system. This Mesquite By-Pass project is not considered a non-point source runoff control or a stormwater BMP for purposes of meeting the TCEQ grant requirement. Due to the flood control benefits and reasonable regulatory and land availability constraints and only minimal ecological constraints, the Mesquite By-Pass project is the highest ranked recommended project, with an overall construction budget of $1,600,000. Only the Tule Creek West Sediment Pond and Habitat Enhancement Project are ranked as high primarily due to the FY2009 TCEQ grant and available funds.

7.1.2 AREA 2: TULE CREEK WEST SEDIMENT POND AND HABITAT ENHANCEMENT

This project is located in a position that will enable capture of most flows and sediment from the watershed before discharge to Little Bay. Therefore, it is recommended that a pond be constructed to remove sediment transported from erosion occurring upstream. Due to certain areas at this site already functioning as BMP's and supporting a stable ecosystem, the emphasis is to maintain the existing forested wetlands and live oaks and minimize the loss of their stormwater quality functions by incorporating riparian and aquatic habitat components to the sediment pond design. Removal of Chinese tallow invasive species can be accomplished provided that ecosystem and BMP

functionality of the existing forested wetland are maintained. The pond emphasizing sediment control should be placed more or less on-line but so as to avoid changes to flood and drainage control. This project is recommended with high priority due to the funding from TCEQ FY 2009 grant with an overall project construction budget of $650,000.

7.1.3 AREA 3: UPPER TULE CREEK WEST WIDENING AND SLOPE PROTECTION

This recommended project will help significantly reduce one of the leading stormwater pollutants (sediment loading) within the Tule Creek Watershed and discharge to little Bay. The proposed widening will not only help establish a more natural meandering stream but will also establish the necessary side slope along the east creek bank for vegetated slope protection. This vegetated slope protection will help control erosion and sedimentation downstream when combined with a maintenance program designed to also control erosion. It is expected that approximately 100 feet of additional ROW is needed to be dedicated and cleared to accommodate the widening.

This plan was not recommended for the FY 2009 TCEQ grant due to budget limitations of the grant program. However, since this plan will control a leading source of contaminants (sediments) within this watershed, it is being recommended for the pending FY 2011 TCEQ grant as discussed in Section 6.0. A construction budget of $650,000 is being recommended for this project.

7.1.4 AREA 4: TULE CREEK NORTH RETENTION POND AND HABITAT ENHANCEMENT

This area has a good potential for off-line and on-line uses, and is located high in the northeast part of the watershed so that the tributary flows are relatively moderate (assuming prior constriction of Mesquite By-pass project), which will enhance stormwater quality treatment. It is positioned near a hydraulically constrained section of the creek (Railroad ROW tributary), however, so it will require a design that takes this into account. An on-line pond, of up to 5 acres, capturing frequent flows from the Railroad ROW tributary as well as the lands to the west (approaching via the golf course) should be designed at this location. It is also recommend that an additional 42" pipe be placed adjacent to the existing 42" outfall from the golf course. A construction budget of $1,325,000 is recommended.

7.1.5 AREA 5: TULE CREEK EAST DETENTION POND AND MARSH ENHANCEMENT

This area is located near the downstream part of the watershed, which makes it ideally located from the perspective of providing a positive capture of contaminants before discharge to the Bay. It is also located so that it has amenity value if configured as wetlands or semi-wild birding site as well as a BMP. Due to the requirement of constructing a weir and overflow device, this project is hydraulically sensitive and will need careful planning to develop an effective project design and avoid obvious potential risks. The Tule Marsh West site should be placed in concert with this facility to reduce the need for intrusive maintenance of sediment buildup at this location. A construction budget of $925,000 is recommended for this project.

7.1.6 AREA 6: TRANSFER STATION

Contained in a specific location and professionally managed, this potential source of water quality contaminants is a high priority opportunity for BMP placement. This location should be treated as a construction site and contained to that level until a more definitive plan for control can be devised. No budget has been identified for this project.

7.2 OTHER CONSIDERATIONS

1. There are various drainage problems in the Tule Creek Watershed that have been reported to the County as public comments during Open Houses, public meeting, and through discussions with Commissioners and stakeholders. These drainage issues will be further addressed in the overall Master Plan report.

2. There are additional recommendations and proposed projects addressed in Section 5, Ecological Resources Plan that provide habitat and/or public access benefits with limited to no relationship to stormwater management. Many of these issues, projects, or programs were addressed at the various public Open Houses and stakeholder/partnership meetings and are identified here for possible future consideration by the County. These additional project considerations include: Lower Tule Creek East Park Pond, Birding Stations/Sites and Birding Conservation Plan, and the Live Oak Nature Trail and Education Center.

3. The *City of Rockport* is not only a partner with Aransas County and member of the SMAC but is also the principal landowner of several properties recommended for stormwater BMPs. The County may need to finalize an inter-local agreement with the City to obtain project approval to utilize these properties for mutually agreed-upon project implementation.

4. The Tule Creek West Project is recommended as the *FY 2009 TCEQ* project and therefore would require a more expedited project implementation timeline consistent with the County-TCEQ contract. The proposed conceptual project, as previously discussed, will require an amendment to the County-TCEQ contract and therefore this amendment could be prioritized in order to finalize design as early as possible to allow the TCEQ construction project to proceed during the fall-winter, 2010.

5. *Lower Tule Creek East Park Pond.* This project is proposed as an optional feature of the Tule Creek East Detention Pond and Marsh Enhancement as recommended in the Ecological Resources Plan. The project involves the removal of Brazilian pepper trees and the conversion of those lands to a park pond. The property is privately owned and there has been only initial discussion with the property owner representatives regarding a possible easement.

6. Various recommended projects involve *USACE permitting.* Should the County proceed with design and construction it will be necessary to first obtain the USACE permits at the preliminary engineering design phase. Such USACE permits to construct can take 6-12 months to process. Obtaining a USACE permit for a project involving a different landowner than the permit applicant can take additional time preparing the permit application. Prior to actual USACE permitting, it is necessary to obtain written USACE permit and wetland jurisdiction which can also require added time.

7. *Tule Creek North Retention Pond and Habitat Enhancement.* This is a grant project for the County to acquire this land for future use as a stormwater BMP site. The County-TxGLO contract is not expected until the Fall, 2010. The land must be acquired first before project implementation and any necessary USACE permitting. A USACE permit determination is still required for the related Tule Creek North ditch area.

TABLE 9

EXISTING WATER QUALITY AND ECOLOGICAL FUNCTIONS/VALUES
TULE CREEK WATERSHED RECOMMENDED BMP SITES

	AREA 1 MESQUITE STREET BY-PASS	AREA 2 TULE CREEK WEST	AREA 3 UPPER TULE CREEK WEST	AREA 4 TULE CREEK NORTH	AREA 5 TULE CREEK EAST	AREA 6 TRANSFER STATION
EXISTING WATER QUALITY FUNCTIONS						
Traps Pollutants		✓	✓	X	X	
Slows Water Runoff/Enhances Infiltration		✓	X	✓	X	
Stabilizes Soil/Reduces Erosion		✓	X	X	X	
Traps Sediments		✓	✓	X	X	
Provides Groundwater Recharge		✓	✓	✓	✓	
EXISTING WATER QUALITY PROBLEMS						
Transports Pollutants		X	✓	X	X	✓
Poor Stormwater Infiltration		X	X	X	X	
Contributes to Erosion/Sedimentation		X	✓	X	✓	
EXISTING HABITAT FUNCTIONS						
Habitat for Resident and Migratory Birds		✓	✓	✓	✓	
Habitat for Other Wildlife		✓	✓	✓	✓	
Relatively Un-Fragmented Habitat		✓	X	✓	X	
Serves as a Wildlife Corridor		✓	✓	✓	✓	
Serves as a Buffer to Surrounding Development		✓	✓	✓	✓	
Potential Habitat for Federal/State Listed Species		✓	✓	✓	✓	
Habitat Uniqueness/Biodiversity		✓	✓	✓	✓	
Disturbed Habitat/Poor Wildlife Value		X	X	X	X	✓
Contains Non-Native Invasive Plants		✓	✓	X	✓	
AESTHETICS/OUTDOOR RECREATIONAL OPPORTUNITIES						
Promotes Nature-Based Recreation		X	X	X	✓	X
Enhances Visual Interest/Aesthetics		✓	X		✓	X
Separates Human Activities		✓	X		✓	X
Provides Greenspace		✓	✓	✓	✓	X

✓ = Some Current Level of Function X = No Current Level of Function Blank = Unknown or Does Not Apply

TABLE 11

COMPARISON OF RECOMMENDED STORMWATER BMPs
TULE CREEK WATERSHED

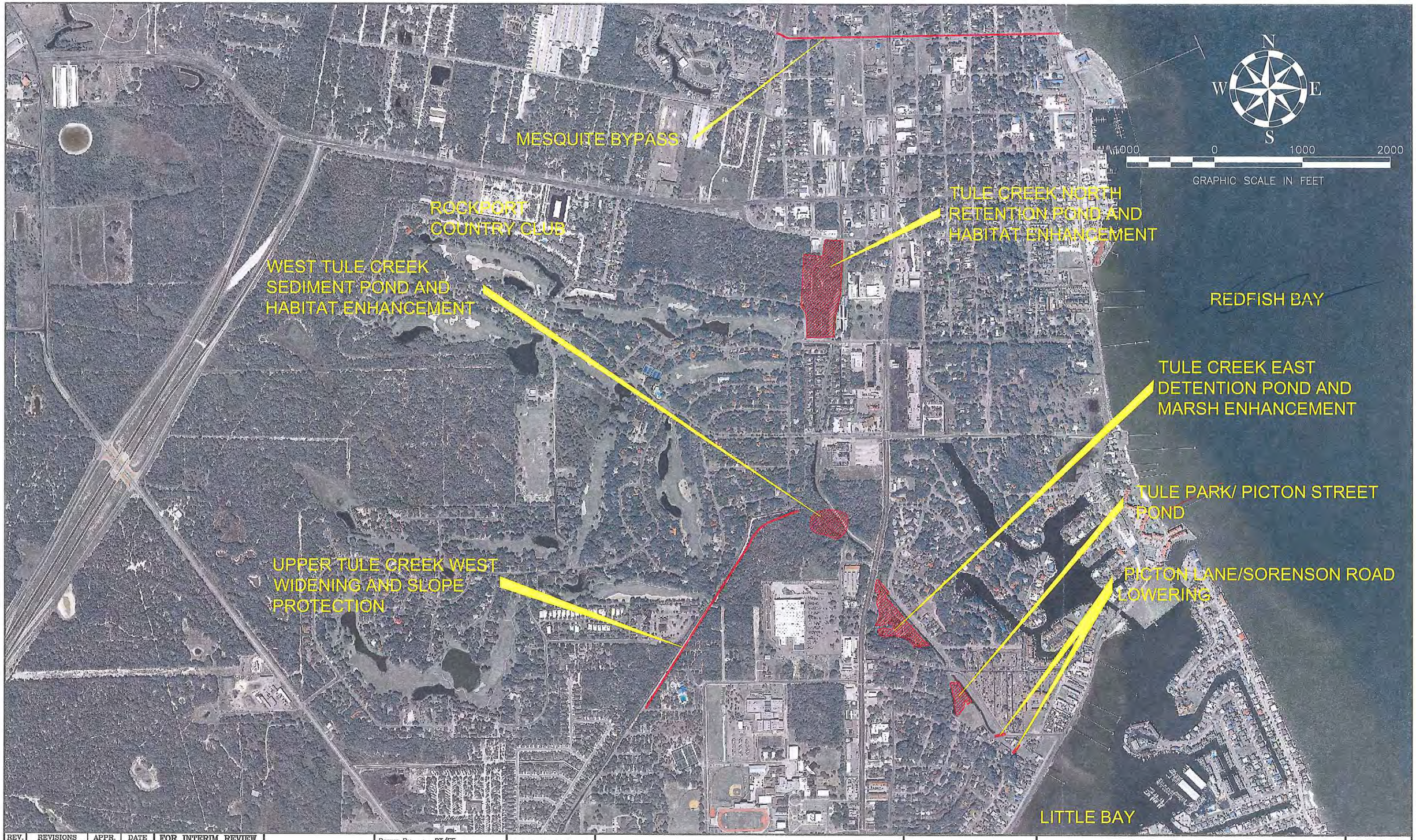
DESCRIPTION OF CRITERIA	MESQUITE STREET BY-PASS (AREA 1)	TULE CREEK WEST (AREA 2)	UPPER TULE DITCH WEST (AREA 3)	TULE CREEK NORTH (AREA 4)	TULE CREEK EAST (AREA 5)	TRANSFER STATION (AREA 6)
RECOMMENDED STORMWATER BMPs						
Stabilize Banks to Reduce Erosion	NO	YES – By Re-Sloping Eroding Banks and by Providing Vegetated Slope Protection of Pond	YES – By Re-Sloping Eroding Bank, Creating Vegetated Wetlands, and Restoring Native Riparian Vegetation	YES – By Providing Vegetated Slope Protection of Ponds and Channel	YES – By Providing Vegetated Slope Protection of Pond Banks	NO
Reshape Ditch to Create Meandering Stream	NO	NO	YES	YES	NO	NO
Construct Sediment Pond, Detention Pond With Weir and/or Shallow Vegetated Wetlands, or Retention Pond	NO	YES - Detention Pond to be Situated In-Line so as to Avoid Important Ecological Habitats	YES – Bank Re-Sloping May Involve Creating Shallow Vegetated Wetlands	YES – Within Re-Shaped Channel and Retention Pond	YES - /detention Pond and Maintenance of Existing Marsh	NO
Install Outfall and In-Line Sediment Traps	YES – In Stream Sediment Traps	NO	NO	NO	NO	YES
Divert Stormwater	YES – Diverts 25 percent of historic runoff directly to Aransas Bay	NO	NO	YES	YES	NO
Remove/Control Invasive Plants	NO	YES – Selective Clearing of Chinese Tallow Trees	YES – Brazilian Pepper Trees	NO	YES – Brazilian Pepper Trees	NO
Perimeter Containment System/Capture Offsite Drainage	NO	NO	NO	NO	NO	YES
OPPORTUNITIES/BENEFITS						
Drainage and Flood Control						
Improves Water Conveyance	YES	NO	YES – With More Cross Section Area	YES – Adds 48” RCP Outfall Type From Rockport Country Club	NO	NO
Addresses Problematic Flooding Area(s) and Reduces Flood Levels/Damage	YES	NO	No	YES	NO – In Fact, Lowering of Picton Lane, Tule Park, and Sorenson Lane is Required to Off-Set Effect	NO
Reduces Discharge to Little Bay	YES - Diverts 25 percent of historic runoff directly to Aransas Bay	Sediment Pond Will Infiltrate Some Runoff to Groundwater	Possible - Larger Wetland Cross-Section will Infiltrate Some Runoff to Groundwater	Retention Pond Will Infiltrate Some Runoff to Groundwater	Detention Pond will Infiltrate Some Runoff to Groundwater	NO
Water Quality						
Reduces Nutrients/Pollutants	YES – Reduces Discharge to Little Bay	Some With Sediment Removal	Some With Created Vegetated Wetlands	Some With Sediment Removal	Some With Sediment Removal and Created Vegetated Wetlands	YES
Reduces Debris/Floatables	YES – With Sediment Traps and Debris Collection At Outfall	YES - With Sediment Pond and Booms (Maintained)	Some With Created Vegetated In-Stream Wetlands	YES – With Sediment Traps	YES – Sediment Traps	YES
Reduces Erosion/Sedimentation	NO	YES – Through Sediment Pond	YES – By Bank Stabilization/Re-sloping and Vegetated Wetlands	YES – Retention Pond	NO	YES

TABLE 11 (Cont)

DESCRIPTION OF CRITERIA	MESQUITE STREET BY-PASS (AREA 1)	TULE CREEK WEST (AREA 2)	UPPER TULE DITCH WEST (AREA 3)	TULE CREEK NORTH (AREA 4)	TULE CREEK EAST (AREA 5)	TRANSFER STATION (AREA 6)
Habitat/Ecological						
Protects/Enhances Habitat	NO	Pond Location Minimizes Impacts to Live Oak Woodlands and Forested Wetlands	Avoids Disturbance to North Bank Containing Native Riparian Vegetation and May Involve Creating Shallow Vegetated Wetlands	Minimizes Disturbance to Riparian Vegetation and Live Oak Woodlands and Protects Woodlands from Urban Development	Avoids Loss of Existing Preferred Park Habitat	NO
Outdoor Recreation/Greenspace						
Provides Greenspace/Green Corridor	NO	YES – Will Serve as Greenspace	YES, Will Serve as Greenspace	YES, Will Serve as Greenspace	YES, Will Serve as Greenspace	NO
Provides Access for Birdwatching, etc.	NO	YES	YES	YES	Maintaining Existing	NO
Grants/Funding						
TCEQ	NO	YES, Recommended FY 2009 Project	YES, Candidate FY 2011 Project	No	YES, Candidate FY 2011 Project	NO
CMP	NO	NO	NO	YES, Cycle 16 Approved Project (Land Acquisition)	YES, Possible Cycle 17 Project	NO
POSSIBLE CONSTRAINTS						
Hydraulic/Hydrologic						
Increased Flooding/Decreased Drainage Control	NO	NO	NO	NO	NO – In Conjunction with the Lowering of Tule Park Road, Picton Lane, and Sorenson Lane	NO
Grade/Structural	YES	NO	NO	NO	YES	NO
Habitat/Ecological						
Impacts to Habitat	NO	YES – Some Live Oak Woodlands	YES – Some Live Oak Woodlands	YES – Some Live Oak Woodlands	NO – Terrestrial Habitat is Dominated by Invasives	NO
Potential Federal/State Listed Species	NO	YES, But Pre-Project Planning Should Avoid Impacts	YES, But Pre-Project Planning Should Avoid Impacts	YES, But Pre-Project Planning Should Avoid Impacts	YES, But Pre-Project Planning Should Avoid Impacts	NO
Increased Opportunities for Invasive Plants	NO	NO – Invasive Plants (Tallows) Would Be Removed/Controlled	NO – Invasive Plants Would be Removed/Controlled	NO	NO – Invasive Plants Would be Removed/Controlled	NO
Wildlife Impacts (ex. Nesting birds/Migratory Bird Treaty Act)	NO	NO – Construction Would be Limited to Non-Nesting Season and/or Compliance Plan	NO – Construction Would be Limited to Non-Nesting Season and/or Compliance Plan	NO – Construction Would be Limited to Non-Nesting Season and/or Compliance Plan	NO – Construction Would be Limited to Non-Nesting Season and/or Compliance Plan	NO
Increased Discharge to Little Bay	NO	NO	NO	NO	NO	NO
Other						
Potential Access/Maintenance Issues	NO	YES – Design Needs to Include Access for Maintenance	YES – Design Needs to Include Access for Future Maintenance	YES – design Needs to Include Access for Maintenance	YES – Design Needs to Include Access for Future Maintenance	N/A
Hike and Bike Trail	N/A	NO	Coordination With Trail Design/Layout is Needed	N/A	Possible Future Trail Connection	N/A

TABLE 11 (Cont)

DESCRIPTION OF CRITERIA	MESQUITE STREET BY-PASS (AREA 1)	TULE CREEK WEST (AREA 2)	UPPER TULE DITCH WEST (AREA 3)	TULE CREEK NORTH (AREA 4)	TULE CREEK EAST (AREA 5)	TRANSFER STATION (AREA 6)
Permitting						
USACE	NWP 43 at Outfall	Possible – Avoids Need for Permit if no Filling is Involved	Possible – NWP 41, Re-Shaping Ditches	NWP 41 is Possible if Ditch is Jurisdictional	Individual Permit or NWP 27	NO
TxGLO	YES, at Outfall	NO	NO	NO	NO	NO
Regulatory Agency Coordination	YES, with NWP 43 (less involved)	NO – Permit Not Required	Likely a NWP 41 if Greater than 500 LF of Reshaped Ditch	Possible if Upper North Tule is Jurisdictional	YES with NWP 27	
CONSTRUCTION/OPERATION						
Constructability	Culvert Placement and Outfall Structure at Bay Shoreline/SH 35 Crossing/Other Utilities	Avoidance of Significant Ecological Habitat Areas	Avoidance of Significant Ecological Habitat Areas	Avoidance of Significant Ecological Habitat Areas	Avoidance of Significant Ecological Habitat Areas	
Maintenance	Standard Storm Sewer Maintenance	Periodic Removal of Sediment Build-Up	Standard Channel Maintenance	Periodic Removal of Sediment Build-Up	Periodic Removal of Sediment Build-Up	
COST						
Construction	$1,600,000	$650,000	$650,000 (Excavation Only)	$1,325,000	$925,000	
O&M						
INSTITUTIONAL/LAND AVAILABILITY						
Land Availability	City Owned ROW	City Owned Property	City Owned Property	City Owned Property	City and TxDOT Owned	County Owned
Property Agreements	City/County Agreement	City/County Interlocal Agreement	City/County Interlocal Agreement	City/County Interlocal Agreement	City/County Interlocal Agreement, Agreement with Aransas First, TxDOT	County Owned



REV.	REVISIONS	APPR.	DATE

FOR INTERIM REVIEW
Not for construction, Bidding, or Permit purposes

Name
Serial No.
Date :

Drawn By :	DT/EF
Checked By :	DS
Approved By:	DS
Project No. :	8162
Scale :	NOTED
Date :	6/2010
Revision :	0

OFFICE LOCATION :

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ENGINEERING ■ ENVIRONMENTAL ■ SURVEYING
TBPE No. F-355

OVERALL SITE MAP
RECOMMENDED PROJECTS

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

Dwg. No. OVERALL

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Sheet 1 Of 1

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MESQUITE BYPASS

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

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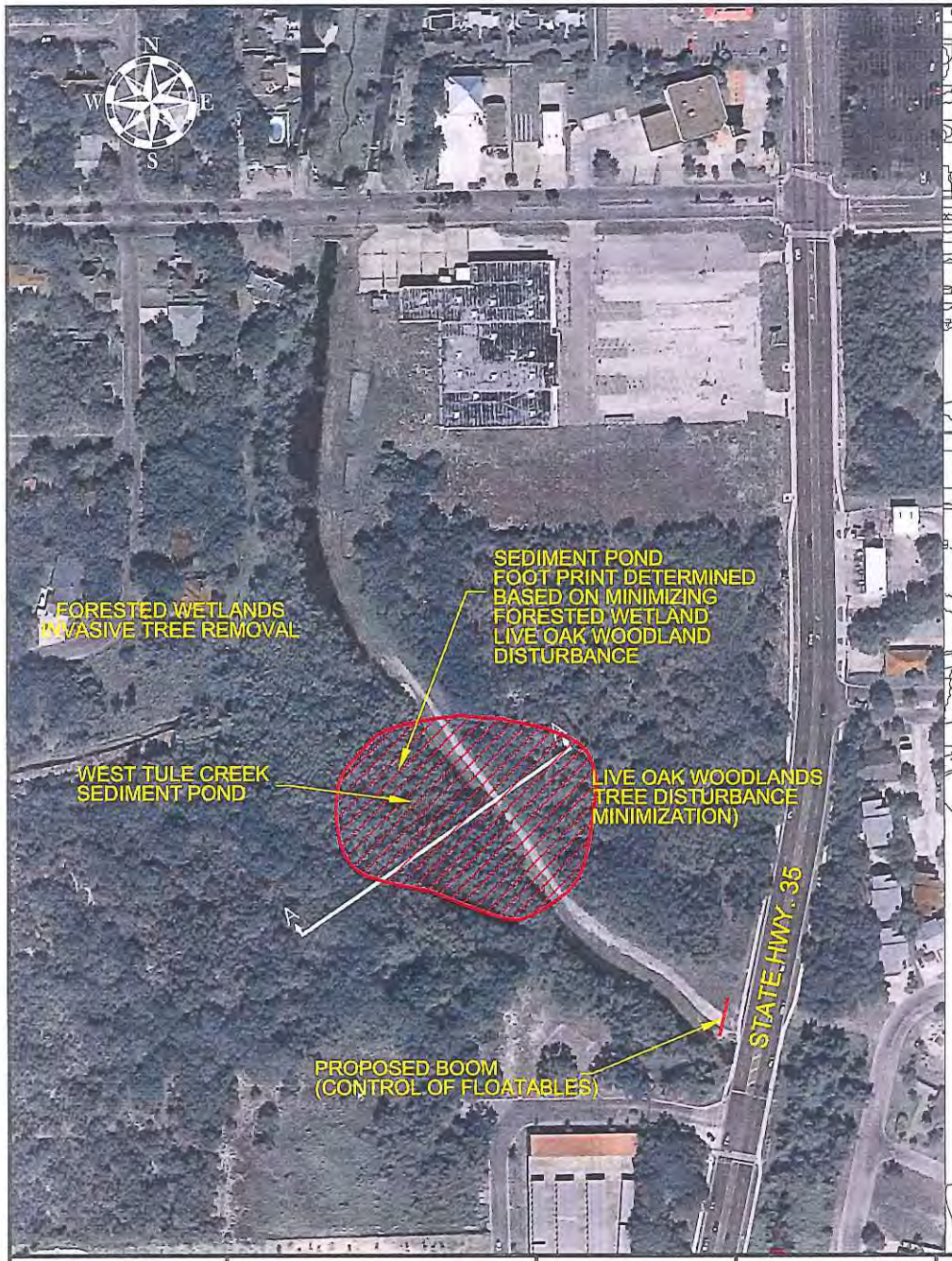

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TULE CREEK WEST SEDIMENT POND AND HABITAT ENHANCEMENT

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

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12A

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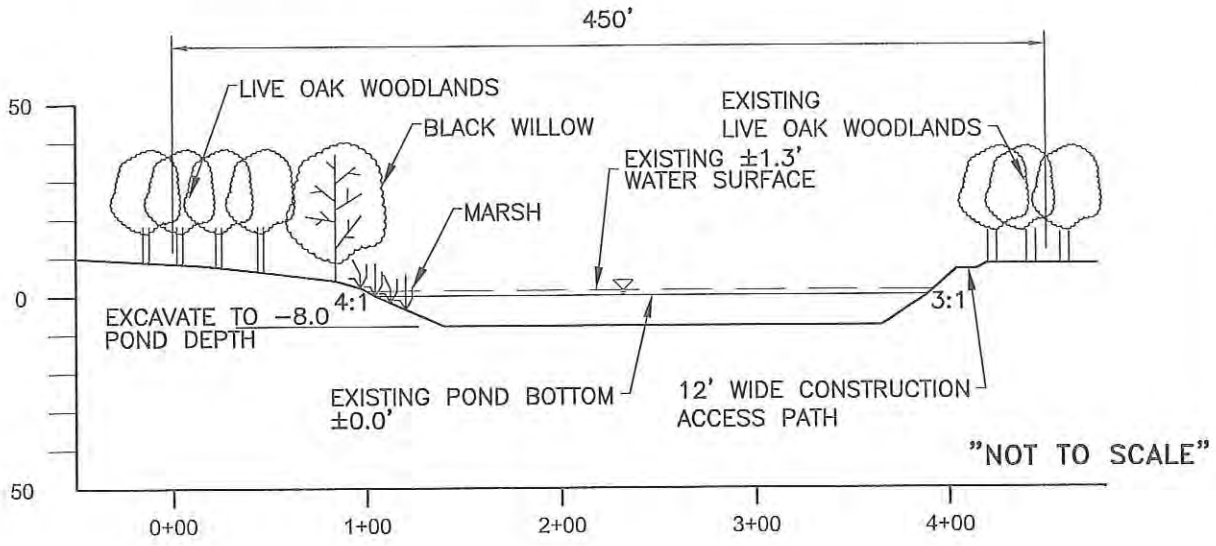

WEST TULE SEDIMENT POND

SECTION–A

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TULE CREEK WEST SEDIMENT POND AND HABITAT ENHANCEMENT

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

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12B

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UPPER TULE CREEK WEST WIDENING AND SLOPE PROTECTION

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
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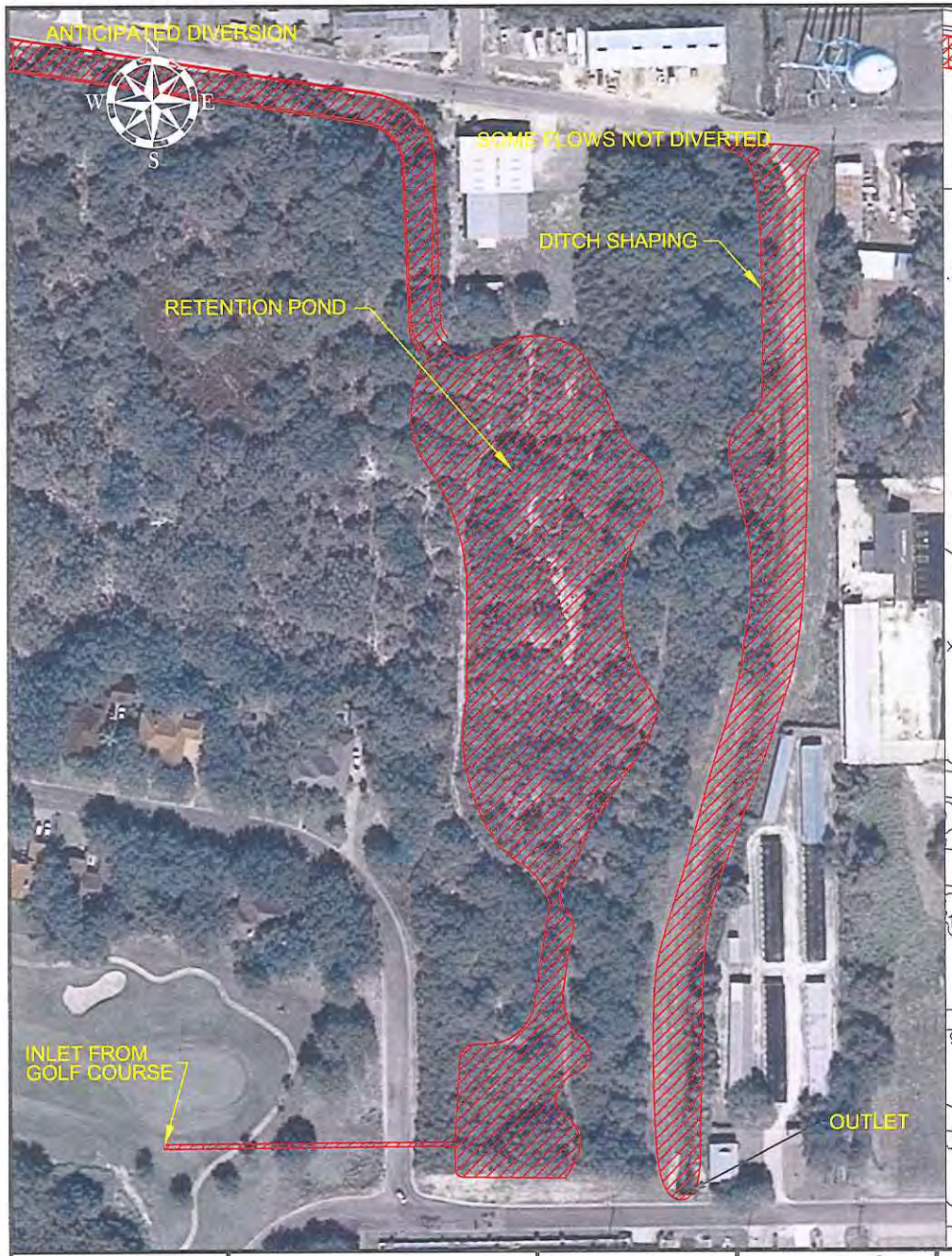

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TULE CREEK NORTH RETENTION POND AND HABITAT ENHANCEMENT

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
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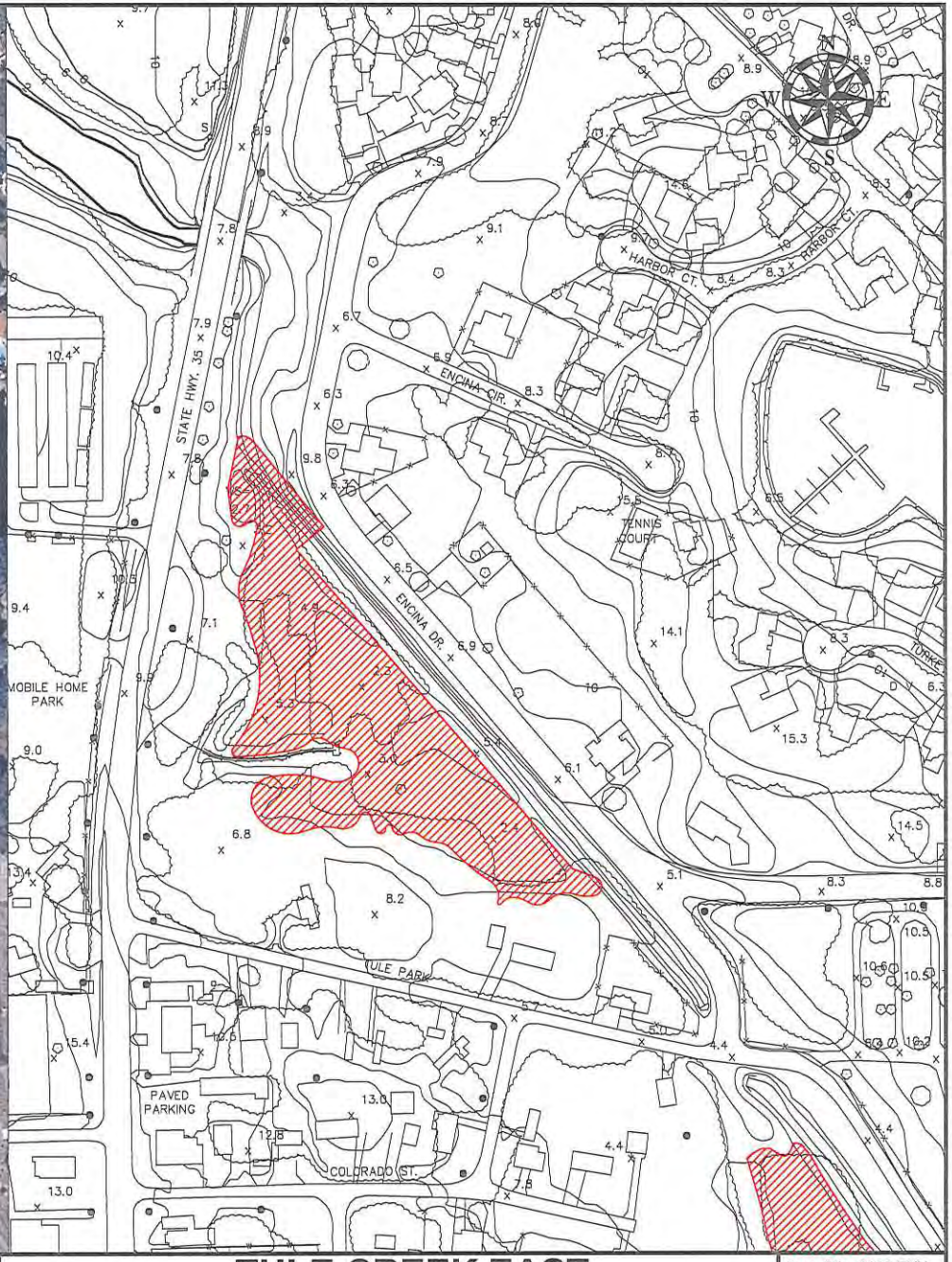

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TULE CREEK EAST DETENTION POND AND MARSH ENHANCEMENT

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

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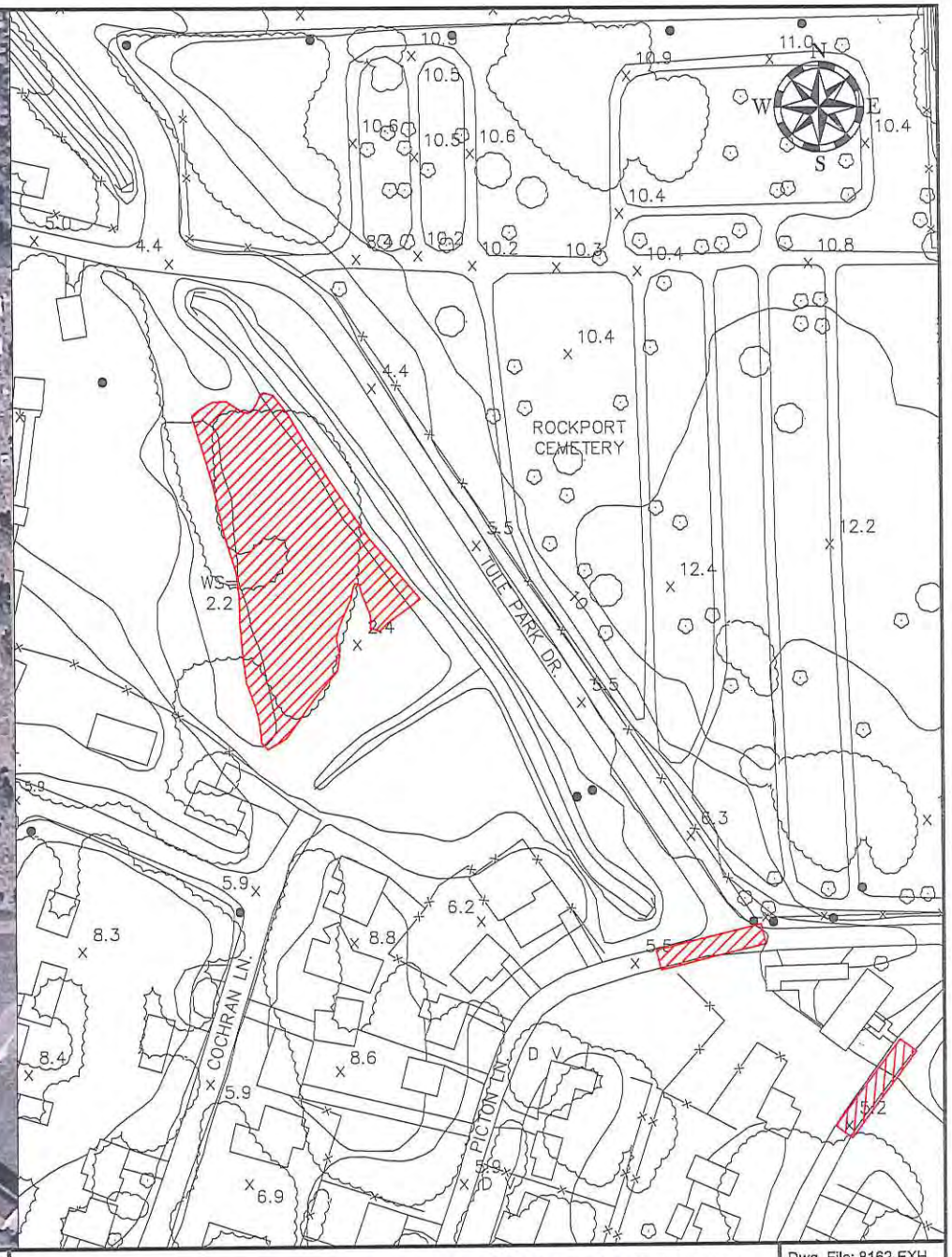

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PICTON LANE AND SORENSON ROAD IMPROVEMENTS AND PARK POND

TULE CREEK WATERSHED
RECOMMENDED IMPROVEMENTS
ARANSAS COUNTY STROMWATER MANAGEMENT PLAN

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