



# NUECES COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT #4

## WATER AND WASTEWATER FACILITIES MASTER PLAN



Adopted: June 17, 2009  
Job No. 9872.B5.00  
**Revised/Updated: December 2016**



2725 Swantner, Corpus Christi, Texas 78404  
Phone (361) 854-3101, Fax (361) 854-6001

# TABLE OF CONTENTS

LIST OF TABLES.....	iii
LIST OF FIGURES.....	iii
LIST OF ABBREVIATIONS.....	iv
LIST OF DEFINITIONS.....	v
CHAPTER I - INTRODUCTION.....	I.1-2
Acknowledgements	
Previous Master Plans	
Scope and Purpose	
CHAPTER II - SERVICE AREA CHARACTERISTICS.....	II.1-7
Principal Environmental Characteristics	
Population and Peaking Factor	
Land Use and Densities	
CHAPTER III - EXISTING WATER SYSTEM.....	III.1-6
Storage and Pumping	
Water Distribution	
CHAPTER IV - WATER SYSTEM ANALYSIS.....	IV.1-9
Water Supply and Storage	
Pumping Facilities	
Water Pressures	
Distribution Lines, Fire Hydrants, and Valves	
Water Unaccounted for	
Water Quality	
Operational Procedures	
Water Costs and Water System Rates	
CHAPTER V - DEVELOPMENT OF WATER SYSTEM MODEL.....	V.1-5
Development of Model	
Water System Model Calibration	
Update to the 2009 Model	
Water Demand Scenarios	
CHAPTER VI - SUMMARY OF WATER ANALYSIS AND RECOMMENDATIONS.....	VI.1-8
Contractual Agreement with City of Corpus Christi and SPWMD	
High Service Pump Capacity	
Elevated Storage	
Distribution System Improvements	
Fire Flow Improvements	
Ground Storage	
Proposed Water System Projects	

CHAPTER VII – HARBOR ISLAND WATER STUDY & RECOMMENDATIONS.....	VII.1-8
Water Transmission Analysis & Pumping Facilities	
Water Supply Model	
Recommended Improvements	
CHAPTER VIII - EXISTING WASTEWATER SYSTEM.....	VIII.1-4
Collection System	
Wastewater Treatment Plant	
CHAPTER IX - WASTEWATER FLOW ANALYSIS AND LOAD FACTORS.....	IX.1-2
CHAPTER X - WASTEWATER SYSTEM ANALYSIS.....	X.1-12
Wastewater Treatment Plant	
Collection System	
Evaluation of the Collection System	
Projected 15 Year Performance and Improvement Plan	
Estimated Probable Costs	

- APPENDIX A: NCWC&ID#4 WATER MASTERPLAN ESTIMATE OF PROBABLE COSTS
- APPENDIX B: HARBOR ISLAND WATER STUDY ESTIMATE OF PROBABLE COSTS
- APPENDIX C: NCWC&ID#4 WASTEWATER MASTERPLAN ESTIMATE OF PROBABLE COSTS
- APPENDIX D: GROUND STORAGE OPTIONS AND IMPROVEMENTS BEYOND 2030
- APPENDIX E: MASTERPLAN BASEMAPS

## LIST OF TABLES

<b>Table</b>	<b>Title</b>	<b>Page</b>
II-1	Population Projections for NCWC&ID#4 Service Area.....	II-5
II-2	Projected Peak Population by Zone.....	II-5
II-3	Land Usage Characteristics.....	II-7
II-4	Density Assumptions Used Throughout the Master Plan for Year 2030....	II-7
III-1	Summary of Existing Water Storage.....	III-3
IV-1	Projection of Population, Water Demand and Water Connections.....	IV-2
IV-2	NCWC&ID#4 Current Water System Capacities (2015).....	IV-3
IV-3	TCEQ Water System Minimum Requirements based on Demand.....	IV-3
IV-4	Projected Peak Demand.....	IV-4
IV-5	Annual Drinking Water Quality (2007).....	IV-8
IV-6	NCWC&ID#4 Residential Water Rates .....	IV-9
VI-1	Probable Costs of Water System Improvements.....	VI-7-8
VII-1	Source of Water Supply .....	VII-2
VIII-1	Existing Lift Stations	VIII-1
VIII-2	Effluent Quality Under Existing 10/15/2 Permit	VIII-3
IX-1	Wastewater Treatment Plant Operating Data	IX-1
IX-2	Approximate Wastewater Flows Per Acre of Land	IV-2
X-1	Option 1 – Expand North WWTP First	

## LIST OF FIGURES

<b>Figure</b>	<b>Title</b>
II-1	Primary Service Area
II-2	Secondary Service Area
II-3	Basic Environmental Zones
II-4	Primary Service Area -Year 2007 Land Usage Plan
II-5	Primary Service Area -Year 2030 Land Usage Plan
III-1	Location Map for Pump Stations and Storage Tanks
VII-1	Harbor Island Water Study

## LIST OF ABBREVIATIONS

Key abbreviations used in this report are as follows:

AAD	- Average annual daily demand
ACP	- Asbestos cement pipe
Conn.	- Connection
CDC	- Centers for Disease Control and Prevention
District	- Nueces County Water Control and Improvement District #4
gal	- Gallon
gpcd	- Gallons per capita per day
gpd	- Gallons per day
gpm	- Gallons per minute
EPA	- Environmental Protection Agency
FEMA	- Federal Emergency Management Agency
ft	- Feet
hp	- Horsepower
HS	- High Service (Pump)
ISO	- Insurance Services Organization
MD	- Maximum daily demand
MG	- Million Gallons
MGD	- Million Gallons per Day
MH	- Maximum hourly demand
MSL	- Mean Sea Level
NCWC&ID#4	- Nueces County Water Control and Improvement District #4
PVC	- Polyvinyl chloride pipe
Pop.	- Population
PS	- Pump Station
psi	- Pounds per square inch
rpm	- Revolutions per minute
SPMWD	- San Patricio Municipal Water District
SBI	- State Board of Insurance
TCEQ	- Texas Commission on Environmental Quality
TDH	- Total Dynamic Head (feet)
TNRCC	- Texas Natural Resources Conservation Commission
TWDB	- Texas Water Development Board
USGS	- United States Geological Survey
WWTP	- Wastewater Treatment Plant
WTP	- Water Treatment Plant

## LIST OF DEFINITIONS

Key definitions used in this report are as follows:

- Distribution mains – Mains connected to supply mains that provide fire protection and domestic service.
- Transmission mains – Mains of large diameter are used to transport water from treatment facilities or re-pump stations to distribution areas.
- Connection – A single-family residential unit or each commercial or industrial establishment to which drinking water is supplied from the system. As an example, the number of service connections in an apartment complex would be equal to the number of individual apartment units. \*
- Distribution system – A system of pipes that conveys potable water from a treatment plant to the consumers. The term includes pump station, ground and elevated storage tanks, potable water mains, and potable water service lines and all associated valves, fittings, and meters, but excludes potable water customer service lines. \*
- Peak hourly demand – In the absence of verified historical data, peak hourly demand means 1.25 times the maximum daily demand if a public water supply meets the commission's minimum requirements for elevated storage capacity. \*

\*As defined by the Texas Commission on Environmental Quality, Chapter 20 – Public Drinking Water, Subchapter D: Rules and Regulations for Public Water Systems, § 290.38, 290.39, 290.41 – 290.47, Effective December 10, 2015.

## **CHAPTER I - INTRODUCTION**

Urban Engineering would like to express its sincere appreciation for the assistance provided during the preparation of the master plan by the staff of the Nueces County Water Control and Improvement District #4 (NCWC&ID #4).

### **Previous Master Plans**

The original Water and Wastewater Master Plan was prepared for the District by Urban Engineering in 1995. Due to the many improvements made to the wastewater and water systems, the Master Plan and its Basemaps have been regularly updated to reflect the additional land developments within the service area and the improvements made to the distribution and collection systems. The previous update, was made in 2009 depicted the improvements, facilities, and land developments existing within the serviceable area as of June of 2007. This master plan was upgraded to incorporate color, a larger scale, more detailed information, and a map of Harbor Island.

Since the preparation of the 2009 master plan the District has changed the operation of the distribution system. The following operational changes have been implemented:

- 1) The Beasley Street Pump Station, located in Aransas Pass now pumps directly into the distribution system.
- 2) The Ferry Landing Pump Station is no longer being used to supply and pressurize the system.
- 3) The existing elevated water storage facility at SH 361/Mariners Drive will be decommissioned in 2017 and a new elevated storage has been sited 4,500-ft. north on SH 361 at across from the Gulf Waters RV Park.

### **Scope and Purpose**

The primary purpose of the Water and Wastewater Master Plan report is to evaluate the adequacy of the existing water distribution & wastewater collection systems and to determine the improvements needed to meet the projected demands through the year 2030. The plan includes base mapping, population characteristics and land use inventory, hydraulic analysis & modeling

of the distribution system, water system capital improvements program, wastewater system analysis, and a wastewater capital improvements program.

The water and wastewater system studies were based on census data, population projections, future land development, and area densities. The water study begins in Chapter III and includes an analysis of the distribution system, storage capacity, and water system analysis. The wastewater study begins in Chapter VIII and includes an analysis of the existing collection system, treatment facilities, flow analysis, and wastewater system analysis. Chapter VII describes the existing conditions of the transmission system, the pumping capacity at Beasley Pump Station. Recommendations for ground storage options at the Ferry Landing Pump Station, and for future improvements, beyond 2030 can be found in Appendix D.

## **CHAPTER II - SERVICE AREA CHARACTERISTICS**

The Nueces County Water Control and Improvement District #4 (NCWC&ID#4) currently provides water and wastewater service for residents and businesses within the City of Port Aransas and the surrounding areas. The primary service boundary for both the water and wastewater is bound by the Corpus Christi Ship Channel on the north, the Gulf of Mexico on the east, Mustang Island State Park on the south, and Corpus Christi Bay on the west. It is relatively narrow (about 1 mile wide by 10 to 11 miles long), and is divided by a major highway (State Highway 361), with approximately 2,700 acres to the East and 4,000 acres to the West. With the exception of the City of Port Aransas which occupies the very North end of Mustang Island, the remainder of the service area is moderately developed. The primary service area boundary is shown on Figure II-1. As illustrated on Figure II-2, the District maintains a secondary service boundary along Harbor Island; which is bound by Redfish Bay on the north, the Corpus Christi Ship Channel on the east, the Corpus Christi Bay on the south, and the City of Aransas Pass on the west. The boundary runs parallel with State Highway 361 from the City of Aransas Pass to the City of Port Aransas, and consists of approximately 1400 acres that is sparsely developed.

### **A. PRINCIPAL ENVIRONMENTAL CHARACTERISTICS**

The area is generally identified by four basic environmental units. These units are the beach, dune complex, barrier flats, and tidal flats, see Figure II-3.

#### **1. BEACH**

The beach is about 200 to 300 feet wide, and composed primarily of fine to very fine sand. It is subject to erosion and accretion at a rate between -4.9 to 1.6 ft/year, according to the U.T. Bureau of Economic Geology. The beach serves as an energy dissipater complex during non-storm conditions.

#### **2. DUNE COMPLEX**

The dune complex varies in height from 15 to 25 feet, and averages 800 feet in width. It serves as protection to the barrier island during storm surges.

### **3. BARRIER FLAT**

The barrier flat is generally the level plain between the dune complex and the tidal flat on the Corpus Christi Bay side of Mustang Island. Elevations range from sea-level to approximately ten feet. This area collects rain water and transmits it to ground water, and experiences flooding at low elevations, with heavy flooding during hurricanes. This is the environmental unit of the island that is comparatively more suitable for development. Roads, home sites, utilities and other facilities can be placed within the barrier flats with limited adverse impact; however, storm drainage and the management of surface water provide the biggest challenge. The wastewater utilities for this area are managed at higher than normal costs due to the subsurface water conditions and ground composition.

### **4. TIDAL FLATS**

The tidal flats of the island consist of the low lying areas with either water cover or areas impacted by continuous to intermittent wind and tidal influences. The tidal flats vary in elevation from nearly 3 feet below to 3 feet above sea-level, and consist of grass flats, salt marshes, sand beaches and wind tidal flats. The relatively low elevation of this area makes it generally undesirable for development, while its main purpose is to serve as a barrier dissipating energy to the island from the bay.

The primary service area, with the exception of the Port Aransas City Limits, is divided approximately as follows:

- Beach - approximately 200 acres
- Dune Complexes - approximately 1,100 acres
- Barrier Flats - approximately 3,700 acres
- Tidal Flats - approximately 2,000 acres

The secondary service area is divided approximately as follows:

- Barrier Flats - approximately 700 acres
- Tidal Flats - approximately 700 acres

The NCWC&ID #4 was originally formed to provide water service to the City of Port Aransas. In the early years, some of the landowners petitioned to the Courts for exclusion. They contended that as rural areas they would not expect to receive water and sewer service from the District and thus should not be included within its service area. Some of these petitioned requests were granted, one of which was for the Wilson family trusts, who owned a large portion of Mustang Island. Consequently, as the Wilson properties have been subdivided and sold for development, they have had to negotiate with the Water District for reinclusion into its service area. Presently, only a small number of tracts remain excluded from the District, such as the San Ramon and Bob Clark tracts to name a few.

## **B. POPULATION AND PEAKING FACTOR**

The demand placed on the water and wastewater systems is attributed to roughly three general types of population. The first type consists of residents that permanently reside within the District's service area including the City of Port Aransas. The second category includes customers that have second homes but live elsewhere the majority of the time, and have an active account and meter with the District but may not always create the same type of demand that a permanent resident would. The third type of population consists of tourists and vacationers that visit on weekends and holidays. Due to climate and location, the City of Port Aransas and the surrounding areas are an excellent recreational destination which attracts many visitors during the summer and winter months.

The 2011 State Water Plan prepared by TWDB reported the population of permanent residents within NCWC&ID#4 service boundary including the City of Port Aransas to be 14999 in 2010. The Texas Water Development Board uses these statistics to project populations for the future, as shown in Table II-1.

Throughout this report, an average and a peak population is mentioned to project both water demand and wastewater needs. In order to determine the peak population, a peaking factor of 1.5 was calculated in 2009 using NCWC&ID #4 supervisory control and data acquisition (the peaking factor is the ratio of peak day demand over average day demand).

Water usage for 2012 to 2014 was assessed to determine if the peak factor of 1.5 was still valid. Using this data, we found the following:

<u>Year</u>	<u>Peak Factor</u>
2012	1.35 – 2.24
2013	1.31 – 2.44
2014	1.30 – 2.52

The peak factor of 1.5 is within the range of peak factors obtained for the years 2012 to 2014.

The method to calculate the projected demand and the value assigned to the per capita water consumption rate differs from the previous master plan as a result of more abundant data being accessible during the analysis period. In the 1995 master plan, an equivalent population was calculated using the typical 130 gpd per capita and was used as a reference to project demand. The 2009 Master plan used historical data and calculations, to determine that the typical per capita water usage of 130 gpd per capita was really 170 gpd per capita. A per capita water usage rate of 170 gpd per capita was used throughout the 2009 report.

The average daily consumption rate for 2013 and 2014 were used to determine a revised/updated per capita rate of 162 gpd per capita. This is discussed further in Chapter IV, Section A.1.

According to historical data in the year 2007, the peak day in the peak month wastewater contribution was 1.811 MGD and the peak population during that time was 19,364 which equates to an average daily wastewater contribution to the plant of approximately 100 gpd per capita.

The table below illustrates permanent and peak projected populations for a 20-year period to year 2030. The high influx of people has an impact on the wastewater and water facilities;

therefore, the master plan analyzes the peak day demands. The population to year 2030 is anticipated to increase to 28,534 permanent residents and 42,801 transient residents during seasonal months.

TABLE II-1: Population Projections for NCWC&ID#4 Service Area

	2010	2015 <sup>(1)</sup>	2020	2025	2030
Permanent Residents	14999	18614	22,228	25,381	28,534
Peak Population <sup>(2)</sup>	22499	27921	33342	38,072	42,801

<sup>(1)</sup> Based on linear interpolation between TWDB projections for years 2010 and 2020.

<sup>(2)</sup> Based on peaking factor of 1.5 applied to TWDB projections.

The NCWC&ID#4 primary service boundary was sub-divided into three zones; therefore, the population projections were separated into three primary distributions system zones: Old Town, Gulf Area, and Bay Area. These zones are discussed in greater detail in the following section of this report. Refer to Table II-2 for a summary of the projected peak populations by zone.

TABLE II-2: Projected Peak Population by Zone

	2007	2010	2020	2030
Zone 1: Old Town	13,412	14,849	18,338	18,993
Zone 2: Gulf Area	4,460	5,850	11,670	18,674
Zone 3: Bay Area	1,492	1,800	3,334	5,134
TOTAL	19364 <sup>(1)</sup>	22499 <sup>(1)</sup>	33342 <sup>(1)</sup>	42801 <sup>(1)</sup>

<sup>(1)</sup> Based on peaking factor applied to TWDB projections.

### C. LAND USE AND DENSITIES

A number of studies have been made regarding the potential development of Padre and Mustang Island. This list includes the following:

- Comprehensive Plan for Mustang Island/Port Aransas, Texas, 1980 by Harland & Bartholomew.
- Mustang Island Area Development Plan, 1988 by City of Corpus Christi Planning Department.

- Area Development Plan for Mustang Island/ Port Aransas/ Harbor Island, 2007 by Urban Engineering & NCWC&ID#4 personnel.

The plans recommend low density residential development west of State Highway 361, with a higher density east of State Highway 361. Under the plans, no development is recommended in the tidal flats portion of the Island and the beach. No density development is recommended in the dune complex portion, and nearly all development and density is recommended within the barrier flats.

Within the District's primary service boundary, the Area Development Plan was sub-divided in to three planning zones; Old Town, Gulf Area, and Bay Area. Old town, which currently consists of approximately 70% of the District's customers, is bound by the Corpus Christi Ship Channel on the north, Gulf of Mexico on the east, Access Road 1A/ Piper Blvd. on the south and Corpus Christi Bay on the west. The Gulf area is defined by Access Road 1A on the north, the Gulf of Mexico on the east, Mustang Island State Park on the south, and State Highway 361 on the west. The Bay area is bound by Piper Blvd. on the north, State Highway 361 on the east, Mustang Island State Park on the south, and Corpus Christi Bay on the west.

Furthermore, each zone was separated into five land usage categories: open acreage, one acre single family residential/commercial, single family residential/commercial, low rise condominiums/hotels, and high rise condominiums/hotels. Each land usage type was assigned a unit per acre value based on actual density on the developed properties at the present time. Refer to Table II-3 for a list of these values and Figure II-3 and II-4 for an illustration of Year 2007 and 2030 land usage plan. For instance, a single family residential block at the intersection of Avenue B and Trojan Street indicates 19 home sites on 4.2 acres, which equates to approximately 4.5 units per acre. We have assumed these values per land usage type in order to generate projections for ultimate wastewater flows and water consumption demands. In year 2007, the average densities (units/acre) for the three zones, according to the updated land usage plan was calculated to be 2.97 for Old Town, 0.81 for

Gulf area, and 0.28 for Bay area. Refer to Table II - 4, for a list of the average densities per zone for year 2030.

TABLE II-3: Land Usage Characteristics

	<b>Units per Acre</b>
Zero Density (Open Acreage)	0
Extra-low Density (One acre Single Family Residential/ Commercial)	1
Low Density (Single Family Residential/ Commercial)	4.5
Medium Density (Low Rise Condominiums)	14.5
High Density (High Rise Condominiums)	30

According to the Area Development Plan study, the size of a typical household equates to approximately 2.7 persons per household (dwelling unit) during the peak periods. This was calculated using the total 2007 land usage units and the peak population (19,364 persons divided by 7,093 units).

TABLE II-4: Density Assumptions Used Throughout the Master Plan for Year 2030

<b>AREA</b>	<b>Density (Dwelling units/acre)</b>	<b>Persons per Dwelling Unit</b>	<b>Density (persons/acre)</b>
Zone 1: Old Town	4.2	2.7	11.34
Zone 2: Gulf Area	3.7	2.7	9.99
Zone 3: Bay Area	0.7	2.7	1.89

(dwelling units/acre) x (persons/dwelling unit) = persons/acre

## **CHAPTER III - EXISTING WATER SYSTEM**

The NCWC&ID #4 provides water service to developed lands from the North boundary of Mustang Island State Park to the Corpus Christi ship channel, including Harbor Island. By agreement with the City of Corpus Christi, responsibility for providing water from the North boundary of Mustang Island State Park to the South rests with the City of Corpus Christi; however, this contract contains the following provision:

“Should there be a shortage in the basic supply of water which requires the restriction or curtailing of any consumer of water within the city limits of Corpus Christi that coincide with such restriction or limitation within Corpus Christi, the District will limit and restrict all of its customers, both direct and indirect through resale to the same extent.”

Presently, there are two water systems that provide water to the Island. From the North, treated water is purchased from the San Patricio Municipal Water District (SPMWD) which is re-pumped at the Beasley PS in the City of Aransas Pass. It is then transmitted through an 8-inch and a 12-inch line on Harbor Island to the Corpus Christi Ship Channel, and a 20-inch line carries the water under the ship channel to the Ferry Landing PS in the City of Port Aransas. In 2013 the District upgraded 12,000 ft. of the 12-inch line from the Beasley Street P.S. to SH 361 to 24-inch. The pump station was also up graded with two (2) 125 HP pumps with a total firm capacity of 1000 gpm (1.44 MGD).

SPMWD’s contractual agreement with NCWC&ID#4 presently states that the maximum daily supply is 1.2 MG. In the South, the Island obtains water from the City of Corpus Christi by a 24-inch line from the Flour Bluff area which is re-pumped at the Sanddollar PS and transmitted through a 20-inch line to the Mustang Island PS. A 20-inch line and a 16-inch line carry the water to the NCWC&ID #4 system at the North end of Mustang Island State Park.

The water supply from the North is accomplished by an agreement with the SPMWD. The SPMWD purchases treated and untreated water from the City of Corpus Christi, which in turn

obtains its supply from the Lake Corpus Christi/Choke Canyon Reservoir System along with an intake from the Mary Rhodes Pipeline.

The contract provision indicated above regarding restriction applies to the supply from the SPMWD as well. In addition to the main transmission for water supply indicated above, the District has the following facilities:

#### **A. STORAGE AND PUMPING**

The elevated and ground storage tanks perform different functions; however they both aim to decrease the impact of the demand fluctuations. The distribution system provides water to the elevated storage tanks that serves three purposes:

- Equalization of peak demands to maintain a fairly constant pumping rate.
- Provide pressure maintenance and system surge protection.
- Reserve capacity for fire protection and emergency conditions.

In addition to meeting the TCEQ elevated storage criteria, sufficient storage should be provided to meet four hours of fire flow demand in excess of 3,500 gpm with no pumping according to Insurance Services Organization (ISO). The current system has an elevated storage capacity of 1.00 MG. The district is currently designing a new 1.0 MG elevated storage on SH 361 across from the Gulf Waters R.V. Park, to replace the existing Mid Island storage tank. The new 1.0 MG tank will bring the total elevated storage capacity to 1.5 MG; therefore the system is adequate and meets the maximum fire flow demand with no pumping (3,500 gpm multiply by 60 minutes/ hour multiply by 4 hours equals 840,000 gallons). Refer to Table's IV-2 and IV-3 for a comparison of the TCEQ minimum standard requirements to the District's available storage and pumping capacity.

Ground storage tanks are located at the pump stations and generally serve two functions:

- Equalizing the different rates of supply and pumping into the system.
- Reserve for emergency conditions.

Ground storage must contain sufficient capacity to supply the difference between average and maximum demands. In addition to meeting the TCEQ storage criteria, sufficient ground storage should provide a minimum of 50% of the Maximum Day Demand (MD). In year 2015, the District’s ground storage capacity provided 61% of the maximum day demand (2.70 MG ground storage capacity divided by 4.41 MGD maximum day demand); therefore, the system meets and exceeds the minimum capacity needed.

The existing NCWC&ID #4 water distribution system is served by two elevated storage tanks, six ground storage tanks, and two full-time pump stations. The Ferry Landing pump station is only used as a stand-by as needed. The total existing available storage capacity is provided in the following table:

TABLE III-1: Summary of Existing Water Storage

LOCATION	CAPACITY (gallons)
Existing Mid-Island Elevated Tank (Mustang Island) (Will be decommissioned once the new tank is in service)	500,000
Port Aransas Elevated Tank (Eskridge Rd. & Glover Rd)	500,000
(New) Mid- Island Elevated Tank	1,000,000
Mustang Island Pump Station (South end of the Primary Service Boundary)	1,500,000 & 100,000
Ferry Landing Pump Station (Port Street) “Stand-by”	1,000,000 & 200,000
Beasley Street Pump Station (Beasley Ave., Aransas Pass)	200,000 & 40,000
<b>TOTAL</b>	<b>4,040,000</b>

The storage tank and pump station locations and capacities are described in the following:

### 1. ELEVATED STORAGE

The District has the following two elevated storage tanks:

- (Exist.) Mid-Island Elevated Tank: 500,000 gallons.  
Spherical Tower  
Located West of S.H. 361 along Mustang Island  
Overflow Elev.: El. 126.5  
Base Elev.: El. 5

The existing mid-island elevated storage will be decommissioned once the new tank is in service.

- (New) Mid-Island Elevated Tank: 1,000,000 gallons.  
Composite Tank  
Located on SH 361 across from Gulf Waters RV Park  
Overflow Elev.: El. 134  
Base Elev.: El.10
- Port Aransas Elevated Tank: 500,000 gallons.  
Composite Tank  
Located at intersection of Eskridge & Glover Rd.  
Overflow Elev.: El. 134  
Base Elev.: El. 8

When the new mid-island elevated storage tank is online the existing tank will be decommissioned and the combined elevated storage capacity for the District will be 1,500,000 gallons. Until that time the elevated storage capacity is 1,000,000 gallons.

## **2. GROUND STORAGE**

The District has the following six ground storage tanks:

- Beasley Ground Storage Tanks - 200,000 gallons and 40,000 gallons. These are located at the Beasley Street Pump Station in the City of Aransas Pass.
- Mustang Island Ground Storage Tanks - 1,500,000 gallons and 100,000 gallons. These two tanks are located at the Mustang Island Pump Station at the south end of the District's primary service boundary.
- Ferry Landing Ground Storage Tanks - 1,000,000 gallons and 200,000 gallons. These are located at the Port Street Pump Station within the city of Port Aransas near the ferry landing.

Due to pump location and piping, only 1,500,000 gallons are available at the Mustang Island PS and the storage at the Beasley Street PS is used only to maintain pressure on the pumps. Considering that the ground storage tanks will not be completely emptied during normal operation, the combined storage capacity for the District is 1,500,000 gallons of elevated storage and 2,700,000 gallons of ground storage.

### **3. WATER PUMP STATIONS**

The Beasley Pump Station and associated storage tanks located on Beasley Street in Aransas Pass, approximately seven miles west of Port Aransas, store water received from the SPMWD and pumps it to the distribution system in Port Aransas through an 8-inch, 24-inch, 12-inch, and 20-inch transmission lines. The pump station was upgraded in 2013 and is now equipped with two new 125 HP pumps and variable frequency drive (VFD) units that run independently of one another. Each pump is 125 Hp and has a firm capacity of 1000 gpm. According to District personnel, the normal operating pressure is 80 psi and the average pumping capacity is 1.44 MGD (1,000 gpm) with one 125 Hp pump in operation.

The Ferry Landing Pump Station and associated storage tanks located at Port Street and Cotter Avenue in Port Aransas, store water received from Beasley PS in Aransas Pass. The pump station is equipped with three pumps used to pump water to the Port Aransas Elevated Tank and provide service to the distribution system. Two are equipped with a 50 Hp motor with a capacity of 800 gpm each maintaining an average operating pressure of 50 psi, and one is equipped with a 20 Hp motor with a capacity of 400 gpm. The maximum pumping capacity at the Ferry Landing PS is approximately 2.88 MGD according to District personnel. The Ferry Landing PS was taken out of normal service in 2013. The pump station is now only used in emergency situations.

The Mustang Island Pump Station and associated storage tanks located approximately 11 miles south of the city of Port Aransas on Mustang Island store water received from the City of Corpus Christi. The water is then pumped to Port Aransas through a 12-inch, 14-inch, 16-inch, and 18-inch transmission lines. The pump station is equipped with two

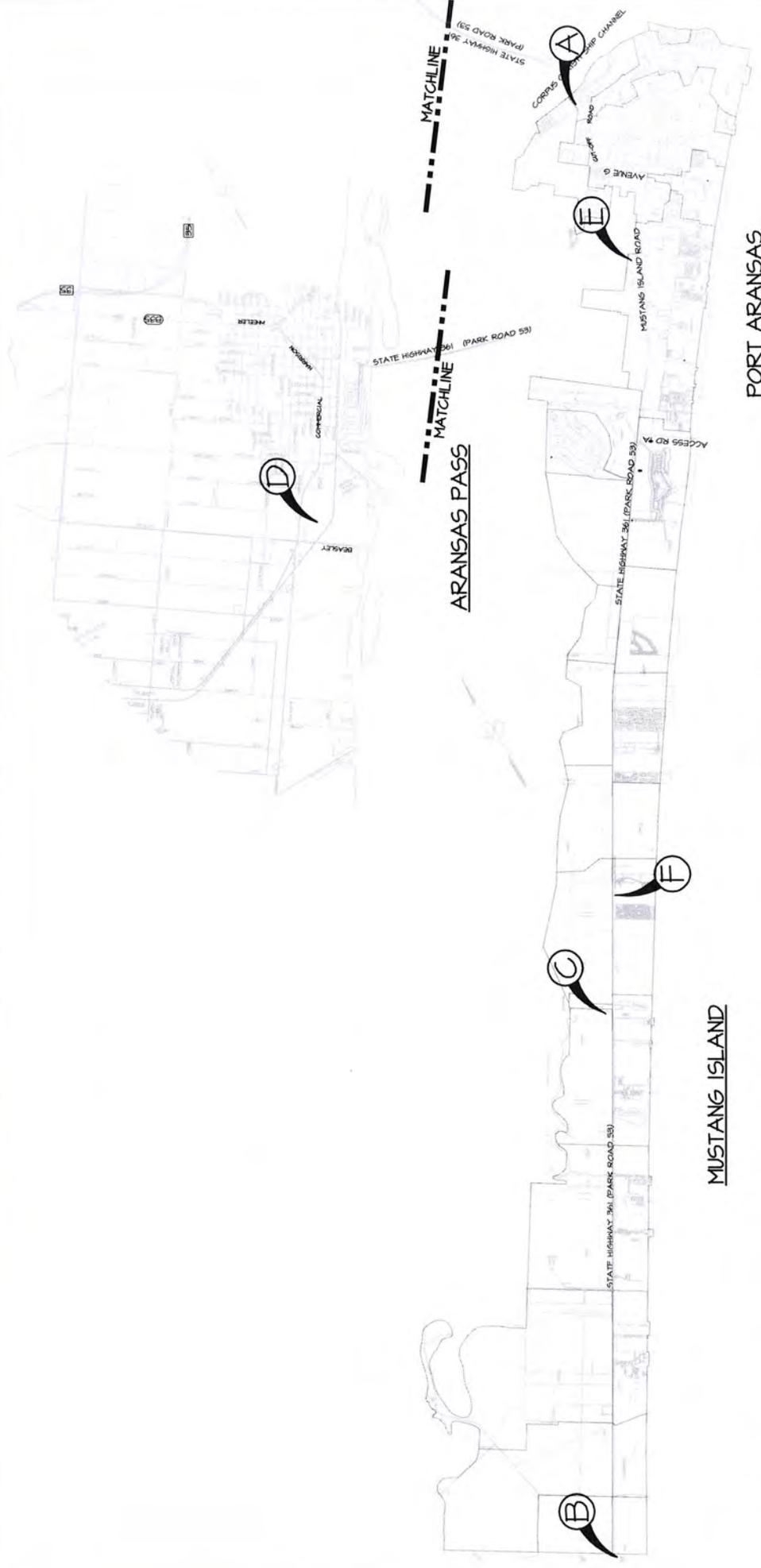
pumps that run independently of one another; two pumps have a 200 Hp motor with a capacity of 2,070 gpm each maintaining an average operating pressure of 70 psi. The maximum pumping capacity of the Mustang Island Pump Station is approximately 3.60 MGD according to District personnel. The pump station is currently being up graded to a firm capacity of 4,360 gpm. The firm capacity will be provided through two (2) 2180 gpm pumps.

The NCWCID #4 no longer operates or maintains any water wells. The locations of the pump stations and storage tanks are illustrated on Figure III-1.

## **B. WATER DISTRIBUTION**

The District owns and operates the water distribution system which supplies water to the customers of Port Aransas, Mustang Island, and Harbor Island. In order to maintain and operate the distribution system, the District has seventeen employees and ten certified operators; one of which has “B” certification, three of which have “C” certification licenses and six have “D” certification licenses. In the year 2015, the distribution system served approximately 27,920 customers during the peak season with a system of pipelines ranging in diameter from 2 inches to 20 inches. The existing distribution system is shown on the NCWC&ID#4 Master Utility Maps attached to this report.

The distribution system is designed and should be sustained to provide a minimum operating pressure of 35 psi during normal conditions and a minimum of 20 psi during extreme operating conditions, such as during a fire flow demand. According to TCEQ, the minimum normal pressure allowed is 35 psi. Pressures above 80 psi should be limited and no greater than 120 psi due to potential harmful affect on the system and higher operating costs. Maximum allowable velocities in the piping should be limited to 8 FPS. Refer to Table’s IV-2 and IV-3 for a comparison of the existing system and the TCEQ requirements.



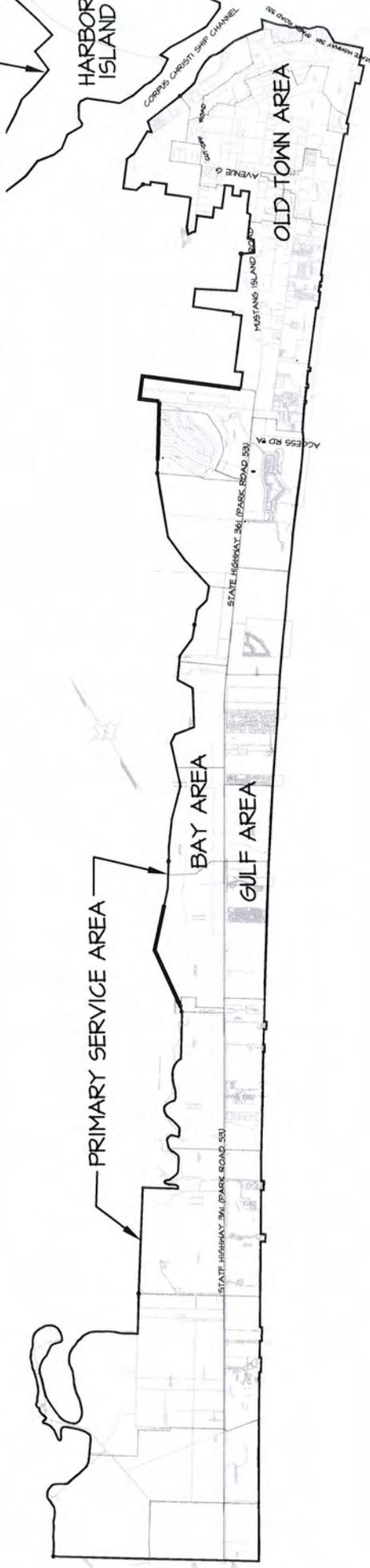
- LEGEND:**
- Ⓐ FERRY LANDING PUMP STATION & GROUND STORAGE TANKS  
LARGE - 1,000,000 GAL. SMALL - 200,000 GAL.
  - Ⓑ MUSTANG ISLAND PUMP STATION & GROUND STORAGE TANKS  
LARGE - 1,500,000 GAL. SMALL - 100,000 GAL.
  - Ⓒ MID-ISLAND ELEVATED TANK - 500,000 GAL. (BEING DECOMMISSIONED)
  - Ⓓ BEASLEY PUMP STATION & GROUND STORAGE TANKS  
LARGE - 200,000 GAL. SMALL - 40,000 GAL.
  - Ⓔ PORT ARANSAS ELEVATED TANK - 500,000 GAL.
  - Ⓕ NEW 1,000,000 GAL. ELEVATED TANK

**FIGURE III-1:**  
**LOCATION MAP FOR PUMP STATIONS  
 AND STORAGE TANKS**  
 NUECES COUNTY WATER CONTROL  
 AND IMPROVEMENT DISTRICT #4  
 PAGE III-7

SCALE: NOT-TO-SCALE

**URBAN**  
**ENGINEERING**  
 CORPUS CHRISTI, TEXAS  
 2725 Southport St. Corpus Christi, TX 78404  
 PHONE: (361) 884-9101 FAX: (361) 884-6001

SECONDARY SERVICE AREA  
(REFER TO FIGURE II-2)



**NOTE:**

PRIMARY SERVICE AREA DIVIDED INTO THREE ZONES:  
OLD TOWN AREA, BAY AREA, & GULF AREA.

**FIGURE II-1:**

**PRIMARY SERVICE AREA**

**NUEGES COUNTY WATER CONTROL  
AND IMPROVEMENT DISTRICT #4**

PAGE II-8

SCALE: NOT-TO-SCALE

**URBAN**  
ENGINEERING  
CORPUS CHRISTI, TEXAS  
2725 Summer St., Corpus Christi, TX 78404  
PHONE: (361) 684-5161 FAX: (361) 684-6001

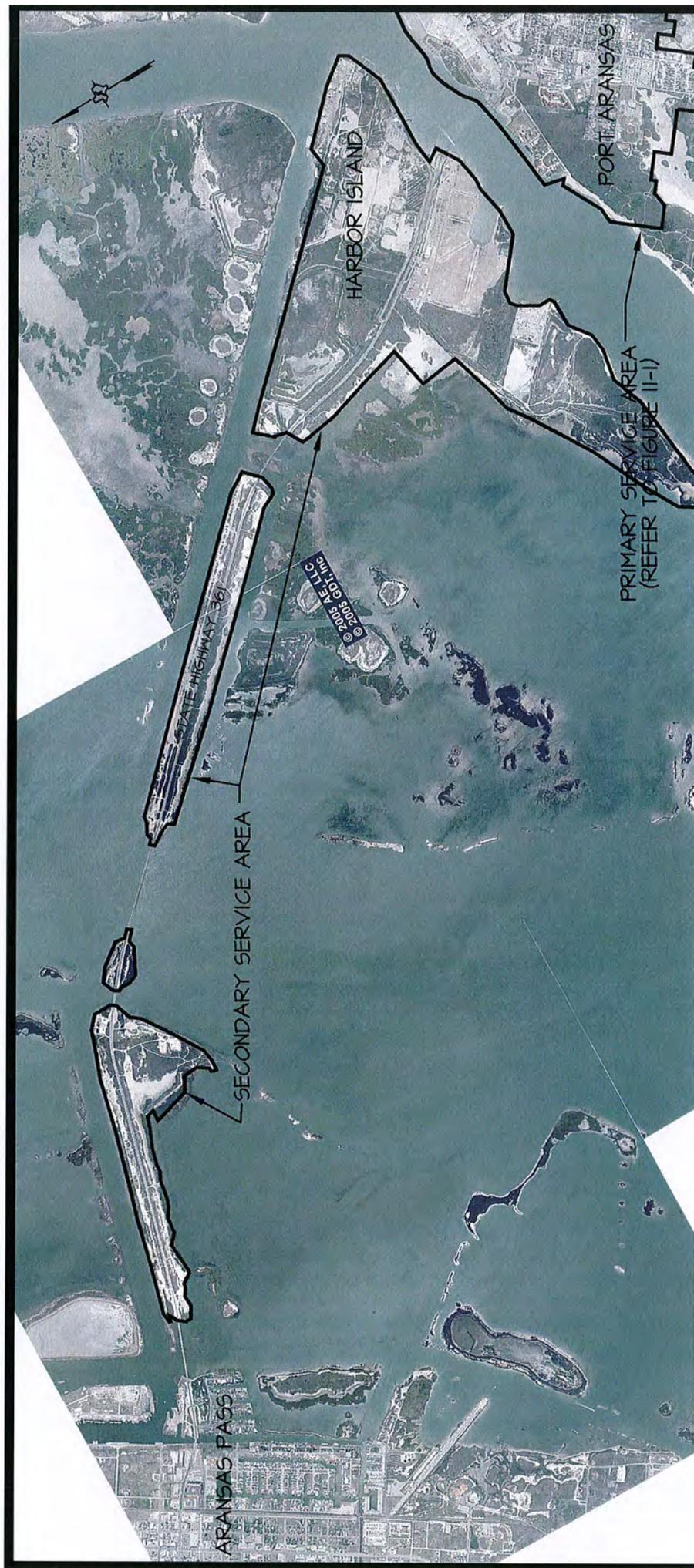
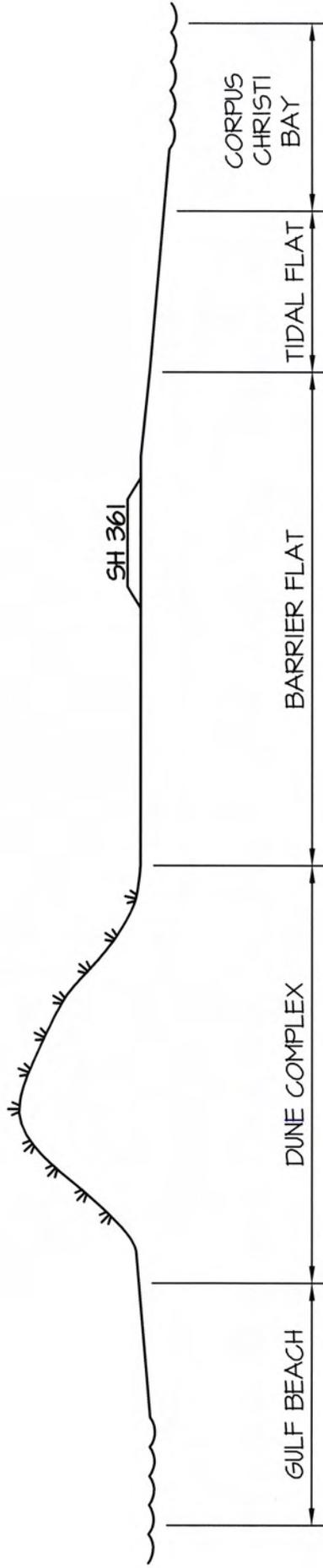


FIGURE II-2:

SECONDARY SERVICE AREA  
 NUECES COUNTY WATER CONTROL  
 AND IMPROVEMENT DISTRICT #4  
 PAGE II-9

SCALE: NOT-TO-SCALE





ENVIRONMENTAL ZONES

**FIGURE II-3:**  
BASIC ENVIRONMENTAL ZONES  
 NUECES COUNTY WATER CONTROL  
 AND IMPROVEMENT DISTRICT #4

SCALE: NOT-TO-SCALE



P.O. BOX 4555, CORPUS CHRISTI, TEXAS 78444-0555  
 PHONE: (361) 884-5101 FAX: (361) 884-6001



**LEGEND**

- ZERO DENSITY (OPEN ACREAGE)
- EXTRA-LOW DENSITY (ONE ACRE SINGLE FAMILY RESIDENTIAL/COMMERCIAL)
- LOW DENSITY (SINGLE FAMILY RESIDENTIAL/COMMERCIAL)
- MEDIUM DENSITY (LOW RISE CONDOMINIUMS/ HOTELS)
- HIGH DENSITY (HIGH RISE CONDOMINIUMS/ HOTELS)

**FIGURE II-4:**

**PRIMARY SERVICE AREA - YEAR 2007 LAND USAGE PLAN**

**NUECES COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT #4**

PAGE II-II

SCALE: NOT-TO-SCALE



2725 Swanton St., Corpus Christi, TX 78404  
 PHONE: (361) 854-9101 FAX: (361) 854-6001



**LEGEND**

- ZERO DENSITY (OPEN ACREAGE)
- EXTRA-LOW DENSITY (ONE ACRE SINGLE FAMILY RESIDENTIAL/COMMERCIAL)
- LOW DENSITY (SINGLE FAMILY RESIDENTIAL/COMMERCIAL)
- MEDIUM DENSITY (LOW RISE CONDOMINIUMS/ HOTELS)
- HIGH DENSITY (HIGH RISE CONDOMINIUMS/ HOTELS)

**FIGURE II-5:**

**PRIMARY SERVICE AREA - YEAR 2030 LAND USAGE PLAN**

**NUECES COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT #4  
PAGE II-12**

SCALE: NOT-TO-SCALE



2725 Shafter St., Corpus Christi, TX 78404  
PHONE: (361) 884-9101 FAX: (361) 884-6001

## CHAPTER IV - WATER SYSTEM ANALYSIS

Port Aransas is a small recreational and tourist community located on the coast adjacent to the Gulf of Mexico. Due to the vacation and recreational appeal, the community receives a high influx of population which impacts the water supply in the same manner as it does the wastewater. The census only shows the permanent residents, which does not represent actual connections and varies substantially, due to weekend visitors and vacationers.

### A. WATER SUPPLY AND STORAGE

The factors which actually affect water supply and storage are as follows:

- The resident population.
- The influx of weekend tourists and other visitors who occupy the hotels, motels and condominiums.
- The influx of additional people on major holidays such as the Fourth of July and three-day weekends.

#### 1. **Water Demand Analysis**

Water usage data for 2012 to 2014 supplied by the District indicates an annual average daily demand of 2.939 MGD in 2012, 2.786 in 2013 and 2.793 in 2014. The average daily demand drops between 2012 and 2013 and then levels out in 2014. The 2013 and 2014 the values were assumed to be attributed to a reduction in water usage as a result of water conservation methods that have been instituted throughout the service area. Using the 2013 and 2014 data along with the projected population of 16,878 and 17,555, the per capita water usage ranges from 165.06 to 159.09. The average of this range of values indicates a water usage of 162 gpd per capita. This is slightly less than the 170 determined in the 2009 master plan and was used to project the water usage for this master plan update.

Projecting demand resulted in a multi-step process that analyzed many facets of the existing water system including demand per single family, single family equivalents, and

peaking factors which assisted in producing a quantitative trend in demand growth. As anticipated, the increasing trend in demand had a direct correlation to the percent growth in population. This relationship allowed us to base the projected future water demand on the published population data collected by the TWDB.

Table IV-1 was developed using District water records and Texas Water Development Board statistics; which depict a water demand increase ranging from of 2% to 4% per year.

TABLE IV-1: Projection of Population, Water Demand, and Water Connections

	POPULATION		DEMAND (MG)		CONNECTIONS	
	Permanent	Peak	Avg. Daily	Max Daily	Average	Max
<b>2015</b>	18614	27921	2.94	4.41	6894	10341
<b>2020</b>	22228	33342	3.60	5.4	8233	12349
<b>2025</b>	25381	38072	4.11	6.17	9400	14101
<b>2030</b>	28534	42801	4.62	6.93	10568	15852

NOTE: Peak population provides maximum daily flow.

In reference to the table above, the per capita water consumption rate was estimated to be 162 gpd/ capita (projected demand divided by projected population); which was used throughout the analysis and report for master plan purposes.

## 2. Evaluation Results

Table IV-2 illustrates the current water system capacity based on Year 2015 demand; whereas Table IV-3 depicts the minimum design standards set forth by the Texas Commission on Environmental Quality (TCEQ) in regard to the existing and projected demands for the District through the Year 2030.

TABLE IV - 2: NCWC&ID#4 Current Water System Capacities (2015)

Facility	Current Total Capacity
	Conn. = 10,341 Pop. = 27,921
<b>Total Storage</b>	3,700,000 gal (1) and (2)
<b>Existing Elevated Storage</b>	1,000,000 gal (1)
<b>New Elevated Storage</b>	1,500,000 gal (2)
<b>Ground Storage</b>	2,700,000 gal
<b>Existing High-Service Pumps</b>	4.42 MGD (3,070 gpm) (3)
<b>New High service Pumps</b>	7.72 MGD (5,360 gpm) (3)
<b>Distribution Lines</b>	6" - 20"
<b>Pressure:</b>	
Residual Operating / Fire Flow	45 psi / 20 psi
<b>Certified Operators</b>	8

NOTES:

- (1) Two (2) 500,000 gallon elevated storage tanks
- (2) 1,000,000 is being constructed in 2017. Once complete the existing 500,000 MI tank will be decommissioned leaving a total of 1,500,000 gallons.
- (3) With one of two pumps off @ Mustang Island Pump Station. Pump Stations is being upgraded to 4360 gpm in 2017. This upgrade will bring the total capacity to 5360 gpm.

TABLE IV - 3: TCEQ Water System Minimum Requirements based on Demand

Facility	TCEQ Minimum Requirements Needed	Year 2015 System Needed	Year 2030 System Needed
		Conn. = 10,341 Pop. = 27,921	Conn. = 15,582 Pop = 42,801
<b>Total Storage</b>	200 gal/conn	(200 gal/conn * 10,341 conn) = 2,068,161 gal	(200 gal/conn * 15,852 conn) = 3,170,444 gal
<b>Elevated Storage</b>	100 gal/conn	1,034,083 gal	1,585,222 gal
<b>Ground Storage</b>	100 gal/conn	1,034,083 gal	1,585,222 gal
<b>High-Serv Pumps</b>	Peak hourly demand	5.51 MGD (3,826 gpm)	8.67 MGD (6,020 gpm)
<b>Distribu-tion Lines</b>	1.5 gpm/conn	6" - 20"	6" - 20"
<b>Pressure</b>			
Residual	35 psi	35 psi	35 psi
Operating			
Fire Flow	20 psi	20 psi	20 psi

In analyzing the existing capacity in Table IV-2 and comparing the TCEQ’s minimum requirements based on demand in Table IV-3, it appears that the elevated storage capacity has become deficient (2015). The District is constructing a new 1.0 MG elevated storage and will be decommissioning the existing 0.5 MD mid-island tank, which will provide an additional 0.5 MG. Once constructed the new total elevated storage will be 1.5 MG. The elevated storage capacity will be sufficient until 2028.

Table IV – 4: Projected Peak Demand

	<b>Minimum Criteria</b>	<b>Year 2007 (7,093 Conn.)</b>	<b>Year 2015 (10,341 Conn.)</b>	<b>Year 2030 (15,852 Conn.)</b>
<b>AAD<sup>(1)</sup></b>	0.22 gpm/conn.	2.207 MGD (1,532 gpm)	2.911 MGD (2,042 gpm)	4.62 MGD (3,208 gpm)
<b>MD<sup>(2)</sup></b>	1.5 x AAD	3.371 MGD (2,341 gpm)	4.411 MGD (3,063 gpm)	6.93 MGD (4,813 gpm)
<b>MH<sup>(3)</sup></b>	1.25 x MD	4.214 MGD (2,926 gpm)	5.51 MGD (3,826 gpm)	8.66 MGD (6,014 gpm)

<sup>(1)</sup> Average Annual Daily demand (AAD) in peak month

<sup>(2)</sup> Maximum Daily demand (MD) - data was obtained from District personnel in order to determine historical peak daily demand.

<sup>(3)</sup> Maximum Hourly demand (MH) – According to TCEQ, Page 4, "in the absence of verified historical data, peak hourly demand equals 1.25 times the maximum daily demand (prorated to an hourly if a public water supply meets the commission's minimum requirements for elevated storage capacity and 1.85 times the max daily demand (prorated to an hourly rate) if the system uses pressure tanks or fails to meet the commission's minimum elevated storage capacity requirement.

## **B. PUMPING FACILITIES**

The minimum high-service pump capacity for the 2015 through 2030 projected population was calculated according to TCEQ minimum standard requirements, Section 290.45 (b)(1)(D)(iii).

“Two or more pumps that have a total capacity of 2.0 gpm per connection or that have a total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less, at each pump station or pressure plane. For systems which provide an elevated storage capacity of 200 gallons per connection, two service pumps with a minimum combined capacity of 0.6 gpm per connection are required at each pump station or pressure plane. If only wells and elevated storage are provided, service pumps are not required.”

The current available high-service pump capacity is 4.42 MGD (3,070 gpm), and the required capacity according to TCEQ is 5.51 MGD (3,826 gpm) based on the calculated peak hourly demand. This indicates that the pump system is currently deficient. As noted in Section A.3 the District is in the process of upgrading the Mustang Island PS, to a firm capacity of 6.28 MGD (4,360 gpm), which will bring the total firm capacity to 7.71 MGD (5360 gpm). Once the new pump station is in service the firm capacity will be meet the projected 2025 system demand.

### **C. WATER PRESSURES**

District officials indicated that the normal operating pressure was 47 psi, with a minimum residual pressure of 45 psi. These figures are consistent with the required pressures indicated in Table IV - 3. In order to evaluate the pressure system throughout the distribution system, the 2009 hydraulic model was updated and is discussed in detail in Chapter V.

#### **D. DISTRIBUTION LINES, FIRE HYDRANTS, AND VALVES**

Problems associated with the distribution lines were evaluated as a result of the pressure distribution analysis and fire flow analysis. Observations and evaluations of the lines are based on information received from the water model, District personnel, and general knowledge of the existing conditions. The following are a list of recommendations:

- Installation of any future water mains should be with 8” or larger lines. This will allow for the ability of the system to cope with the peak demands placed on it by the population fluctuations.
- A program should be implemented to replace old existing lines in business areas and should be replaced with minimum 8” lines. This program should be initiated after determination is made of the condition of pipe and its ability to provide the required service and demand.
- An effort should be made by the District to provide a distribution line loop system in a number of areas to insure that in the event of a line break, continuous fire protection is provided at all times. We have indicated on the plan where such loop lines will be most beneficial. Some of these lines can be completed concurrent with property development; however, where possible, the distribution loops should be planned as soon as finances become available.
- According to the water model, in order to meet the requirements for fire flow, eleven segments within the distribution system are proposed to be upgraded or looped and are discussed in Chapter VI.

## **E. WATER UNACCOUNTED FOR**

The difference between the water purchased and the amount sold in a defined time period is generally referred to as unaccounted water for the system. Some of the main causes for these losses are listed below:

- Leakage of lines
- Fire fighting or flushing lines
- Facility or inaccurate meters

District's records trace the actual loss of water per month including unknown losses and known losses, such as flushing lines. The actual loss per month averages from four to eight percent; which is expected even in a well maintained system. The actual loss percentage includes the unknown loss that averages between three to seven percent per month according to water records.

**F. WATER QUALITY**

According to the Annual Drinking Water Quality Report conducted in 2007 which is depicted in Table IV-5, the District distributes and maintains high quality water well within the limits set by the EPA/ Centers for Disease Control and Prevention (CDC).

TABLE IV - 5: Annual Drinking Water Quality ( 2007)

<b>CONSTITUENT</b>	<b>NCWCID #4 AVERAGE LEVEL</b>  (ppm, unless otherwise noted)	<b>EPA/ CDC'S MAXIMUM LEVEL/ LIMIT</b>  (ppm, unless otherwise noted)
Aluminum	0.133	0.05
Atrazine	0.00049	0.003
Barium	0.089	2
Bicarbonate	115	NA
Bromodichloromethane	0.04311	
Bromoform	0.00103	
Calcium	49.4	NA
Chloramine Residual	2.2	4
Chloride	229	NA
Chloroform	0.05689	
Copper	0.512	1.3
Dibromochloromethane	0.01903	
Fluoride	0.76	4
Gross beta emitters	3.93 pCi/L	50 pCi/L
Hardness as Ca/ Mg	246	NA
Lead	0.0101	0.015
Magnesium	8.1	NA
Manganese	0.0011	0.05
Nickel	0.002	NA
Nitrate	0.27	10
pH	7.7 units	> 7.0 units
Selenium	0.0048	0.05
Sodium	90	NA
Sulfate	102	300
Total Alkalinity as CaCO <sub>3</sub>	115	NA
Total Dissolved Solids	640	1000
Total Haloacetic Acids	0.0315	0.06
Total Trihalomethanes	0.0391	0.08
Turbidity	0.60 NTU	0.3

NTU (Nephelometric Turbidity Units)

## **G. OPERATIONAL PROCEDURES**

1. Repairing of Water Mains and Services during times of moderate weather conditions:  
Due to the sandy soil conditions with the District's Jurisdiction, very few problems occur with line breakage. District officials indicate that during extreme conditions, they may repair a maximum of two breaks per month. This is a good indication that the system is in good condition and well maintained.
2. Checking and/or Replacing Water Meters: Each month meter readings are examined to determine abnormal readings. Any meter in question is replaced. This is also an excellent approach to maintenance of meters.
3. Flushing Water Lines: Water lines with dead ends (no loops) are flushed each month, or every two weeks depending on the conditions. The Fire Department flushes the fire hydrants as needed. This is also a further indication that the District has adopted quality maintenance procedures for the overall performance of its water lines.

## **H. WATER COSTS AND WATER SYSTEM RATES**

Table IV - 6 illustrates the cost to residential customers purchasing 10,000 gallons of water within the NCWC&ID #4. The table also shows the water rates on which that amount was based.

TABLE IV-6: NCWC&ID#4 Residential Water Rates

<b>Average Cost Per Month<sup>1</sup></b>	<b>Residential Water Rate</b>	<b>Use (1000 gal)</b>
\$39.25	\$14.75 \$3.50 /1000	0-3 min. 4 and up

<sup>1</sup> Based on residence using 10,000 gallons

## **CHAPTER V - DEVELOPMENT OF WATER SYSTEM MODEL**

This chapter describes the development and application of the water system model for the Nueces County Water Control and Improvement District #4 (NCWC&ID #4) existing and future water system analysis. Water GEMS V8 XM Edition by Bentley Systems, Inc. was the modeling software utilized to evaluate the water system. It was used in conjunction with AutoCAD 2007 and ArcGIS 9.2 to depict the distribution network portion and assign density demands within the boundary. The database contains information pertaining to the diameter, pipe material, age of pipe and length of all waterlines equal to or greater than 4-inch in diameter within the distribution system. The water demands used in the model are found in Chapter IV.

### **A. DEVELOPMENT OF MODEL**

The District's water system model was developed in 2009 based upon the updated base maps as described in Chapter I and the current and future land usage plan. The assumptions and criteria that were used in the development and verification of the District model are described by the following:

- Model nodes indicate waterline intersections, dead ends, and significant points of demand, pump stations and elevated storage tanks.
- All known waterlines that are 4 inch or greater in diameter are included in the model.
- Pump station piping configurations are obtained from record drawings and District personnel knowledge; pump performance data was obtained from manufacturer's pump curves and staff input.
- The pressure that is being investigated per node is the pressure at the ground elevation; therefore the ground elevation is the elevation assigned to the node in the model.
- The District is relatively flat and therefore assigning an elevation would have insignificant affects to the analysis of the model; therefore all nodes are assigned an elevation of zero with the exception of the pumps and tanks. The elevation assigned was the difference between the ground elevation and the elevation of the pump or tank.

- Pressures and flow data for the 2009 model calibration were obtained from the NCWC&ID#4 supervisory control and data acquisition.
- Demands were assigned to nodes using Load Builder; a tool of WaterGEMS that leverages the spatial abilities of GIS software to distribute demands according to demand density information. The type of allocation tactic that was applied using Load Builder was 'Projection by Land Use.' There are two steps to this process. First, a service polygon per node was assigned. Second, the demand is allocated based upon the density per land use type of each service polygon that assigned the peak day demand. A global multiplier was applied to create the max hour demand for the system.
- Hazen-Williams C-factors (the pipe roughness coefficient) were assigned based on the pipe material and the age of the pipe.
- Minor losses occurring at valves, tees, bends, reducers, and other appurtenances within the piping system result in turbulence within the bulk flow as it moves through fittings. This type of loss is negligible compared to the head loss due to friction; therefore an overall minor loss was not applied to the model.

The hydraulic model is based on the actual distribution system layout created in AutoCAD with added inputs for line sizes and the pipe roughness coefficient (Hazen Williams 'C' Factor). Node inputs consist of the water demand, a fire flow requirement and the node elevation.

## **B. WATER SYSTEM MODEL CALIBRATION**

In 2009 field data and knowledge obtained from District personnel was used to verify the model operation comparing predicted trends to observed performance.

## **C. UPDATES TO THE 2009 MODEL**

The following updates were made to the 2009 model so that we could carry out the water distribution system analysis:

- 8" and 12" Transmission mains from the Beasley Street Pump Station were added to the model.
- Record drawings were reviewed and new distribution lines were added to the model.
- The Ferry Landing Pump Station was not included in the analysis.

- The 2015 and 2030 demands were input globally and weighted on land usage densities from the 2009 model. The land usage was updated to account for changes post 2009.
- The 2009 calibrated model was modified by a factor to produce results under the 2015 and 2030 average daily (AD), maximum daily (MD), and peak hourly (PH) system demands.

#### **D. WATER DEMAND SCENARIOS**

A steady-state simulation was performed for the existing 2015 and future water systems 2030. This analysis determines the operating behavior under steady-state conditions (flow rates and hydraulic grades remaining constant over time). This type of analysis was used to determine pressure and flow rates during average and peak demand scenarios. Eight scenarios were produced to analyze the water system reaction to different demands and physical conditions, including fire flow situations.

##### Water Distribution System Analysis

The model was run under using the average daily, maximum daily and peak hour demand for existing conditions, 2015 and the future condition, 2030. The following conditions were used in our assessment of the system,

##### Existing Conditions 2015

- Water level in the existing Port Aransas and new elevated storage tanks was set at the mid-point, 119-ft
- The water level in the ground storage tank was set at the mid-point, 23-ft
- The Beasley Street pump station was pumping 1,000 gpm and the proposed pumps for the new Mustang Island pump station were set to deliver 2,070 gpm. The combined flow was the capacity of the existing pumps.

### Future Conditions 2030

- Water level in the existing Port Aransas and new elevated storage tanks was set at the mid-point, 119-ft
- The water level in the ground storage tank was set at the mid-point, 23-ft
- The Beasley Street pump station was pumping 1,000 gpm and the proposed pumps for the new Mustang Island pump station were set to deliver 4,300 gpm. The combined flow is the projected peak hourly flow for 2025.

### Water Distribution System - Fire Flow Analysis

The water distribution system was also assessed under existing and future maximum daily demands with fire flows at each node to determine the amount of flow available at each node for fire suppression. The City of Corpus Christi requires 750 gpm in residential areas, 1,500 gpm in commercial areas and 3,000 gpm in industrial areas. The TCEQ requires that the fire flow be the minimum flow achieved when the system pressure is 20 psi or greater. The following conditions were set in the model:

### Existing Conditions 2015

- Water level in the existing Port Aransas and new elevated storage tanks was set at the mid-point, 119-ft
- The water level in the ground storage tank was set at the mid-point, 23-ft
- The Beasley Street pump station was pumping 1,000 gpm and the proposed pumps for the new Mustang Island pump station were set to deliver 2,070 gpm. The combined flow was the capacity of the existing pumps.

## Future Conditions 2030

- Water level in the existing Port Aransas and new elevated storage tanks was set at the mid-point, 119-ft
- The water level in the ground storage tank was set at the mid-point, 23-ft
- The Beasley Street pump station was pumping 1,000 gpm and the proposed pumps for the new Mustang Island pump station were set to deliver 4,300 gpm. The combined flow is the projected peak hourly flow for 2025.

## **CHAPTER VI - SUMMARY OF WATER ANALYSIS AND RECOMMENDATIONS**

In order for the District to provide safe and adequate amounts of water to the general public, the District must adhere to guidelines set out by the Texas Commission on Environmental Quality (TCEQ). Outlined below are comparisons of existing conditions that are required by TCEQ.

Another set of guidelines that have been used on past master plans to identify any deficiencies within the water system during fire flow demands are guidelines set out by the former State Board of Insurance (SBI). Insurance companies adjust their premiums based on the water system capabilities to suppress certain size fires. Based on population, the State Board of Insurance had guidelines outlining the amount of elevated storage, ground storage, high service pump capacity ratings, distribution line sizes, and the number of certified water system operators. Between the periods of 1997-1998, a transition was made from the State Board of Insurance requirements to grading criteria defined by the newly formed Insurance Services Office (ISO).

The ISO does not have specific requirements that have to be met; however, they do analyze each building within the city and determine a flow, in gpm, that will be needed to suppress a fire at that building. They then analyze the water system around that particular building to determine if the fire flow demands can be met.

The rating system that ISO uses is a point type system that adds and deducts points based on the condition of the District's overall water system. Nationwide, every water district or city receives a rating between one and ten, with one being the best; the District currently has a rating of four. Insurance companies then use the ratings produced by ISO to determine insurance premiums for the buildings within the city.

**A. CONTRACTUAL AGREEMENT WITH CITY OF CORPUS CHRISTI & SPMWD**

The City of Corpus Christi and SPMWD have a contractual agreement with NCWC&ID#4 to provide a maximum amount of water to the District per day. SPMWD is contracted to provide 1.2 MGD and the City is contracted to provide 4.86 MGD (2014). Total contractual supply is 6.06 MGD. But currently the City can only provide 2.79 (1940 gpm) so the firm capacity supplied is only 3.99 MGD. As indicated in Table IV – 1 and in Chapter III, the peak day demand in Year 2015 (4.41 MGD), which exceeds the firm capacity of water supplied by both water providers. It is recommended that the NCWC&ID#4 begins negotiation with both the City of Corpus Christi and SPMWD in order to provide an additional water supply to the District.

**B. HIGH SERVICE PUMP CAPACITY**

As indicated in Table IV-2 and IV-3, the current high-service (HS) pump capacity is 3,070 gpm and the TCEQ minimum standard calculated capacity based on peak hourly demand is 3,826 gpm, therefore the District’s pumping facilities are not adequate at the present time. It is recommended that the following actions be taken by the District.

As previously stated the District is in the design phase of a new pumping station to replace the existing Mustang Island Pump Station. The new pump station will have a firm capacity of 4,360 which will bring the total firm capacity (including Beasley Pump Station) to 5,360 gpm. This upgrade will service to District until 2025 at which point the District will need to begin planning for another upgrade to the system.

**C. ELEVATED STORAGE**

The 2015 required elevated storage is 10341 connections x 100 gpd/c = 1,034,100. The District currently has a total elevated storage capacity of 1,000,000 gallons, which does not meet the Texas Commission on Environmental Quality (TCEQ) minimum requirement of 100 gallons per connection, as shown above. The District is currently in the design phase of a new 1.0 MG elevated storage tank approximately 4500 north of the existing Mid-Island tank. Once the new 1.0 MG tank is built the existing 0.50 MG Mid-Island tank will be demolished. This will leave the District with a total elevated storage capacity of 1.5 MG. According to the 2028 projected population of 40,716 people and 15,080 service connections, the elevated

storage will become deficient sometime after the year 2027; it is recommended that the following actions be taken by the District.

- Construct a minimum 1,000,000 gallon elevated storage tank in the vicinity of the existing Port Aransas elevated storage tank. This will increase the elevated storage to a total capacity of 2.0 MGD; which is projected to meet TCEQ's requirement of 100 gallons per connection of elevated storage beyond the year 2030.

#### **D. DISTRIBUTION SYSTEM IMPROVEMENTS**

##### **Assessment of Existing Conditions 2015**

Under the existing conditions the average daily flow of 2.95 MGD (2,049 gpm) is met with 1,300 to 1,700 gpm flowing to the elevated storage. The maximum daily flow of 4.32 MGD (3078 gpm) is met with 300 to 700 gpm flowing to the elevated storage. The existing pumps alone cannot meet the 2015 peak hourly demand of 5.54 MGD (3,848 gpm), approximately 100 to 500 gpm is required from the elevated storage to supplement the flow from the pumps to meet the peak hourly demand.

The existing condition (2015) system pressure under average day ranged from 41 psi to 53 psi, under maximum day the pressures ranged from 40 psi to 52 psi and under peak hour they ranged from 39 psi to 51 psi. As can be seen the system pressures under the existing conditions meet the TCEQ minimum pressure requirements of 35 psi.

##### **Assessment of Future Conditions 2030**

The 2030 conditions were initially assessed with the existing 16-inch transmission main from the Mustang Island Pump Station to the new elevated storage tank. Under these conditions as the demand on the system increases the pumped flow had to be met with increased flow from the elevated storage. The average daily flow of 4.62 MGD (3,210 gpm) was met with 400 to 1,300 gpm flowing to the elevated storage tanks. The maximum daily flow of 6.93 MGD (4,815 gpm) cannot be met and must be supplemented with 230 to 1,100 gpm from the elevated storage tanks. The peak hour flow also cannot be met and must be supplemented with 1,370 to 2,220 gpm from

the elevated storage. As the demand on the system increases the pumping rate at the new Mustang Island pump station increases to meet the demand. The increased pump rate increases the pressure at the pump station and limits the amount that the pumps will deliver. Larger pumps could be installed but they would be required to pump at pressures in excess of 80 psi which over time would be costly to the district. To provide more flow at more reasonable pressures a 24-inch transmission main from the pumping station to the new elevated storage tower was assessed. Using the current projections the 24-inch should be in place between 2020 and 2025.

With the proposed 24-inch transmission main in place the average daily flow of 4.62 MGD is met with 1,640 to 2,830 gpm flowing to the elevated storage tanks. The maximum daily flow of 6.93 MGD is also met with 140 to 1,330 gpm flowing to the elevated storage. The peak hourly flow of 8.67 MGD cannot be met when the water level in the tower is higher than the halfway point. The peak hourly flow must be supplemented with 350 to 980 gpm from the elevated storage. As noted previously the new pumps

For the Mustang Island pumping station have been selected to meet the 2025 peak hour demand on the system. Based on the analysis carried out on the future condition when the peak hour demand surpasses 7.71 MGD the pump system needs to be upgraded. Using the current projections this will occur between 2025 and 2030.

The future condition (2030) the system pressures under average day demand ranged from 44 psi to, 57 psi, under the maximum daily demand the system pressures ranged from 43 psi to 56 psi and under the peak hour demand they ranged from 41 psi to 54 psi. As can be seen the system pressures under the future conditions also meet the TCEQ minimum system requirements of 35 psi.

#### **E. FIRE FLOW IMPROVEMENTS**

According to the hydraulic model's fire flow analysis, there are 15 areas within the service boundary that do not meet fire flow requirements of 20 psi at 750 gpm. Improvements to these areas are indicated below:

In both the existing conditions and future conditions cases the model indicates 15 main areas where the available fire flow is less than 750 gpm. These areas are mainly dead end lines which were also identified in the 2009 modeling analysis. The following locations were identified as being deficient;

- The existing 6-inch DIP on the north side of the Ship Channel only provides 493 to 516 gpm. If it is upsized to a 14-inch PVC it will provide 3100 gpm.
- The existing 6-inch ACP at the marina park on provides 629 gpm. If it is upsized to an 8-inch PVC it will provide 1459 gpm.
- The existing 6-inch ACP on Turtle Cove on provides 741 gpm. If it is upsized to an 8-inch PVC it will provide 916 gpm.
- The existing 6-inch ACP on Private Road A only provides 617 gpm. If it is upsized to an 8-inch PVC it will provide 861 gpm.
- The existing 4-inch ACP on Private Road E only provides 462 gpm. If it is upsized to a 6-inch PVC it will provide 1048 gpm.
- The existing 4-inch ACP on Private Road D will only provide 530 gpm. If it is upsized to a 6-inch PVC it will provide 1095 gpm.
- The existing 4-inch ACP on Private Road C only provides 576 gpm. If it is upsized to a 6-inch PVC it will provide 1105 gpm.
- The existing 4-inch ACP on RV Park at East Cotter Ave only provides 225 gpm. If it is upsized to a 6-inch PVC it will provide 727 gpm.
- The existing 4-inch and 6-inch ACP on Lantana Drive, East and West of Dunes Drive, only provides 589 to 705 gpm. If they are upsized to 6-inch and 8-inch PVC they will provide 784 gpm to 1230 gpm.

- The existing 2-inch PVC on Del Mar Lane only provides 83 gpm. It does not require upsizing at this time as it can be serviced by the fire hydrant on Avenue G.
- The existing 4-inch ACP on North Palimino Drive only provides 623 gpm. If it is upsized to a 6-inch PVC it will provide 2035 gpm.

#### **F. GROUND STORAGE**

The District currently has a total ground storage of 2,700,000 gallons which meets and greatly exceeds TCEQ's minimum requirement of 100 gallons per connections. In 2030 the projected population is 42,801 people and 15,678 service connections or 1.6 MG; therefore the District will meet TCEQ's ground storage requirement.

The ground storage is also required to meet 50% of the maximum daily demand. The 2030 maximum daily flow (MD) is 6.93 MDG (6,930,000 gal). The required ground storage capacity in 2030 is  $6,930,000 \text{ gal} \times 0.5 = 3,465,000$  and the total available is 2,700,000 the total available does not meet total required in 2030. Based on the 50% of MD requirement the total existing capacity will last until 2020. Since 2020 is not that far off it appears that we should look at a 1.5 MG tank. This would provide a total capacity of 3 MG which would last until around 2025. Ground storage options were assessed for the Ferry Landing Pump Station and for improvements beyond 2030, see Appendix D.

#### **G. PROPOSED WATER SYSTEM PROJECTS**

The recommended improvements are listed below in order of priority together with their probable costs. The probable costs for budgeting purposes are provided for all recommended improvements. The detailed cost estimates are included in Appendix A. All costs are based on 2016 prices and include allowances of 20 percent for construction contingencies and 12 percent for engineering design. The effect of inflation should be considered when planning budget costs for these recommended improvements.

### **High Service Pump Capacity Improvements**

Construct new Mustang Island pumping station with a firm capacity of 6.27 MGD (4,360 gpm) at a cost of **\$775,800**, see also detailed cost estimate in Appendix A.

### **Elevated Storage Improvements**

Construct 1.0 MG elevated storage facility at a cost of **\$3,651,650**, see also detailed cost estimate in Appendix A

### **Distribution System Improvements**

Construct 24-inch transmission main from the Mustang Island pump station to the new elevated storage facility on SH 361 across from the Gulf Waters RV park at a cost of **\$3,093,620**, see also detailed cost estimate in Appendix A.

### **Fire Flow Improvements**

The following fire flow improvements are required to increase the available fire flow capacity

TABLE VI – 1 Probable Costs of Water System Improvements

Location	Description	Pipe Size and Flow before Proposed Improvement	Pipe Size and Flow after Proposed Improvement	Cost of Improvement
1	Northside of Ship Channel	6-inch DIP, 493 to 516 gpm	14-inch PVC, 3100 gpm	\$865,300
2	Park	6-inch ACP, 629 gpm	8-inch PVC, 1459 gpm	\$254,520
3	Turtle Cove	6-inch ACP, 741 gpm	8-inch PVC, 916 gpm	\$69,700
4	Private Road A	6-inch ACP, 617 gpm	8-inch PVC, 861 gpm	\$98,710
5	Private Road E	4-inch ACP, 462 gpm	6-inch PVC, 1048 gpm	\$50,840
6	Private Road D	4-inch ACP 530 gpm	6-inch PVC, 1095 gpm	\$50,090
7	Private Road C	4-inch ACP, 576 gpm	6-inch PVC, 1105 gpm	\$42,290
8	RV Park at East Cotter Ave	4-inch ACP, 225 gpm	6-inch PVC, 727 gpm	\$121,990

9 to 13	Lantana Drive, East and West of Dunes Drive	4-inch and 6-inch ACP, 589 to 705 gpm	6-inch and 8-inch PVC, 784 gpm to 1230 gpm	\$105,480
14	Del Mar Lane	2-inch PVC, 83 gpm	None proposed as an existing FH within 600-ft	\$0
15	North Palimino Drive	4-inch ACP, 623 gpm	6-inch PVC, 2035 gpm	\$34,210

**Ground Storage Improvements**

Construct new 1.5 MG ground storage tank at a cost of \$1,440,630, see also detailed cost estimate in Appendix A.

## **CHAPTER VII - HARBOR ISLAND WATER STUDY & RECOMMENDED IMPROVEMENTS**

In 2012 the NCWC&ID#4 authorized Urban Engineering to review the 2009 Harbor Island study and recommend water transmission main improvements of the water supply system that runs along Harbor Island. The results of this study are found in the report “Harbor Island Water Improvements Route Study”.

The primary purpose of the 2012 report was to evaluate the water transmission system that provides water from Beasley Pump Station to the Districts water distribution system and to determine the improvements needed to increase pumping capacity. A water transmission model was created in order to analyze the existing supply system and is discussed later in this chapter. The scope of the 2012 report was to establish parameters for providing an increase in pumping capacity from Beasley Pump Station. According to water records, the Beasley Pump Station provides approximately 27% of the water supplied to the District. This report was prepared to provide recommendations to increase the percentage of water supplied by the Beasley Pump Station. For purposes of the 2012 study, the 2009 water quality was assumed to be adequate. The study was not designed to assess the existing water system quality but to be a tool for future improvements for the District.

Two providers, one on the north side San Patricio Municipal Water District (SPMWD) and one on the south side of the District’s service boundary, City of Corpus Christi supply the present water distribution system. This chapter will focus on the supply system from the north, which provides water to the distribution system. The District maintains a transmission line that serves as a distribution line for customers along Harbor Island; therefore the District maintains a secondary Service Boundary along Harbor Island; which is discussed in Chapter II. The boundary runs parallel with State Highway 361 from the City of Aransas Pass to the City of Port Aransas.

**A. Water Transmission Analysis & Pumping Facilities**

The District experiences a variation of water demand as a result of the influx of weekend tourists/visitors who occupy the hotels, motels and condominiums as well as the influx of additional people on major holidays; therefore the amount of water supply needed by the District fluctuates.

Water records were obtained from District personnel, in order to analyze the quantity of water provided by the Beasley Street Pump Station to the District; which indicated that the Beasley Street Pump Station provides on average approximately 27% of the water supplied to the District, with the remaining 73% being supplied by the Mustang Island Pump Station. Refer to Table VII - 1, for the projected amount of water supplied per pump station if the percentage of water being provided and the existing infrastructure remains the same.

In 2012 the pumping capacity at the Beasley Pump Station was maintained by 2 – 20 hp pumps and 2 - 60 hp pumps; which run independently of each other. According to District personnel, the normal operating pressure is 55 psi and the average pumping capacity is 1.30 MGD with one 60 hp pump in operation. This data was used to calibrate the transmission model that is discussed later in this chapter.

TABLE VII-1: Source of Water Supply

Year	AAD Demand in Peak Month (MG)		Peak Day Demand (MG)	
	Beasley PS	Mustang Island PS	Beasley PS	Mustang Island PS
2015	0.86	2.32	1.31	3.55
2020	1.03	2.77	1.57	4.24
2025	1.17	3.17	1.79	4.84
2030	1.32	3.56	2.01	5.44

Note: The above noted flows have been updated based on more current data, see Table IV-1.

Table VII - 1 depicts before the Year 2020, the percentage of water being supplied by the Beasley Pump Station will reach its optimum pumping capacity of 1.55 MG; therefore improvements will need to be implemented in order to maintain the 27% water supplied to

the District it currently experiences on a peak day. The District expressed an interest to create a plan to make Beasley PS the major supplier of water into the District; which is discussed in more detail in the last section of this chapter.

The 8-inch and 12-inch transmission lines are aged and contain several head losses throughout the pipes. Head losses, known as minor losses, occur at valves, tees, bends, reducers, and other appurtenances within the piping network that result in turbulence within the bulk flow as it moves through fittings and bends. The pumping capacity in the current system has decreased over time as a consequence of the head losses and pipe's age.

Another reason for the reduction of pumping capacity being provided from Beasley Pump Station to Ferry Landing Pump Station is the fact that the 12-inch transmission line serves as a distribution line for customers along Harbor Island; There are disadvantages of having the 12-inch transmission line serve as a distribution line; for example, the existing pumping capacity could increase if the pressure on the receiving side at the Ferry Landing PS is reduced. Another disadvantage is that there is no reserve capacity such as ground storage for customers along Harbor Island; which may result in a deficient quantity of water supply and/or pressure if the 12-inch line goes out of service. These issues can be resolved by creating a separate distribution and transmission system along Harbor Island, which is discussed briefly in Appendix D.

## **B. Water Supply Model**

In order to analyze the existing transmission system, a hydraulic model was developed to evaluate the existing and future water piping network from Beasley Pump Station to the Port Aransas distribution system. The modeling software utilized to evaluate the system was Water GEMS V8 XM Edition by Bentley Systems, Inc.

The water model was developed based upon construction plans and/ or record drawings obtained from District personnel. The assumptions and criteria that were used in the development and verification of the model are described by the following:

- Model nodes indicate pipeline intersections, pipeline dead ends, pump stations and storage tanks.
- Transmission main pipes were included in the model.
- Demand along Harbor Island was not included in the development of the model. Our assumption was that the demand is negligible compared to the water supply and pumping capacity needed by the District.
- Pump station piping configurations were obtained from record drawings and District personnel knowledge; pump performance data was obtained from manufacturer's pump curves and staff input.
- The pressure that is being investigated per node is the pressure at the ground elevation; therefore the ground elevation is the elevation assigned to the node in the model.
- The District is relatively flat and therefore assigning an elevation would have insignificant affects to the analysis of the model; therefore all nodes were assigned an elevation of zero with exception to the elevations, or heights of pump stations and tanks, these were reconfigured and based on the zero base elevation.
- Pressures and flow data for the model calibration were obtained from the District's SCADA system and personnel knowledge of the current system.
- Hazen-Williams C-factors (the pipe roughness coefficient) were assigned based on the pipe material and the age of the pipe.

- Head losses/ minor loss coefficients were assigned according to the approximate number of valves, tees, bends, reducers, and other appurtenances within a section of pipe. Record drawings and District personnel knowledge assisted in determining the approximate number of losses per pipe.

The hydraulic model is based on the actual transmission system layout, input of line sizes, minor loss coefficients, and the pipe roughness coefficient (Hazen Williams 'C' Factor).

A steady-state simulation was performed for the existing and future water systems. This analysis determines the operating behavior under steady-state conditions (flow rates and hydraulic grades remaining constant over time). This type of analysis was used to determine pressure and pumping capacity during average and peak supply scenarios. Several scenarios were produced to analyze the water system's reaction to different transmission main size improvements and physical conditions.

Field data and knowledge obtained from District personnel was used to verify the model operation therefore comparing predicted trends to observed performance.

### **C. Recommended Improvements**

The Harbor Island Water Improvements Route Study was conducted to identify existing problems in the District's transmission system, to develop an improvement program that will eliminate these issues for the future, and to provide additional pumping capacity. It represents the recommended improvements for the water transmission mains from Beasley PS to the Port Aransas distribution system. The following are the recommendations from the Harbor Island Water Improvements Route Study:

1. We recommend that the District proceed with the design phase of the project using the preferred alignment described by as shown on Figure 1.
2. Phase One

Due to the high capital cost of the water transmission main it is recommended that the project be phased over several years. In 2012 we recommend that the District proceed

with Phase One, which comprises alignment in the City of Aransas Pass and an upgrade to the Beasley Street Pump Station. In order to convey the flows for the ultimate build out of Phase 4 we recommend that the two existing 60 hp booster pumps and the two existing 20 hp jockey pumps be replaced with two larger capacity 125 hp pumps equipped with variable frequency drives. We recommend that the new pumps be installed in Phase 1 with impellers upsized in Phase 4 to pump the higher ultimate build-out flows. Variable frequency drives will also be used to handle the flow variations over the course of an average day. The new booster pumps will be further assessed during the design phase of the project. Phase One with a 24-inch transmission main was completed in 2013 at total cost of **\$3,178,125**, see detailed cost estimate in Appendix B.

3. We recommend that the District begin negotiations with the City of Corpus Christi to get the existing transmission main upgraded to include a new 20-inch transmission main. This would allow an additional capacity to be provided from the Sand Dollar Pumping Station. Funding for this upgrade would need to be discussed with the City of Corpus Christi.
  
4. We recommend that the remaining length of transmission main from Aransas Pass to Port Aransas be broken into 3 or 4 phases that can be completed after 2027 if the City of Corpus Christi constructs the improvements noted above. The phases are as follows:

#### Phase Two

The Phase Two transmission main improvements will be constructed by open trenching in 3 separate segments. Segment 1 will extend approximately 5,500-ft from the east side of Phase 3A to the west side of Phase 4, Segment 2 will extend 6,500-ft from east side of the south Bay crossing (the termination of Phase Four) to the Aransas Channel Crossing and Segment 3 will extend along Harbor Island for 5,700-ft east of the Aransas Channel crossing to the Corpus Christi Ship channel.

The total cost of Phase Two with a 24-inch transmission main is \$2,643,700, see also detailed cost estimate in Appendix B.

### Phase Three

The Phase Three pipe improvements can be done as two separate phases or together as Phase 3A and 3B. Both of these segments are HDD bores. Phase 3A will extend 4,000-ft from the termination of Phase One at the west side of the Seawall Channel across the Seawall Channel and the Inter-coastal Waterway. Phase 3B will extend approximately 3,300-ft south east from the termination of Phase Two across the Aransas Pass Channel.

The total cost of Phase Three A and B with a 24-inch transmission main is \$6,447,200, see also detailed cost estimate in Appendix B.

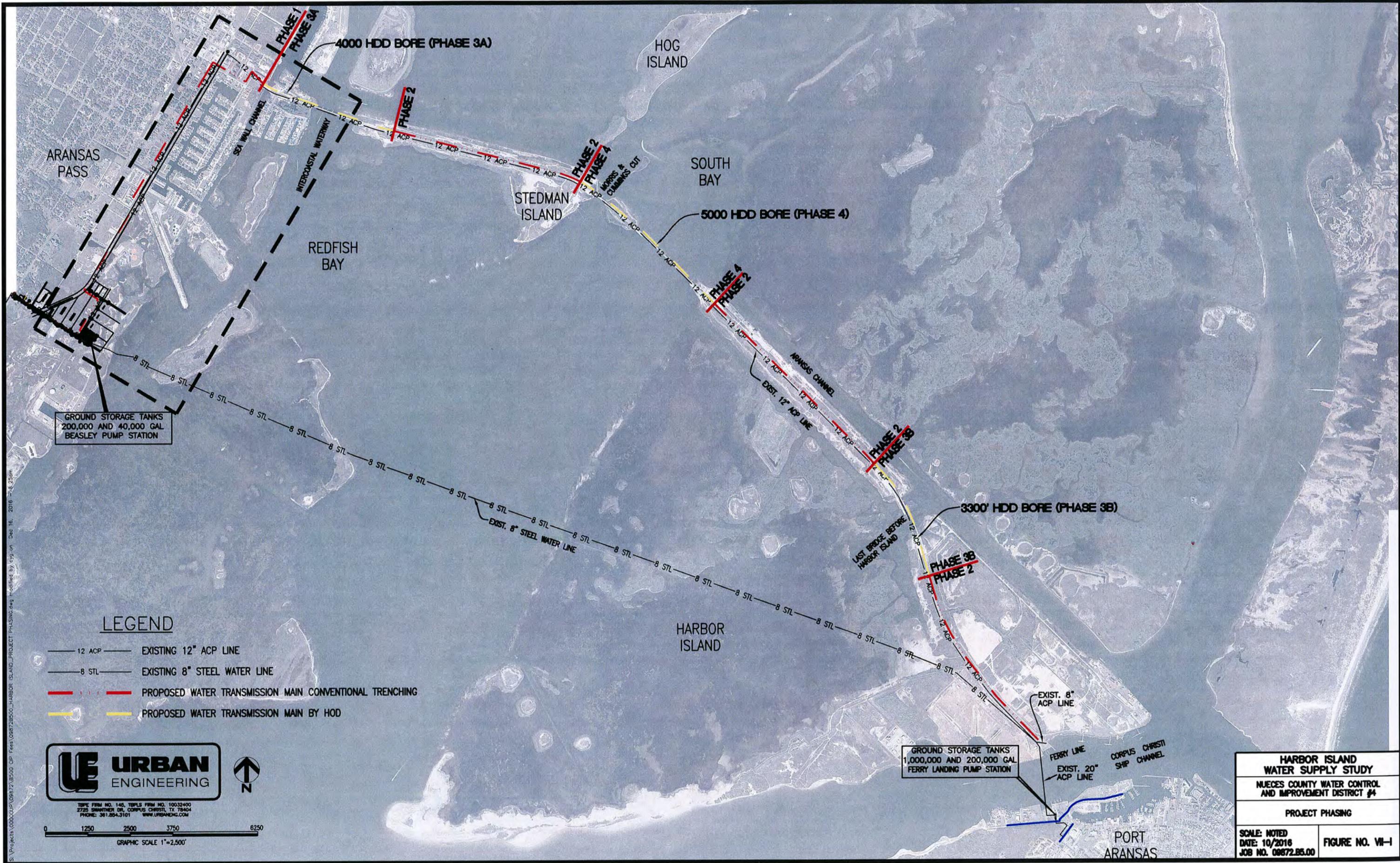
### Phase Four

The Phase Four pipe improvements will extend from the termination of Phase Two at the west side of the Morris and Cummings Cut and will extend 2,000-ft south east of South Bay. This entire phase will consists of a 5,500-ft horizontal directional bore under the Morris and Cummings Cut and the South Bay.

The total cost of Phase Four with a 24-inch transmission main is \$4,394,800, see also detailed cost estimate in Appendix B.

5. The majority of the cost attributed to this project is the cost to install the pipe across the 5 water crossings, Sea Wall Channel, Inter-coastal Waterway, Morris & Cummings Cut, South Bay and at the Bridge over the Aransas Channel. At each of these locations tidally influenced wetlands with associated environmentally sensitive resources are located adjacent to the waters edge. These wetlands extend from the shoreline inland to the upland areas along the SH 361 ROW. The design strategy used to develop the above

noted cost estimates is one that utilizes avoidance of these areas. In order to avoid these areas we have increased the length of the bore, which in turn increased the cost of the project. By avoiding these sensitive areas we believe that the USACE will allow the installation of the water transmission main using the Nation Wide Permit 12 process. This process requires a preconstruction notification and a 30 to 60 day review of the project documents by the USACE. An alternative to the NWP12 is the individual permit. The USACE will also consider applications for individual permits that allow disturbance of the wetland resources during the construction phase. These permits are much more difficult to obtain and require a much longer inter-agency review and approval process. The individual permitting process requires that all disturbed wetland resources be mitigated to the satisfaction of the USACE and the cost of mitigation could out-weigh the savings in shortening the bores. During the design phase of Phase One of the project it is our recommendation that the wetland/jurisdictional boundary be determined by a qualified biologist. Once we have the wetland boundaries defined we will determine if the bore lengths can be shortened.



GROUND STORAGE TANKS  
200,000 AND 40,000 GAL  
BEASLEY PUMP STATION

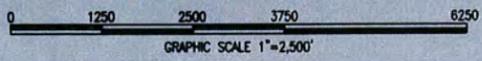
GROUND STORAGE TANKS  
1,000,000 AND 200,000 GAL  
FERRY LANDING PUMP STATION

**LEGEND**

- 12 ACP — EXISTING 12" ACP LINE
- 8 STL — EXISTING 8" STEEL WATER LINE
- · · · — PROPOSED WATER TRANSMISSION MAIN CONVENTIONAL TRENCHING
- — PROPOSED WATER TRANSMISSION MAIN BY HOD



TYPE FIRM NO. 146, TEMPL FIRM NO. 10032400  
2725 SMARTER DR, CORPUS CHRISTI, TX 78404  
PHONE: 361.854.3101 WWW.URBANENG.COM



<b>HARBOR ISLAND WATER SUPPLY STUDY</b>	
NUECES COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT #4	
PROJECT PHASING	
SCALE: NOTED DATE: 10/2016 JOB NO. 08872.B5.00	FIGURE NO. VII-1

## **CHAPTER VIII - EXISTING WASTEWATER SYSTEM**

### **A. COLLECTION SYSTEM**

For the purpose of this master plan update we compared the 2009 peak flow predictions with more recent data and found that the peak flows predicted in 2009 were greater than the peak flows predicted using the more recent data. For example the 2009 master plan predicted a peak flow of 1.69 MGD for the year 2015 and the more recent data predicted a peak flow of 1.57 MGD in 2015. The peak flow of 1.69 MGD will not occur until 2017 using the more recent data. The performance and evaluation of the collection system components was not changed from the 2009 assessment. In general we assumed that the 2009 collection system recommendations could be delayed for an additional 2 years based on the more recent data.

The wastewater collection system can be identified as separate components, one serving the City of Port Aransas and the other serving the remainder of Mustang Island, including the Terramar tracts. The two components are interconnected and the flow is transported by a series of lift stations to the District's wastewater treatment plant.

The overall collection system consists of force main and gravity lines varying in diameter from 4" to 24", including 21 lift stations, which are an essential element of design in flat terrain areas such as Port Aransas. The following table denotes each lift station and describes the existing pumps and their available pumping capacity.

TABLE VIII-1: Existing Lift Stations

#	LOCATION	SUBMERSIBLE PUMPS		PUMP CAPACITY
		Quantity	HP -Type	GPM
1	La Concha #1	2	10 hp - Flygt	501
2	La Concha #2	2	12 hp - Flygt	1026
3	Admiral's Row	2	3 hp - Flygt	384
4	Lost Colony	2	10 hp - Flygt	466
5	Port Royal	2	15 hp - Flygt	560
6	Gulf Waters	2	5 hp - Flygt	405
7	LS #7	N/A	---	
8	Beachwalk	3	20 hp - Flygt	809
9	Pioneer RV	2	15 hp - Ebara	513
10	Newport	2	20 hp - Flygt	1068
11	Island Moorings	2	15 hp - Flygt	560
12	Airport	2	10 hp - Flygt	727
13	Cemetery	2	20 hp - Flygt	943
14	Avenue G @ Alister	1	40 hp - Ebara	1400
		2	40 hp - Flygt	2315
15	Avenue G @ 11 <sup>th</sup> St.	2	3 hp - Flygt	384
16	Channel Vista	2	5 hp - Flygt	400
17	Dunes	2	3 hp - Flygt	384
18	Private Marina	2	3 hp - Flygt	384
19	Municipal Harbor	2	3 hp - Flygt	313
20	Cotter	2	20 hp - Flygt	809
21	WWTP	2	10 hp - Flygt	466

The three largest lift stations, which are responsible for collecting the flow from various areas of the service boundary and delivering it to the treatment plant, are as follows:

- ◆ Beachwalk - Lift Station #8, is located south of Port Aransas and equipped with three submersible pumps rated at 20 Hp and 809 gpm. With all the other pumps running in the system, this lift station is able to deliver approximately 893.1 gpm (446.55 gpm/pump)
- ◆ The Cemetery Lift Station (LS #13) is equipped with two 20 Hp submersible pumps rated at 875 gpm. It is currently operating at 638.63 gpm when all pumps are on.

- ◆ The lift station at Avenue G and Alister Street is equipped with three, 40 Hp submersible pumps; two are rated at 1400 gpm and the other at 2315 gpm. This triplex is producing a total of 2167.6 gpm when all other pumps are operating (1083.8 gpm/pump).

The combined capacity of these three lift stations is 5.33 MGD, which equates to 94.45% of the two-hour peak hydraulic capacity of the existing wastewater treatment plant.

## **B. WASTEWATER TREATMENT PLANT**

The wastewater treatment plant is located approximately 1/4 mile west of the intersection of Sixth Street and Avenue I, at the end of Ross Avenue in the City of Port Aransas, Texas. It is operated under TCEQ's TPDES Permit No. WQ0010846001 and discharges into the marsh area west of the plant, then into Corpus Christi Bay in water segment No. 2481 of the Bays and Estuaries. The annual average design hydraulic capacity of the plant is 1.88 MGD with a two-hour peak of 3,917 gpm (5.64 MGD).

The plant consists of two separate treatment units: Unit 1 has capacity for 60% of the design flows and Unit 2 the remaining 40%. Flow is presently split 50:50 between the units until flow rate approaches the design capacity of the plant. Unit 1 is an oxidation ditch type aeration basin with horizontal rotors providing the air and Unit 2 is a circular tank with diffused air provided by blowers. Both units use complete mix activated sludge for the treatment process. The treatment plant consists of fine screening and degritting followed by biological treatment using activated sludge (complete mix), followed by secondary clarification, chlorination and dechlorination. Settled solids from the clarifiers is periodically wasted to the Aerobic Digesters where it is thickened and stabilized aerobically and then all sludge is dried on sludge drying beds. Final sludge disposal is to a sanitary landfill.

The current discharge permit has a 10 milligram per liter (mg/l) limit of carbonaceous biochemical oxygen demand (CBOD<sub>5</sub>), 15 mg/l limit on total suspended solids (TSS), 2 mg/l

of ammonia nitrogen (NH<sub>3</sub>) and a minimum 5 mg/l of dissolved oxygen (DO). The complete effluent quality measurements for one year are given in the table below:

TABLE VIII-2: Effluent Quality Under Existing 10/15/2 Permit

<b>DATE</b>	<b>BOD<sub>5</sub> (mg/L)</b> 30-Day Avg.	<b>TSS (mg/L)</b> 30-Day Avg.	<b>DO (mg/L)</b> 30-Day Avg.	<b>pH</b> Range	<b>NH<sub>3</sub> (mg/L)</b> 30-Day Avg.
Jan-07	4.22	5.80	6.88	6.81	0.541
Feb-07	4.57	4.88	6.99	6.89	0.185
Mar-07	5.24	9.17	6.44	6.80	0.40
Apr-07	4.00	3.86	5.96	7.06	0.61
May-07	3.15	3.45	5.66	7.07	1.89
June-07	3.41	4.03	5.40	6.97	0.475
July-07	5.05	9.31	5.63	7.12	0.89
Aug-07	5.11	4.33	5.41	6.97	0.9
Sept-07	4.24	4.48	5.40	7.04	0.74
Oct-07	5.16	5.41	5.57	7.08	0.69
Nov-07	4.10	4.89	5.81	7.10	0.5
Dec-07	5.20	4.14	6.37	6.90	0.5
<b>Average</b>	<b>4.45</b>	<b>5.31</b>	<b>5.96</b>	<b>6.98</b>	<b>0.693</b>

The 2009 master plan used data obtained in 2008 indicating that the Port Aransas Wastewater Treatment Plant (North WWTP) treated a daily average of 1.246 MGD of wastewater during its peak summer months (June – August) which, equates to 66.3% of the existing plant design average daily flow capacity of 1.88 MGD. This information was compared to data obtained in 2014 which indicates that the North WWTP treated a daily average of 1.313 MGD during its peak summer months (June – August) which, equates to 69.8% of the existing plant design average daily flow capacity of 1.88 MGD.

The North plant was expanded in 2003 by 0.5 MGD and can be expanded further, but the limited availability of usable land will determine the ultimate plant size at this location. The District, however, owns a tract of land on the west side of State Highway 361, approximately midway down the island, which is planned to be used for a future treatment plant. This wastewater treatment plant may become a more viable option when projected flows generated by the development on Mustang Island exceed the expansion capacity of the existing plant. This report will refer to this future plant as the “Mid-Island Plant.”

## CHAPTER IX - WASTEWATER FLOW ANALYSIS AND LOAD FACTORS

In order to evaluate the adequacy and size of the wastewater system, it is necessary to determine the peak wet weather flow (PWWF). This is normally a function of average per capita daily flow, a peaking factor, plus infiltration and inflow. The operating data table of wastewater flows for 2008 is included below:

TABLE IX-1: Wastewater Treatment Plant Operating Data

DATE	30-Day Avg. Daily Flow	Avg. Daily Flow/Cap.	Peak Day Flow	Peak Day Flow/Cap.
	(MGD)	(gpd)	(MGD)	(gpd)
Jan-08	0.863	44.6	1.134	83.3
Feb-08	0.872	45.0	1.022	52.8
Mar-08	0.993	51.3	1.337	69.0
Apr-08	0.844	43.6	1.334	68.9
May-08	0.953	49.2	1.616	83.5
June-08	1.090	56.3	1.452	75.0
July-08	1.361	70.3	2.085	107.7
Aug-08	1.288	66.5	2.319	119.8
Sept-08	0.892	46.1	1.563	80.7
Oct-08	0.800	41.3	1.142	59.0
Nov-08	0.735	38.0	1.003	51.8
Dec-08	0.690	35.6	0.962	49.7
<b>Average</b>	<b>0.948</b>	<b>49.0</b>	<b>1.414</b>	<b>75.1</b>

In most communities, wastewater flow is composed of residential, commercial and industrial flow; however, in Port Aransas there is no industry, so the greatest impact is from the residential community. The operating data displayed above was used to establish the major components used in design. Average flow per person, which was determined to be 65 gpcd, existing and future basin demands, and pump capacities that were calculated in the model were derived from this raw data. A factor of 3.0 is typical and was used to arrive at the peak flow, which equates to 195 gpcd. All this information was used to evaluate line sizes and applied to the projected population and land usage to arrive at the various milestones for the collection system improvements.

As discussed in Chapter IV, the projected population has a direct correlation to the projected density established within the service boundary and can be used interchangeably. The following table depicts the projected population density used to calculate the current and future flows during the peak 2-hour, diurnal periods.

TABLE IX-2: Approximate Wastewater Flows Per Acre of Land

<b>AREA</b>	<b>Avg. Density 2007 (Dwelling Units/acre)</b>	<b>Avg. Density 2030 (Dwelling Units /acre)</b>	<b>Peak Water Consumption (gal/cap/day)</b>	<b>Wastewater Flow 2007 - 2030<sup>1</sup> (gal/acre/day)</b>
Gulf	0.8	3.7	195	421 – 1948
Bay	0.3	0.7	195	157 – 368
Old Town	3.0	4.2	195	1580 - 2211

1. Based on 2.7 persons per Dwelling Unit

The associated Master Plan maps of Mustang Island indicate the calculated present flows and projected flows through the design period.

## **CHAPTER X - WASTEWATER SYSTEM ANALYSIS**

### **A. WASTEWATER TREATMENT PLANT**

For the wastewater system analysis, the 2008 projected land use/population density and average wastewater flow of 65 gallons/capita/day were used to establish the design flows which the sanitary model and proposed improvements were based upon. As previously discussed in Chapter II, the land use/population density was derived from several sources. Data was also collected from the District in the form of Monthly Operating Reports (MOR), and was determined that the District experiences an average daily flow of 65 gpcd, which equates to approximately 1.25 MGD during the peak summer months. This information was further used to evaluate individual drainage basins which in turn aided us in evaluating the individual lift stations' performance, existing capacities, and future improvements required to maintain the system and keep up with the development and the resulting increases in demand.

The 1995 Master Plan proposed a 0.5 MGD expansion of the existing North Wastewater Treatment Plant and the probable construction of a new Mid-Island Wastewater Treatment Plant to cope with existing and future flows beyond 2016. The report intended to have the North Plant handle existing flows in the City of Port Aransas and the Mid-Island Plant was to handle flows from the existing and proposed development along Mustang Island. The Facility Plan, prepared in 1981, prompted the District to complete the design and obtain the discharge permits for a 1.2 MGD Mid-Island Wastewater Treatment Plant.

The 0.5 MGD expansion of the North Plant from a capacity of 1.38 MGD to a capacity of 1.88 MGD was completed in 2003. The 0.5 MGD expansion, although critical in the development of the island, was only temporary solution before the District would need to provide adequate reserve capacity with the construction of the Mid-Island Plant, or additional capacity at the North Plant.

According to the data from the 2009 master plan, as depicted by the operating data table (Table IX-1), during the peak summer months of 2008, June, July, and August, the wastewater flow reached 66.3% of the plant's capacity. The report also indicated that if the

population and projected density continue to grow as predicted that the plant will reach its 90% capacity of 1.69 MGD during the year 2015. The data from the 2009 master plan was compared to more recent data to determine if the timing for construction of additional treatment capacity was required as noted above. Based on the new flow data it was determined that the existing capacity reached 70% (1.316 MGD) in 2014. The new data also indicates that it would reach 90% (1.692 MGD) capacity by 2017 and 100% (1.88 MGD) capacity by 2020. The new data was projected using the Texas Water Development Board (TWDB) population estimates.

Based on this analysis, it is apparent that some type of addition (plant expansion or new plant) will be required to be under construction by 2018 or 2019. It is important to point out that many factors can influence the need for expansion. The population fluctuates from winter to summer months quite substantially, the economy strengthens and weakens, and lifestyles change, thus demand on the plant could be expected prior to or just after 2019. Monitoring flow increases to the plant is essential in arriving at the exact date of expansion requirement. The TCEQ requires that construction of an increase in capacity be underway when the existing system is processing at least 90% of its capacity for a period of three (3) consecutive months.

Urban Engineering prepared the report *Nueces County WCID No. 4 Long Term Strategy for Wastewater Treatment* in 2013 to update the 2009 Water and Wastewater Facilities Master Plan, related to treatment of wastewater. The report also developed a strategy for dealing with the District's short term and long term wastewater treatment needs. The report recommends that the District move forward with the provision of additional capacity at the North WWTP. The recommended expansion of 0.62 MGD will bring the rated capacity to a total of 2.5 MGD. These improvements will delay the construction of the South WWTP for approximately 20 years. The South plant would then be constructed in phases with diversion of existing and future lift stations to the new plant as growth dictates. Postponing construction of the South plant will allow the District to continue to operate one plant in one location which is a major plus for realizing efficiency of operations and staff time. The

following table summarizes the target expansion and construction dates for the two wastewater treatment plants.

TABLE X1 - Option 1: Expand North WWTP First\*

<b>Year</b>	<b>Activity</b>
2017	Design North WWTP 0.63 MGD Expansion
2019	Construct North WWTP Expansion
2024	Design Ph 1 0.60 MGD South WWTP
2031	Construct Ph 1 0.60 MGD South WWTP
2032	Divert LS #5 To New South WWTP
2039	Design South WWTP Ph 2 1.20 MGD Exp.
2044	Construct South WWTP Ph 2 1.20 MGD Exp.
2045	Divert LS #8 To Expanded South WWTP

\*Does not protect the South WWTP permit

## **B. COLLECTION SYSTEM**

The collection system, including the lift stations, force main network, and major gravity mains were modeled and analyzed in the 2009 master plan in order to provide the District with a better understanding of the collection system’s behavior.

The entire service area was divided into major drainage basins which were then evaluated utilizing the same assumptions described below. Each basin was then calculated to determine its flow attributes which were then applied to a complex spreadsheet tracking all 21 lift station’s data simultaneously. A lift station model incorporating line sizes, pump curves, pipe configuration, and basin data was developed and used to analyze the network and run possible alternatives for future expansion.

In order to evaluate the system correctly and determine the expected flows for each basin, it was necessary to make several assumptions regarding development, as well as the expected land use density on the Island. The following figures are a result of the data interpretations and projections, which were determined during the analysis and measurement of the water

and wastewater networks. These numbers below represent the ranges of the estimated percentage of probable development through the year 2030, which varies with location and includes existing construction.

- 0.0 – 6.37 Dwelling Units per acre on the Gulf
- 0.0 – 4.04 Dwelling Units per acre on the Bay
- 0.1 – 7.77 Dwelling Units per acre within Old Town
- 2.7 Persons per Dwelling Unit
- 195 gpcd (includes infiltration & inflow)
- 20 Year Growth Projection to be 2-5% per Year

Under 1995 Master Plan, major gravity lines and force mains were generally located along the West side of State Highway 361 due to ROW and serviceable issues. As the need arises, projected beyond 2030, it is intended to eliminate the existing lift stations along the East side and replace them with new stations on the West side by constructing major gravity crossings across State Highway 361. These crossing were proposed in the 1995 Master Plan, but after modeling the system in 2009, they were not required until the demands exceed the physical limitations of the Lift Station and their improvements.

The 2009 study calculated the serviceable area by extending the flow line of all gravity lines (illustrated in green) to an elevation of 0.0' at the minimum slope required by the TCEQ, regardless of location. Manholes are not shown in all areas, but spacing of them shall not exceed 500'. The plan assumes that the future developers would be able to acquire a permit to grade their developable land up to an elevation of 5.0'; however, final calculations shall be performed to verify if these specific developments could effectively be served by the existing system. Extensions of collection lines are shown on the plan for guidance only in order to illustrate the practical reach of the collection system directly connected to each lift station. Where the extensions of these lines would require crossing adjacent property, provisions shall be made by the owner (developer) with the downstream tract for extension upstream, within the service area. In some areas, many of the existing lift stations cannot serve the furthest points of their individual basins and require additional means to serve these areas. Minor lift

stations were chosen as the most practical method to serve the larger boundaries and are depicted on the plans to compliment the nearest lift station and allow to it to serve the extents of the proposed basin.

Some areas within the city limits are not presently tied to the system. However, extensions are indicated within streets and easements to provide service to them. These extensions are also shown as a guide only. The timing, or the responsibility for such extensions, will depend on the District's policies and development demands in the future.

The plan recognizes the uniqueness of these areas and that some areas are more impacted by tidal fluctuations than others and that it is possible for these areas to be developed in the future. Should this occur, our assumptions on density of development, particularly west of S.H. 361 are liberal to the extent that some additional flows could be contributed to the proposed ultimate system without adversely impacting the system's capacity. A service plan for approval by the District must be submitted as part of the development plan. Notes to this effect have been added to the plan for clarification.

### **C. EVALUATION OF THE COLLECTION SYSTEM**

The performance of the collection system was evaluated in 2009 utilizing the basic assumptions described above. When analyzing the lift station network, the results indicated two (2) current areas of concern. These include the Pioneer RV LS (#9) and the Cemetery LS (#13). The Pioneer LS seemed to be the most critical as it was assessed at running as its maximum motor capacity in 2009. It appears that the pumps are capable of handling the demands of the basin alone but they cannot effectively pump against the head pressures created in the system when all pumps are running (i.e. LS#8 to #14) which forces the pumps to shut off. For this reason, the 2009 Master Plan recommended that the pumps be upgraded to handle the head pressures experienced through the network and allow the LS to operate as intended. A temporary fix that was considered in 2009 was to configure the SCADA system to allow the Pioneer LS to pump alone during high demand periods. This would postpone the need to replace these pumps until 2023 (2025 using the updated peak flow data), but will negatively affect the rest of the pumps on the same force main because they will essentially

be turned off during the heaviest demand periods. According to the District the Pioneer lift station improvements have not been completed.

The Cemetery LS also showed signs of reaching its maximum pumping capacity in 2009 and was estimated to be running at 105% by the end of that year. In 2009 we recommended replacing these pumps as soon as possible, but no later than 2011 (2013 using the updated peak flow data) with larger pumps, sized to carry the demand predicted for 2030. According to the District the Cemetery lift station improvements have not been completed.

The 2009 model also indicates two other lift stations, Beachwalk (#8) and Lost Colony (#4), quickly approaching their maximum capacity between 2012 and 2014 (2014 and 2016 using the updated peak flow data). This is mainly due to the network configuration, pipe distance, the flow LS #8 currently has to manage, and the small 6" force main that is limiting Lost Colony's potential. The 2009 Master Plan recommended construction of the new Mid Island plant complete with a new 12" force main. Since construction of 0.62 MGD upgrade to the North plan was recommended in 2013, construction of the Mid Island plant will be delayed until 2024. We recommend that replacing the pumps at Lost Colony or the design of a 12" force main be carried as soon as possible, but no later than 2014 (2016 using the updated peak flow data). These improvements would aid all lift stations utilizing this line and increase their potential capacity and prolong their serviceable lifetime. According to the District the Lost Colony lift station improvements have not been carried out.

According to the 2009 projections the peak 2-hour demand will exceed the capacity at Beachwalk LS for approximately 3 yrs and will be operating at its maximum capacity until the MI Plant is operational. Since construction of the Mid Island plant has been delayed until 2024 the pumps may need to be upgraded at this lift station to meet the demands beyond 2030. The 2009 Master Plan also indicated that it was likely that this lift station doesn't experience its peak flow at the same time as the other lift stations on the same force main, due to the lift station configuration being in series. This "pumping and dumping" method spreads the peak flow over a longer period allowing additional capacity to LS #8 due to lower

head pressures after the normal two hour peak has subsided. For this reason, we are not recommending pump replacement, but do recommend that we monitor the LS until the new plant is built.

Simple calculations were performed in the 2009 Master Plan to verify that the current gravity lines were adequately sized for the demands estimated in the model. From this data and using the information displayed on the Master Plan maps, it appears that all lines are sufficiently sized to handle the flows beyond 2030. As a maintenance issue, existing clay gravity lines that have not been rehabilitated should be repaired or improved with CIPP (Cured-in-Place Pipe). This process is relatively less expensive than replacing the clay pipe with new material and extends the life span of the existing structures.

#### **D. PROJECTED 15 YEAR PERFORMANCE AND IMPROVEMENT PLAN**

In 2009 the future sanitary network was modeled using the same criteria and methods formerly established, except that the increases in population and density have been incorporated to depict the increase in demand. As discussed previously in this chapter, the North Plant is recommended for construction. The design phase should begin in the year 2017, with construction to commence in 2018 or 2019 and terminate in 2020.

Nearly all the scenarios analyzed indicated the same potential problem areas, just with different degrees of intensity. We combined and created a variation of two alternatives to come up with the best case scenario and developed a recommendation list and time table of when these improvements should be investigated and implemented.

According to the 2009 Master Plan and verified in this update the pumps at Pioneer, Cemetery and Lost Colony lift stations should be upgraded. Following these improvements the next items to consider upgrading are the pumps at Port Royal LS (#5) by 2022 (2024 using the updated peak flow data). The model shows this LS approaching its maximum capacity shortly after 2020 and operating at 108% by 2022 (2022 and 2024 using the updated peak flow data). Beyond 2030, the model indicates that the next possible improvements

would be to LS #8 (Beachwalk) which will be at 79% and LS #3 (Admiral's) which will be at 88.9% in 2030.

**E. ESTIMATED PROBABLE COSTS**

The following tables are organized chronologically and describe the probable cost for the proposed improvements derived from this study and described in this chapter.

**1. Pioneer RV – LS #9 Pump Upgrades (2017)**

This estimate does not include labor or installation costs for the pumps. It is assumed that the District's personnel have the capabilities to complete the replacement. The electrical is a rough estimate that assumes the control panel will have to be replaced and the SCADA system would need some revisions or updating.

Item	Description	Qty +5%	Units	Unit Price	Total
1	Pump Installation (6.5 HP)	2	EA	\$7,313.00	\$14,626.00
2	Electrical & SCADA Modifications	1	LS	\$14,775.00	\$14,775.00
				Sub Total =	\$29,400.00
				15% Contingency =	\$4,410.00
				10% Engineering =	\$2,940.00
				<b>Total =</b>	<b>\$36,751.00</b>

**2. Cemetery – LS #13 Pump Upgrades (2017)**

This estimate does not include labor or installation costs for the pumps. It is assumed that the District's personnel have the capabilities to complete the replacement. The electrical is a rough estimate that assumes the control panel will have to be replaced and the SCADA system would need some revisions or updating.

Item	Description	Qty +5%	Units	Unit Price	Total
1	Pump Replacement (25 HP)	2	EA	\$26,000.00	\$52,000.00
2	Electrical & SCADA Modifications	1	LS	\$14,775.00	\$14,775.00
				Sub Total =	\$66,775.00
				15% Contingency =	\$10,016.00
				10% Engineering =	\$6,678.00
				<b>Total =</b>	<b>\$83,469.00</b>

**3. Lost Colony - LS #4 Pump Upgrades (2017)**

This estimate does not include labor or installation costs for the pumps. It is assumed that the District's personnel have the capabilities to complete the replacement. The electrical is a rough estimate that assumes the control panel will have to be replaced and the SCADA system would need some revisions or updating

Item	Description	Qty +5%	Units	Unit Price	Total
1	Pump Replacement (20 HP)	2	EA	\$17,877.00	\$35,754.00
2	Electrical & SCADA Modifications	1	LS	\$14,775.00	\$14,775.00
				Sub Total =	\$50,529.00
				15% Contingency =	\$7,579.00
				10% Engineering =	\$5053.00
				<b>Total =</b>	<b>\$63,161.00</b>

#### 4. North Wastewater Treatment Plant (2017-2019)

Item	Description	Qty	Units	Unit Price	Total
1	0.62 MGD Expansion	630,000	Gal	\$4.00	\$2,520,000.00
2	Sludge Dewatering Building	1	LS	\$750,000.00	\$750,000.00
3	Generator Building	1	LS	\$400,000.00	\$400,000.00
4	Blower Building, Blowers, Piping	1	LS	\$200,000.00	\$200,000.00
				Sub Total =	\$3,870,000.00
				20% Contingency =	\$774,000.00
	Bonds (2%)				\$92,880
	Move-in Move-out (2.4%)				\$111,456
				12% Engineering =	\$581,800.00
				Soil testing =	\$10,000
				<b>Total =</b>	<b>\$5,440,136.00</b>

#### 5. 12-inch Force Main (2017)

The 12-inch force main is a recommendation to improve the flow from the Lost Colony lift station.

Item	Description	Qty +5%	Units	Unit Price	Total
1	12-inch PVC Force Main	23183	LF	\$45.00	\$1,043,235.00
2	12-inch Fittings	12	EA	\$2,220.00	\$26,640.00
3	SWPPP	1	LS	\$14,775.00	\$14,775.00
				Sub Total =	\$1,084,650.00
				15% Contingency =	\$162,698.00
				10% Engineering =	\$108,465.00
				<b>Total =</b>	<b>\$1,355,813.00</b>

#### 6. Port Royal – LS #5 Pump Upgrades (2024)

This estimate does not include labor or installation costs for the pumps. It is assumed that the District’s personnel have the capabilities to complete the replacement. The electrical is a rough estimate that assumes the control panel will have to be replaced and the SCADA system would need some revisions or updating.

Item	Description	Qty +5%	Units	Unit Price	Total
1	Pump Replacement (35 HP)	2	EA	\$34,130.00	\$68,260.00
2	Electrical & SCADA Modifications	1	LS	\$14,775.00	\$14,775.00
				Sub Total =	\$83,035.00
				15% Contingency =	\$12,455.00
				10% Engineering =	\$8,304.00
				<b>Total =</b>	<b>\$103,794.00</b>

**APPENDIX A**

**NCWC & ID #4 WATER MASTERPLAN**

**ESTIMATE OF PROBABLE COSTS**

## OPINION OF PROBABLE CONSTRUCTION COST

### 1.5 Million Gallon Ground Storage Tank

NCWCID #4 PORT ARANSAS, TEXAS

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tank Foundation (Base Material)	121	CY	\$60	\$7,260
2	Tank Structure	1	LS	\$885,000	\$885,000
3	Site Fill	1,250	CY	\$15	\$18,750
4	Piping and Valves	1	LS	\$85,000	\$85,000
5	Sidewalk	1,307	SF	\$7	\$9,149
6	Seeding or Sodding	1,010	SY	\$6	\$6,060
	<b>Subtotal</b>				<b>\$1,011,219</b>
	Bonds, (3%)				\$30,340
	Move-in Move-out (3%)				\$30,340
	<b>Subtotal</b>				<b>\$1,071,899</b>
	Contingencies (20%)				\$214,380
	<b>Total Construction</b>				<b>\$1,286,279</b>

Engineering (12%)

\$154,353

TOTAL

\$1,440,632

## OPINION OF PROBABLE CONSTRUCTION COST

### 1.0 Million Gallon Elevated Storage Tank

NCWCID #4 PORT ARANSAS, TEXAS

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
	1.0 Million Gallon Composite				
1	Elevated Tank	1	LS	\$2,491,000	\$2,491,000
2	Coating	1	LS	\$195,000	\$195,000
3	Access Road	1	LS	\$92,400	\$92,400
4	Fence	1	LS	\$19,100	\$19,100
5	Water Connection	1	LS	\$46,900	\$46,900
6	Offsite Water	1	LS	\$48,500	\$48,500
7	Power Supply	1	LS	\$16,100	\$16,100
8	SWPPP	1	LS	\$5,000	\$5,000
9	Construction/Paint Inspection	1	LS	\$50,000	\$50,000
	<b>Subtotal</b>				<b>\$2,964,000</b>
	Bonds, (incl. in Item 1)				
	Move-in Move-out (incl. in Item 1)				
	<b>Subtotal</b>				<b>\$2,964,000</b>
	Contingencies (10%) <sup>1</sup>				\$296,400
	<b>Total Construction</b>				<b>\$3,260,400</b>

Engineering (12%)

\$391,248

TOTAL

\$3,651,648

Note: 1. Prices from Tank Manufactures so the Contingency was lowered to 10%

## OPINION OF PROBABLE CONSTRUCTION COST

### Pumping Capacity

NCWCID #4 PORT ARANSAS, TEXAS

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Potable Water Pumps	2	EA	\$31,000	\$62,000
	Pump Station Building, Piping,				
2	Valves, Fittings, Electrical	1	LS	\$440,000	\$440,000
3	Yard Piping	1	LS	\$65,000	\$65,000
	Access Driveway and Parking				
4	Area	170	SY	\$25	\$4,250
5	SCADA	1	LS	\$25,000	\$25,000
6	Site Fill	70	CY	\$12	\$840
7	Seeding or Sodding	125	SY	\$7	\$875
	<b>Subtotal</b>				<b>\$597,965</b>
	Bonds, (3%)				\$17,940
	Move-in Move-out (3%)				\$17,940
	<b>Subtotal</b>				<b>\$633,845</b>
	Contingencies (20%)				\$126,770
	<b>Total Construction</b>				<b>\$760,615</b>

Engineering (12%)

\$15,212

TOTAL

\$775,827

**CONSTRUCTION COST**  
**24-inch Water Transmission Main**  
 NCWCID #4 PORT ARANSAS, TEXAS

	Description	Quantity + 5%	Unit	Unit Price	Total Price
<b>A.</b>	<b>WATER TRANSMISSION IMPROVEMENTS (Mustang Island to New Elevated Storage Tank)</b>				
1	Bonds & Insurance	1	LS	\$ 45,000.00	\$ 45,000.00
2	Move In and Move Out	1	LS	\$ 40,000.00	\$ 40,000.00
3	24" PVC DR-25 Water Trans. Main	21500	LF	\$ 85.00	\$ 1,827,500.00
4	24" D.I.11.25 ° Bend (MJ)	4	EA	\$ 3,100.00	\$ 12,400.00
5	24" D.I.22.5 ° Bend (MJ)	2	EA	\$ 3,200.00	\$ 6,400.00
6	24" D.I.45° Bend (MJ)	2	EA	\$ 3,300.00	\$ 6,600.00
7	24" D.I. 90° Bend (MJ)	2	EA	\$ 4,100.00	\$ 8,200.00
8	24" X 12" Reducer (MJ)	1	EA	\$ 2,200.00	\$ 2,200.00
9	12" Cap (MJ)	1	EA	\$ 800.00	\$ 800.00
10	Stainless Steel Bell Restraints	12	EA	\$ 1,200.00	\$ 14,400.00
11	Air Valve Installation	2	EA	\$ 2,500.00	\$ 5,000.00
12	24" Gate Valves	3	EA	\$ 17,500.00	\$ 52,500.00
18	Asphalt Pavement Repair	1200	SY	\$ 75.00	\$ 90,000.00
19	Repair of Concrete Pavement with Flex Base	660	SF	\$ 15.00	\$ 9,900.00
21	Removal & Replacement of Curb Gutter	210	LF	\$ 40.00	\$ 8,400.00
23	Seed and Fertilize	2500	SY	\$ 0.80	\$ 2,000.00
26	Trench Excavation Safety	21500	LF	\$ 2.00	\$ 43,000.00
27	Trench Dewatering	10750	LF	\$ 10.00	\$ 107,500.00
28	Traffic Control	1	LS	\$ 10,000.00	\$ 10,000.00
31	SWPPP Items	1	LS	\$ 10,000.00	\$ 10,000.00
					\$ 2,301,800.00
	Contingency (20%)				\$ 460,360.00
	<b>Total Construction</b>				<b>\$ 2,762,160.00</b>

Engineering (12%)

\$331,459

TOTAL

\$ 3,093,619.20

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 1

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	2	EA	\$3,300	\$6,600
2	Install 30" Steel Casing Pipe w/ 16" Water Main by Jacking and Boring	140	LF	\$525	\$73,500
3	16" PVC C-905 installed by Conventional Trenching	7,080	EA	\$76	\$538,080
4	16" Gate Valve	2	EA	\$9,400	\$18,800
5	16" Fittings	16	EA	\$800	\$12,800
6	16" Gate Valve	2	EA	\$9,300	\$18,600
7	Trench Safety	7,080	LS	\$1	\$7,080
8	Pavement Repair	60	SY	\$80	\$4,800
	<b>Subtotal</b>				<b>\$680,260</b>
	Bonds, (3%)				\$20,410
	Move-in Move-out (3%)				\$20,410
	<b>Subtotal</b>				<b>\$721,080</b>
	Contingencies (20%)				\$144,220
	<b>TOTAL</b>				<b>\$865,300</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 2

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 8" Dia. C-900 DR-18 PVC	2,200	LF	\$37	\$81,400
3	Install 8" Dia. C-900 DR-18 by HDD	400	LF	\$255.00	\$102,000
4	8" Gate Valve	2	EA	\$1,400	\$2,800
5	8" Fittings	8	EA	\$500	\$4,000
6	Reconnect Services	2	EA	\$400	\$800
7	Trench Safety	2,200	LS	\$1	\$2,200
8	Pavement Repair	45	SY	\$80	\$3,600
	<b>Subtotal</b>				<b>\$200,100</b>
	Bonds, (3%)				\$6,000
	Move-in Move-out (3%)				\$6,000
	<b>Subtotal</b>				<b>\$212,100</b>
	Contingencies (20%)				\$42,420
	<b>TOTAL</b>				<b>\$254,520</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 3

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 8" Dia. C-900 DR-18 PVC	600	LF	\$37	\$22,200
3	8" Gate Valve	1	EA	\$1,400	\$1,400
4	8" Fittings	3	EA	\$500	\$1,500
5	Fire Hydrant	1	EA	\$5,000	\$5,000
6	Reconnect Services	12	EA	\$400	\$4,800
7	Trench Safety	600	LS	\$1	\$600
8	Pavement Repair	200	SY	\$80	\$16,000
	<b>Subtotal</b>				<b>\$54,800</b>
	Bonds, (3%)				\$1,640
	Move-in Move-out (3%)				\$1,640
	<b>Subtotal</b>				<b>\$58,080</b>
	Contingencies (20%)				\$11,620
	<b>TOTAL</b>				<b>\$69,700</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 4

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 8" Dia. C-900 DR-18 PVC	1,200	LF	\$37	\$44,400
3	8" Gate Valve	1	EA	\$1,400	\$1,400
4	8" Fittings	9	EA	\$500	\$4,500
5	Fire Hydrant	2	EA	\$5,000	\$10,000
6	Reconnect Services	25	EA	\$400	\$10,000
7	Trench Safety	1,200	LS	\$1	\$1,200
8	Pavement Repair	35	SY	\$80	\$2,800
	<b>Subtotal</b>				<b>\$77,600</b>
	Bonds, (3%)				\$2,330
	Move-in Move-out (3%)				\$2,330
	<b>Subtotal</b>				<b>\$82,260</b>
	Contingencies (20%)				\$16,450
	<b>TOTAL</b>				<b>\$98,710</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 5

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 6" Dia. C-900 DR-18 PVC	430	LF	\$28	\$12,040
3	6" Gate Valve	2	EA	\$1,000	\$2,000
4	6" Fittings	8	EA	\$300	\$2,400
5	Fire Hydrant	1	EA	\$5,000	\$5,000
6	Reconnect Services	12	EA	\$400	\$4,800
7	Trench Safety	430	LS	\$1	\$430
8	Pavement Repair	125	SY	\$80	\$10,000
	<b>Subtotal</b>				<b>\$39,970</b>
	Bonds, (3%)				\$1,200
	Move-in Move-out (3%)				\$1,200
	<b>Subtotal</b>				<b>\$42,370</b>
	Contingencies (20%)				\$8,470
	<b>TOTAL</b>				<b>\$50,840</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 6

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 6" Dia. C-900 DR-18 PVC	320	LF	\$28	\$8,960
3	6" Gate Valve	1	EA	\$1,000	\$1,000
4	6" Fittings	4	EA	\$300	\$1,200
5	Fire Hydrant	1	EA	\$5,000	\$5,000
6	Reconnect Services	13	EA	\$400	\$5,200
7	Trench Safety	320	LS	\$1	\$320
8	Pavement Repair	180	SY	\$80	\$14,400
	<b>Subtotal</b>				<b>\$39,380</b>
	Bonds, (3%)				\$1,180
	Move-in Move-out (3%)				\$1,180
	<b>Subtotal</b>				<b>\$41,740</b>
	Contingencies (20%)				\$8,350
	<b>TOTAL</b>				<b>\$50,090</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 7

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 6" Dia. C-900 DR-18 PVC	260	LF	\$28	\$7,280
3	6" Gate Valve	1	EA	\$1,000	\$1,000
4	6" Fittings	4	EA	\$300	\$1,200
5	Fire Hydrant	1	EA	\$5,000	\$5,000
6	Reconnect Services	8	EA	\$400	\$3,200
7	Trench Safety	260	LS	\$1	\$260
8	Pavement Repair	150	SY	\$80	\$12,000
	<b>Subtotal</b>				<b>\$33,240</b>
	Bonds, (3%)				\$1,000
	Move-in Move-out (3%)				\$1,000
	<b>Subtotal</b>				<b>\$35,240</b>
	Contingencies (20%)				\$7,050
	<b>TOTAL</b>				<b>\$42,290</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 8

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 8" Dia. C-900 DR-18 PVC	1,700	LF	\$37	\$62,900
3	8" Gate Valve	4	EA	\$1,400	\$5,600
4	8" Fittings	10	EA	\$500	\$5,000
5	Fire Hydrant	3	EA	\$5,000	\$15,000
6	Reconnect Services	2	EA	\$400	\$800
7	Trench Safety	1,700	LS	\$1	\$1,700
8	Pavement Repair	20	SY	\$80	\$1,600
	<b>Subtotal</b>				<b>\$95,900</b>
	Bonds, (3%)				\$2,880
	Move-in Move-out (3%)				\$2,880
	<b>Subtotal</b>				<b>\$101,660</b>
	Contingencies (20%)				\$20,330
	<b>TOTAL</b>				<b>\$121,990</b>

# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 9-13

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 8" Dia. C-900 DR-18 PVC	1,060	LF	\$37	\$39,220
3	Install 6" Dia. C-900 DR-18 PVC	160	EA	\$28	\$4,480
4	8" Gate Valve	2	EA	\$1,400	\$2,800
5	6" Gate Valve	1	EA	\$1,000	\$1,000
6	8" Fittings	10	EA	\$500	\$5,000
7	6" Fittings	5	EA	\$300	\$1,500
8	Fire Hydrant	2	EA	\$5,000	\$10,000
9	Reconnect Services	20	EA	\$400	\$8,000
10	Trench Safety	1,220	LS	\$1	\$1,220
11	Pavement Repair	80	SY	\$80	\$6,400
	<b>Subtotal</b>				<b>\$82,920</b>
	Bonds, (3%)				\$2,490
	Move-in Move-out (3%)				\$2,490
	<b>Subtotal</b>				<b>\$87,900</b>
	Contingencies (20%)				\$17,580
	<b>TOTAL</b>				<b>\$105,480</b>



# OPINION OF PROBABLE CONSTRUCTION COST

NCWCID #4 PORT ARANSAS, TEXAS

## LOCATION No. 15

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	1	EA	\$3,300	\$3,300
2	Install 6" Dia. C-900 DR-18 PVC	310	LF	\$28	\$8,680
3	6" Gate Valve	1	EA	\$1,000	\$1,000
4	6" Fittings	5	EA	\$300	\$1,500
5	Fire Hydrant	1	EA	\$5,000	\$5,000
6	Reconnect Services	13	EA	\$400	\$5,200
7	Trench Safety	310	LS	\$1	\$310
8	Pavement Repair	20	SY	\$95	\$1,900
	<b>Subtotal</b>				<b>\$26,890</b>
	Bonds, (3%)				\$810
	Move-in Move-out (3%)				\$810
	<b>Subtotal</b>				<b>\$28,510</b>
	Contingencies (20%)				\$5,700
	<b>TOTAL</b>				<b>\$34,210</b>

**APPENDIX B**

**HARBOR ISLAND WATER STUDY**

**ESTIMATE OF PROBABLE COSTS**

**CONSTRUCTION COST**  
**24-inch Water Transmission Main**  
 NCWCID #4 PORT ARANSAS, TEXAS

	Description	Quantity + 5%	Unit	Unit Price	Total Price
<b>A. WATER TRANSMISSION IMPROVEMENTS (Beasley Street to SH 361)</b>					
1	Bonds & Insurance	1	LS	\$ 45,000.00	\$ 45,000.00
2	Move In and Move Out	1	LS	\$ 40,000.00	\$ 40,000.00
3	24" PVC DR-25 Water Trans. Main	11700	LF	\$ 85.00	\$ 994,500.00
4	24" D.I.11.25 ° Bend (MJ)	11	EA	\$ 3,100.00	\$ 34,100.00
5	24" D.I.22.5 ° Bend (MJ)	8	EA	\$ 3,200.00	\$ 25,600.00
6	24" D.I.45° Bend (MJ)	6	EA	\$ 3,300.00	\$ 19,800.00
7	24" D.I. 90° Bend (MJ)	4	EA	\$ 4,100.00	\$ 16,400.00
8	24" X 12" Reducer (MJ)	1	EA	\$ 2,200.00	\$ 2,200.00
9	12" Cap (MJ)	1	EA	\$ 800.00	\$ 800.00
10	Stainless Steel Bell Restraints	42	EA	\$ 1,200.00	\$ 50,400.00
11	Air Valve Installation	4	EA	\$ 2,500.00	\$ 10,000.00
12	24" Gate Valves	3	EA	\$ 17,500.00	\$ 52,500.00
13	12" Gate Valves	1	EA	\$ 3,000.00	\$ 3,000.00
14	Tie-in to Existing 12" Waterline	1	LS	\$ 4,500.00	\$ 4,500.00
15	36" PVC PS-115 Pipe	350	LF	\$ 400.00	\$ 140,000.00
16	Installation of 36" Steel Casing Pipe by Bor	130	LF	\$ 1,000.00	\$ 130,000.00
17	Concrete Encasement (Levee Crossing)	45	LF	\$ 100.00	\$ 4,500.00
18	Asphalt Pavement Repair	4030	SY	\$ 75.00	\$ 302,250.00
19	Repair of Concrete Pavement with Flex Base	2200	SF	\$ 15.00	\$ 33,000.00
20	1" Asphalt Overlay (Porpoise Drive)	8300	SY	\$ 16.00	\$ 132,800.00
21	Removal & Replacement of Curb Gutter	700	LF	\$ 40.00	\$ 28,000.00
22	Regrade and Reshape Existing Ditch	390	LF	\$ 10.00	\$ 3,900.00
23	Seed and Fertilize	8500	SY	\$ 0.80	\$ 6,800.00
24	Remove and Replace Existing Wooden Fence	35	LF	\$ 25.00	\$ 875.00
25	Removal of Excess Fill Dirt	1200	CY	\$ 12.00	\$ 14,400.00
26	Trench Excavation Safety	11700	LF	\$ 2.00	\$ 23,400.00
27	Trench Dewatering	5850	LF	\$ 10.00	\$ 58,500.00
28	Traffic Control	1	LS	\$ 10,000.00	\$ 10,000.00
29	Removal of Existing Concrete Manholes	2	EA	\$ 500.00	\$ 1,000.00
30	Removal of Existing 8" and 10" Sanitary Sewers	100	LF	\$ 15.00	\$ 1,500.00
31	SWPPP Items	1	LS	\$ 10,000.00	\$ 10,000.00
					\$ 2,199,725.00
<b>B. PUMPSTATION IMPROVEMENTS</b>					
1	Yard Piping	1	LS	\$ 168,000.00	\$ 168,000.00
2	Beasley Ave. Pumping Station	1	LS	\$ 467,000.00	\$ 467,000.00
					\$ 635,000.00
			<b>BASE BID</b>		\$ 2,834,725.00
<b>C. ADDITIVE ALTERNATE NO. 1</b>					
1	Installation of 24" Water Transmission Main by Horizontal Directional Drilling	1	LS	\$ 10,000.00	\$ 10,000.00
<b>Total Construction</b>					<b>\$ 2,844,725.00</b>

Engineering (12%)  
 TOTAL

\$333,400  
 \$ 3,178,125.00

## OPINION OF PROBABLE CONSTRUCTION COST

San Patricio Supply  
NCWCID #4 PORT ARANSAS, TEXAS

### 24-inch Transmission Main Southside SH 361

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Tie-In	2	EA	\$5,000	\$10,000
2	Install 24" Dia. C-905 DR-18 PVC by Conventional Trenching	18,450	LF	\$95	\$1,752,750
3	Utility Crossing (Vertical)	5	EA	\$14,400	\$72,000
4	Fittings (Horizontal)	4	EA	\$3,600	\$14,400
5	20" Gate Valve	6	EA	\$19,250	\$115,500
6	2' ARV and Conc. MH	6	EA	\$3,000	\$18,000
7	Dewatering	9,225	LF	\$11	\$98,710
8	Install 24" Dia. C-905 DR-18 PVC by Horizontal Direction Drilling	12,300	LF	\$680	\$8,364,000
9	Install 24" Dia. C-905 DR-18 PVC w/ 32" STL Casing by Boring	50	LF	\$1,100	\$55,000
10	Pavement Repair	150	SY	\$100	\$15,000
11	Clearing and Grubbing	0	AC	\$10,000	\$0
12	Curb and Gutter Restoration	0	LF	\$30	\$0
13	Seeding and Sodding	12433	SY	\$2	\$18,650
14	Traffic Control	1	LS	\$10,000	\$10,000
15	Trench Safety	18,450	LF	\$2	\$36,900
16	SWPPP	1	LS	\$10,000	\$10,000
17	Caliche Repair	668	SY	\$17	\$11,020
	<b>Subtotal</b>				<b>\$10,601,930</b>
	Bonds, (3%)				\$318,060
	Move-in Move-out (3%)				\$318,060
	<b>Subtotal</b>				<b>\$11,238,050</b>
	Contingencies (20%)				\$2,247,610
	<b>TOTAL</b>				<b>\$13,485,660</b>

## OPINION OF PROBABLE CONSTRUCTION COST

San Patricio Supply  
NCWCID #4 PORT ARANSAS, TEXAS

Cost Per Phase for 24-inch Transmission Main Southside SH 361

ITEM	DESCRIPTION	Phase 2	Phase 3	Phase 4	Total
1	Tie-In	\$5,000	\$5,000	\$0	\$10,000
2	Install 24" Dia. C-905 DR-18 PVC by Conventional Trenching	\$1,752,750	\$0	\$0	\$1,752,750
3	Utility Crossing (Vertical)	\$72,000	\$0	\$0	\$72,000
4	Fittings (Horizontal)	\$0	\$7,200	\$7,200	\$14,400
5	20" Gate Valve	\$0	\$77,000	\$38,500	\$115,500
6	2' ARV and Conc. MH	\$0	\$12,000	\$6,000	\$18,000
7	Dewatering	\$98,710	\$0		\$98,710
8	Install 24" Dia. C-905 DR-18 PVC by Horizontal Direction Drilling	\$0	\$4,964,000	\$3,400,000	\$8,364,000
9	Install 24" Dia. C-905 DR-18 PVC w/ 32" STL Casing by Boring	\$55,000	\$0	\$0	\$55,000
10	Pavement Repair	\$15,000	\$0	\$0	\$15,000
11	Clearing and Grubbing	\$0	\$0	\$0	\$0
12	Curb and Gutter Restoration	\$0	\$0	\$0	\$0
13	Seeding and Sodding	\$18,650	\$0	\$0	\$18,650
14	Traffic Control	\$10,000	\$0	\$0	\$10,000
15	Trench Safety	\$36,900	\$0	\$0	\$36,900
16	SWPPP	\$3,333	\$3,333	\$3,333	\$10,000
17	Caliche Repair	\$11,020	\$0	\$0	\$11,020
	<b>Subtotal</b>	<b>\$2,078,363</b>	<b>\$5,068,533</b>	<b>\$3,455,033</b>	<b>\$10,601,930</b>
	Bonds, (3%)	\$62,350	\$152,060	\$103,650	\$318,060
	Move-in Move-out (3%)	\$62,350	\$152,060	\$103,650	\$318,060
	<b>Subtotal</b>	<b>\$2,203,063</b>	<b>\$5,372,653</b>	<b>\$3,662,333</b>	<b>\$11,238,050</b>
	Contingencies (20%)	\$440,610	\$1,074,530	\$732,470	\$2,247,610
	<b>TOTAL</b>	<b>\$2,643,673</b>	<b>\$6,447,183</b>	<b>\$4,394,803</b>	<b>\$13,485,660</b>

**APPENDIX C**

**NCWC&ID#4 WASTEWATER MASTERPLAN**

**ESTIMATE OF PROBABLE COSTS**

# OPINION OF PROBABLE CONSTRUCTION COST

## Wastewater Treatment Plant 0.63 MGD Expansion

NCWCID #4 PORT ARANSAS, TEXAS

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	0.63 MGD Plant Expansion	1	LS	\$2,520,000	\$2,520,000
	<b>Subtotal</b>				<b>\$2,520,000</b>
	Bonds, (2.0%)				\$50,000
	Move-in Move-out (2.4%)				\$60,000
	<b>Subtotal</b>				<b>\$2,630,000</b>
	Contingencies (20%)				\$526,000
	<b>Total Construction</b>				<b>\$3,156,000</b>

Engineering (12%)

\$379,000

TOTAL

\$3,535,000

## OPINION OF PROBABLE CONSTRUCTION COST

### Belt Press and Generator

NCWCID #4 PORT ARANSAS, TEXAS

ITEM	DESCRIPTION	Quantity	Unit	Unit Cost	Total
1	Sludge Dewatering Building	1	LS	\$750,000	\$750,000
2	Generator Building	1	LS	\$400,000	\$400,000
3	Blower Building, Blowers, Piping	1	LS	\$200,000	\$200,000
	<b>Subtotal</b>				<b>\$1,350,000</b>
	Bonds, (2.0%)				\$26,790
	Move-in Move-out (2.4%)				\$32,140
	<b>Subtotal</b>				<b>\$1,408,930</b>
	Contingencies (20%)				\$281,790
	<b>Total Construction</b>				<b>\$1,690,720</b>

Engineering (12%)	\$203,000
Soil Testing	\$10,000
<b>TOTAL</b>	<b>\$1,893,720</b>

**APPENDIX D**

**GROUND STORAGE OPTIONS AND IMPROVEMENTS BEYOND 2030**

# Technical Memorandum

---



## NCWCID #4 – Water Distribution

Date: October 10, 2016  
Subject: Ground Storage Options  
To: Mark Young  
From: J. Douglas McMullan, P. E.

The following memorandum discusses the system requirements and proposed options for ground storage in Port Aransas.

### Design Criteria

#### TCEQ

Elevated Storage	100 gal/connection
Ground Storage	100 gal/connection
Service Pumps	Peak Hour (with largest pump out of service)

#### Water District

Elevated Storage	100 gal/connection
Ground Storage	215 gal/connection (Based on 50% of the Max Daily Demand)
Service Pumps	0.38 gpm / connection (Peak Hourly /Peak Connections)
Maximum Daily	1.5 x Average Daily
Peak Hour	1.25 x Maximum Daily
Population Peak Factor:	1.5

2015 connections = TWDB Population Projection (18,614) x 1.5 = 27,920 / 2.7 = 10,341  
2030 connections = TWDB Projection (28,534) x 1.5 = 42,801 / 2.7 = 15,852

Note: The District's storage requirement is higher than the TCEQ requirement because the two suppliers (Corpus Christi and San Patricio MWD) can only provide a total capacity of 2,940 gpm (4.23 MGD), which is less than the 2015 Max Day.

### Pump Capacity

2015 Peak Hour = 10,341 conn x 0.38 gpm/conn = 3,923 gpm (5.65 MGD)

# Technical Memorandum

---

2015 Max Daily = 3,923 gpm/1.25 = 3138 gpm (4.52 MGD)

2030 Peak Hour = 15,852 conn x 0.38 gpm/conn = 6,020 gpm (8.67 MGD)

2030 Max Daily = 6,020 gpm /1.25 = 4,816 (6.93 MGD)

## Assessment of Existing Ground Storage System

The following are the existing ground storage capacities and requirements per the masterplan:

### Total Available

Mustang: 1 tank @ 1,500,000 gallons, 1.5 million gallons (MG)

Ferry: 1 tank @ 200,000 gallons (0.2 MG) + 1 tank @ 1,000,000 gallons (1.0 MG) = 1,200,000 gallons (1.2 MG)

Beasley: Ground storage was not considered.

Total available storage is 2,700,000 gallons (2.7 MG).

The following are the required capacities from 2015 to 2030:

### Total Required Capacity (TCEQ)

2015 = 10341 x 100 = 1,034,000 gal (1.03 MG) < 2.7 MG

2030 = 15,852 x 100 = 1,585,200 gal (1.59 MG) < 2.7 MG

The total available meets the total required based on the TCEQ requirements.

### Total Required Capacity (Water District)

2015 = 10341 x 215 = 2,223,315 gal (2.22 MG) < 2.7 MG

The total available meets total required to satisfy the maximum daily requirement in 2015.

2030 = 15,852 x 215 = 3,408,180 gal (3.41 MG) > 2.7 MG

The total available does not meet the total required to satisfy the maximum daily requirement in 2030.

As noted above the District has a total ground storage capacity of 2.7 million gallons (MG). Based on the TCEQ requirements the existing ground storage capacity will last until after 2060. Based on the District requirement the total existing capacity will last until 2020.

The existing ground storage capacity provided by the tanks at the Ferry Landing pump station is required to meet the maximum daily requirements, as described above. One if not both of the steel ground storage tanks at the Ferry landing are in need of major repair or replacement. Since 2020 is not that far off we believe that a new 1.5 MG tank should be constructed somewhere within the system to replace the 1.0 MG tank at Ferry Landing. This will provide a total capacity of 3 MG which would last until around 2025.

# Technical Memorandum

---

We believe that there are three (3) options available to provide the ground to meet the system requirements, Option 1 construct new 1.5 MG tanks at Mustang Island, Option 2 construct new 1.5 MG tank pumping station and supply line at the Port Aransas elevated storage tank site and Option 3 Construct a new 1.5 MG tank at Ferry Landing and demolish the 1.0 MG tank at the same location.

## Ground Storage Options

General:

Ground storage is more functional if it is filled by a supply transmission line rather than floating on the distribution system, filling only in off peak periods. Mustang Island pump station currently operates this way. Ferry landing was originally designed to be supplied by the Beasley transmission line and only lately has been converted to operate off the distribution system. It is my recommendation that once the Harbor Island 24-inch supply line is fully constructed that the Ferry Landing operation be changed back to the original configuration. This will require a portion of the old 12-inch Harbor Island supply line be converted permanently to a distribution line and a small pump station constructed (approx. \$350,000 to \$700,000) to provide distribution pressure to Harbor Island. The construction of all of these improvements are beyond the planning period and are provided only as a guide for phasing improvements towards the ultimate system configuration. For this option the new harbor island line must be fully constructed at a cost of approximately \$13.5M. The following options discuss the rationale used to decide if we want to make Ferry Landing our long term second pump station supplied by a transmission line from Beasley or if we want to build a new replacement pump station, ground storage and a transmission line extension from the ship channel transmission line at the Port Aransas elevated tank site.

### Option 1 – Mustang Island Pump Station Site

We assessed the Mustang Island site last year with respect to ground storage capacity and found that two (2) 1.5 MG tanks (90' in dia.) or three (3) 1 MG tanks (75.5' in dia.) will fit on the existing site. This assessment includes demolishing the existing 1.5 MG tank. So the ultimate capacity using the 1.0 MG and 1.5 MG tanks is 3.0 MG. Per DN Tanks it is more cost effective to construct the two (2) 1.5 MG tanks. Based on this assessment Option 1 would be to construct a new 1.5 MG tank and leave the existing 1.5 MG tank in place for the near future. Once the new 1.5MG tank is constructed the small 80,000 Gallon can be demolished.

Selecting Option 1 means no improvements will be made at the Ferry Landing site for the near future. Since the 1.5 MG tank is in poor condition it would likely need to be taken out of service which would essentially mean taking the entire pump station out of service. This would leave the District without the redundant 1200 gpm firm capacity of the pump station. If the Beasley Street pump station goes down the District would need to rely solely on the Mustang Island pump station.

The total cost to construct the 1.5 MG ground storage tank at the Mustang Island pump station site is **\$1.44 M**. The new pump station is assumed to be constructed and the cost is not included in this estimate.

# Technical Memorandum

---

## Option 2 – Existing Elevated Storage Site

This site has more than enough space to construct the ground storage tankage needed to meet the future conditions. It is also more beneficial than locating all of the storage capacity at Mustang Island, as it is closer to the demand center of the service area.

The down side of this option would be the requirement to construct a new pump station and a 9,700-ft transmission line from the Ferry Landing pump station to supply the new pump station. The cost of the new pump station and transmission main makes this the most costly option. Due to the higher cost of construction, siting a new ground storage tank at the Port Aransas elevated storage tank site was not considered to be an economical option.

The total cost to construct a new pump station (\$ 0.78M), 1.5 MG ground storage tank (\$1.44 M) and 24-inch transmission main (\$1.4 M) is **\$3.62 M**.

## Option 3 - Ferry Landing Site

There are two options at the Ferry Landing site, repair and provide protective coating to extend life of existing tank (s), or build a new replacement tank. For the long term the cost of a new tank was assumed to be the best option.

Using Google Earth it appears that we could site two (2) 90' dia 1.5 MG tanks or two (2) 75' dia 1.0 MG tanks in the open area to the west of the existing tanks. It appears that the ultimate capacity at this site is also 3.0 MG. Only the replacement of the existing 1.5MG steel tank is required within the planning period, but the ultimate capacity would allow for up to 3MG of ground storage at this site.

The total cost of construction of this option is **\$1.5 M**. This cost includes a new 1.5 MG ground storage tank (\$1.44 M) and demolition of the existing tank (\$0.06 M). If this site is selected for the location of the long term second pump station supplied by a transmission line from Beasley it will likely require construction of a new pump station (\$0.78M). The total cost of a 1.5 MG ground storage tank and pump station is \$2.28 M. This is less than the cost to relocate the ground storage and pump station to the elevated storage tank site (see Option 2).

**Assuming that the long range transmission main improvements from Beasley are completed it appears that the best option is to build a new 1.5 MG storage tank at Ferry Landing and replace the aging 1.2 MG storage tank.** Prior to completion of the 24-inch Harbor Island transmission main the Beasley Street pump station will continue to pump into the distribution system and the Ferry Landing pump station will be used as a back-up supplying water to the system as needed.

Using the Ferry Landing site as the second pump station site fits into our concept for the ultimate water distribution system on the Island. Based on our review of development on the Island it appears that the ultimate build out is 100,000 to 120,000 persons. Most of the new development will be along the SH 361 corridor south of Port Aransas. We believe that two (2) pump station/ground storage facilities located at each end of the island and serviced by two separate transmission systems (Beasley/San Patricio and City of Corpus Christi) will best serve the water needs on the island far beyond 2060.

# Technical Memorandum

---

## Ultimate System (Beyond 2060)

The above ground storage analysis indicates that the ultimate ground storage capacity on the Island using the Mustang Island and Ferry Landing sites is 6.0 MG, with 3.0 MG at each site. A ground storage capacity of 6.0 MG is equivalent to between 27,906 and 60,000 connections (75,350 to 162,000 persons). The variation in the number of connections is due the variation between the TCEQ's ground storage requirement (100 gal/conn.) and the District's ground storage requirement (215 gal/conn.). If in the future the two suppliers (City of Corpus Christi and SPMWD) are able to provide a more consistent quantity of water then the requirement for 215 gal/conn. can be discontinued.

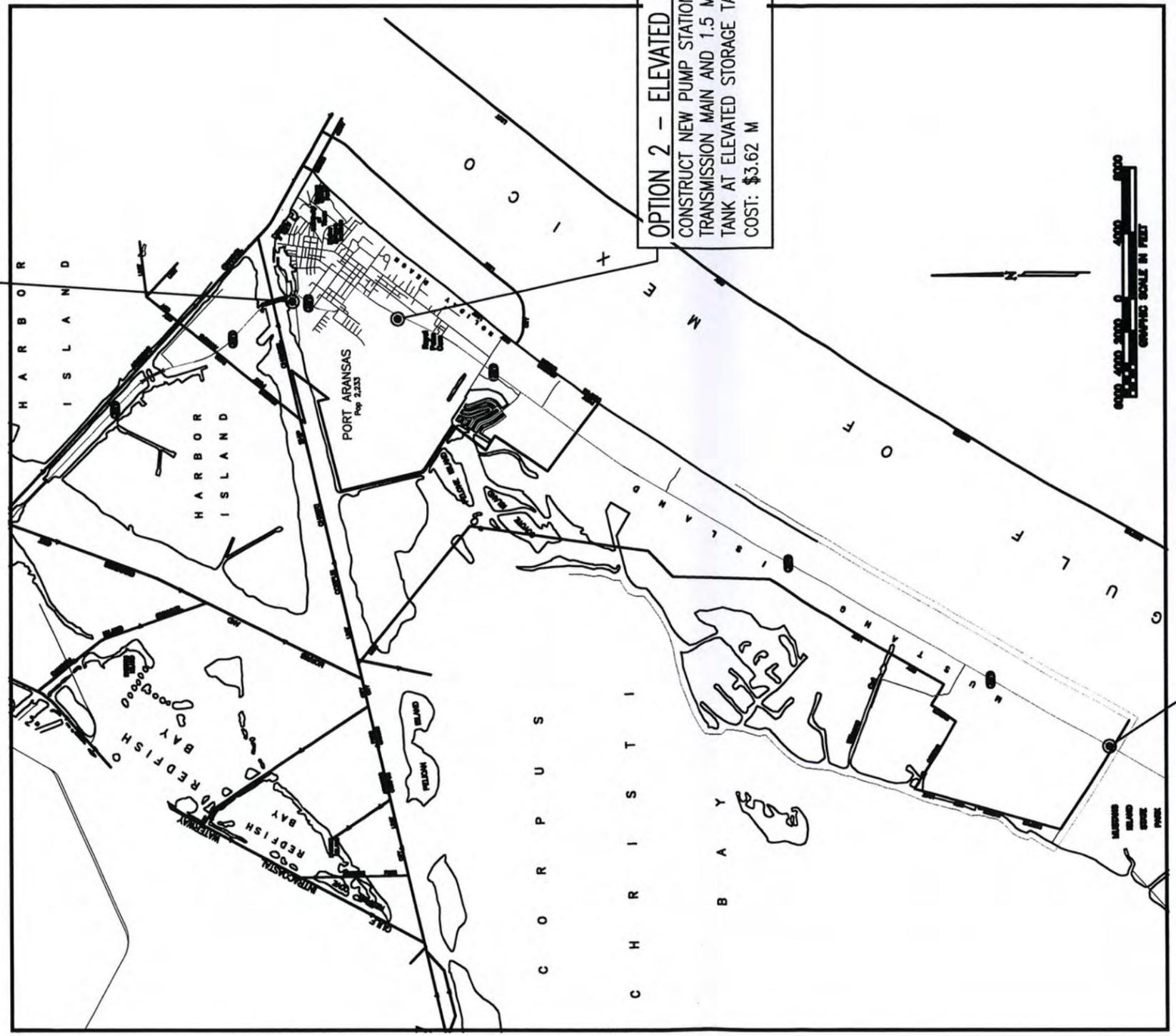
We used the required 2030 ground storage capacity and the 2030 peak hour flow to estimate the ultimate peak hour pumping capacity. Using a ground storage capacity 3.41 MG and a peak hour flow of 6,020 gpm the ultimate peak hour pumping capacity is 10,600 gpm.

This pumping capacity will be provided by two ultimate pump stations, one at the Ferry Landing site and one at the Mustang Island site, each with a firm capacity of 5,300 gpm.

The ultimate water distribution system will consist of the following:

Connections:	27,906 to 60,000 (Average = 43,900)
Population:	75,350 to 162,000 persons (Average = 118,700)
Ground Storage Capacity:	6.0 MG, 3.0 MG at Mustang Island and 3.0 MG at Ferry Landing
Pump Station Capacity:	10,600-gpm, 5,300 gpm at Mustang and 5,300 gpm at Ferry
Transmission Main Capacity:	5,000 to 7,000 gpm at Beasley
Elevated Storage:	3.0 MG to 6.0 MG

**OPTION 3 – FERRY LANDING**  
 DEMOLISH EXISTING 1.0 MG GROUND STORAGE TANK AND CONSTRUCT NEW 1.5 MG GROUND STORAGE TANK  
 COST: \$1.50 M



**OPTION 2 – ELEVATED STORAGE**  
 CONSTRUCT NEW PUMP STATION TRANSMISSION MAIN AND 1.5 MG TANK AT ELEVATED STORAGE TANK SITE  
 COST: \$3.62 M

**OPTION 1 – MUSTANG ISLAND PUMP STATION**  
 CONSTRUCT NEW 1.5 MG GROUND STORAGE TANK AT THE MUSTANG ISLAND PUMP STATION  
 COST: \$1.44 M

**GROUND STORAGE OPTIONS**



DATE: 10/14/16  
 DRAWN: CG  
 ENG: JDM  
 © 2016 by Urban Engineering

S:\Projects\00000UP\09872\8500 CP Fees\10-14-16 EXHIBIT.dwg modified by cyg on Oct 14, 2016 - 11:12am

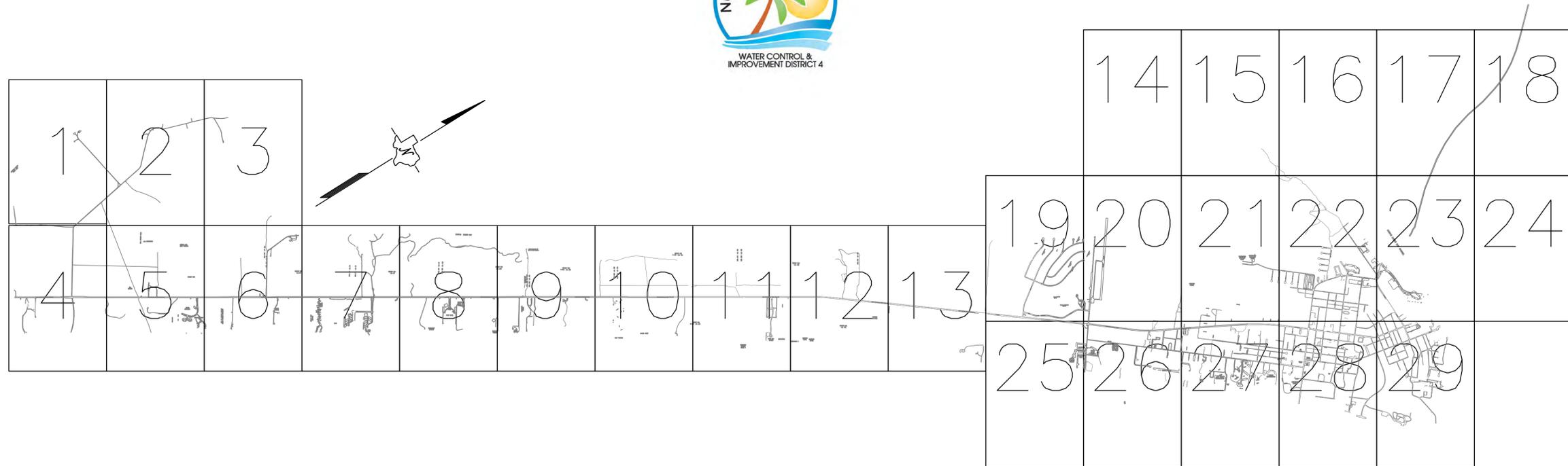
**APPENDIX E**  
**MASTERPLAN BASEMAPS**

# WATER & WASTEWATER MASTER PLAN

## FOR THE

### NUECES COUNTY WCID #4

JOB NO. 09872.B5.00  
 DECEMBER 2016  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS



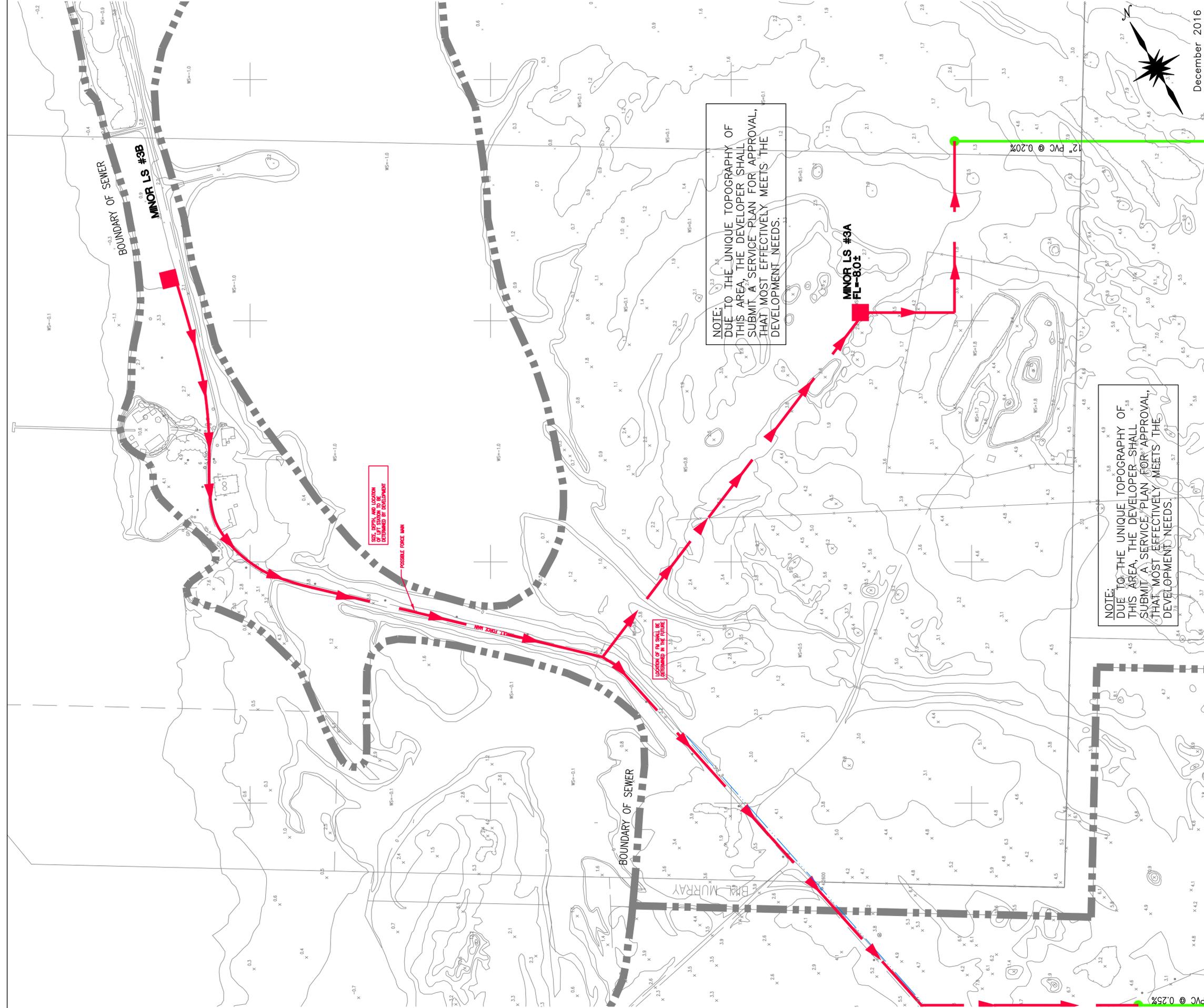
KEY MAP  
 NOT TO SCALE

ENGINEER: J. DOUGLAS MCMULLAN, P.E.



TBPE FIRM NO. 145, TBPLS FIRM NO. 10032400  
 2725 SWANTNER DR., CORPUS CHRISTI, TX 78404  
 PHONE: 361.854.3101 WWW.URBANENG.COM





NOTE: DUE TO THE UNIQUE TOPOGRAPHY OF THIS AREA, THE DEVELOPER SHALL SUBMIT A SERVICE PLAN FOR APPROVAL, THAT MOST EFFECTIVELY MEETS THE DEVELOPMENT NEEDS.

NOTE: DUE TO THE UNIQUE TOPOGRAPHY OF THIS AREA, THE DEVELOPER SHALL SUBMIT A SERVICE PLAN FOR APPROVAL, THAT MOST EFFECTIVELY MEETS THE DEVELOPMENT NEEDS.

SEE, DETAIL AND LOCATION OF SEWER LINES TO BE DETERMINED BY DEVELOPMENT

POSSIBLE FORCE MAIN

LOCATION OF SEWER LINES TO BE DETERMINED BY DEVELOPMENT

LEGEND

WATER	SEWER
AC PIPE	CLAY PIPE
PVC PIPE	FORCE MAIN
CAST IRON PIPE	CONCRETE PIPE
GLAZED PIPE	UNLINED
NEW PVC PIPE	PVC PIPE
	MANHOLE
	CEPT
	CEPT STATION

OTY UNITS
-----------



TBPE FIRM NO. 145, TBPLS FIRM NO. 1002400  
 3700 W. 50th St., Suite 310, Corpus Christi, TX 78411  
 PHONE: 361.843.3100 FAX: 361.843.3101 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering

KEY MAP

0 200 400  
 GRAPHIC SCALE  
 1" = 200'

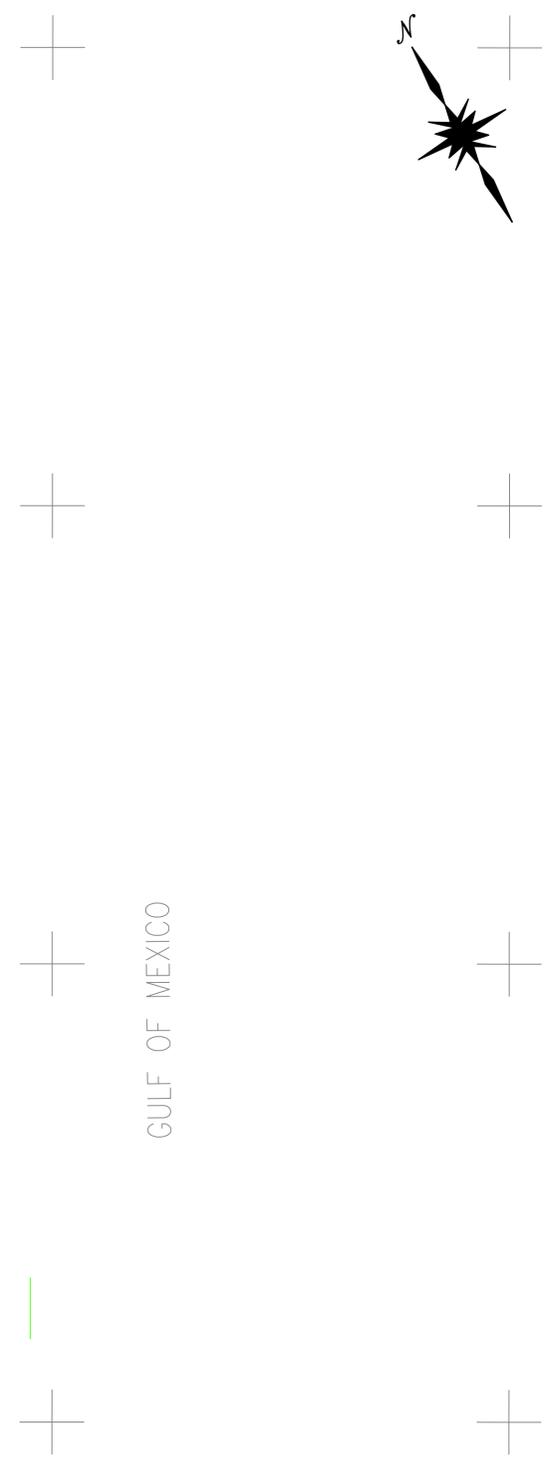
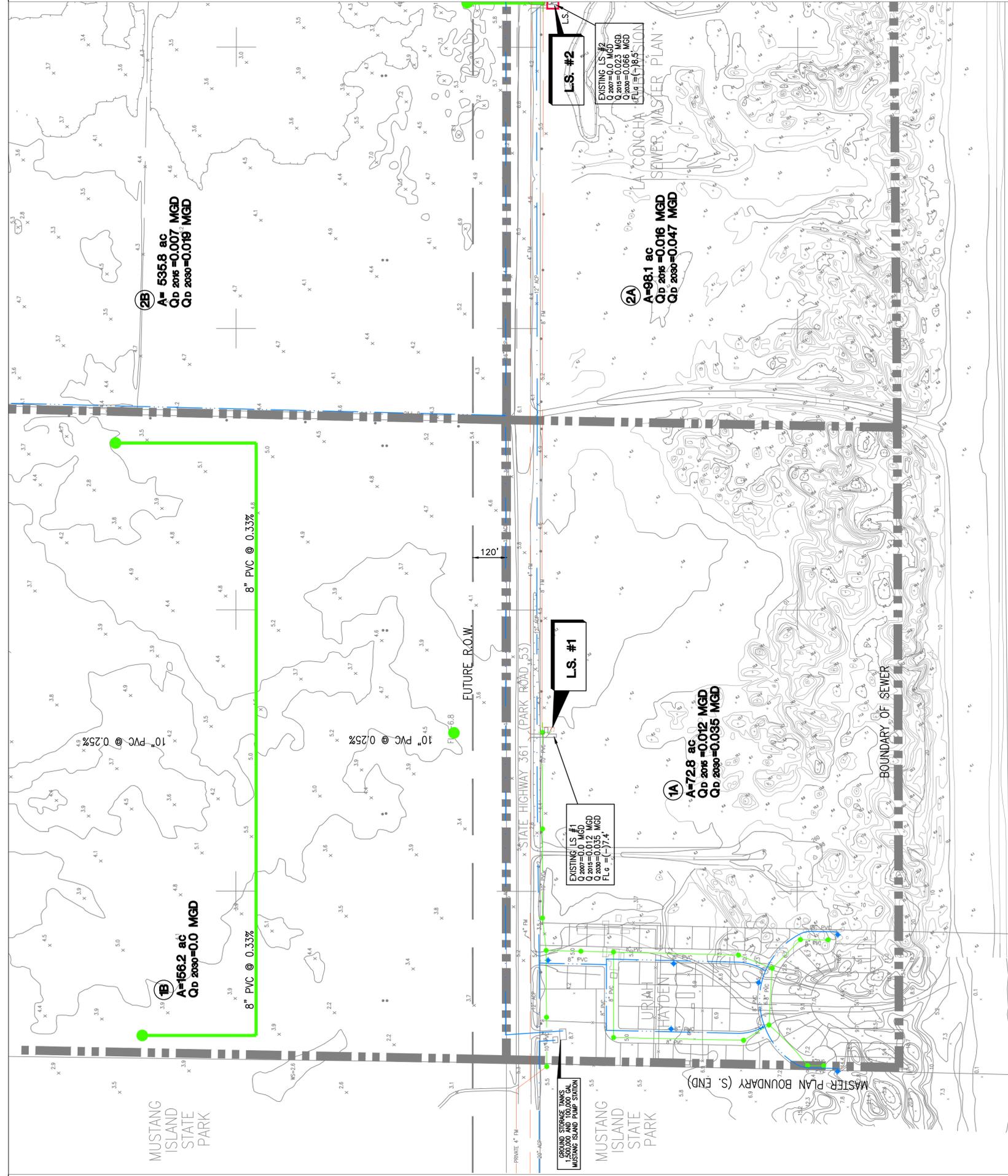
14	15	16	17	18
1	2	3		
4	5	6	7	8
9	10	11	12	13
14	15	16	17	18

December 2016  
 SHEET 2 OF 29

NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS





December 2016

KEY MAP

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30

GRAPHIC SCALE  
1" = 200'

SHEET 4 OF 29

JOB NO. 9872.B5.00

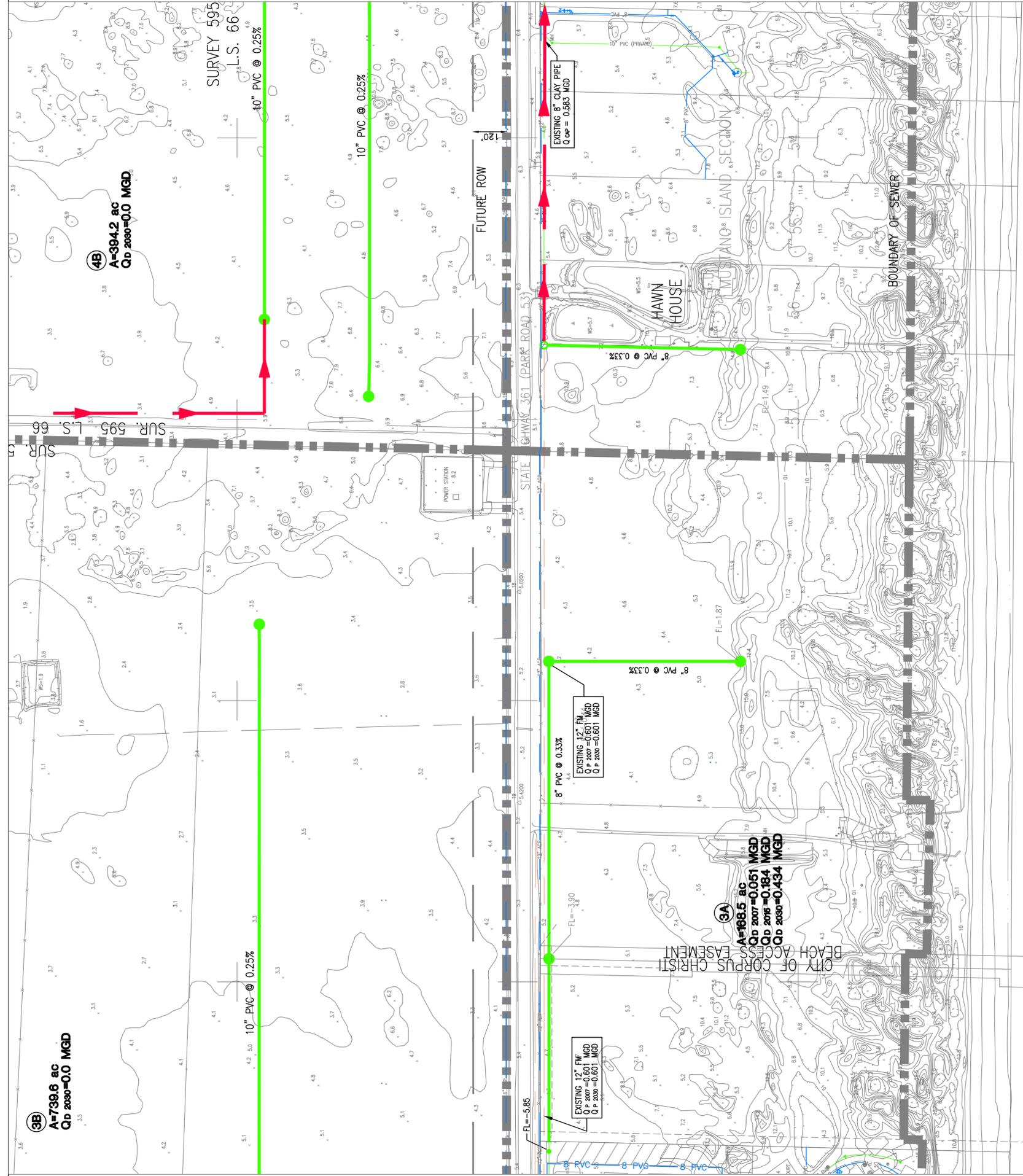
NUECES COUNTY WCID #4  
 WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS

LEGEND

WATER	SEWER
AC PIPE	CLAY PIPE
PVC PIPE	FORCE MAIN
CGI IRON PIPE	LINE
GUANIZED PIPE	LINE
NEW PVC PIPE	PVC PIPE
CITY LIMITS	MANHOLE
	LEVER STATION
	UFT STATION

URBAN ENGINEERING  
 TBE FIRM NO. 145, TBE LS FIRM NO. 10022400  
 2700 W. STATE HIGHWAY 361, PORT ARANSAS, TEXAS 78373  
 PHONE: 361.843.3100 FAX: 361.843.3101 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering





1:dwg modified by cyg on Dec 16, 2016 - 5:05pm



GULF OF MEXICO



TBPE FIRM NO. 145, TBPLS FIRM NO. 1002400  
 3100 W. UNIVERSITY BLVD., SUITE 310, FORT WORTH, TX 76107  
 PHONE: 817.342.3100 FAX: 817.342.3101 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering

**LEGEND:**

	WATER		SEWER
	AC PIPE		CLAY PIPE
	PVC PIPE		FORCE MAIN
	DUCT IRON PIPE		LINER
	GALVANIZED PIPE		PVC PIPE
	NEW PVC PIPE		MANHOLE
	CITY LIMITS		LIFT STATION

NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS

KEY MAP

1	2	3
4	5	6

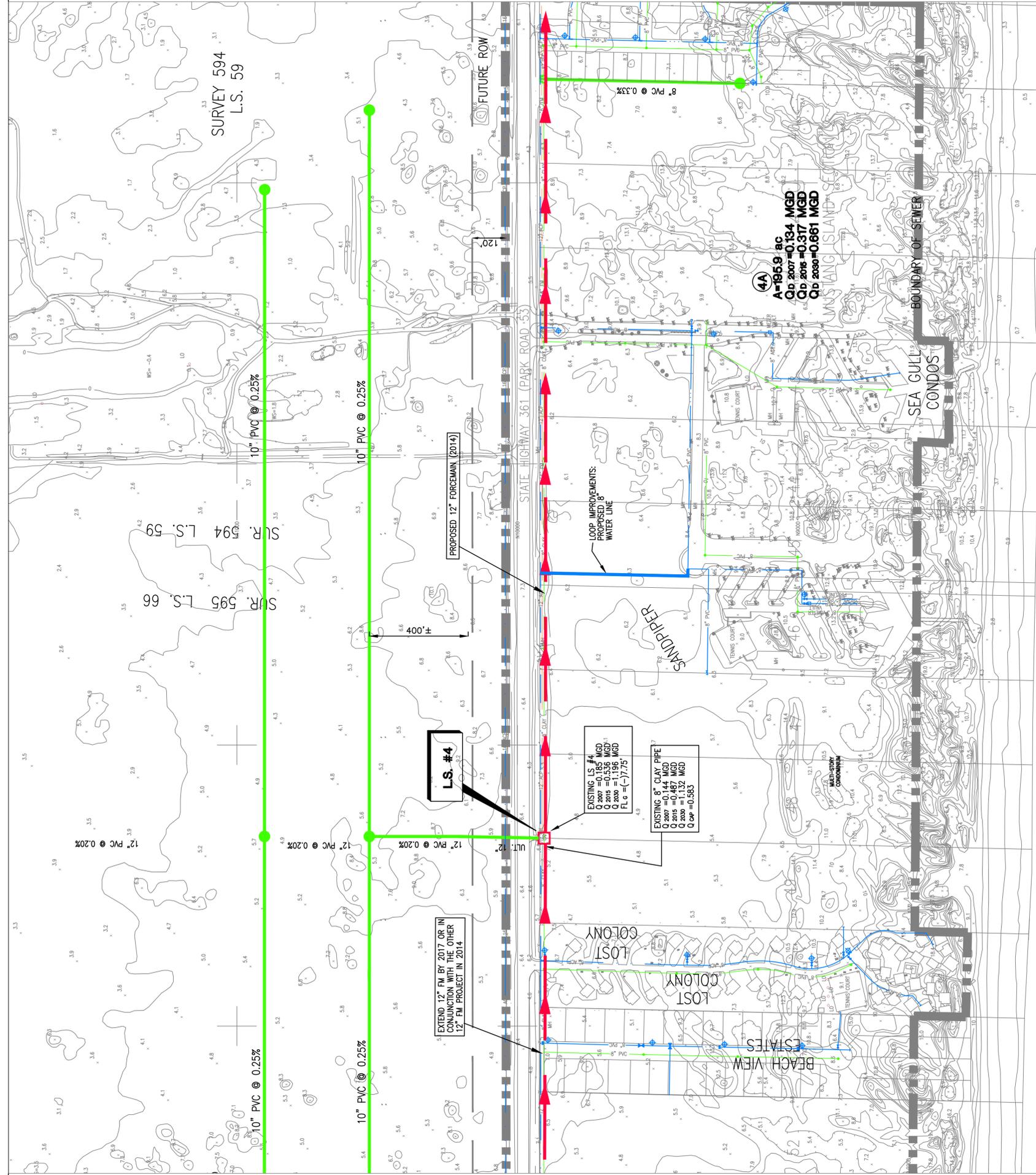
GRAPHIC SCALE  
 0 200 400  
 1" = 200'

14	15	16	17	18
19	20	21	22	23
24	25	26	27	28
29	30	31	32	33

December 2016

JOB NO. 9872.B5.00

SHEET 6 OF 29



1.dwg modified by cyg on Dec 16, 2016 - 5:05pm



GULF OF MEXICO



LEGEND:

WATER		SEWER	
—	42\"/>		

NUECES COUNTY WCID #4  
 WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS

KEY MAP

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

GRAPHIC SCALE  
 0 200 400  
 1\"/>

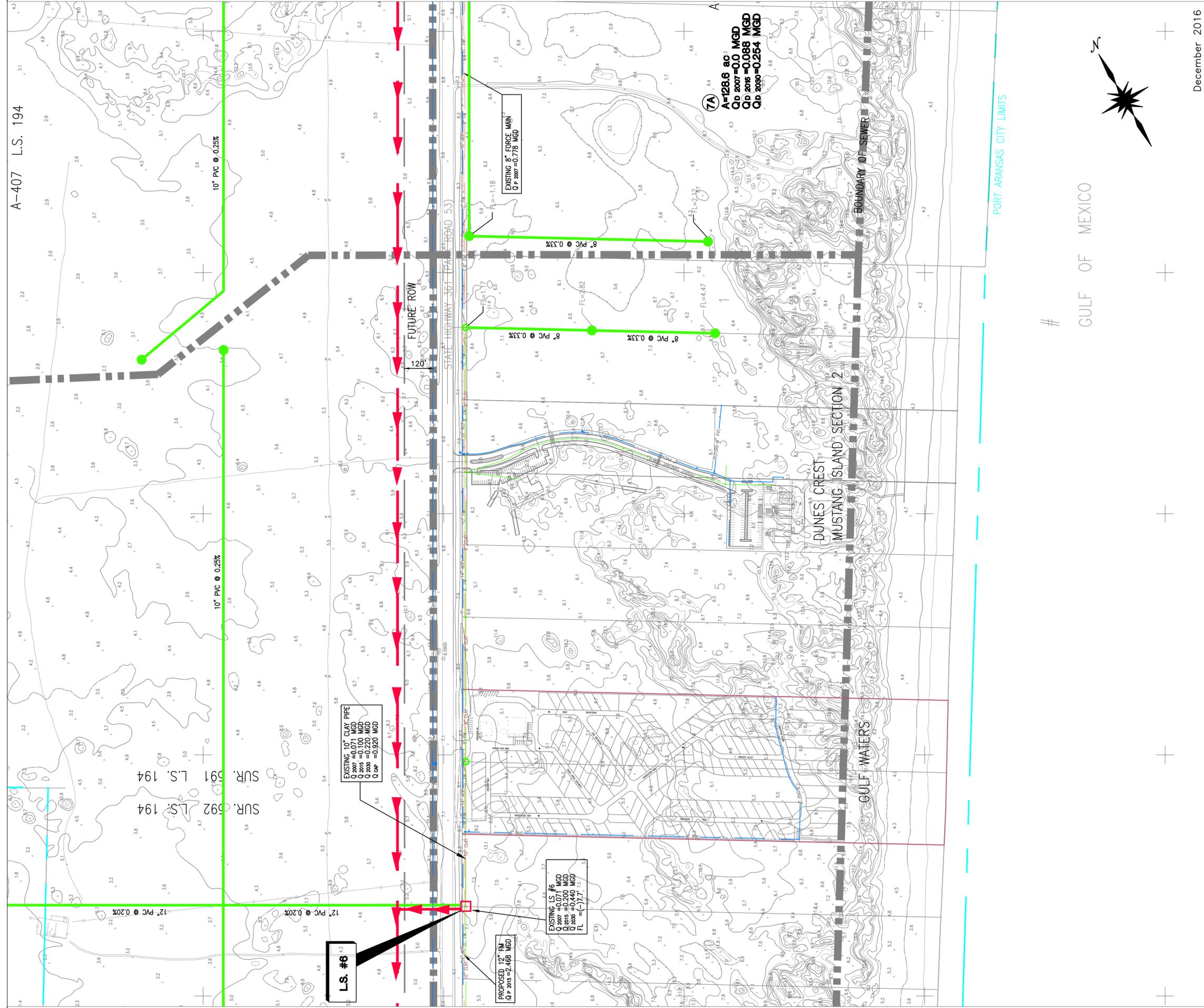
December 2016

14	15	16	17	18
19	20	21	22	23
24	25	26	27	28
29	30	31		

SHEET 7 OF 29







:.dwg modified by cyg on Dec 16, 2016 - 5:06pm



**LEGEND:**

WATER		SEWER	
AC PIPE	CLAY PIPE	CLAY PIPE	CLAY PIPE
PVC PIPE	FORCE MAIN	FORCE MAIN	FORCE MAIN
CAST IRON PIPE	LINE	LINE	LINE
GLAZED PIPE	PVC PIPE	PVC PIPE	PVC PIPE
NEW PVC PIPE	MANHOLE	MANHOLE	MANHOLE
	LIFT STATION	LIFT STATION	LIFT STATION
	CITY LIMITS		

**NUECES COUNTY WCID #4**  
**WATER AND SEWER MASTER PLAN**  
**MUSTANG ISLAND**  
**PORT ARANSAS, TEXAS**

**KEY MAP**

1	2	3	14	15	16	17	18									
4	5	6	7	8	9	10	11	12	13	19	20	21	22	23	24	
												25	26	27	28	29

GRAPHIC SCALE  
 0 200 400  
 1" = 200'

December 2016

SHEET **10** OF **29**

JOB NO. 9872.B5.00



# GULF OF MEXICO

PORT ARANSAS CITY LIMITS

DUNES CREST  
 MUSTANG ISLAND SECTION 2

**7A**  
 A=128.6 ac  
 Qd 2007=0.0 MGD  
 Qd 2015=0.088 MGD  
 Qd 2050=0.254 MGD

**PROPOSED 12" FM**  
 Q P 2015 = 2.468 MGD

**EXISTING LS #6**  
 Q 2007 = 0.071 MGD  
 Q 2015 = 0.200 MGD  
 Q 2050 = 0.940 MGD  
 FL = (-17.7) / 5

**EXISTING 10" CLAY PIPE**  
 Q 2007 = 0.071 MGD  
 Q 2015 = 0.220 MGD  
 Q 2050 = 0.920 MGD  
 Q CP = -0.920 MGD

**LS. #6**

12" PVC @ 0.20%

SUR. 592 L.S. 194

SUR. 591 L.S. 194

10" PVC @ 0.25%

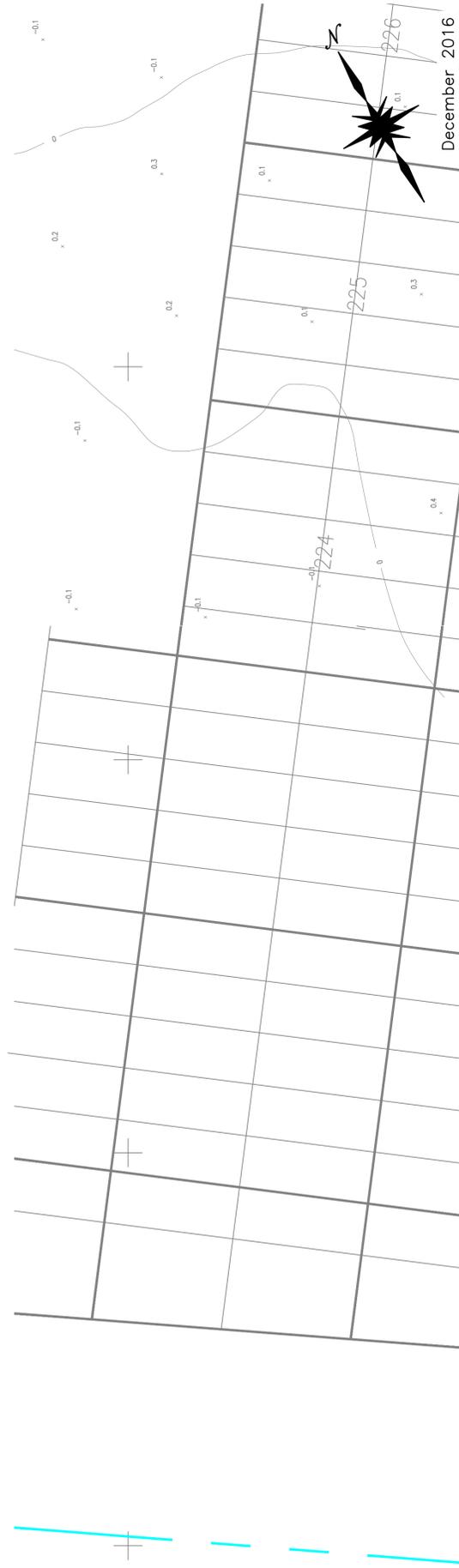
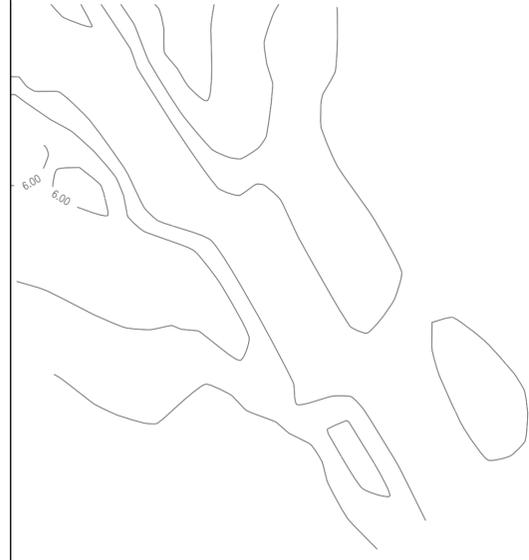
10" PVC @ 0.25%

A-407 L.S. 194









LEGEND	
	WATER
	A/C PIPE
	PVC PIPE
	CAST IRON PIPE
	GLAZED PIPE
	NEW PVC PIPE
	CITY LIMITS
SEWER	
	CLAY PIPE
	FORCE MAIN
	CAST IRON LINER
	PVC PIPE
	MANHOLE
	LIFT STATION

**NUECES COUNTY WCID #4**

WATER AND SEWER MASTER PLAN  
MUSTANG ISLAND  
PORT ARKANSAS, TEXAS

KEY MAP

GRAPHIC SCALE  
1"=200'

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29							

JOB NO. 9872.05.00

December 2016

SHEET 14 OF 29



URBAN ENGINEERING  
 TYPE FIRM NO. 45, TEXAS FIRM NO. 10032400  
 2700 W. UNIVERSITY BLVD., SUITE 200  
 FORT WORTH, TEXAS 76102  
 PHONE: 817.854.3311 FAX: 817.854.3310  
 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering

WATER		SEWER	
—	4" PVC PIPE	—	CLAY PIPE
—	6" PVC PIPE	—	FORCE MAIN
—	8" PVC PIPE	—	CAST IRON PIPE
—	12" GALVANIZED PIPE	—	NEW PVC PIPE
—	18" NEW PVC PIPE	—	MANHOLE
—	CITY LIMITS	—	LEFT STATION

**NUECES COUNTY WCID #4**  
**WATER AND SEWER MASTER PLAN**  
**MUSTANG ISLAND**  
**PORT ARANSAS, TEXAS**

KEY MAP

GRAPHIC SCALE  
 0 200 400  
 1" = 200'

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

December 2016

1415161718  
 192021222324  
 2526272829

SHEET  
**15**  
 OF 29



December 2016

KEY MAP

GRAPHIC SCALE  
1"=200'

1	2	3	4	5	6	7	8	9	10	11	12	13			
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

SHEET 16 OF 29

JOB NO. 9872.05.00

NUECES COUNTY WCID #4

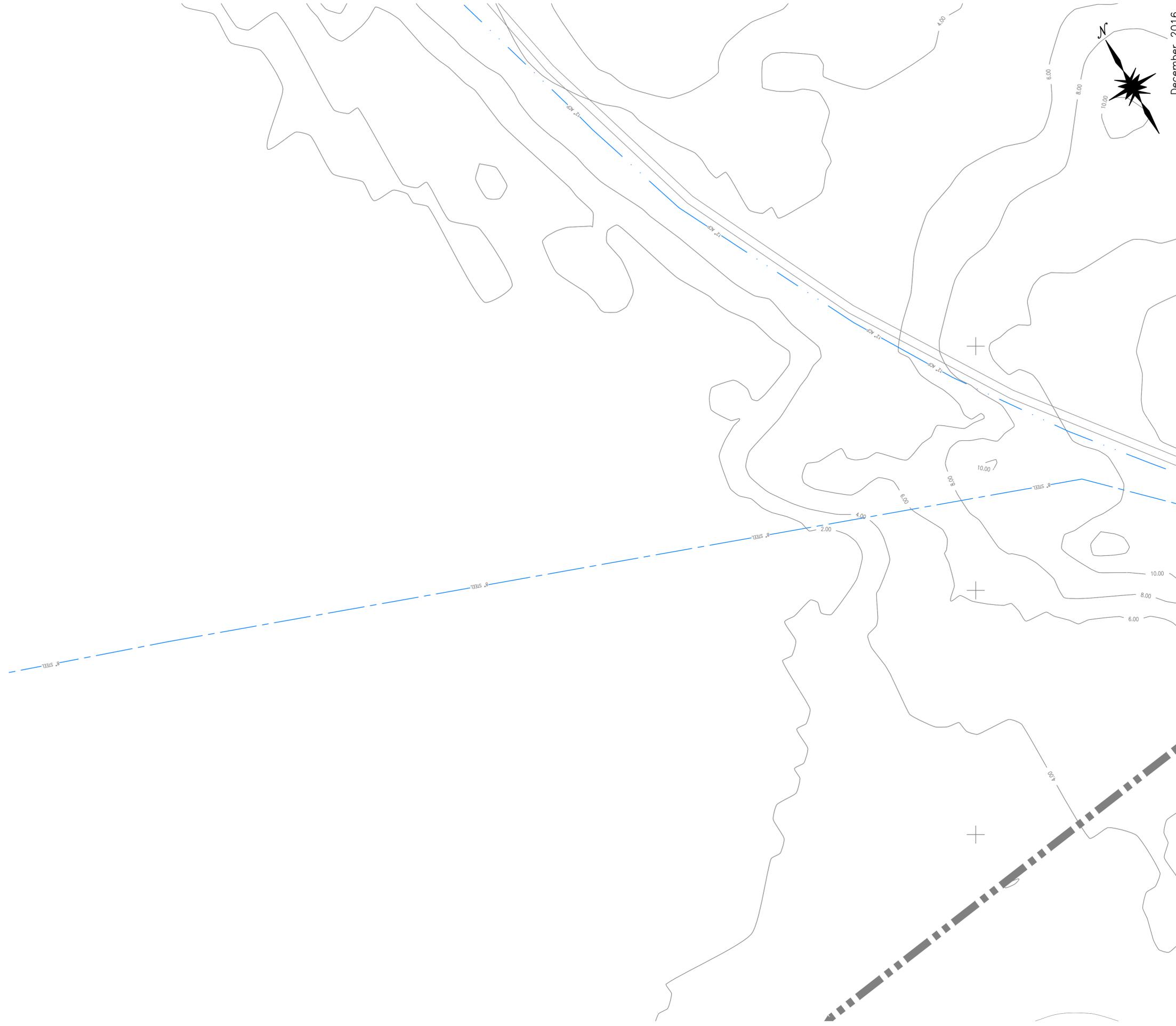
WATER AND SEWER MASTER PLAN  
MUSTANG ISLAND  
PORT ARKANSAS, TEXAS

LEGEND

WATER	SEWER
AS PIPE	CLAY PIPE
PVC PIPE	FORCE MAIN
CST IRON PIPE	LINE
GALVANIZED PIPE	LINER
NEW PVC PIPE	PVC PIPE
CITY LIMITS	MANHOLE
	LEFT STATION

URBAN ENGINEERING

TYPE FIRM NO. 45, TEBELS FIRM NO. 10032400  
 2700 W. 15TH ST., SUITE 100, PORT ARKANSAS, TEXAS 72451  
 PHONE: 501.854.3311 FAX: 501.854.3310 WWW.URBANENG.COM  
 ©2016 Copyright by Urban Engineering



URBAN ENGINEERING  
 TYPE FIRM NO. 145, TYPEBLS FIRM NO. 10032400  
 2700 W. UNIVERSITY BLVD., SUITE 200  
 FORT WORTH, TEXAS 76107  
 PHONE: 817.854.3311 FAX: 817.854.3310  
 WWW.URBANENGINEERING.COM  
 © 2016 Copyright by Urban Engineering

WATER		SEWER	
AS PIPE	CLAY PIPE	FORCED MAIN	CAST IRON MANHOLE
PCP PIPE	FORCED MAIN	PCP PIPE	PCP PIPE
CAST IRON PIPE	UNLINED PIPE	UNLINED PIPE	UNLINED PIPE
UNLINED PIPE	NEW PCP PIPE	NEW PCP PIPE	NEW PCP PIPE
NEW PCP PIPE	CITY LIMITS	CITY LIMITS	CITY LIMITS

**NUECES COUNTY WCID #4**  
**WATER AND SEWER MASTER PLAN**  
**MUSTANG ISLAND**  
**PORT ARKANSAS, TEXAS**

KEY MAP

0 200 400  
 GRAPHIC SCALE  
 1"=200'

December 2016

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29							

SHEET 17 OF 29

JOB NO. 9872.05.00



**LEGEND**

WATER	SEWER
AS PIPE	CLAY PIPE
PVC PIPE	FORCE MAIN
CAST IRON PIPE	MANHOLE
GLAZED PIPE	PVC PIPE
NEW PVC PIPE	MANHOLE
	LEFT STATION
	CITY LIMITS

**NUECES COUNTY WCID #4**  
**WATER AND SEWER MASTER PLAN**  
 MUSTANG ISLAND  
 PORT ARANSAS, TEXAS

KEY MAP

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26

GRAPHIC SCALE  
 1" = 200'

0 200 400

JOB NO. 9872.05.00





12  
 A=183.3 ac  
 Qd 2007=0.031 MGD  
 Qd 2016=0.060 MGD  
 Qd 2030=0.114 MGD

L.S. #12  
 EXISTING L.S. #12  
 Q 2007=0.031 MGD  
 Q 2016=0.060 MGD  
 Q 2030=0.114 MGD

EXISTING 18" CLAY SEWER  
 Q P 2007=0.031 MGD  
 Q P 2016=0.060 MGD  
 Q P 2030=0.114 MGD

LEGEND

WATER	SEWER
CLAY PIPE	CLAY PIPE
PCP PIPE	FORCE MAIN
COST IRON PIPE	LINE
ALUMINUM PIPE	PCP PIPE
NEW PCP PIPE	MANHOLE
	LEFT STATION
	CITY LIMITS

**URBAN ENGINEERING**

TYPE FIRM NO. 45, TERLS FIRM NO. 10032400  
 PROJECT NO. 1601111213  
 PHONE: 361.853.3101 WWW.URBANENG.COM  
 ©2016 Copyright by Urban Engineering

NUECES COUNTY WCID #4  
 WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARKANAS, TEXAS

KEY MAP

0 200 400  
 GRAPHIC SCALE  
 1"=200'

1	2	3	14	15	16	17	18								
4	5	6	7	8	9	10	11	12	13	19	20	21	22	23	24
								25	26	27	28	29			

December 2016



NOTE:  
ANY FUTURE SEWER SERVICE  
IN THIS AREA SHALL BE  
DESIGNED TO FLOW DIRECTLY  
TO THE PLANT.

**(NORTH W.W.T.P.)**  
Q1.2008 =1246 MGD  
Q1.2016 =113 MGD  
Q1.2039 =145 MGD

NOTE:  
ANY FUTURE SEWER SERVICE  
IN THIS AREA SHALL BE  
DESIGNED TO FLOW DIRECTLY  
TO THE PLANT.

NOTE:  
ANY FUTURE SEWER SERVICE  
IN THIS AREA SHALL BE  
DESIGNED TO FLOW DIRECTLY  
TO THE PLANT.

NOTE:  
ANY FUTURE SEWER SERVICE  
IN THIS AREA SHALL BE  
DESIGNED TO FLOW DIRECTLY  
TO THE PLANT.

NOTE:  
ANY FUTURE SEWER SERVICE  
IN THIS AREA SHALL BE  
DESIGNED TO FLOW DIRECTLY  
TO THE PLANT.

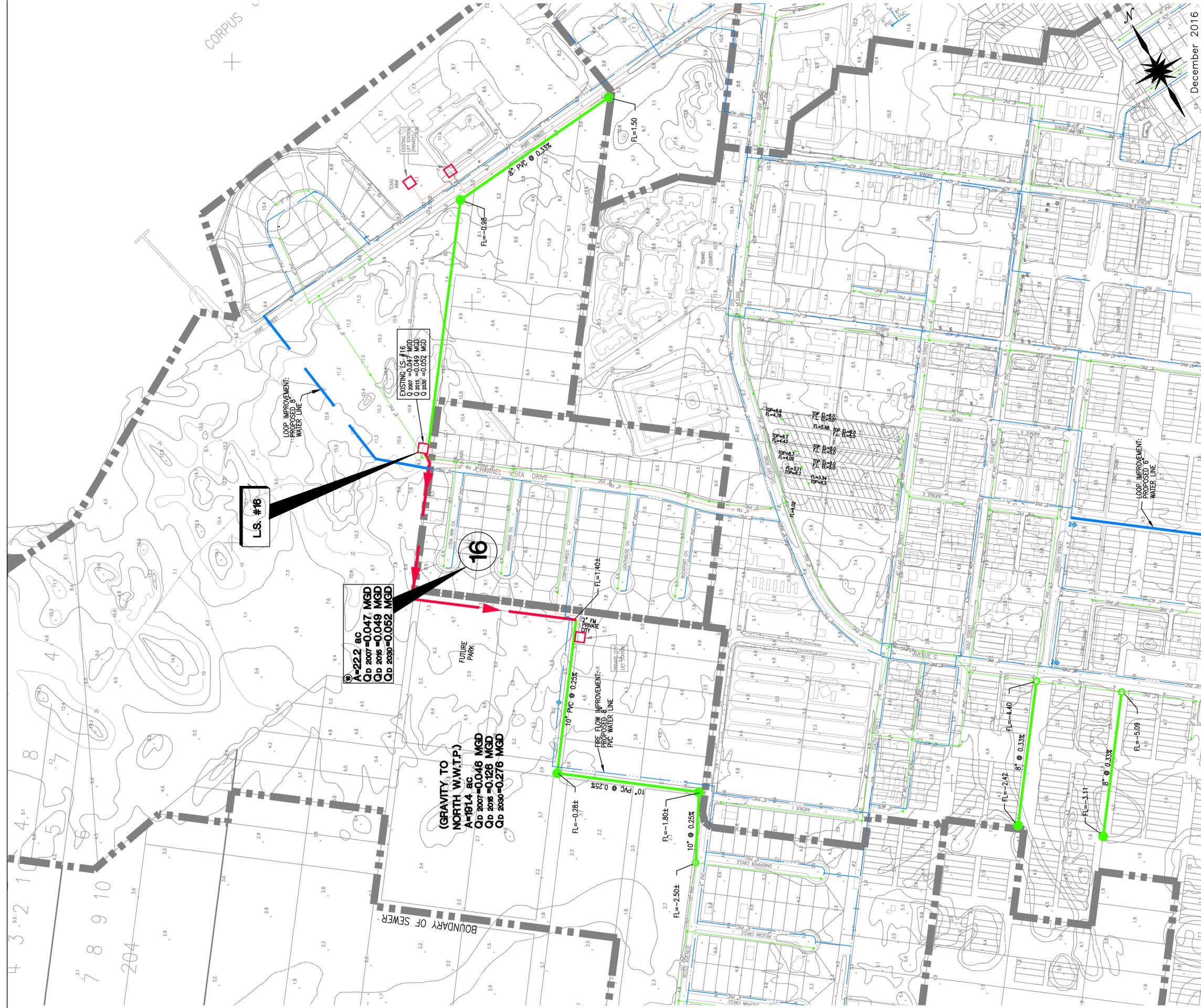
ULTIMATE 24" FORCE MAIN  
ULT. FLOW=10.4 MGD

ULTIMATE 24" FORCE MAIN  
ULT. FLOW=10.4 MGD

ELEVATED STORAGE TANK  
500,000 GAL  
PORT ARKANAS

LEGEND

WATER	SEWER
4" PVC	CLAY PIPE
6" PVC	FORCE MAIN
8" PVC	COST IRON PIPE
12" PVC	UNLINED PIPE
18" PVC	PVC PIPE
24" PVC	MANHOLE
30" PVC	LEFT SIDING
36" PVC	
42" PVC	
48" PVC	
54" PVC	
60" PVC	
66" PVC	
72" PVC	
78" PVC	
84" PVC	
90" PVC	
96" PVC	
102" PVC	
108" PVC	
114" PVC	
120" PVC	
126" PVC	
132" PVC	
138" PVC	
144" PVC	
150" PVC	
156" PVC	
162" PVC	
168" PVC	
174" PVC	
180" PVC	
186" PVC	
192" PVC	
198" PVC	
204" PVC	
210" PVC	
216" PVC	
222" PVC	
228" PVC	
234" PVC	
240" PVC	
246" PVC	
252" PVC	
258" PVC	
264" PVC	
270" PVC	
276" PVC	
282" PVC	
288" PVC	
294" PVC	
300" PVC	
306" PVC	
312" PVC	
318" PVC	
324" PVC	
330" PVC	
336" PVC	
342" PVC	
348" PVC	
354" PVC	
360" PVC	
366" PVC	
372" PVC	
378" PVC	
384" PVC	
390" PVC	
396" PVC	
402" PVC	
408" PVC	
414" PVC	
420" PVC	
426" PVC	
432" PVC	
438" PVC	
444" PVC	
450" PVC	
456" PVC	
462" PVC	
468" PVC	
474" PVC	
480" PVC	
486" PVC	
492" PVC	
498" PVC	
504" PVC	
510" PVC	
516" PVC	
522" PVC	
528" PVC	
534" PVC	
540" PVC	
546" PVC	
552" PVC	
558" PVC	
564" PVC	
570" PVC	
576" PVC	
582" PVC	
588" PVC	
594" PVC	
600" PVC	
606" PVC	
612" PVC	
618" PVC	
624" PVC	
630" PVC	
636" PVC	
642" PVC	
648" PVC	
654" PVC	
660" PVC	
666" PVC	
672" PVC	
678" PVC	
684" PVC	
690" PVC	
696" PVC	
702" PVC	
708" PVC	
714" PVC	
720" PVC	
726" PVC	
732" PVC	
738" PVC	
744" PVC	
750" PVC	
756" PVC	
762" PVC	
768" PVC	
774" PVC	
780" PVC	
786" PVC	
792" PVC	
798" PVC	
804" PVC	
810" PVC	
816" PVC	
822" PVC	
828" PVC	
834" PVC	
840" PVC	
846" PVC	
852" PVC	
858" PVC	
864" PVC	
870" PVC	
876" PVC	
882" PVC	
888" PVC	
894" PVC	
900" PVC	
906" PVC	
912" PVC	
918" PVC	
924" PVC	
930" PVC	
936" PVC	
942" PVC	
948" PVC	
954" PVC	
960" PVC	
966" PVC	
972" PVC	
978" PVC	
984" PVC	
990" PVC	
996" PVC	
1002" PVC	
1008" PVC	
1014" PVC	
1020" PVC	
1026" PVC	
1032" PVC	
1038" PVC	
1044" PVC	
1050" PVC	
1056" PVC	
1062" PVC	
1068" PVC	
1074" PVC	
1080" PVC	
1086" PVC	
1092" PVC	
1098" PVC	
1104" PVC	
1110" PVC	
1116" PVC	
1122" PVC	
1128" PVC	
1134" PVC	
1140" PVC	
1146" PVC	
1152" PVC	
1158" PVC	
1164" PVC	
1170" PVC	
1176" PVC	
1182" PVC	
1188" PVC	
1194" PVC	
1200" PVC	
1206" PVC	
1212" PVC	
1218" PVC	
1224" PVC	
1230" PVC	
1236" PVC	
1242" PVC	
1248" PVC	
1254" PVC	
1260" PVC	
1266" PVC	
1272" PVC	
1278" PVC	
1284" PVC	
1290" PVC	
1296" PVC	
1302" PVC	
1308" PVC	
1314" PVC	
1320" PVC	
1326" PVC	
1332" PVC	
1338" PVC	
1344" PVC	
1350" PVC	
1356" PVC	
1362" PVC	
1368" PVC	
1374" PVC	
1380" PVC	
1386" PVC	
1392" PVC	
1398" PVC	
1404" PVC	
1410" PVC	
1416" PVC	
1422" PVC	
1428" PVC	
1434" PVC	
1440" PVC	
1446" PVC	
1452" PVC	
1458" PVC	
1464" PVC	
1470" PVC	
1476" PVC	
1482" PVC	
1488" PVC	
1494" PVC	
1500" PVC	
1506" PVC	
1512" PVC	
1518" PVC	
1524" PVC	
1530" PVC	
1536" PVC	
1542" PVC	
1548" PVC	
1554" PVC	
1560" PVC	
1566" PVC	
1572" PVC	
1578" PVC	
1584" PVC	
1590" PVC	
1596" PVC	
1602" PVC	
1608" PVC	
1614" PVC	
1620" PVC	
1626" PVC	
1632" PVC	
1638" PVC	
1644" PVC	
1650" PVC	
1656" PVC	
1662" PVC	
1668" PVC	
1674" PVC	
1680" PVC	
1686" PVC	
1692" PVC	
1698" PVC	
1704" PVC	
1710" PVC	
1716" PVC	
1722" PVC	
1728" PVC	
1734" PVC	
1740" PVC	
1746" PVC	
1752" PVC	
1758" PVC	
1764" PVC	
1770" PVC	
1776" PVC	
1782" PVC	
1788" PVC	
1794" PVC	
1800" PVC	
1806" PVC	
1812" PVC	
1818" PVC	
1824" PVC	
1830" PVC	
1836" PVC	
1842" PVC	
1848" PVC	
1854" PVC	
1860" PVC	
1866" PVC	
1872" PVC	
1878" PVC	
1884" PVC	
1890" PVC	
1896" PVC	
1902" PVC	
1908" PVC	
1914" PVC	
1920" PVC	
1926" PVC	
1932" PVC	
1938" PVC	
1944" PVC	
1950" PVC	
1956" PVC	
1962" PVC	
1968" PVC	
1974" PVC	
1980" PVC	
1986" PVC	
1992" PVC	
1998" PVC	
2004" PVC	
2010" PVC	
2016" PVC	
2022" PVC	
2028" PVC	
2034" PVC	
2040" PVC	
2046" PVC	
2052" PVC	
2058" PVC	
2064" PVC	
2070" PVC	
2076" PVC	
2082" PVC	
2088" PVC	
2094" PVC	
2100" PVC	
2106" PVC	
2112" PVC	
2118" PVC	
2124" PVC	
2130" PVC	
2136" PVC	
2142" PVC	
2148" PVC	
2154" PVC	
2160" PVC	
2166" PVC	
2172" PVC	
2178" PVC	
2184" PVC	
2190" PVC	
2196" PVC	
2202" PVC	
2208" PVC	
2214" PVC	
2220" PVC	
2226" PVC	
2232" PVC	
2238" PVC	
2244" PVC	
2250" PVC	
2256" PVC	
2262" PVC	
2268" PVC	
2274" PVC	
2280" PVC	
2286" PVC	
2292" PVC	
2298" PVC	
2304" PVC	
2310" PVC	
2316" PVC	
2322" PVC	
2328" PVC	
2334" PVC	
2340" PVC	
2346" PVC	
2352" PVC	
2358" PVC	
2364" PVC	
2370" PVC	
2376" PVC	
2382" PVC	
2388" PVC	
2394" PVC	
2400" PVC	
2406" PVC	
2412" PVC	
2418" PVC	
2424" PVC	
2430" PVC	
2436" PVC	
2442" PVC	
2448" PVC	
2454" PVC	
2460" PVC	
2466" PVC	
2472" PVC	
2478" PVC	
2484" PVC	
2490" PVC	
2496" PVC	
2502" PVC	
2508" PVC	
2514" PVC	
2520" PVC	
2526" PVC	
2532" PVC	
2538" PVC	
2544" PVC	
2550" PVC	
2556" PVC	
2562" PVC	
2568" PVC	
2574" PVC	
2580" PVC	
2586" PVC	
2592" PVC	
2598" PVC	
2604" PVC	
2610" PVC	
2616" PVC	
2622" PVC	
2628" PVC	
2634" PVC	
2640" PVC	
2646" PVC	
2652" PVC	
2658" PVC	
2664" PVC	
2670" PVC	
2676" PVC	
2682" PVC	
2688" PVC	
2694" PVC	
2700" PVC	
2706" PVC	
2712" PVC	
2718" PVC	
2724" PVC	
2730" PVC	
2736" PVC	
2742" PVC	
2748" PVC	
2754" PVC	
2760" PVC	
2766" PVC	
2772" PVC	
2778" PVC	
2784" PVC	
2790" PVC	
2796" PVC	
2802" PVC	
2808" PVC	
2814" PVC	
2820" PVC	
2826" PVC	
2832" PVC	
2838" PVC	
2844" PVC	
2850" PVC	
2856" PVC	
2862" PVC	
2868" PVC	
2874" PVC	
2880" PVC	
2886" PVC	
2892" PVC	
2898" PVC	
2904" PVC	
2910" PVC	



December 2016

KEY MAP

0 200 400

GRAPHIC SCALE  
1"=200'

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

1415161718  
192021222324  
2526272829

SHEET 22 OF 29

JOB NO. 9872.B5.00

NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
MUSTANG ISLAND  
PORT ARKANAS, TEXAS

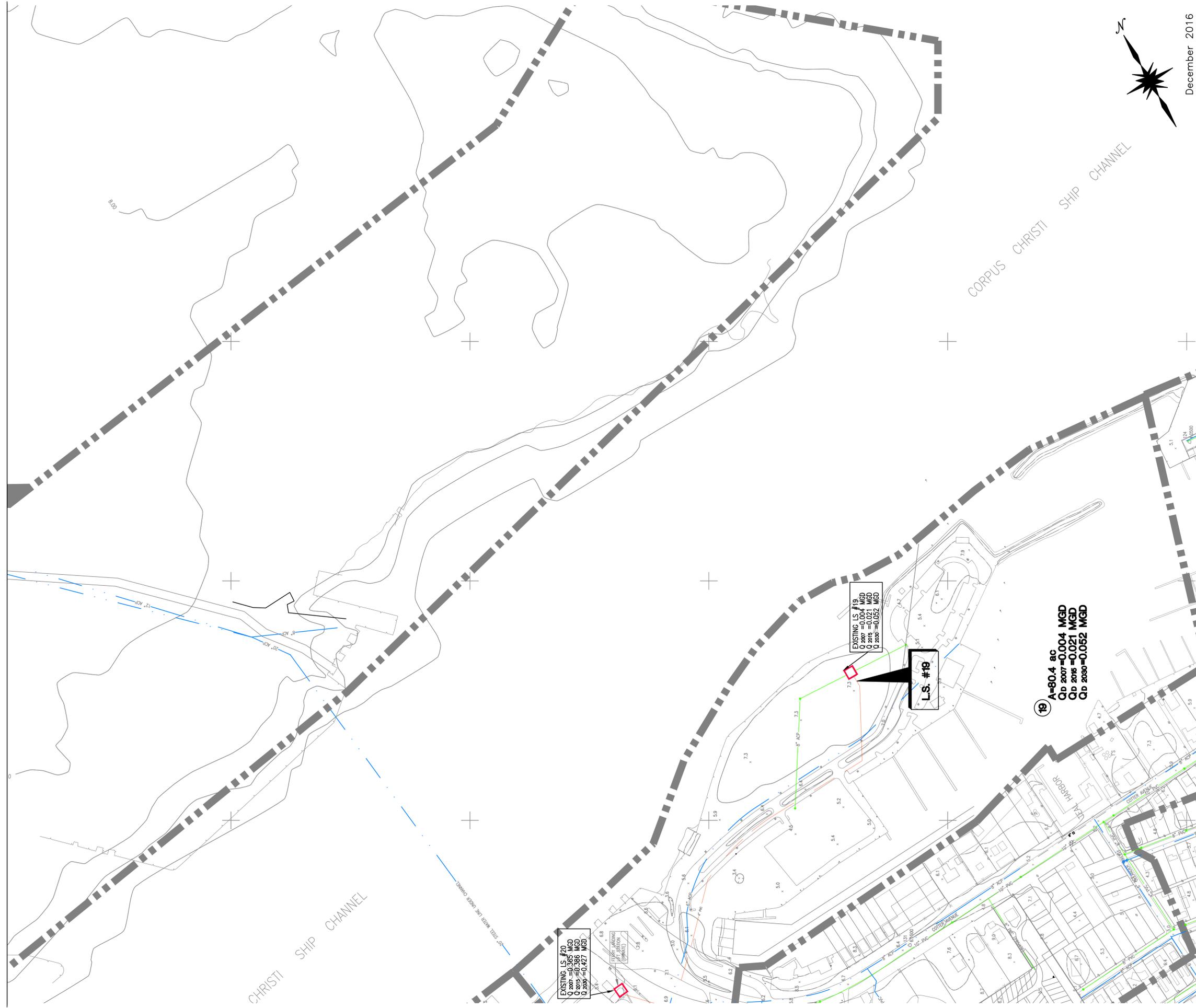
LEGEND

WATER	SEWER
A" PPE	CLAY PIPE
PVC PIPE	FORCE MAIN
CST IRON PIPE	CAST IRON PIPE
GLAZED PIPE	GLAZED PIPE
NEW PVC PIPE	NEW PVC PIPE
CITY LIMITS	CITY LIMITS

CLAY PIPE  
 FORCE MAIN  
 CAST IRON PIPE  
 GLAZED PIPE  
 NEW PVC PIPE  
 CITY LIMITS

**URBAN ENGINEERING**

TYPE FIRM NO. 45, TELS. FIRM NO. 10032400  
 PHONE: 361.854.3111 FAX: 361.854.3112  
 WWW.URBANENG.COM  
 ©2016 Copyright by Urban Engineering



i.dwg modified by cyg on Dec 16, 2016 - 5:08pm

December 2016

KEY MAP

GRAPHIC SCALE  
1"=200'

1	2	3	4	5	6	7	8	9	10	11	12	13			
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

SHEET 23 OF 29

JOB NO. 9872.05.00

NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
MUSTANG ISLAND  
PORT ARKANSAS, TEXAS

LEGEND

WATER

- A2 PIPE
- PVC PIPE
- CAST IRON PIPE
- GALVANIZED PIPE
- NEW PVC PIPE
- CITY LIMITS

SEWER

- CLAY PIPE
- FORCE MAIN
- CAST IRON PIPE
- LINEAR
- PVC PIPE
- MANHOLE
- LEFT STATION

URBAN ENGINEERING

TYPE FIRM NO. 445, TEXELS FIRM NO. 10032400  
 PROJECT: 9872.05.01 - MUSTANG ISLAND  
 PHONE: 361.854.3111 | WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering



LEGEND	
	WATER
	A2 PIPE
	PVC PIPE
	CST IRON PIPE
	GLAZED PIPE
	NEW PVC PIPE
	CITY LIMITS
	SEWER
	CLAY PIPE
	FORCE MAIN
	IRON LINER
	PVC PIPE
	MANHOLE
	WATER MAIN
	LEFT STATION

### NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
MUSTANG ISLAND  
PORT ARANSAS, TEXAS

KEY MAP

GRAPHIC SCALE  
1"=200'

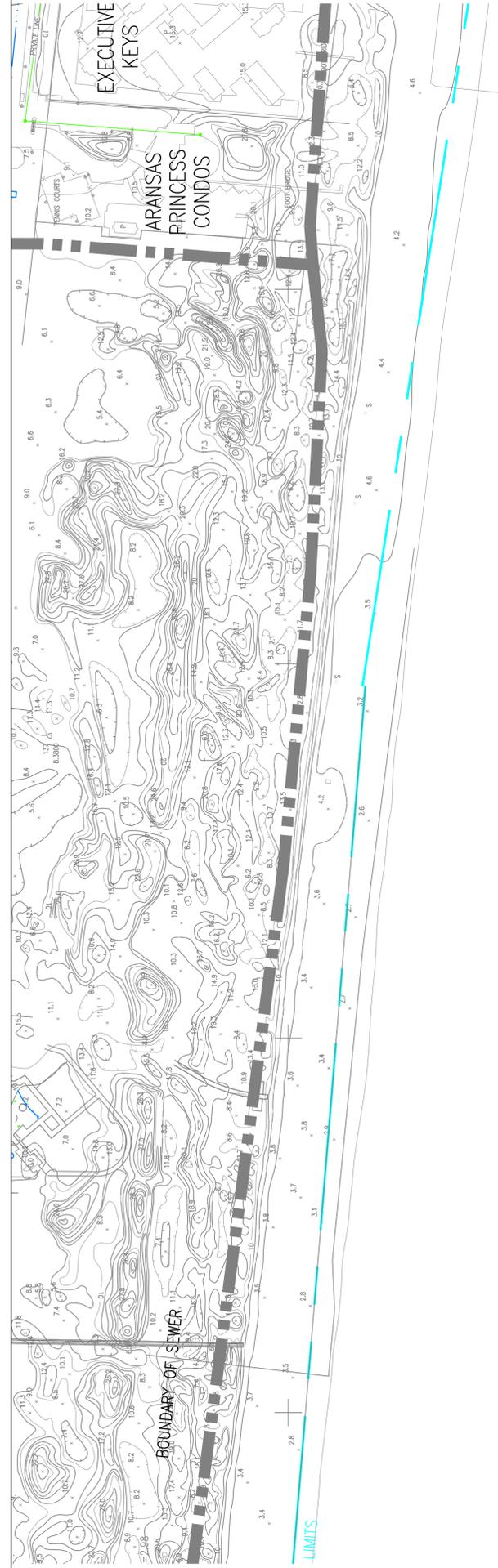


1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	

JOB NO. 9872.B5.00

December 2016

SHEET  
24  
OF 29



i.dwg modified by cyg on Dec 16, 2016 - 5:08pm

GULF OF



URBAN ENGINEERING  
 145 TERRELL FIRM NO. 10032400  
 2700 W. UNIVERSITY BLVD. SUITE 100  
 PORT ARANSAS, TEXAS 78373  
 PHONE: 361.854.3101 WWW.URBANENG.COM  
 ©2016 Copyright by Urban Engineering

LEGEND

WATER	SEWER
42" PIPE	CLAY PIPE
30" PIPE	FORCE MAIN
24" PIPE	18" MANHOLE
18" PIPE	12" MANHOLE
12" PIPE	6" MANHOLE
6" PIPE	4" MANHOLE
4" PIPE	2" MANHOLE
2" PIPE	1" MANHOLE
1" PIPE	1/2" MANHOLE
1/2" PIPE	1/4" MANHOLE
1/4" PIPE	1/8" MANHOLE
1/8" PIPE	1/16" MANHOLE
1/16" PIPE	1/32" MANHOLE
1/32" PIPE	1/64" MANHOLE
1/64" PIPE	1/128" MANHOLE
1/128" PIPE	1/256" MANHOLE
1/256" PIPE	1/512" MANHOLE
1/512" PIPE	1/1024" MANHOLE
1/1024" PIPE	1/2048" MANHOLE
1/2048" PIPE	1/4096" MANHOLE
1/4096" PIPE	1/8192" MANHOLE
1/8192" PIPE	1/16384" MANHOLE
1/16384" PIPE	1/32768" MANHOLE
1/32768" PIPE	1/65536" MANHOLE
1/65536" PIPE	1/131072" MANHOLE
1/131072" PIPE	1/262144" MANHOLE
1/262144" PIPE	1/524288" MANHOLE
1/524288" PIPE	1/1048576" MANHOLE
1/1048576" PIPE	1/2097152" MANHOLE
1/2097152" PIPE	1/4194304" MANHOLE
1/4194304" PIPE	1/8388608" MANHOLE
1/8388608" PIPE	1/16777216" MANHOLE
1/16777216" PIPE	1/33554432" MANHOLE
1/33554432" PIPE	1/67108864" MANHOLE
1/67108864" PIPE	1/134217728" MANHOLE
1/134217728" PIPE	1/268435456" MANHOLE
1/268435456" PIPE	1/536870912" MANHOLE
1/536870912" PIPE	1/1073741824" MANHOLE
1/1073741824" PIPE	1/2147483648" MANHOLE
1/2147483648" PIPE	1/4294967296" MANHOLE
1/4294967296" PIPE	1/8589934592" MANHOLE
1/8589934592" PIPE	1/17179869184" MANHOLE
1/17179869184" PIPE	1/34359738368" MANHOLE
1/34359738368" PIPE	1/68719476736" MANHOLE
1/68719476736" PIPE	1/137438953472" MANHOLE
1/137438953472" PIPE	1/274877906944" MANHOLE
1/274877906944" PIPE	1/549755813888" MANHOLE
1/549755813888" PIPE	1/1099511627776" MANHOLE
1/1099511627776" PIPE	1/2199023255552" MANHOLE
1/2199023255552" PIPE	1/4398046511104" MANHOLE
1/4398046511104" PIPE	1/8796093022208" MANHOLE
1/8796093022208" PIPE	1/17592186044416" MANHOLE
1/17592186044416" PIPE	1/35184372088832" MANHOLE
1/35184372088832" PIPE	1/70368744177664" MANHOLE
1/70368744177664" PIPE	1/140737488355328" MANHOLE
1/140737488355328" PIPE	1/281474976710656" MANHOLE
1/281474976710656" PIPE	1/562949953421312" MANHOLE
1/562949953421312" PIPE	1/1125899906842624" MANHOLE
1/1125899906842624" PIPE	1/2251799813685248" MANHOLE
1/2251799813685248" PIPE	1/4503599627370496" MANHOLE
1/4503599627370496" PIPE	1/9007199254740992" MANHOLE
1/9007199254740992" PIPE	1/18014398509481984" MANHOLE
1/18014398509481984" PIPE	1/36028797018963968" MANHOLE
1/36028797018963968" PIPE	1/72057594037927936" MANHOLE
1/72057594037927936" PIPE	1/144115188075855872" MANHOLE
1/144115188075855872" PIPE	1/288230376151711744" MANHOLE
1/288230376151711744" PIPE	1/576460752303423488" MANHOLE
1/576460752303423488" PIPE	1/1152921504606846976" MANHOLE
1/1152921504606846976" PIPE	1/2305843009213693952" MANHOLE
1/2305843009213693952" PIPE	1/4611686018427387904" MANHOLE
1/4611686018427387904" PIPE	1/9223372036854775808" MANHOLE
1/9223372036854775808" PIPE	1/18446744073709551616" MANHOLE
1/18446744073709551616" PIPE	1/36893488147419103232" MANHOLE
1/36893488147419103232" PIPE	1/73786976294838206464" MANHOLE
1/73786976294838206464" PIPE	1/147573952589676412928" MANHOLE
1/147573952589676412928" PIPE	1/295147905179352825856" MANHOLE
1/295147905179352825856" PIPE	1/590295810358705651712" MANHOLE
1/590295810358705651712" PIPE	1/1180591620717411303424" MANHOLE
1/1180591620717411303424" PIPE	1/2361183241434822606848" MANHOLE
1/2361183241434822606848" PIPE	1/4722366482869645213696" MANHOLE
1/4722366482869645213696" PIPE	1/9444732965739290427392" MANHOLE
1/9444732965739290427392" PIPE	1/18889465931478580854784" MANHOLE
1/18889465931478580854784" PIPE	1/37778931862957161709568" MANHOLE
1/37778931862957161709568" PIPE	1/75557863725914323419136" MANHOLE
1/75557863725914323419136" PIPE	1/151115727451828646838272" MANHOLE
1/151115727451828646838272" PIPE	1/302231454903657293676544" MANHOLE
1/302231454903657293676544" PIPE	1/604462909807314587353088" MANHOLE
1/604462909807314587353088" PIPE	1/1208925819614629174706176" MANHOLE
1/1208925819614629174706176" PIPE	1/2417851639229258349412352" MANHOLE
1/2417851639229258349412352" PIPE	1/4835703278458516698824704" MANHOLE
1/4835703278458516698824704" PIPE	1/9671406556917033397649408" MANHOLE
1/9671406556917033397649408" PIPE	1/19342813113834066795298816" MANHOLE
1/19342813113834066795298816" PIPE	1/38685626227668133590597632" MANHOLE
1/38685626227668133590597632" PIPE	1/77371252455336267181195264" MANHOLE
1/77371252455336267181195264" PIPE	1/154742504910672534362390512" MANHOLE
1/154742504910672534362390512" PIPE	1/309485009821345068724781024" MANHOLE
1/309485009821345068724781024" PIPE	1/618970019642690137449562048" MANHOLE
1/618970019642690137449562048" PIPE	1/123794003928538027489924096" MANHOLE
1/123794003928538027489924096" PIPE	1/247588007857076054979848192" MANHOLE
1/247588007857076054979848192" PIPE	1/495176015714152109959696384" MANHOLE
1/495176015714152109959696384" PIPE	1/990352031428304219919392768" MANHOLE
1/990352031428304219919392768" PIPE	1/1980704062856608439838795536" MANHOLE
1/1980704062856608439838795536" PIPE	1/3961408125713216879677591072" MANHOLE
1/3961408125713216879677591072" PIPE	1/7922816251426433759355182144" MANHOLE
1/7922816251426433759355182144" PIPE	1/15845632502852867518710364288" MANHOLE
1/15845632502852867518710364288" PIPE	1/31691265005705735037420728576" MANHOLE
1/31691265005705735037420728576" PIPE	1/63382530011411470074841457152" MANHOLE
1/63382530011411470074841457152" PIPE	1/126765060022822940149682894304" MANHOLE
1/126765060022822940149682894304" PIPE	1/253530120045645880299365788608" MANHOLE
1/253530120045645880299365788608" PIPE	1/507060240091291760598731577216" MANHOLE
1/507060240091291760598731577216" PIPE	1/1014120480182583521197463154432" MANHOLE
1/1014120480182583521197463154432" PIPE	1/2028240960365167042394926288864" MANHOLE
1/2028240960365167042394926288864" PIPE	1/4056481920730334084789852577728" MANHOLE
1/4056481920730334084789852577728" PIPE	1/81129638414606681695779051555552" MANHOLE
1/81129638414606681695779051555552" PIPE	1/162259276829213373915581031111104" MANHOLE
1/162259276829213373915581031111104" PIPE	1/324518553658426747831162062222208" MANHOLE
1/324518553658426747831162062222208" PIPE	1/649037107316853495662324124444416" MANHOLE
1/649037107316853495662324124444416" PIPE	1/1298074214637069911325248248888832" MANHOLE
1/1298074214637069911325248248888832" PIPE	1/259614842927413982265049697777664" MANHOLE
1/259614842927413982265049697777664" PIPE	1/51922968585482796453009939555552" MANHOLE
1/51922968585482796453009939555552" PIPE	1/103845937170965592906019879111104" MANHOLE
1/103845937170965592906019879111104" PIPE	1/207691874341931185812039782222208" MANHOLE
1/207691874341931185812039782222208" PIPE	1/415383748683862371624075964444416" MANHOLE
1/415383748683862371624075964444416" PIPE	1/830767497367724743248151928888832" MANHOLE
1/830767497367724743248151928888832" PIPE	1/166153499473544948496303857777664" MANHOLE
1/16615349947354494849630385777664" PIPE	1/33230699894708989699260771555552" MANHOLE
1/33230699894708989699260771555552" PIPE	1/66461399789417979398521543111104" MANHOLE
1/66461399789417979398521543111104" PIPE	1/132922799578835958797043082222208" MANHOLE
1/132922799578835958797043082222208" PIPE	1/265845599157671917594086164444416" MANHOLE
1/265845599157671917594086164444416" PIPE	1/53169119831534383518881328888832" MANHOLE
1/53169119831534383518881328888832" PIPE	1/106338239663068770377766765777664" MANHOLE
1/106338239663068770377766765777664" PIPE	1/21267647932613754075553351555552" MANHOLE
1/21267647932613754075553351555552" PIPE	1/42535295865227508151107067111104" MANHOLE
1/42535295865227508151107067111104" PIPE	1/850705917304550163022141342222208" MANHOLE
1/850705917304550163022141342222208" PIPE	1/170141183460910032604422684444416" MANHOLE
1/170141183460910032604422684444416" PIPE	1/340282366921820065208845368888832" MANHOLE
1/340282366921820065208845368888832" PIPE	1/68056473384364013041777073777664" MANHOLE
1/6805647338436401304177707377664" PIPE	1/13611294676872802608354147555552" MANHOLE
1/13611294676872802608354147555552" PIPE	1/27222589353745605216708295111104" MANHOLE
1/27222589353745605216	





i.dwg modified by cyg on Dec 16, 2016 - 5:08pm

GULF OF MEXICO



URBAN ENGINEERING  
 TYPE FIRM NO. 145, TEXAS FIRM NO. 10032400  
 2700 W. UNIVERSITY BLVD., SUITE 200  
 FORT WORTH, TEXAS 76102  
 PHONE: 817.854.3311 FAX: 817.854.3312  
 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering

LEGEND

WATER		SEWER	
—	A2 PIPE	—	CLAY PIPE
—	PVC PIPE	—	FORCE MAIN
—	CAST IRON PIPE	—	LINER
—	GLAZED PIPE	—	PVC PIPE
—	NEW PVC PIPE	—	MANHOLE
—		—	LEFT STATION
—	CITY LIMITS		

NUECES COUNTY WCID #4  
 WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARKANSAS, TEXAS

KEY MAP

GRAPHIC SCALE  
 1"=200'

1	2	3	14	15	16	17	18								
4	5	6	7	8	9	10	11	12	13	19	20	21	22	23	24
								25	26	27	28	29			

JOB NO. 9872.05.00

December 2016  
 SHEET 27 OF 29



i.dwg modified by cyg on Dec 16, 2016 - 5:08pm



**LEGEND**

WATER	SEWER
4" PVC PIPE	CLAY PIPE
6" PVC PIPE	FORCE MAIN
8" CAST IRON PIPE	8" LINER
12" GALVANIZED PIPE	12" PVC PIPE
18" NEW PVC PIPE	MANHOLE
	LEFT STATION
	CITY LIMITS

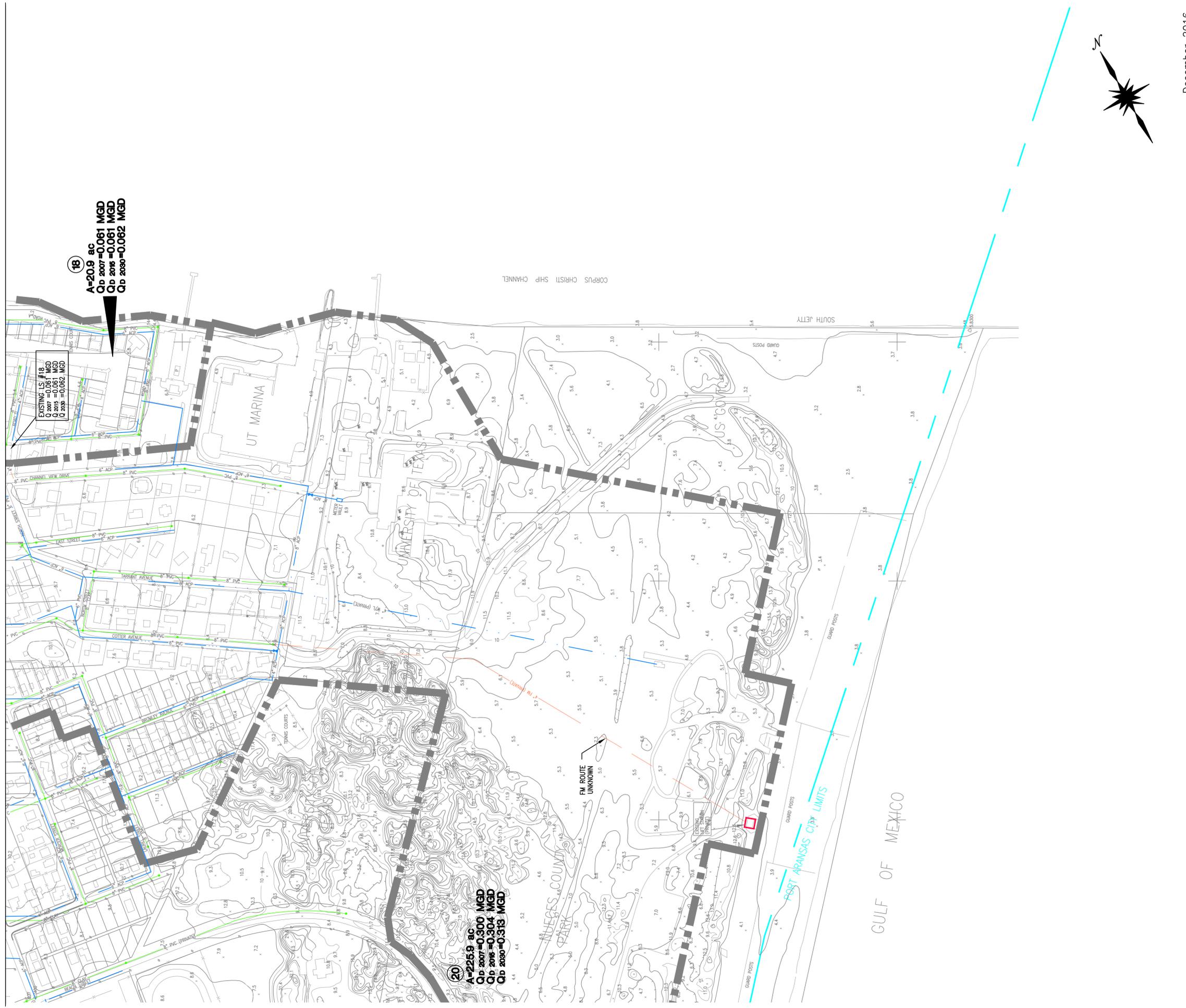
**NUECES COUNTY WCID #4**  
**WATER AND SEWER MASTER PLAN**  
**MUSTANG ISLAND**  
**PORT ARKANSAAS, TEXAS**

**KEY MAP**

0 200 400  
 GRAPHIC SCALE  
 1"=200'

1	2	3	14	15	16	17	18								
4	5	6	7	8	9	10	11	12	13	19	20	21	22	23	24
										25	26	27	28	29	

JOB NO. 9872.05.00



EXISTING LS # 18  
 Cd 2007 = 0.061 MGD  
 Cd 2016 = 0.062 MGD  
 Cd 2030 = 0.062 MGD

18  
 A=20.9 ac  
 Cd 2007=0.061 MGD  
 Cd 2016 =0.061 MGD  
 Cd 2030=0.062 MGD

20  
 A=225.9 ac  
 Cd 2007=0.300 MGD  
 Cd 2016 =0.304 MGD  
 Cd 2030=0.313 MGD

FM ROUTE UNKNOWN

December 2016

KEY MAP

GRAPHIC SCALE  
 0 200 400  
 1" = 200'

1	2	3	14	15	16	17	18										
4	5	6	7	8	9	10	11	12	13	19	20	21	22	23	24		
													25	26	27	28	29

SHEET 29 OF 29

JOB NO. 987246.00

NUECES COUNTY WCID #4

WATER AND SEWER MASTER PLAN  
 MUSTANG ISLAND  
 PORT ARKANSAS, TEXAS

LEGEND

<b>WATER</b>	<b>SEWER</b>
AC PIPE	CLAY PIPE
PVC PIPE	FORC MAIN
CGI IRON PIPE	LINE
GLAZED PIPE	LINE
NEW PVC PIPE	MANHOLE
	LET STATION
	LET STATION
	CITY LIMITS

**URBAN ENGINEERING**

TRBE FIRM NO. 145, TRPLS FIRM NO. 10022400  
 2700 W. UNIVERSITY BLVD., SUITE 310, PORT ARKANSAS, TX 78064  
 PHONE: 512.863.3100 FAX: 512.863.3104 WWW.URBANENG.COM  
 © 2016 Copyright by Urban Engineering

S:\Projects\00000\09872\B9500 CIP Fees\MASTER PLAN EXHIBITS\SEPT2016\UPDATED\_SHEETS.dwg modified by cyg on Dec 16, 2016 - 5:08pm