

**HISTORICAL DATA REVIEW AND SITE ASSESSMENT  
ON  
TMDL INVESTIGATION FOR BACTERIA IN CORPUS CHRISTI BAY BEACHES**

Prepared for:

**Texas Commission on Environmental Quality  
Total Maximum Daily Load Program  
P.O. Box 13087  
Austin, Texas 78711-3087**

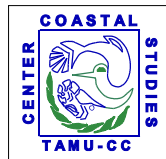


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## 1.0 INTRODUCTION

This historical data review provides support to the Texas Commission on Environmental Quality (TCEQ) and future Total Maximum Daily Load (TMDL) development for *Enterococcus* spp. bacteria concerns at beaches along Corpus Christi Bay (Segment 2481). Project goals will require a historical data review and collection of supplementary *Enterococcus* spp. data in Corpus Christi Bay. Data collection will specifically target beaches at Cole Park (Segment 2481CB\_03), Ropes Park (Segment 2481CB\_04), Emerald Beach (Segment 2481CB\_05), McGee Beach (Segment 2481CB\_06), and Poenisch Park (Segment 2481CB\_07), Corpus Christi Beach, University Beach and at additional public access beaches/points as needed. Public and stakeholder meetings will be attended as necessary to support the TCEQ TMDL Team. This project will be referred to as the Corpus Christi Bay Beaches Study and is issued within Contract No. 582-11-90501 between the Center for Coastal Studies at Texas A&M University-Corpus Christi and the TCEQ.

Disease causing microorganisms, or pathogens, can adversely affect human health in estuarine systems. Densities of these microorganisms when considered unsafe often result in adverse effects on human health through transmittal of microbial pathogens during recreational use involving primary contact with water (i.e., wading, swimming, fishing, etc.) (Heilman 2000; USEPA 2002; Nicolau and Nunez 2004). While protecting public health is the primary concern, the potential loss of recreational beach use, through multiple swimming advisories and beach closures, may also result in lost economic opportunities to coastal communities (TCEQ 2008).

Typically, high pathogen concentrations in the water column result from sources such as polluted stormwater runoff, wastewater overflows, boating wastes, and malfunctioning septic systems that carry microorganisms from fecal material into the environment. Besides humans, it may indicate contamination by fecal matter originating from other warm-blooded animals.

While it is not possible to monitor all pathogens present in recreational waters, TCEQ analyzes concentrations of three organisms to determine support of the Primary Contact Recreation (PCR) criteria: fecal coliform and *Escherichia coli* in freshwater, and *Enterococcus* in tidal water. TCEQ guidance stresses that full support of the PCR does not necessarily guarantee that freshwater or tidal waters are completely free of disease causing organisms. However, TCEQ addresses this type of water quality impairment through 303(d) listing and the TMDL process (TCEQ 2008).

In 2008, based on data collected under the Texas Beach Watch Program, EPA took action to list Corpus Christi Bay (Segment 2481) on the [303\(d\) List of Impaired Waters](#) for bacteria and subsequently listed the entire water body in Category 5a, meaning a TMDL will be scheduled. Upon request by TCEQ, EPA reconsidered listing the entire Corpus Christi Bay segment and changed the listing to include only beaches at Cole Park and Ropes Park, and designated them into separate assessment units (Segment 2481CB\_03 and 2481CB\_04, respectively). In addition, the listing category changed to 5c, meaning additional bacteria data were needed before a TMDL is conducted. These actions have resulted in establishment and funding for the current project, “*TMDL Investigation for Bacteria in Corpus Christi Bay Beaches*”. To ensure that data generated for the purposes described herein are scientifically

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valid and legally defensible, this project will be conducted under a TCEQ approved Quality Assurance Project Plan (QAPP). This will ensure that data submitted to the TCEQ Surface Water Quality Monitoring Information System database have been collected and analyzed in a way that guarantees its reliability.

### **1.1 Water Quality Standards**

Goals to maintain surface water quality that supports public health, protects aquatic life, and are consistent with sustainable economic development are defined in the Texas Surface Water Quality Standards. These standards identify appropriate uses, including aquatic life, recreation, and public water supply (or drinking water) sources. Criteria for evaluating use support include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria. Primarily, comparison of individual parameter values to either numerical criteria or screening levels determines the number of values exceeded. Based on number of exceedances, the assessment classifies a segment as either being in full support, partial support, or not supportive of the official designated use. Statewide water quality standards are subject to revision on a triennial basis.

TCEQ analyzes concentrations of *Escherichia coli* and fecal coliform in freshwater, and *Enterococcus* in marine or tidal water to determine PCR support. Presence of these naturally occurring organisms in high numbers within the water column indicates contamination by fecal matter originating from warm-blooded animals, including humans. [TCEQ 2010 Guidance for Assessing and Reporting Surface Water Quality in Texas](#) stresses that full PCR support does not necessarily guarantee that waters are completely free of disease causing organisms.

Depending on the analytical test performed, results are reported as colony forming units (CFU) or most probable number (MPN). The membrane filtration test (EPA Method 1600) counts actual colonies' (CFU) of bacteria and the newer defined substrate tests such as Enterolert<sup>®</sup>, is a statistical representation of the MPN of enterococci likely present in a sample. Both methods are used and considered interchangeable by regulatory agencies.

Support of the TCEQ PCR utilizes a 10-sample minimum per individual site taken over the assessment period (two to seven years). For routinely monitored bacteria data, the long-term geometric average for enterococci is 35 CFU or MPN/100 ml in tidal water. For individual samples in tidal water and recreational beaches, the old criterion of 89 CFU or MPN/100 ml has been revised to 104 CFU or MPN/100 ml, which is the same as the national EPA Beach Watch Program, which monitors Texas beaches for enterococci concentrations to determine closures based on elevated bacterial concentrations.

The following information was obtained from the *Draft 2010 Guidance for Assessing and Reporting Surface Water Quality in Texas*. In 2010, the assessment method considers recreational beaches a sub-category of the recreation use. According to the [Beaches Environmental Assessment and Coastal Health \(BEACH\) Act of 2000](#), states are required to participate with EPA in monitoring coastal recreation waters adjacent to public bathing beaches for pathogens and pathogen indicators. The Act requires public notification when bacteria water quality standards are exceeded.

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Currently, the Texas General Land Office (GLO) administers the Texas Beach Watch Program (TBWP) and collects water samples from 163 stations along the Texas coast in Aransas, Brazoria, Cameron, Galveston, Jefferson, Kleberg, Matagorda, Nueces, and San Patricio Counties. Sample collection occurs weekly (one time at each station) during the peak beach season from May through September and bi-weekly from October through April with water samples collected at approximately 0.6 m (2 ft.), or knee depth. The GLO maintains a website at [Texas Beach Watch](#) where maps and bacteria water quality information are available. Bacteria results are updated each time sample data are entered into the TBWP database. Local government entities typically post Beach Watch advisory signs at beach access points and issue advisories that warn the public not to swim in affected waters when bacterial levels are exceeded.

TBWP advisories are recommended when the average of two samples exceed EPA's recommended single sample maximum density (SSMD) criteria of 104 CFU or MPN/100 ml. Once issued, that beach is subject to continued monitoring every 24 hours until bacteria levels fall to <104 CFU or MPN/100 ml. Advisories last for 24 hours, and are extended if bacteria levels continue to exceed SSMD recommended levels. All samples are collected under a QAPP consistent with TCEQ bacteria collection and analysis protocols and analyzed for enterococci bacteria using EPA's Method 1600 or the IDEXX Enterolert® system.

TCEQ is provided with a compilation of all beach data collected and analyzed by GLO under the TBWP. Based on total number of samples for each beach and the number of days each beach is under an advisory, TCEQ assesses each individual year within the multi-year assessment period of record. For all available data, the total number of advisory days are divided by the total number of samples collected. If there are numerous sites monitored at one beach area, only one advisory is counted per beach per day. All impairments identified using this method are categorized as 5a (available data and/or information indicate at least one designated or existing use is not being supported and necessary TMDLs are underway or scheduled) due to human health considerations.

TCEQ proposes including the TBWP information in the 303(d)/305(b) assessment process in order to protect human health by identifying beaches with persistent advisories. Assessment would consist of identifying the percentage of days each beach has an advisory. The recreation use is not supported if the geometric mean of the samples collected over the assessment period exceeds the criterion (35 CFU or MPN/100 ml) or if the criteria for individual samples (104 CFU or MPN/100) ml are exceeded greater than 25 percent of the time.

Beach advisories <25% of the time—Fully Supporting

Beach advisories 20-25% of the time—Concern and Fully Supporting.

Beach advisories < 20% of the time—Delisted and Fully Supporting.

Beach advisories ≥ 25% of the time—Not Supporting.



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## 2.0 STUDY AREA DESCRIPTION

### 2.1 Corpus Christi

According to data obtained from the City of Corpus Christi Department of Developmental Services, the total area within the city limits is 1060.6 km<sup>2</sup> (409.5 mi<sup>2</sup>). Land represents 409.7 km<sup>2</sup> (158.2 mi<sup>2</sup>) with water and right-of-way easements contributing 526.3 km<sup>2</sup> (230.2 mi<sup>2</sup>) and 54.6 km<sup>2</sup> (21.1 mi<sup>2</sup>), respectively. The population was 305,215 at the [2010 census](#) making it the eighth-largest city in Texas. The population of the Corpus Christi Metropolitan Statistical Area, which consists of Nueces, Aransas, and San Patricio Counties, was 428,185. Corpus Christi is a popular tourist destination and the [Corpus Christi Convention and Visitors Bureau](#) actively promotes coastal living and area beaches as a premier attraction.

### 2.2 Climate

Corpus Christi is located between a humid subtropical region to the northeast and a semiarid region to the west and southwest of the city. Summers are hot and humid, with June through August high temperatures exceeding 32.2°C (90.0°F) 83.0% of the time with an average morning humidity of 93.0% (National Climatic Data Center 2010). Moderate winters, where the average high in January is 18.3°C (65.0°F) and the low is 7.2°C (45.0°F), may occasionally produce a freeze following the passage of strong northerly high-pressure fronts (Jones 1975; Chabreck 1990). December through February low temperatures are below freezing only 11% of the time (National Climatic Data Center 2010).

Mean annual precipitation recorded at Corpus Christi International Airport is approximately 77.6 cm yr<sup>-1</sup> (30.6 in yr<sup>-1</sup>) (NOAA 2010). This is offset by evaporation rates ranging from 90 to 115 cm yr<sup>-1</sup> (35.4 to 45.3 in yr<sup>-1</sup>) but may reach as high as 150 cm yr<sup>-1</sup> (TWC 1991). Peak rainfall months are from May to September with the winter months being the driest season. Southeasterly prevailing winds serve as a primary source of atmospheric moisture. The hurricane season runs from June to November (peak months are August and September), with tropical storms and hurricanes occasionally yielding substantial amounts of rainfall during late summer and early fall (Armstrong 1987).

### 2.3 Land Use/Land Cover

The land use/land cover data presented in this report was obtained through the City of Corpus Christi's Municipal Information Systems Department and the Department of Developmental Services. Land Use/Land Cover utilizes the Classifications Database created by the City of Corpus Christi in April 2003. The data displayed in Fig. 2.1 identifies Future Land Use contained in the City's Comprehensive Plan and are estimates of current Land Use from May 2010 (City of Corpus Christi 2010). The geographic scope of this map includes all property located inside city limits and property located outside the city limits but within the five mile extraterritorial jurisdiction. Per the City's disclaimer;

*“This map is illustrative of goals, objectives and policies of the Comprehensive Plan. The Comprehensive Plan shall not constitute zoning regulations or establish zoning district boundaries. This map should be used in combination with the goals, objectives and policies of the Comprehensive Plan to determine City Council intent.*”

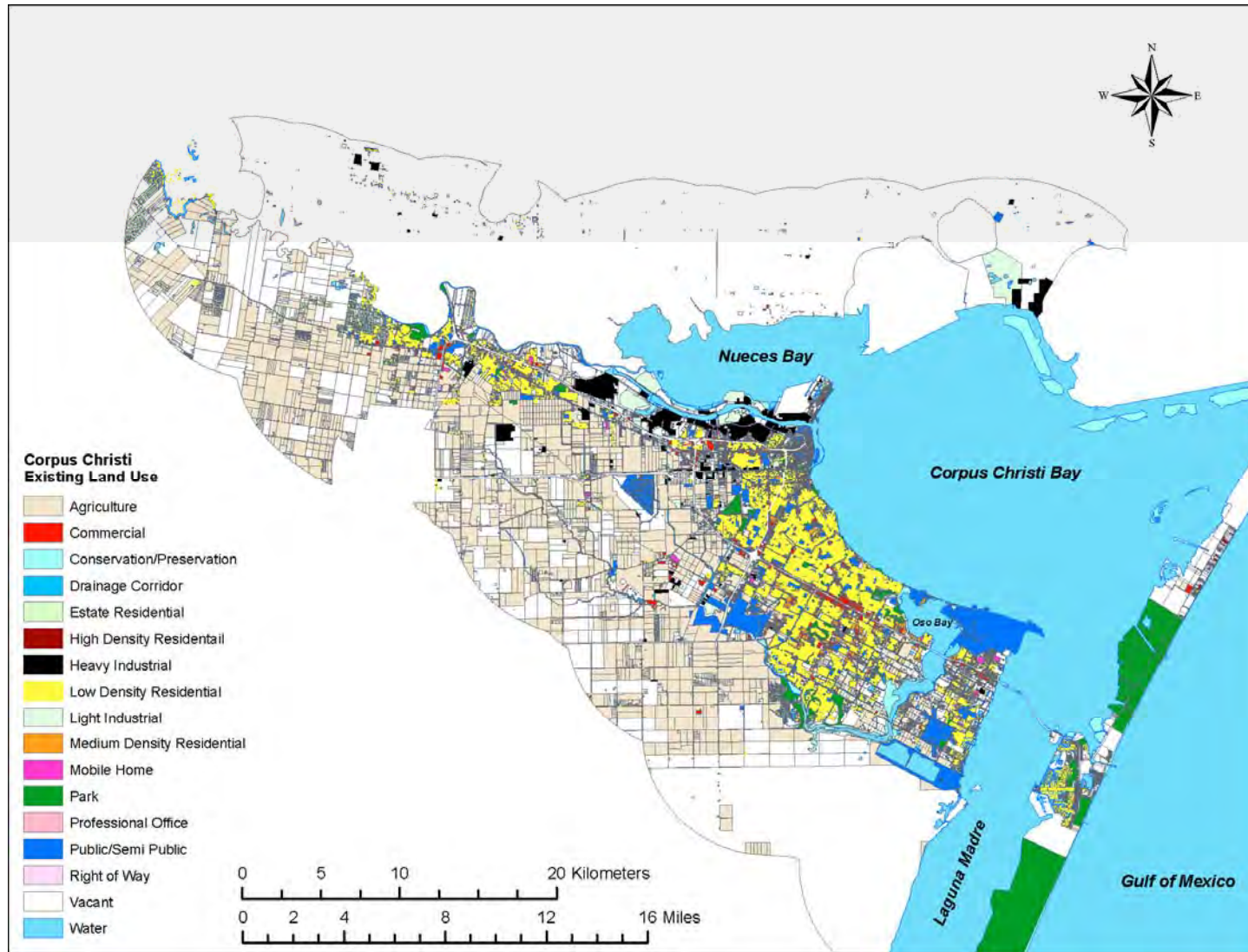


Fig. 2.1. Land Use/Land Cover for City of Corpus Christi and 5-mile extraterritorial jurisdiction area (City of Corpus Christi 2011).

Due to the large extent of Corpus Christi Bay, the dominant land use/land cover is water, representing 51.61% of the total area (Fig. 2.1 and Table 2.1). Removing water from the analysis, the major category is land listed as Vacant, at 56.52%. Much of this vacant land is actually agricultural, but not classified by the City yet. Land classified as Agriculture represents 22.60%, Residential 6.6%, and Parks 5.28%. The greatest amount of Heavy Industrial Use is located at the Port of Corpus Christi along the Inner Harbor. While the Port of Corpus Christi is the sixth largest port in the United States, the total Heavy Industrial use only comprises 1.34% of total land use.

Table 2.1. Land Use/Land Cover summary for the Corpus Christi area.

<b>Description</b>	<b>Area (ha)</b>	<b>Area (ac)</b>	<b>% of Total</b>	<b>% of Total (not including water)</b>
Water	153,106	378,334	<b>51.61%</b>	
Vacant (Undeveloped/Not classified)	81,121	200,456	<b>27.35%</b>	<b>56.52%</b>
Agriculture	32,444	80,170	<b>10.94%</b>	<b>22.60%</b>
Residential				
Low Density Residential	6,490	16,037	2.19%	4.52%
Estate Residential	1,850	4,572	0.62%	1.29%
Mobile Home	197	487	0.07%	0.14%
Medium Density Residential	890	2,200	0.30%	0.62%
High Density Residential	52	128	0.02%	0.04%
<b>Sub Total Residential</b>	<b>9,479</b>	<b>23,424</b>	<b>3.20%</b>	<b>6.60%</b>
Park	7,580	18,730	<b>2.56%</b>	<b>5.28%</b>
Public/Semi-Public	4,363	10,780	<b>1.47%</b>	<b>3.04%</b>
Industrial				
Light Industrial	2,131	52,66	0.72%	1.48%
Heavy Industrial	1,928	4,763	0.65%	1.34%
<b>Sub Total Industrial</b>	<b>4,059</b>	<b>10,029</b>	<b>1.37%</b>	<b>2.83%</b>
Conservation Preservation	2,309	5,705	<b>0.78%</b>	<b>1.61%</b>
Commercial and Professional				
Commercial	1,472	3,638	0.50%	1.03%
Professional Offices	175	433	0.06%	0.12%
<b>Sub Total Commercial and Professional</b>	<b>16,470</b>	<b>4,071</b>	<b>0.56%</b>	<b>1.15%</b>
Drainage Corridor	448	1,108	<b>0.15%</b>	<b>0.31%</b>
Right of Way	81	199	<b>0.03%</b>	<b>0.06%</b>
<b>Total</b>	<b>296,637</b>	<b>733,007</b>	<b>100.00%</b>	<b>100.00%</b>

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## 2.4 Drainage Basins and Associated Land Cover within the Project Area

The City of Corpus Christi Draft Storm Water Master Plan-Drainage Criteria Manual defines a drainage basin as any land area from which runoff collects into a common point or receiving water; land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel; also called a watershed (City of Corpus Christi 2009). The natural topography of the City is flat, although bluffs exist along the margins of Nueces and Corpus Christi Bays. According to the U.S. Department of Agriculture Soil Survey for Nueces County of 1965 (Franki *et al.* 1965);

*“Most of the soils within and adjacent to Corpus Christi are underlain by and were formed from heavy clays of the Beaumont geologic formation. By far the largest acreage consists of Victoria soils. These soils have a fine-textured surface layer and subsoil that contain clay with a high shrink-swell ratio. This characteristic alone may be responsible for the failure of sewer and water lines, foundations and walls, power line and pole alignment, and pavements that crack and heave. Salinity of the subsoil, poor surface and internal drainage, and erosion are among the factors that contribute to corrosion of utility installation, failures of septic systems, cost of maintaining streets and expressways, and problems in disposing of storm water.”*

Natural drainage within the Corpus Christi city limits is primarily to Oso Creek and Oso Bay. Smaller areas drain naturally to Corpus Christi Bay, Nueces Bay, Corpus Christi Inner Harbor, the Nueces River, Laguna Madre and Gulf of Mexico. The City is divided into eight drainage basins with a total area of 79,522 ha (Table 2.2 and Fig. 2.2). The Oso Creek Basin is by far the largest at 57.15% of total area, followed by West Oso Creek, and the Inner Harbor each at 8.77%. The project area for this TMDL investigation falls within the highly developed urban setting of the Corpus Christi Bay Basin, which represents 4.68% of the total drainage area for the City. The receiving water for the storm water runoff from this basin is Corpus Christi Bay, which TCEQ has classified the aquatic life use for Corpus Christi Bay as “exceptional” and “oyster waters” and categorized Corpus Christi Bay as “contact recreation” use with “recreational beaches” use along the shoreline in many areas.

Table 2.2. Drainage Basin summary for the Corpus Christi area.

<b>Drainage Basin</b>	<b>Area (ha)</b>	<b>Area (ac)</b>	<b>% of Total</b>
Oso Creek	45,465	112,348	57.15%
Inner Harbor	6,976	17,238	8.77%
West Oso Creek	6,978	17,242	8.77%
Laguna Madre	5,444	13,453	6.84%
Oso Bay	5,376	13,285	6.76%
Nueces River	5,206	12,865	6.54%
Corpus Christi Bay	3,721	9,195	4.68%
Nueces Bay	386	953	0.48%
<b>Totals</b>	<b>79,552</b>	<b>196,578</b>	<b>100.00%</b>



The land use/cover data for the Corpus Christi Bay Basin shows total drainage area to be 3,721 ha (9195 ac) (Fig. 2.2). Residential and Streets/Right of Ways account for 48.73% and 26.72%, respectively of the total land use/cover (Table 2.3). Note: This project will have one monitoring station located at University Beach at Texas A&M University-Corpus Christi. However, while the beach is on Corpus Christi Bay the University is actually located within the Oso Bay Drainage Basin and therefore not calculated within the Corpus Christi Bay Basin land use/cover data. The total area of the campus accounts for 87 ha (214.3 ac) or 1.62% of the total Oso Bay Basin drainage area.

Table 2.3. Land use/cover summary of the Corpus Christi Bay Basin.

<b>Description</b>	<b>Area (ha)</b>	<b>Area (ac)</b>	<b>% of Total</b>
Residential	1,813	4,481	48.73%
Streets/Right of Way	994	2,457	26.72%
Commercial	317	783	8.51%
Public/Semi-public	309	764	8.31%
Green Space/Water	129	318	3.45%
Vacant	127	313	3.41%
Industrial	25	62	0.67%
Agricultural	7	18	0.20%
<b>Total</b>	<b>3,721</b>	<b>9,195</b>	<b>100.0%</b>

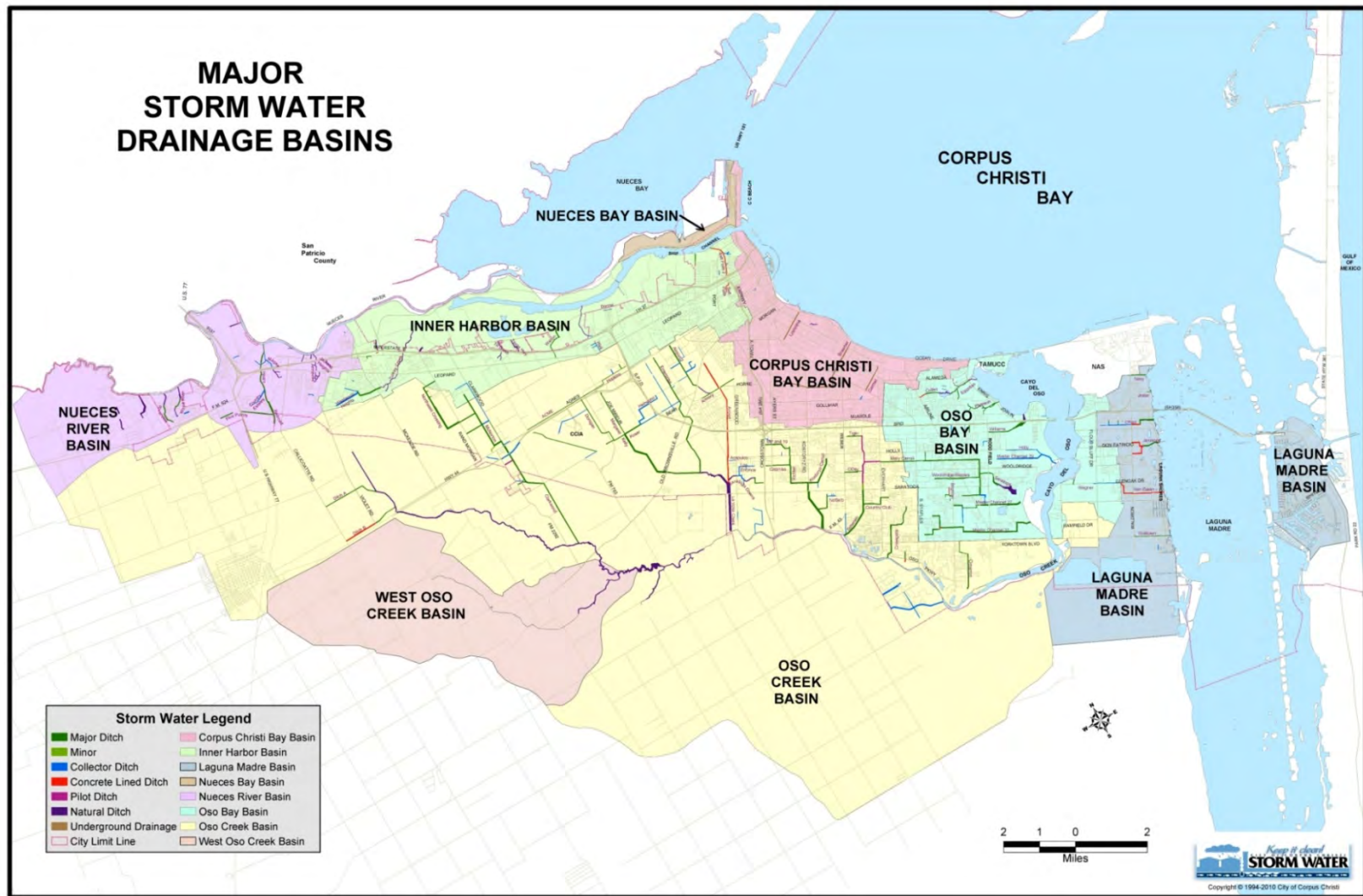


Fig. 2.2. Major storm water drainage basins within the Corpus Christi area (<http://www.cctexas.com/files/g20/MajorDrainageBasins-11x17.pdf>).

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## 2.5 City of Corpus Christi Storm Water Department

For more than 100 years, the City of Corpus Christi has incrementally built the existing storm water system. Responsibility is shared between the City and private property developers. While private enterprises built much of the infrastructure, the City is ultimately responsible for the planning, operation, maintenance, and rehabilitation of the storm water system (City of Corpus Christi 2003). The City of Corpus Christi Storm Water Department is responsible for the following system infrastructure:

- 2 Pump Stations
- 44 Storm Drain Gates
- 5 Storm Surge Protection Levee Gates
- 161+ km (100+ mi) of Major Drainage Ditches
- 1126+ km (700+ mi) of Minor Drainage Ditches
- 966+ km (600+ mi) of Underground Storm Drain Pipe
- 2897+ km (1800+ mi) of Curb & Gutter
- 675+ ha (1667+ ac) of Drainage & Street Right of Way Mowing
- 59+ ha (145+ ac) of Improved Right of Way Mowing
- 18,320+ Storm Drain Inlets
- 6000+ Manholes
- 107+ Bridges

Untreated storm water runoff is commonly transported through Municipal Separate Storm Sewer Systems or MS4s, consisting of roadside ditches, underground pipes and culverts, and major collector ditches that channel rainfall runoff through numerous drainage lines located within the city limits directly to surrounding creeks, rivers, bays, and the Gulf of Mexico (City of Corpus Christi 2003). This untreated runoff may contain, but is not limited to, various pollutants including oils, dirt, pesticides, herbicides, and fertilizers. In 1995, the City received a National Pollutant Discharge Elimination System permit (amended December 1, 2009) from EPA to prevent harmful storm water pollutants from being washed or dumped into the bays. Through a negotiated management plan, the city was tasked with developing a stormwater management program that would provide pollution prevention inspection, monitoring, and educational programs. This program is ongoing at this time.

Analysis of outfall locations within the Corpus Christi Bay Basin shows approximately 70 active storm water outfalls located in the project area that drain into Corpus Christi Bay along the bay front (Fig. 2.3). The largest are the Brawner Parkway outfall at 3.6 x 3.4 m (12.0 x 11.0 ft.) located just south of Ropes Park and the Louisiana Parkway outfall at Cole Park, which is 3.4 x 2.9 m (11.0 x 9.5 ft.) (Fig. 2.3 and Fig. 2.4). Numerous other outfalls range in size from small diameter pipes up to the larger sizes stated above.

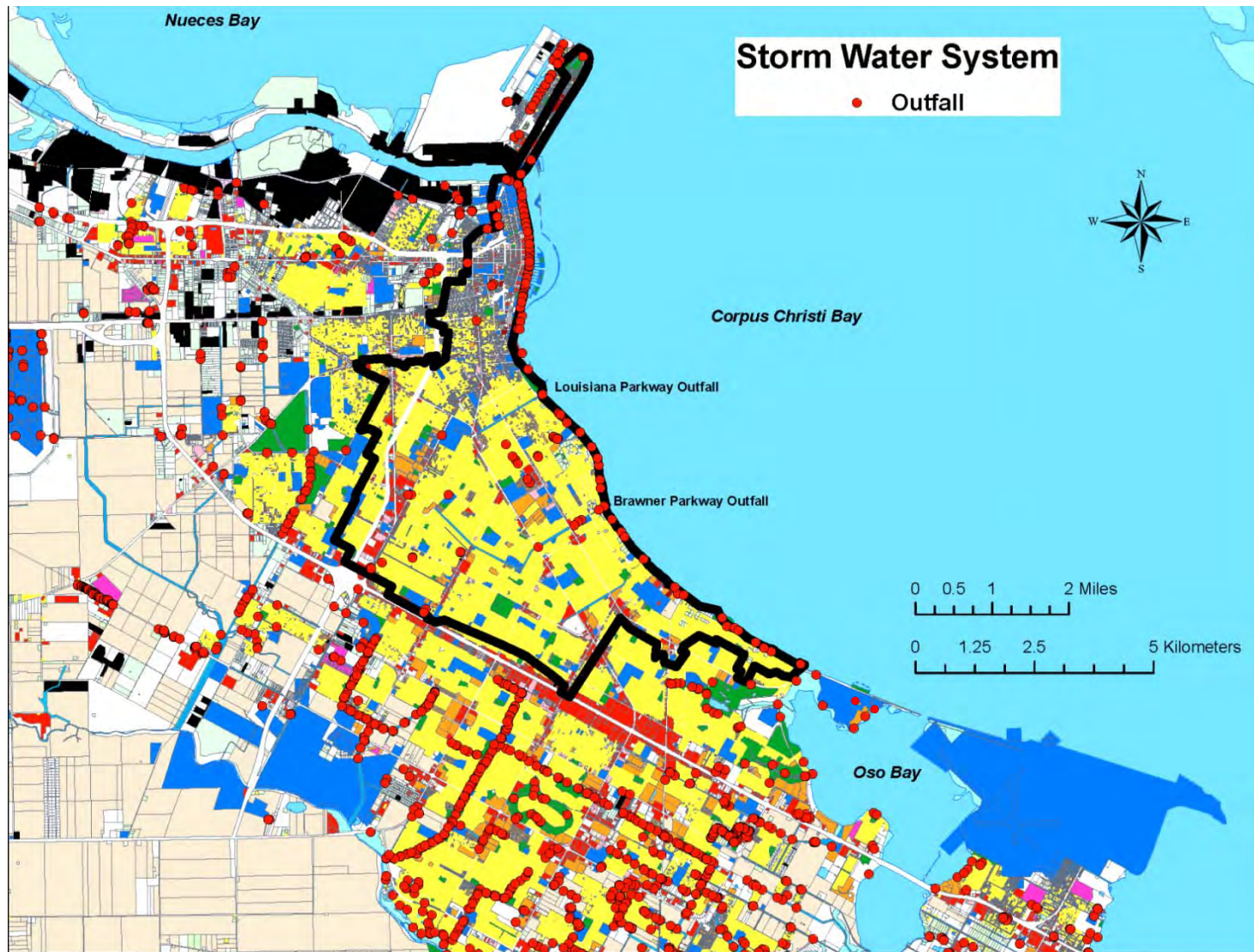


Fig. 2.3. Location of storm water outfalls located within the Corpus Christi Bay Storm Water Drainage Basin, basin area outlined in black (City of Corpus Christi 2011).

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## 2.6 Avian and Wildlife Assessment

An avian and wildlife assessment survey of the project shoreline area was conducted before sampling commenced and species observed are noted on the individual monitoring station descriptions in Section 3 under Wildlife. Literature and online resources were used to note other wildlife species that may use the beach habitat, but were not observed during the survey. While distinctly an urban setting there are nonetheless many types of plants and animals that exist on the land and in the water. One common site along the bay front is the observance of Atlantic bottlenose dolphin, *Tursiops truncatus*, plying the inshore waters of Corpus Christi Bay. As in most urban settings in Texas, Corpus Christi is home to dogs, cats, raccoons, squirrels, opossum, snakes, rats and mice, and bats. While many of these animals are commonly found throughout the City, especially on the outer margins, their occurrence along the bay front may not be as common but they do occur.

Birds are probably the most noticeable wildlife observed by residents and visitors and for the ninth consecutive year, Corpus Christi celebrated the title of '[America's Birdiest City](#)'. Corpus Christi's location on the central flyway makes the area a mecca for birders, with birding and associated activities a mainstay of the local '[experience economy](#)'. In promoting tourism to the area, the Corpus Christi Convention and Visitors Bureau and Texas Parks and Wildlife Department list some possible [animal species](#) to see on their website. While this list is far from complete, and some of these animals are not necessarily found on the bay front, it is apparent that wildlife and tourism are important to the area.

For a detailed scientific review, an excellent resource is the 1996 publication entitled the [Current Status and Trends of the Estuarine Living Resources within the Coastal Bend Bays National Estuary Program Study Area](#) (now the Coastal Bend Bays & Estuaries Program). This extensive four volume report provides details on many organisms, not commonly seen by the average person, that exist in the waters and sediments along the Corpus Christi Bay front and the entire program area.

Estimating the contribution of bacteria from wildlife in TMDL development for this project is important as fecal matter deposited on the land may be potentially carried into the storm water drainage system, or directly into Corpus Christi Bay. Currently the lack of sufficient data to estimate populations and spatial distribution within the Corpus Christi Bay Basin of the storm water system makes assessment difficult. While estimates of pet populations and their impacts on bacteria loadings can be made, actual contributions are unknown.

For example, taking an estimated number of households for the Corpus Christi Basin by Zip Code to be approximately 18,729 ([2010 census](#)) and multiplying by 0.632 dogs per household (AVMA 2011) would yield an estimated dog population of 11,837 dogs. Based on a study at recreational beaches by Wright *et al.* (2009), dogs were the largest contributing source of bacteria at the study site. Enterococci concentrations had average levels of  $3.9 \times 10^7$  CFU/g dry feces. This would yield an estimated production of  $46,164 \times 10^7$  organisms per day that could potentially enter the waters of Corpus Christi Bay should there be sufficient runoff. Additional comparisons showed the microbial load of one dog fecal event was equivalent to 6,940 bird fecal events, thereby emphasizing the potential input from dogs alone. While it is not known what the bacterial input from dogs is within the Corpus Christi Bay Basin, it is obvious that proper pet management through education would help deal with this issue.

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## **2.7 Monitoring Locations for TMDL Project Development**

The following descriptions reflect information observed on site visits made to the location during the planning stages of this project or obtained through city records. These areas represent 10 project sampling locations (Fig. 2.4) that coincide with existing stations sampled by the Texas Beach Watch Program.

Three sampling stations will be established along a transect at each location starting at the beach and continuing offshore. While the distances may vary, the total depth of the water column at which a sample is collected will remain constant at 0.6 m, 1.0 m, and 1.5 m. Actual Water sample collection will occur at 0.3 m beneath the surface at these depths. These samples will be considered as representative of ambient water quality conditions at the “knee”, “waist”, and “chest” depths often encountered by people in the water.

Collection of field parameters and bacteria data may occur up to 60 times at each station in the spring and summer of 2011. Up to six additional sampling events may occur at the 24 and 48 hour marks after a rain event. In addition to water quality sampling, up to 60 sediment samples for bacteria will be collected in the swash or zone of wave interaction, at these locations.

The sample design is based on the program requirements of the Total Maximum Daily Load Program. The TCEQ, and the Center for Coastal Studies at Texas A&M University-Corpus Christi through a TCEQ contract, are tasked with providing data and information to characterize water quality conditions, identify the presence or absence of impairments of designated water body uses, and to support water quality modeling, load allocation development, and other TMDL data and information needs.



Fig. 2.4. Aerial photo depicting Corpus Christi Bay Beaches TMDL sampling locations and three major drainage ditches at Louisiana Parkway, Brawner Parkway, and Carmel Parkway. Retrieved on April 5, 2011 from Google Earth.

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## **Corpus Christi Beach Surfside Park (N 27.824295, W -097.384849)**

**Size and Year Acquired:** 1.0 hectare (2.40 acres), 1962

**Facilities:** A parking lot is available adjacent to the beach at Surfside Park. Seven bathrooms, four shower stalls, six picnic tables with shade cover, a cooking grill, and ten trash cans are available at the park (Fig. 2.5A). The City of Corpus Christi Parks and Recreation Department performs maintenance of the facility on a regular basis.

**Curfew:** None posted or observed.

**Beach:** The approximate total length of Corpus Christi Beach is 2.10 km (6970 ft.), but the focus area is located at Surfside Park and is approximately 100 m (330 ft.) long. The intertidal sandy slope into Corpus Christi Bay is approximately 115° - 120° (Fig. 2.5B).

**Beach Access:** Access to beach and Corpus Christi Bay is from the parking lot adjacent to the beach.

**Beach Debris:** Trash was minimal at time of first inspection and consisted of paper and plastic. City of Corpus Christi Parks and Recreation Department personnel may clean this beach on a regular basis but this is not indicated to the visitor.

**Signage:** Signs were present with the following: “Corpus Christi Beach,” “Corpus Christi Beach Rules” (Fig 2.5C).

**Storm water outfalls:** No visible storm water outfalls.

**Vegetation:** Indian blanket (*Gaillardia pulchella*)

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), and brown pelican (*Pelecanus occidentalis*).

**Activities:** Highly intoxicated individual coming out of bathrooms, dog with owner walking, appears to be a facility used by homeless individuals on a regular basis.

**Additional Information:** This beach was restored in 2001 by the City of Corpus Christi and the Texas General Land Office through a re-nourishment project that placed sand along more than 914 m (3,000 ft.) of Corpus Christi Beach. This project has made this a popular destination for both residents and visitors to Corpus Christi. Location of the three TMDL sampling stations is depicted in Fig. 2.6.

[City of Corpus Christi Parks and Recreation Department - Surfside Park,](#)

[Best Restored Beach Award 2010,](#)

[Corpus Christi Windsurfing.](#)



A



B



C



Fig. 2.5. Views of Corpus Christi Beach at Surfside Park with A) pavilion and bathroom facilities, B) signage, and C) beach looking south towards the U.S.S. Lexington and downtown Corpus Christi.



Fig. 2.6. Aerial photo depicting the three Corpus Christi Beach at Surfside Park TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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## **McGee Beach (N 27.781595, W -097.392423)**

**Size and Year Acquired:** Approximate current size is 3.2 hectare (8.0 acres), 1924

**Facilities:** Parking is available alongside Ocean Drive. Benches and gazebos are available along the seawall with lattice shading (Fig. 2.7A). There is a small food service facility at the north end of the beach.

**Curfew:** None posted or observed.

**Beach:** The approximate length of the beach is 535 m (1765ft.). The intertidal sandy slope into Corpus Christi Bay is approximately 115° - 120° (Fig. 2.7B). Orange hazard fencing was present on the beach but no sign was present to identify caution. The fencing was in line with the outfall pipe.

**Beach Access:** There are two ways to access the beach (1) via the seawall steps and (2) via the wooden stairs at the restaurant and jetty area.

**Beach Debris:** Trash was moderate and consisted of alcohol glass bottles, paper, plastic, baby diapers.

**Signage:** Signs were present with the following: “bus stop,” “handicap parking,” “Beach Watch.”

**Storm water outfalls:** Two storm water outfalls drain into Corpus Christi Bay. One outfall is located in the water approximately 35 m (120 ft.) off the beach and the second outfall is located on the beach in the intertidal area. The pipes are clearly visible from the beach (Fig 2.7C)

**Vegetation:** Saltgrass (*Distichlis spicata*), evening primrose (*Oenothera* sp.)

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), rock pigeon (*Columba livia*), domestic dog (*Canis familiaris*), domestic cat (*Felis catus*), Virginia opossum (*Didelphis virginiana*)

**Activities:** walking, dog walking, picnicking, Tai Chi, and biking.

**Additional Information:** In 2004, the City of Corpus Christi and the Texas General Land Office co-sponsored the re-nourishment of McGee Beach by the placement of approximately 42,815 m<sup>3</sup> (56,000 yd<sup>3</sup>) of sand on a 550 m (1,800 ft.) long by 76 m (250 ft.) wide section of the beach. Location of the three TMDL sampling stations is depicted in Fig. 2.8.

[Best Restored Beach Award 2010](#)

A



B



C



Fig. 2.7. Views of McGee Beach with A) street side parking with benches and gazebos, B) beach view, and C) storm water outfall drains.

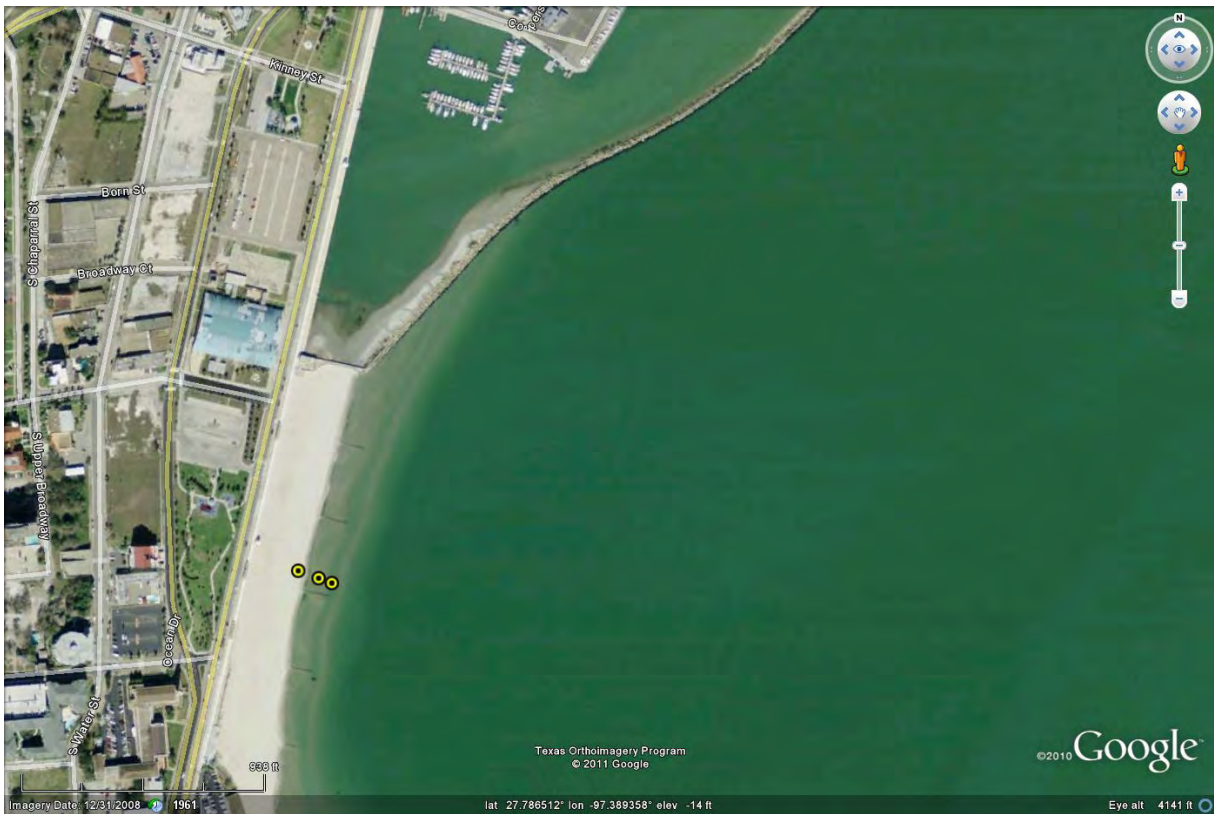


Fig. 2.8. Aerial photo depicting the three McGee Beach TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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**Emerald Beach (N 27.781595, W -097.392423)**

**Size and Year Acquired:** Approximate size is .04 hectares (1.0 acres), year undetermined.

**Facilities** Approximately 240 parking spots are available in the Holiday Inn parking lot.

**Curfew:** None posted or observed.

**Beach:** The total beach is 160 m (530 ft.) in length. Part of the beach is located in front of the Holiday Inn – Emerald Beach and is utilized mainly by the hotels customers. During the season, the hotel offers beach rentals of lounge chairs, umbrellas, Jet Ski rentals, banana float rides, boogie boards and a water jumping trampoline with slide. The south end of Emerald Beach is listed as a public beach. The intertidal sandy slope into Corpus Christi Bay is approximately 115° - 120° (Fig. 2.9A).

**Beach Access:** Access to the public beach area is via a paved parking lot and steps. One red buoy is in the water a distance off the beach marking a “do not swim past” location.

**Beach Debris:** Clean with no trash present. While this section of the beach is listed as a public beach the staff of the Holiday Inn at Emerald Beach routinely cleans this area, as there is no demarcation between the beach in front of the hotel and this section to the southeast (Fig. 2.9B).

**Signage:** Signs were present with the following notations: “public beach,” “slippery when wet,” and “sharp objects underwater” adjacent to bulkhead on south side of beach.

**Storm water outfalls:** One storm water drain in parking lot that drains into basin to the south of the beach behind the bulkhead mentioned above (Fig. 2.9C). No outfall pipes on beach.

**Vegetation:** None

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*)

**Activities:** Two men sitting on chairs, one drinking.

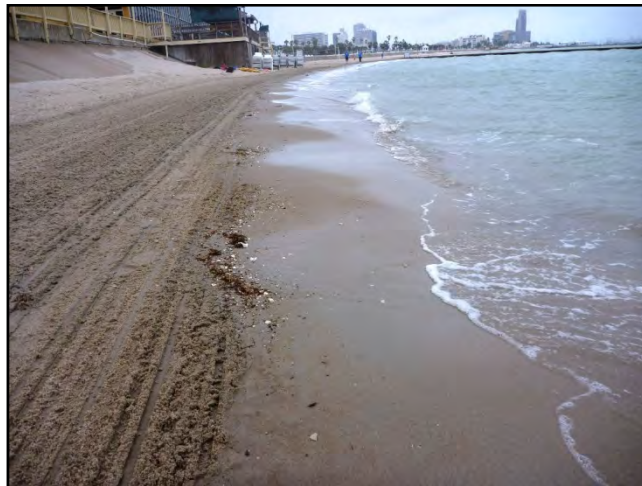
**Additional Information:** Location of the three TMDL sampling stations is depicted in Fig. 2.10.

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A



B



C



Fig. 2.9. Views of Emerald Beach with A) beach view looking northwest with McGee Beach in background, B) beach raking tracks, and C) storm drain.

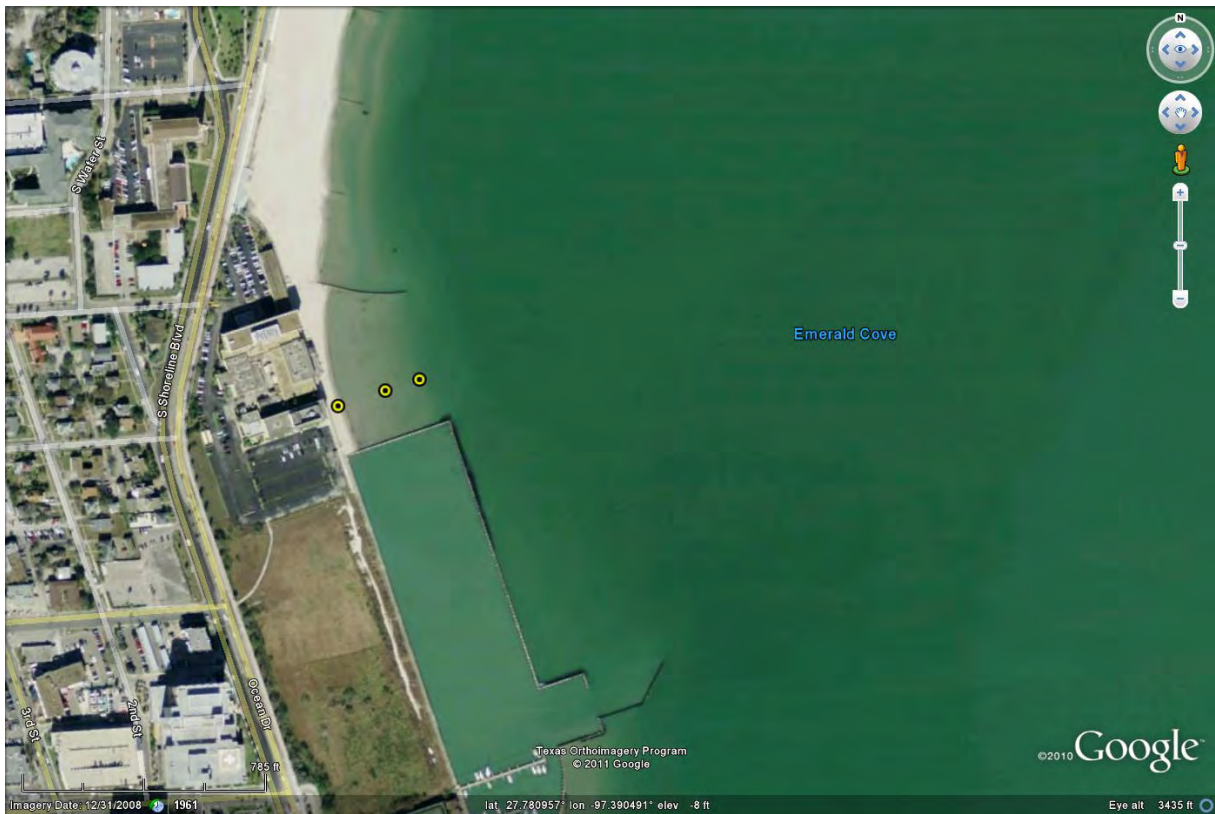


Fig. 2.10. Aerial photo depicting the three Emerald Beach TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.



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### **Cole Park North (N 27.776317, W -097.391480)**

**Size and Year Acquired:** This area is one part of the total size of Cole Park, which is 17.4 hectares (43.0 acres), and no year is listed for acquisition in the City of Corpus Christi's Parks List (City of Corpus Christi 2010).

**Facilities:** Approximately 110 parking spots are available on this side of the park (Fig. 2.11A). Dog feces are common in the park and picnic area.

**Curfew:** Curfew of park is 10 pm. Playground is closed 9 pm through 8 am. Skate Park is closed 10 pm through 8 am.

**Beach:** The total beach at this location is 80 m (265 ft.) in length. The intertidal sandy slope into Corpus Christi Bay is approximately 115° - 120°.

**Beach Access:** Access to the beach is via a paved path that leads directly to the water. A warning sign is present in the water off the beach and warns of "under water obstruction between signs" however, only one sign is present.

**Beach Debris:** Paper, glass, alcohol aluminum and glass containers, cigarette butts, condoms, and plastic trash were present. Leaf litter from residential yards was abundant at the water line (Fig. 2.11B)

**Signage:** Signs were present with the following: "lock your vehicle," "food and drink and bathrooms at amphitheater," "Beach Watch," "underwater obstruction between signs" (only one sign exists), "pedestrian bicycle trail," "no parking or driving in park w/o permit."

**Storm water outfalls:** The parking area has four storm water gutters that drain Ocean Drive and the park (Fig. 2.11C). One submerged outfall is located offshore.

**Vegetation:** Guinea grass (*Megathyrsus maximus*), Sea ox-eye daisy (*Borrchia frutescens*), sea rocket (*Cakile* sp.), and saltgrass (*Distichlis spicata*)

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), raccoon (*Procyon lotor*), domestic dog (*Canis familiaris*), and lightning whelk eggs (*Busycon* sp.).

**Activities:** People biking and walking.

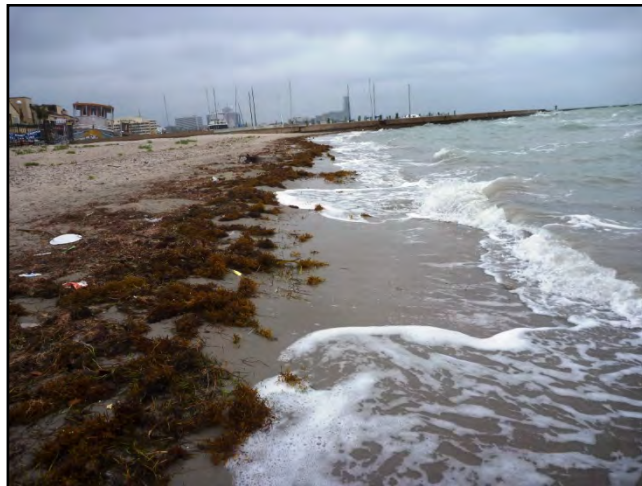
**Additional Information:** See Cole Park Pier description. Location of the three TMDL sampling stations is depicted in Fig. 2.12.

---

A



B



C



Fig. 2.11. Views of Cole Park North with A) parking lot and beach view, B) beach debris, and C) storm water drain in parking lot with additional drain in park in background.

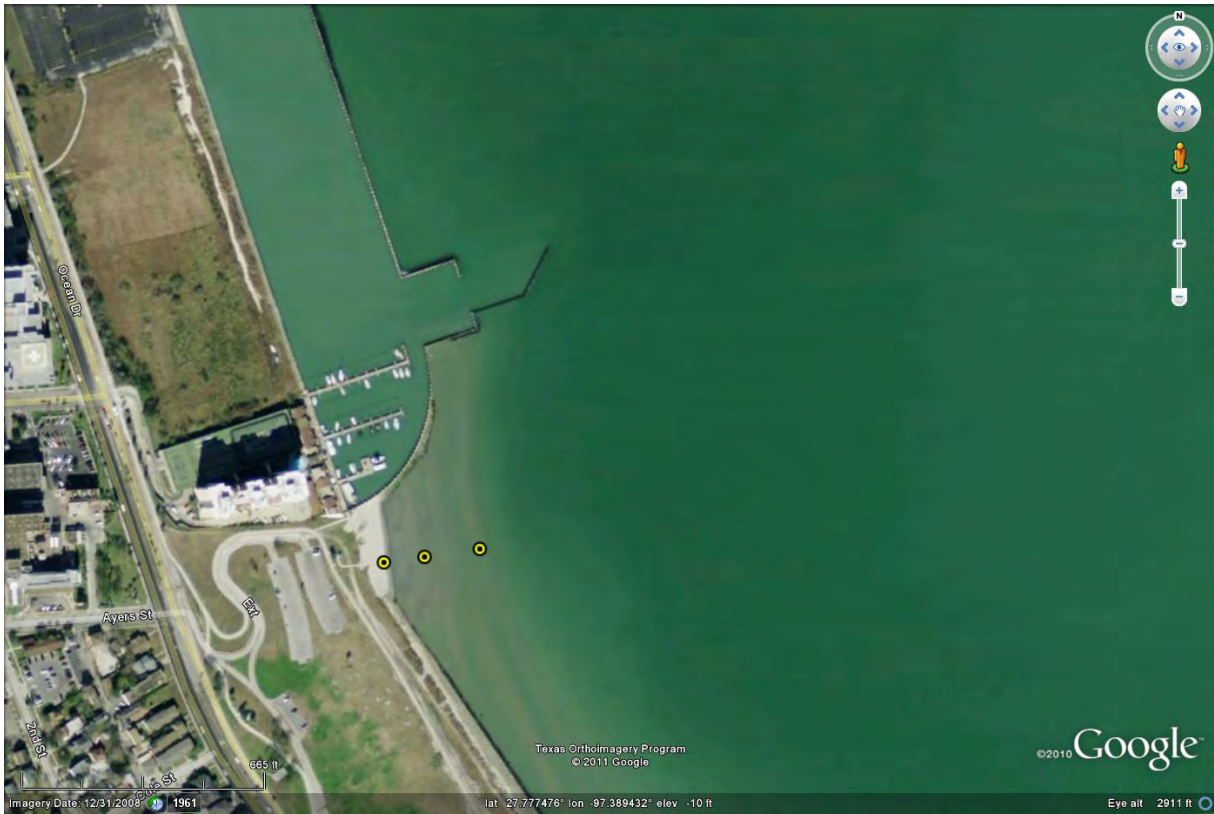


Fig. 2.12. Aerial photo depicting the three Cole Park North TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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### **Cole Park Pier Area (N 27.773297, W -097.388595)**

**Size and Year Acquired:** This area is one part of the total size of Cole Park, which is 17.4 hectares (43.0 acres), and no year is listed for acquisition in the City of Corpus Christi's online Parks List (City of Corpus Christi 2010).

**Facilities:** Approximately 100 parking spots are available at this location which has a lighted fishing pier approximately 145 m (485 ft.) in length (Fig. 2.13A), a large playground called "Kids Place," the Skate Park, an amphitheater, several picnic areas with trash cans, and a public restroom facility. The area is equipped with streetlights and one surveillance camera located near the skate park. Dog feces are common in the park and picnic area.

**Curfew:** Curfew of the park is 10 pm. Playground is closed 9 pm through 8 am. Skate Park is closed 10 pm through 8 am.

**Beach:** There is no beach. The shoreline is a concrete bulkhead with large rocks and obstructions. High wave energy often makes it unsafe to enter the water at this location (Fig. 2.13B).

**Beach Access:** No beach access.

**Beach Debris:** Paper, glass, aluminum/glass containers, cigarette butts, and plastic trash present along bulkhead area. Leaf litter from residential yards was abundant at water line.

**Signage:** Signs were present with the following: "No dumping, motor vehicle or alcohol in park, curfew 10," "Future site of the Gardens of Cole Park [www.beautifycc.org](http://www.beautifycc.org) sign donated by AEP Texas," "Beach Watch," "No Parking on Grass," "No Parking," "Hide your Keys," "City of Corpus Christi rules and regulations of park," "playground closed 9 pm – 8 am," "skate park closed 10 pm – 8 am," "vendors parking only." One gravestone for Richard L. Bemis 1946-2009 and one dedication plaque present.

**Storm water outfalls:** One major outfall that empties into Corpus Christi Bay is located to the south of the pier at the terminus of Louisiana Parkway. The Skate Park has three drains within the concrete area. The parking area has several storm water gutters that drain Ocean Drive and the park (Fig. 2.13C).

**Vegetation:** none

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), ruddy turnstone (*Arenaria interpres*), willet (*Catoptrophorus semipalmatus*), and brown pelican (*Pelecanus occidentalis*).

**Activities:** Person walking with baby, one women walking with child and two dogs, runners, family flying kite.

**Additional Information:** [Cole Park and Skate Park](#). Location of the three TMDL sampling stations is depicted in Fig. 2.14.

---

A



B



C



Fig. 2.13. Views of Cole Park Pier area with A) “Kids Place” playground, B) bulkhead area with fishing pier in background, and C) storm water drain in parking lot.

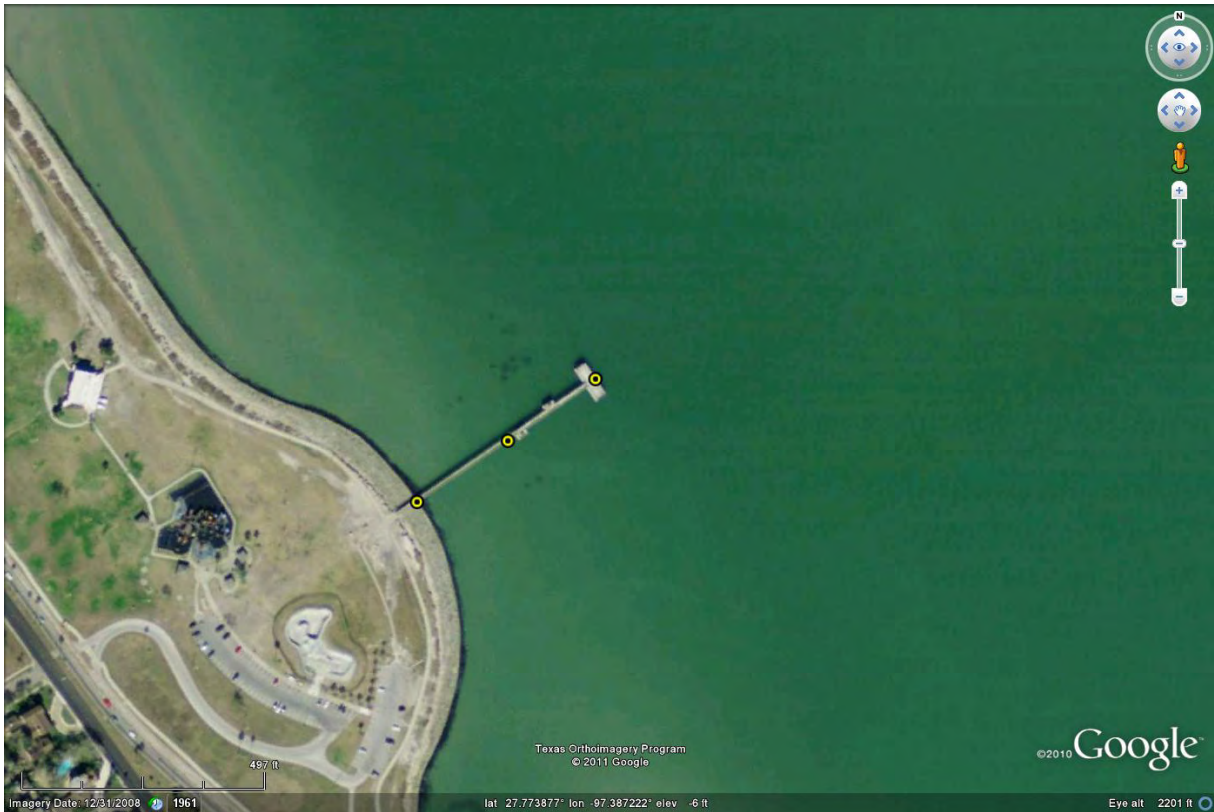


Fig. 2.14. Aerial photo depicting the three Cole Park Pier TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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### **Cole Park near Louisiana Parkway Outfall (N 27.770826, W -097.388371)**

**Size and Year Acquired:** This area is one part of the total size of Cole Park, which is 17.4 hectares (43.0 acres), and no year is listed for acquisition in the City of Corpus Christi's online Parks List (City of Corpus Christi 2010).

**Facilities:** There is no parking at this location. Access is by parking in pier area or at Oleander Point and walking to location down the hike and bike path.

**Curfew:** Curfew of park is 10 pm. Playground is closed 9 pm through 8 am. Skate Park is closed 10 pm through 8 am.

**Beach:** The total sand spit is 30 m (105 ft.) in length. The intertidal slope into Corpus Christi Bay is approximately 115°. The shoreline of this side of Cole Park is bulk headed with concrete and large rock (Fig. 2.15A).

**Beach Access:** There is no beach access at this site except to a small sand spit that is dynamic in nature due to tides and currents (Fig. 2.15B). Access to the sand spit is via a paved path that leads to the concrete seawall steps. Caution is noted when accessing the water because the seawall concrete steps may be slippery and covered with algae.

**Beach Debris:** Paper, glass, aluminum and glass containers alcohol, cigarette butts, and plastic trash were present. Leaf litter from residential yards was abundant at the water line.

**Signage:** Signs were present with the following: "No dumping, motor vehicle or alcohol in park, curfew 10," "Future site of the Gardens of Cole Park [www.beautifycc.org](http://www.beautifycc.org) sign donated by AEP Texas," "Beach Watch," "No Parking on Grass," "No Parking," "Hide your Keys," "City of Corpus Christi rules and regulations of park," "playground closed 9 pm – 8 am," "skate park closed 10 pm – 8 am," "vendors parking only."

**Storm water outfalls:** One main outfall that empties into Corpus Christi Bay is situated at this location at the terminus of Louisiana Parkway (Fig. 2.15C).

**Vegetation:** Guinea grass (*Megathyrsus maximus*).

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), ruddy turnstone (*Arenaria interpres*), willet (*Catoptrophorus semipalmatus*), and brown pelican (*Pelecanus occidentalis*).

**Activities:** No activities observed.

**Additional Information:** See Cole Park Pier description. Location of the three TMDL sampling stations is depicted in Fig. 2.16.

---

A



B



C



Fig. 2.15. Views of Cole Park at Louisiana Outfall area with A) shoreline bulkhead with outfall in near ground and fishing pier in foreground, B) small sand spit access area that migrates down shoreline depending on wind and water currents during the year, and C) Louisiana Parkway storm water outfall.



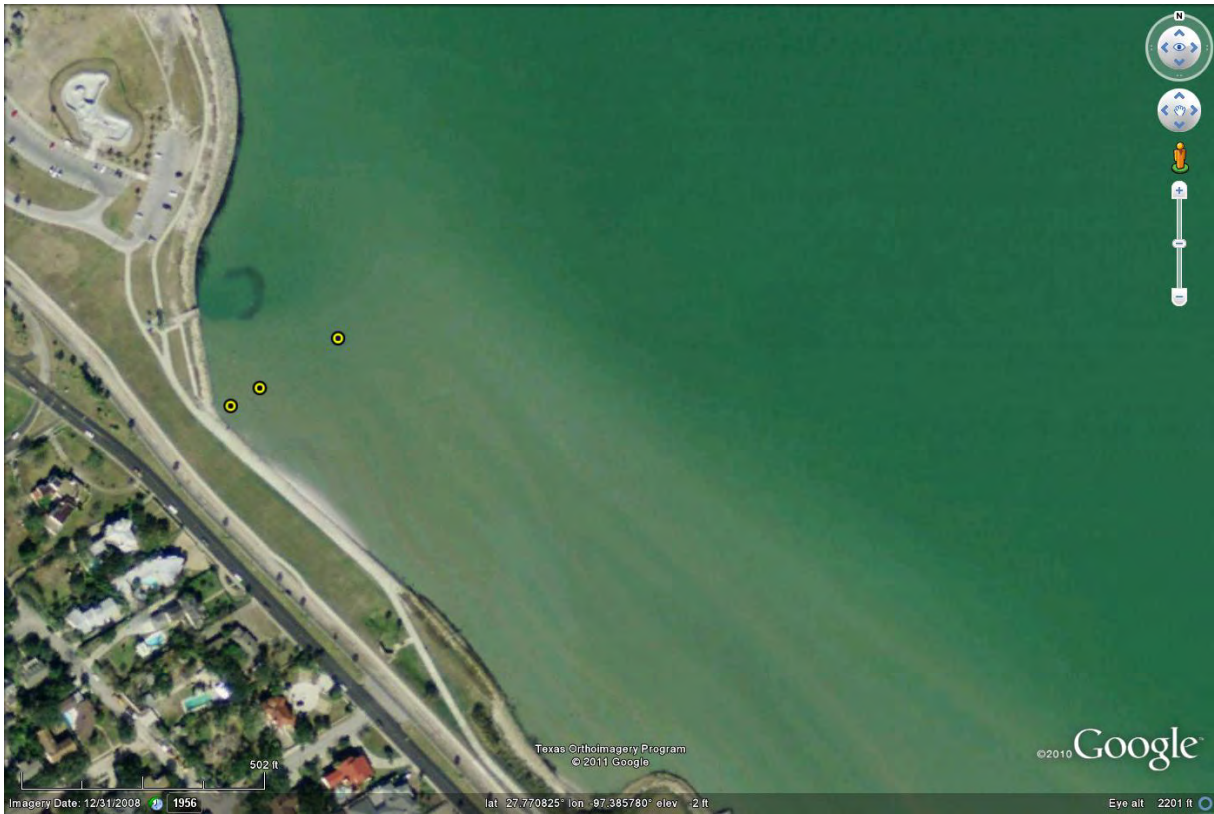


Fig. 2.16. Aerial photo depicting the three Cole Park near Louisiana Outfall TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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### **Cole Park at Oleander Point (N 27.767649, W -097.385383)**

**Size and Year Acquired:** This area is one part of the total size of Cole Park, which is 17.4 hectares (43.0 acres), and no year is listed for acquisition in the City of Corpus Christi's online Parks List (City of Corpus Christi 2010).

**Facilities:** A total of 40 parking spots are available, 38 non-handicaps and two handicap (one parking spot identified with sign) and equipped with street lights. The parking area has one storm water gutter in line with the gutter on Ocean Drive. The Ocean Drive bike lane goes through this park. There is one picnic table with shade, three trash cans, one working water fountain, and one hose outlet.

**Curfew:** Curfew of park in this area is 10 pm.

**Beach:** Total beach length is approximately 548 m (1800 ft.) with approximately 107 m (350 ft.) surveyed for this project. Substrate consists of rubble rock (Fig. 2.17A) with an intertidal slope into Corpus Christi Bay of approximately 115°. Caution was noted when accessing the water due to large concrete material in the water in some locations.

**Beach Access:** Access to the beach is via one set of wooden steps leading to the cobble beach which is not equipped with hand rails but does have signs present that read "Dangerous Steps use at own Risk" (Fig. 2.17B) and "Danger Stay Back- Cliff Drops Off." Handicap beach access is not available at this park.

**Beach Debris:** Paper, glass, aluminum and glass alcohol containers, and plastic trash were present but minimal. Leaf litter from residential yards was common at the high water line.

**Signage:** Four signs with "No dumping, motor vehicle or alcohol in park, curfew 10" (one sign does not give curfew). One sign with the following: "Beach Watch," "Adopt a Spot-State Representative Juan M. Garcia Dist. 32," and Cullen Colts Middle School," "Danger Stay Back – Cliff Drop off," "Dangerous Steps use at own risk," "Adopt a Spot- Sharks Arena Football," "No Parking on Grass with a tow drawing," "Historical Marker for Alonzo Alvarez de' Pienda," "handicap parking sign," and "bike sign for steep grade."

**Storm water outfalls:** Two visible outfalls are located on beach and both empty into Corpus Christi Bay (Fig. 2.17C). There are stagnant pools of water near the outfalls with a foul order. One additional outfall pipe exists approximately 213 m (700 ft.) to the southeast.

**Vegetation:** Guinea grass (*Megathyrsus maximus*), Sea ox-eye daisy (*Borrchia frutescens*), prickly pear (*Opuntia sp.*), evening primrose (*Oenothera sp.*), dandelion (*Taraxacum sp.*)

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), and swallows (family Hirundinidae).

**Activities:** Homeless/transient picking trash from barrels at the picnic table, one woman walking dog, people exercising and bike riding.

**Additional Information:** [The Wind Map for Oleander Point](#) and [Corpus Christi Windsurfing](#). Location of the three TMDL sampling stations is depicted in Fig. 2.18.

---

A



B



C



Fig. 2.17. Views of Cole Park at Oleander Point with A) rubble rock beach shoreline, B) access steps with signage, and C) one of the three storm water outfalls with stagnant water pools.



Fig. 2.18. Aerial photo depicting the three Cole Park at Oleander Point TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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**Ropes Park (N 27.753894, W -097.376431)**

***Size and Year Acquired:*** 1.4 hectares (3.50 acres), 1973

***Facilities:*** Six parking spots are available (five non-handicap and one handicap but no handicap sign is present) and the parking area is equipped with streetlights. The Ocean Drive bike lane goes through this park. The parking area has one storm water gutter in line with the gutter on Ocean Drive. There is one picnic table with shade, one bench, three trash cans, and one working water fountain. Caution should be taken when walking in the grassy area adjacent to the parking area due to a sinkhole that has formed atop a water pipeline. The sinkhole is marked only with dilapidated orange fencing and is not marked with a caution or danger sign. An unlocked metal box buried in the ground also exists adjacent to the parking area and may contain electrical or water lines.

***Curfew:*** One sign reads park curfew is 2 a.m. – 6 a.m.

***Beach:*** Total beach length is approximately 300 m (990 ft.) with 80 m (260 ft.) of sand (Fig. 2.19A). The remaining 220 m (721 ft.) contains large pieces of concrete rubble. The intertidal slope into Corpus Christi Bay is approximately 115° - 120°. Caution should be taken when accessing the beach and bay due to concrete rubble scattered along the shore and in the water.

***Beach Access:*** Access to the beach is via a winding concrete walkway with steps leading to Corpus Christi Bay (Fig. 2.19B). The walkway consists of rock and wooden steps leading to the beach. Handicap access is to the rock winding area only and not to the beach proper. A wooden bridge is also present in the park for visitors to use as a lookout point. Caution should be taken to visitors accessing the beach via walking down the sloped bank due to high erosion and a sinkhole that is currently present on the grassy area overlooking the bay.

***Beach Debris:*** Paper, glass, hypodermic syringes, aluminum and glass alcohol containers, and plastic trash were abundant. Leaf litter from residential yards was common at high water line.

***Signage:*** One sign of the following: “No dumping, motor vehicle or alcohol in park, curfew 2 a.m. – 6 a.m.,” “Beach Watch,” “Adopt a Spot- South Park Civic-Minded Knights,” and “Historical Marker for Elihu Harrison Ropes,” and “bike lane ends.”

***Storm water outfalls:*** One outfall is located on the beach that empties into Corpus Christi Bay (Fig. 2.19C). A stagnant pool of water has formed outside of the pipe and has a foul order. A second outfall is located on the north end of the beach adjacent to residential housing.

***Vegetation:*** Guinea grass (*Megathyrsus maximus*), Sea ox-eye daisy (*Borrchia frutescens*), prickly pear (*Opuntia sp.*), evening primrose (*Oenothera sp.*), and Texas nightshade (*Solanum sp.*)

***Wildlife:*** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), ruddy turnstone (*Arenaria interpres*), and brown pelican (*Pelecanus occidentalis*).

***Activities:*** Homeless sleeping area (one bedroll was found along the winding walkway), three people standing in park area.

***Additional Information:*** [Corpus Christi Windsurfing](#). Location of the three TMDL sampling stations is depicted in Fig. 2.20.

---

A



B



C



Fig. 2.19. Views of Ropes Park with A) sandy part of shoreline, B) access steps with signage, and C) storm water outfall and concrete rubble portion of beach in foreground and background with concrete debris in water clearly visible.



Fig. 2.20. Aerial photo depicting the three Ropes Park TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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**Poenisch Park (N 27.723839, W -097.343546)**

**Size and Year Acquired:** 0.5 hectares (1.32 acres), 1938

**Facilities:** Seven parking spots are available, six non-handicaps and one handicap (with sign) and area is equipped with streetlights. The parking area has one storm water gutter in line with the gutter on Ocean Drive. The Ocean Drive bike lane goes through this park. There is one picnic table with shade, one bench, one trash can, and one bike rack.

**Curfew:** One sign reads park curfew is 2 a.m. – 6 a.m.

**Beach:** The beach shoreline is approximately 90 m (300 ft.) long and consists of large concrete rubble, shell hash, and sand (Fig. 2.21A). The intertidal slope into Corpus Christi Bay is approximately 115°. Caution should be taken when accessing the beach and bay due to the steep bank slope and large concrete material that is scattered along the shore and in the water.

**Beach Access:** Caution is advised when attempting to access this beach since no fabricated entry structures are available. There are no steps, rails, or ramps to Corpus Christi Bay. Access to the bay is at your own risk via walking down the steep sloped bank (Fig. 2.21B).

**Beach Debris:** Paper, glass, aluminum, and plastic trash were present but minimal. Hypodermic syringes were found lying on the beach. Leaf litter and salt cedar clippings from residential yards were common at the high water line.

**Signage:** One sign of the following: “No dumping, motor vehicle or alcohol in park, curfew 2 a.m. – 6 a.m.,” “Beach Watch,” “Adopt a Spot- Preceptor Lambda Psi Beta Sigma Phi,” and “handicap parking sign.” Two signs displaying “bike lane ends.”

**Storm water outfalls:** One outfall is located on beach and empties into Corpus Christi Bay (Fig. 2.21C).

**Vegetation:** Guinea grass (*Megathyrsus maximus*), Sea ox-eye daisy (*Borrchia frutescens*), prickly pear (*Opuntia sp.*), evening primrose (*Oenothera sp.*), annual seepweed (*Sueada linearis*), camphor daisy (*Haplopappus phyllocephalus*), sea rocket (*Cakile sp.*)

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), great-tailed grackle (*Quiscalus mexicanus*), rock pigeon (*Columba livia*), and nine-banded armadillo (*Dasypus novemcinctus*) feeding in grass.

**Activities:** One man walking dog, women sitting in car on phone.

**Additional Information:** [Corpus Christi Windsurfing](#). Location of the three TMDL sampling stations is depicted in Fig. 2.22.



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A



B



C



Fig. 2.21. Views of Poenisch Park with A) sandy and concrete rubble shoreline looking northwest towards downtown Corpus Christi, B) shoreline looking southeast with typical bank profile, and C) storm water outfall with stagnant pool of water.



Fig. 2.22. Aerial photo depicting the three Poenisch Park TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.

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**University Beach (N 27.715081, W -097.321430)**

**Size and Year Acquired:** This 2.2 hectare (5.5 acre) beach was created in 2002 through a joint effort between the Texas General Land Office and Texas A&M University-Corpus Christi.

**Facilities:** Parking is very limited and only available on the rubble shoreline bank adjacent to Corpus Christi Bay on the southeast side of the beach. There are two gazebos located on Ocean Drive overlooking the beach (Fig. 2.23A).

**Curfew:** None known

**Beach:** The approximate total length is 370 m (1210 ft.). The intertidal sandy slope into Corpus Christi Bay is approximately 115° - 120° (Fig. 2.23B). The area is extremely shallow, as much of the area behind the breakwater structures has filled in since the beach was created.

**Beach Access:** Access to beach is via the sloped bank of Corpus Christi Bay or walking from Texas A&M University- Corpus Christi and crossing Ocean Drive.

**Beach Debris:** Trash was moderate and consisted of a foam mattress, paper, plastic, aluminum, and glass.

**Signage:** Signs were present with the following: “No Parking”.

**Storm water outfalls:** Two storm water outfalls exist near this location. Each one is located just outside the beach past the breakwater structures to the northwest and southeast of the beach (Fig. 2.23C).

**Vegetation:** Saltgrass (*Distichlis spicata*), evening primrose (*Oenothera* sp.), sea purslane (*Sesuvium portulacastrum*).

**Wildlife:** Laughing gulls (*Leucophaeus atricilla*), Caspian tern (*Sterna caspia*), Raccoon (*Procyon lotor*), domestic dog (*Canis familiaris*)

**Activities:** No activities observed.

**Additional Information:** [Corpus Christi Windsurfing](#). Location of the three TMDL sampling stations is depicted in Fig. 2.24.

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A



B



C



Fig. 2.23. Views of University Beach with A) gazebos and slope access in distance, B) view of beach looking northwest, and C) storm water outfall and parking on southeast end just outside of beach area.



Fig. 2.24. Aerial photo depicting the three University Beach TMDL sampling locations. Retrieved on April 5, 2011 from Google Earth.



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## 3.0 REVIEW OF HISTORICAL BACTERIA DATA

### 3.1 Data Acquisition

As the impairment listing at Cole and Ropes Parks, Segment 2481CB\_03 and 2481CB\_04, respectively, is due to exceedance of the *Enterococcus* bacterial criteria, this data review focuses only on *Enterococcus* bacterial data collected. While historical fecal coliform and *Escherichia coli* data does exist for some locations, *Enterococcus* is the preferred bacterial indicator for Primary Contact Recreation use in tidal waters and at “Recreational Beaches”.

Ambient enterococci data were obtained from multiple sources for this review. TCEQ data were queried from the Surface Water Quality Monitoring Information System (SWQMIS), formally known as the Texas Regulatory Activities and Compliance System (TRACS) database. The statewide water quality database has received data since 1967 when the original Surface Water Quality Monitoring Program was established. This 44-year period of record allows TCEQ to characterize existing conditions, evaluate spatial and temporal trends, develop water quality standards, determine standards compliance, identify emerging problems, and evaluate water quality control program effectiveness. Most data were collected by TCEQ, contributing river authorities, cities, and other local, state, and federal agencies under approved Quality Assurance Project Plans (QAPP) to ensure data integrity and quality.

Data obtained from Texas A&M University-Corpus Christi came from Regional Coastal Assessment Program (RCAP) project reports submitted to the Coastal Bend Bays & Estuaries Program (CBBEP) by Brien A. Nicolau of the Center for Coastal Studies. A joint effort with Texas Parks & Wildlife Department, the lead agency for the EPA National Coastal Assessment Program, the RCAP collected data throughout the CBBEP program area quarterly in 2000 and 2001 and once during the summer months at randomly chosen stations for 2002, 2003, and 2004. Bacteria samples in Corpus Christi Bay (Segment 2481) were only collected in 2002, 2003, and 2004. Data for all projects were collected under an approved QAPP.

Additional data obtained from Texas A&M University-Corpus Christi came from Dr. Joanna Mott of the Life Science Department and Director of the Environmental Microbiology Laboratory. Dr. Mott has worked on several bacteria source tracking projects in Texas and along the bay front of Corpus Christi Bay at the two stations (Cole Park and Ropes Park) listed as impaired. She is also the current Project Manager for the Texas General Land Office, Texas Beach Watch Program in the Coastal Bend. Data for research projects came from project reports submitted to the CBBEP and Texas Beach Watch data were obtained from the EPA STORET (STorage and RETrieval) website (<http://www.epa.gov/STORET/>). Data for all projects were collected under an approved QAPP.

### 3.2 Data Analysis and Review

While a multitude of TCEQ stations exist in Corpus Christ Bay, many were only sampled once, as part of a special study. Data were reviewed from two long-term regularly monitored TCEQ stations considered representative based on the proximity to Cole and Ropes Park and the proximity to the proposed TMDL study sampling locations. The first location, Station 13441, is located 1.1 km east of Ropes Park in the deeper waters of Corpus Christi Bay and has been routinely (4 times per year) sampled since April 2001 (Fig. 3.1).

Data from the second location, while not close to Cole or Ropes Park were analyzed due to proximity to the shoreline and that there is a paucity of routinely monitored TCEQ stations along the bay front for bacteria data comparison. Station 13410 is located in Corpus Christi Bay outside the entrance to the Corpus Christi Inner Harbor (Fig. 3.1). This station is located 1.6 km to the south of the sampling locations at Surfside Park on Corpus Christi Beach and 2.8 km to the north of the sampling stations at McGee Beach. This station has also been routinely (4 times per year) sampled since April 2001. Data reviewed for these stations showed three (3) exceedances but the Primary Contact Recreation use was being met in the open bay waters based on the criteria (Table 3.1).

Table 3.1. Summary of enterococci data and exceedances of the SSMD (Single Sample Maximum Density) criteria of 104 MPN/100 ml and the geometric mean criteria of 35 MPN/100 ml for estuarine waters at TCEQ stations.

TCEQ Station ID	No. of Samples	Minimum Conc.	Maximum Conc.	SSMD Exceedances	SSMD % Exceedances	Geometric Mean
13410	32	<1	1,200	3	9.4	16.4
13411	32	1	2,489	3	9.4	16.4

Data reviewed from the Regional Coastal Assessment Program (Nicolau and Nuñez 2004, Nicolau and Nuñez 2005a, Nicolau and Nuñez 2005b, Nicolau 2006) consisted of data submitted to TCEQ SWQMIS. However, since the author was the Project Manager for this study, the data were retrieved from the Center for Coastal Studies database for analysis.

While there were 83 stations sampled in Corpus Christi Bay (Segment 2481) for RCAP, none of the stations sampled were located near the shoreline where the current TMDL bacteria data are proposed to be collected. Bacteria data was not collected at the 58 stations sampled in 2000-2001 and was only collected for 11 stations sampled in 2002, 6 stations in 2003, and 8 stations sampled in 2004.

While data from RCAP is not truly representative of the current TMDL project area, it is indicative of conditions in the open waters of Corpus Christi Bay. A review of the data showed only six stations located in the general area of the current TMDL. Open water bay samples for enterococci were 20 MPN/100 ml at Stations 18603 and 18609 and <10 at stations 17758, 18618, and 18621.

One exceedance of the criteria occurred in August 2002 at Station 18327 located at the interface of Nueces Bay and Corpus Christi Bay (Fig. 3.1), where the value recorded was 324 MPN/100 ml and was likely due to excessive inflows from the Nueces River that began in July 2002 and were still ongoing during sampling. Concentrations at all other Corpus Christi Bay stations were <10 MPN/100 ml except for one station located in the southern portion of the segment, north of the JFK Causeway (segment boundary) in the Upper Laguna Madre, where the concentration was 41 MPN/100 ml.



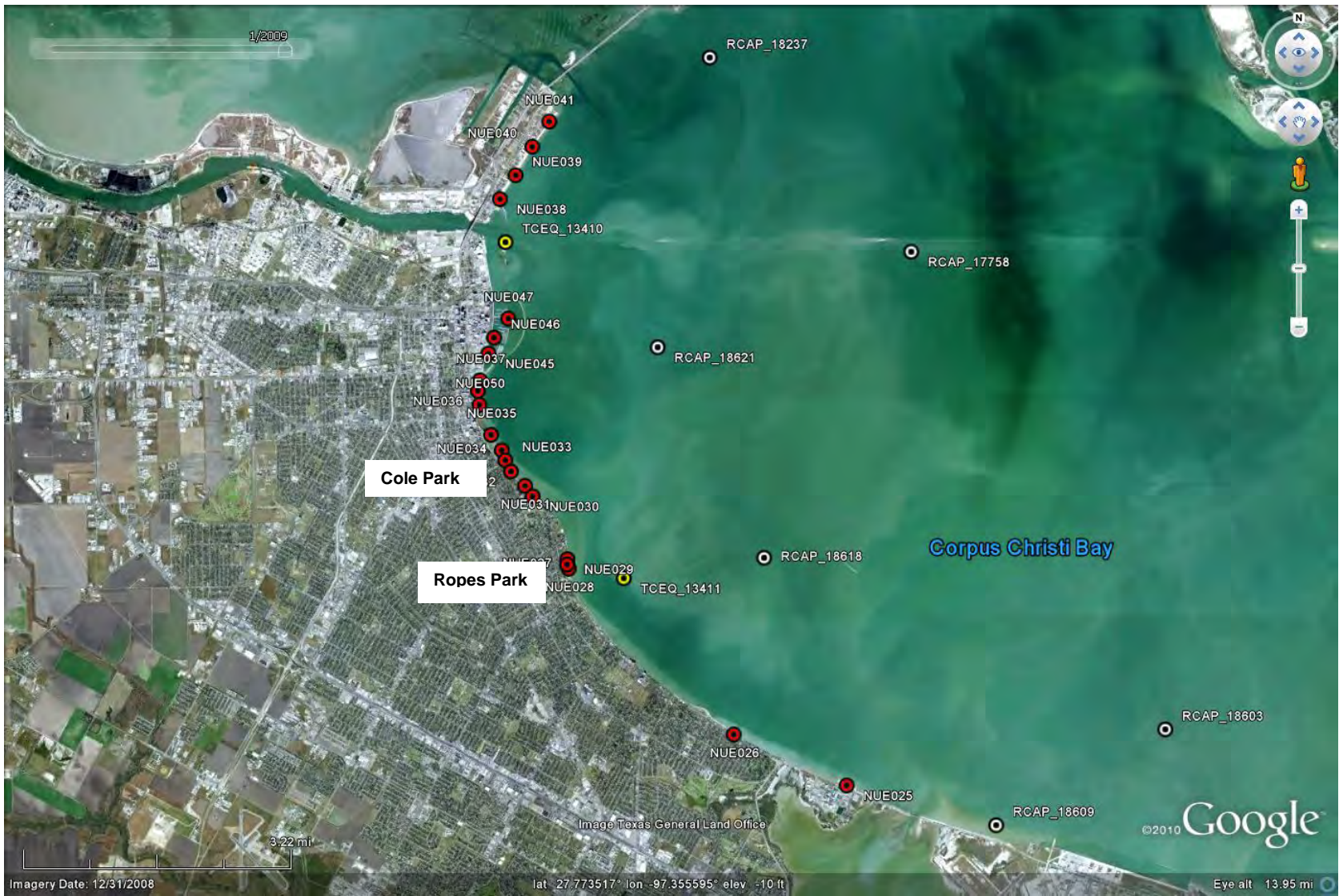


Fig. 3.1. Location of TCEQ stations (yellow dots), RCAP stations (white dots), and Texas Beach Watch stations (red dots) reviewed for enterococci data. Retrieved on July 5, 2011 from Google Earth.

Data was reviewed from three special studies conducted for the Coastal Bend Bays & Estuaries Program by Dr. Joanna Mott of Texas A&M University-Corpus Christi. The first study, *Microbiological Monitoring and Assessment of Storm Drain Runoff within the CBBEP Project Area* (Mott *et al.* 2001) took place from January 1999 through May 2000 and looked at the effects of storm drain runoff at the same locations under TMDL development for this project, Cole and Ropes Parks (Figs. 2.4 and 3.1). In addition, sampling also occurred at McGee Beach and the Corpus Christi City Marina (replaced McGee Beach when the storm drain was shut down for repairs) and at Swantner Park (located between Ropes and Poenisch Park) which was used as a control since no storm water outfall existed at the location.

Samples were collected and analyzed for enterococci, fecal coliforms, and total coliforms during dry and wet weather conditions at three sites (outfall and either side of outfall). The study found that no significant difference in microbial fecal indicators existed in relation to distance from the outfall and that development of a predictive model based on rainfall would be useful. Suggestions for further research looking at bacteria in sediments and effects of turbidity, wave height, and wind speed and direction should be evaluated in future studies.

Looking at percentages of enterococci samples from one site at each location showed Ropes Park exceeded the standard (104 CFU/100 ml) 38% of the time for dry weather sampling (Table 3.2). Mott *et al.* 2001 found that higher enterococci numbers corresponded with lower water temperatures and strong winds but that during wet weather, increases occurred in concentrations regardless of temperature. The percentage of all single samples collected from all locations after rain events exceeded the standard 67% of the time for enterococci. Enterococci levels reached as high as 12,000 CFU/100ml and remained high for several days following the rain event.

Intensive sampling (5 times in 30 days) was also conducted during the six month study and the geometric mean was calculated to compare against the criteria of 35 CFU/100 ml. Results showed the criteria was exceeded at McGee Beach and Corpus Christi Marina 44.4%, Cole Park 33.3%, Ropes Park 88.8%, and at Swantner Park 0.0% of the time.

Table 3.2. Summary of enterococci data and exceedances of the SSMD (Single Sample Maximum Density) criteria of 104 CFU/100 ml at locations sampled in dry weather by Mott *et al.* 2001.

Station Locations	No. of Samples	Minimum Conc.	Maximum Conc.	SSMD % Exceedances
McGee/Marina	21	1	2,200	29.0%
Cole Park	21	1	2,900	19.0%
Ropes Park	21	4	2,100	38.0%
Swantner Park	21	1	2,000	24.0%

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The second study reviewed was *Vibrio vulnificus* Monitoring in Recreational Waters (Mott *et al.* 2008). A common organism found in coastal waters, *V. vulnificus*, is a leading cause of death related to seafood consumption in the U.S. and no current regulatory monitoring occurred in Texas at the time of the study. Sampling occurred monthly from August 2006 through July 2007 at six public-use beaches, fishing areas, and/or recreational sites [Laguna Madre (Bird Island Basin), Corpus Christi Bay (Cole Park), Nueces Bay, Copano Bay and Redfish Bay]. The study looked at seasonal variation and factors such as temperature, salinity, and enterococci levels and how they related to elevated *V. vulnificus* concentrations.

In relation to current TMDL development at Cole Park, the study results showed enterococci levels ranged from <1 to 1055 CFU/100 ml at the six sites but that the highest numbers of *Enterococcus* sp. were found at Cole Park. Of the 12 samples taken at Cole Park the geometric mean was well below the standard of 35 CFU/100 ml at 15.4 CFU/100 ml, but the SSMD of 104 CFU/100 ml was exceeded 25% of the time. For comparison the other locations exceeded the SSMD 16.6% at Bird Island, 25.0% in Nueces Bay, 8.3% in Redfish Bay, 0.0% in Copano Bay, and 8.3% at Bayside (west end of Copano Bay). Higher levels were associated with rainfall events. Due to a significant correlation between *V. vulnificus* and enterococci levels, the study suggested that enterococci might serve as an indicator of elevated *V. vulnificus* levels in Coastal Bend waters.

The third study, *Bacteria Monitoring and Source Tracking in Corpus Christi Bay at Cole and Ropes Parks* (Mott *et al.* 2010) dealt exclusively with the two impaired parks under investigation for this TMDL (Fig. 3.1). Water samples were collected from six sites (two at Ropes Park and four at Cole Park) from February 2010 through September 2010 and analyzed for the enterococcal surface protein (*esp*) associated with the human intestinal tract to determine if human fecal contamination is the problem. Comparison of the *esp* marker was also made to three other human-specific markers from other studies. Six sampling events were classified as No Rainfall and four were classified as Rainfall to compare dry versus wet conditions.

Conclusions from this study indicated that human contamination was detected at both parks under some, but not all, dry weather conditions and that the *esp* gene was detected at Ropes Park following rainfall when enterococci levels were high. Detection at Ropes Park was thought to indicate a human contribution from storm drain outflow or non-point source runoff. Review of the sampling data shows that for all events the geometric mean of the samples at that location exceeded the 35 CFU/100 ml at every station but one (NUE032) and that the SSMD criteria of 104 CFU/100 ml was exceeded from 30% to 50% of the time at all locations (Table 3.3)

Looking at only No Rainfall Events, the geometric mean was exceeded at one Ropes Park station and the SSMD criteria was exceeded at both Ropes Park locations (33.3%) and one Cole Park location (33.3%). Examination of the data for Rainfall Events showed that the geometric mean criterion was exceeded at all locations and the SSMD exceedances ranged from 50% to 100% of all samples at a particular location (Table 3.3).

Table 3.3. Summary of enterococci data (CFU/100 ml) and exceedances of the SSMD (Single Sample Maximum Density) criteria of 104 CFU/100 ml and the geometric mean criteria of 35 CFU/100 ml at locations sampled in dry and wet weather by Mott *et al.* 2010. **Bold** dates signify events classified as rainfall events.

<b>Date</b>	<b>Rain Past 7 Days cm (in)</b>	<b>NUE028 Ropes 2</b>	<b>NUE029 Ropes 3</b>	<b>NUE031 Oleander Point</b>	<b>NUE032 Sand Spit</b>	<b>NUE033 Louisiana Outfall</b>	<b>NUE035 Cole North</b>
02/17/2010	2.3 (0.9)	43.0	3.3	17.0	5.0	4.7	3.7
03/24/2010	1.8 (0.7)	323.3	238	81.3	97.0	27.7	112.3
04/28/2010	0.0 (0.0)	26.7	38.3	6.3	2.7	1.7	25.3
<b>05/16/2010</b>	2.5 (1.0)	58.3	132.8	5.0	5.7	2,313.1	30.0
05/26/2010	0.0 (0.0)	10.3	14.3	3.0	1.3	51.7	3.7
06/03/2010	3.6 (1.4)	566.7	213.3	1,166.7	900.0	66.0	112.0
<b>06/09/2010</b>	9.9 (3.9)	115.7	286.3	232.3	116.6	131.3	67.0
07/06/2010	5.8 (2.3)	6.0	5.7	13.7	1.0	12.0	10.7
<b>09/10/2010</b>	9.1 (3.6)	45.7	38.0	70.3	37.7	176.7	389.0
<b>09/22/2010</b>	21.1 (8.6)	1,603.3	2,313.3	863.3	620.0	710.0	756.7
<b>All Events (10)</b>	Geometric mean	76.0	66.7	44.3	21.8	56.7	44.1
	>104	4	5	3	3	4	4
	% >104	40.0%	50.0%	30.0%	30.0%	40.0%	40.0%
<b>No Rain Events (6)</b>	Geometric mean	48.5	28.4	27.3	10.7	14.4	19.0
	>104	2	2	1	1	0	2
	% >104	33.3%	33.3%	16.7%	16.7%	0.0%	33.3%
<b>Rain Events (4)</b>	Geometric mean	149.1	240.4	91.6	62.8	441.8	156.0
	>104	2	3	2	2	4	2
	% >104	50.0%	75.0%	50.0%	50.0%	100.0%	50.0%

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Funded by EPA and administered by GLO, the Texas Beach Watch program represents the most comprehensive amount of bacteria data collected in the project area (Fig. 3.1) and is the basis for the current impairment. Sampling for the Beach Watch Program in the Coastal Bend began in 2003 and data were reviewed from November 2003 through March 2011 at 18 locations (15 active and 3 discontinued) which correspond to the 10 locations selected for monitoring under the current TMDL.

Review of the data downloaded from EPA STORET showed while the majority of samples collected on a given day at a location were two (98.89%), there were some locations that had one (1.38%), three (4.71%), or four (0.02%) samples collected on that day. Data reviewed in Table 3.3 represents the average of all samples taken at the location on a given day.

While maximum concentrations have exceeded the SSMD of 104 CFU/100 ml at all locations, the following locations exceeded the Not Supporting the Recreational Beach use 25% or more of the time: Poenisch Park, all Ropes Park sites, and four of the six Cole Park sites (Table 3.3). When looking at the graphical representation of this data (Fig. 3.2) it is apparent that as you approach Ropes and Cole Parks from the University Beach location, the percent exceedance increases and then decreases as you move north up the shoreline to Corpus Christi Beach. For all averaged samples over the entire period the geometric mean criteria of 35 CFU/100 ml was exceeded at all three Ropes Park sites and three of the Cole Park sites (Table 3.3).

The data collected for Texas Beach Watch and the three special studies conducted by Texas A&M University-Corpus Christi give an overall representation of the water quality for all types of weather conditions (no rainfall and rainfall). Data analysis clearly indicates that in projects where shoreline sampling occurs, criteria exceedances exist at Cole and Ropes Park. As there are no permitted wastewater discharges along this reach of Corpus Christi Bay, investigations of possible bacteria contamination from storm water outfalls or non-point source discharges is necessary to ensure the protection of public health at these urban beaches and public access points.

Table 3.4. Summary of Texas Beach Watch enterococci data and exceedances of the SSMD (Single Sample Maximum Density) criteria of 104 CFU/100 ml or MPN/100 ml and the geometric mean criteria of 35 CFU/100 ml or MPN/ml for Recreational Beaches. Active stations are in **Bold** and shaded area represents exceedance of the criterion. Number of samples represents the average of all samples taken at that location on a given day.

Beach Watch Station ID	Location	No. of Samples	Minimum Conc.	Maximum Conc.	SSMD Exceedances	SSMD % Exceedances	Geometric Mean
<b>NUE025</b>	<b>University Beach</b>	<b>298</b>	<b>1</b>	<b>2,460</b>	<b>39</b>	<b>13.1%</b>	<b>14</b>
<b>NUE026</b>	<b>Poenisch Park</b>	<b>353</b>	<b>1</b>	<b>4,905</b>	<b>96</b>	<b>27.3%</b>	<b>33</b>
NUE027	Ropes Park #1	99	1	8,500	35	35.4%	54
<b>NUE028</b>	<b>Ropes Park #2</b>	<b>401</b>	<b>1</b>	<b>9,500</b>	<b>145</b>	<b>36.3%</b>	<b>57</b>
<b>NUE029</b>	<b>Ropes Park #3</b>	<b>399</b>	<b>1</b>	<b>6,950</b>	<b>141</b>	<b>35.4%</b>	<b>54</b>
NUE030	Cole Park #1	84	1	14,400	24	28.6%	31
<b>NUE031</b>	<b>Cole Park #2</b>	<b>396</b>	<b>1</b>	<b>6,550</b>	<b>141</b>	<b>35.6%</b>	<b>43</b>
<b>NUE032</b>	<b>Cole Park #3</b>	<b>377</b>	<b>1</b>	<b>7,560</b>	<b>123</b>	<b>32.6%</b>	<b>39</b>
<b>NUE033</b>	<b>Cole Park #4</b>	<b>382</b>	<b>1</b>	<b>13,320</b>	<b>124</b>	<b>32.5%</b>	<b>50</b>
NUE034	Cole Park #5	83	1	5,665	19	22.9%	21
<b>NUE035</b>	<b>Cole Park #6</b>	<b>329</b>	<b>1</b>	<b>6,130</b>	<b>72</b>	<b>21.9%</b>	<b>22</b>
<b>NUE036</b>	<b>McGee Beach #1</b>	<b>298</b>	<b>1</b>	<b>4,550</b>	<b>46</b>	<b>15.4%</b>	<b>15</b>
<b>NUE037</b>	<b>McGee Beach #2</b>	<b>293</b>	<b>1</b>	<b>1,660</b>	<b>40</b>	<b>13.7%</b>	<b>12</b>
<b>NUE050</b>	<b>Emerald Beach</b>	<b>182</b>	<b>1</b>	<b>4,880</b>	<b>32</b>	<b>17.6%</b>	<b>24</b>
<b>NUE038</b>	<b>CC Beach-Coastal</b>	<b>276</b>	<b>1</b>	<b>855</b>	<b>15</b>	<b>5.4%</b>	<b>16</b>
<b>NUE039</b>	<b>CC Beach-Breakers</b>	<b>276</b>	<b>1</b>	<b>430</b>	<b>15</b>	<b>5.4%</b>	<b>12</b>
<b>NUE040</b>	<b>CC Beach-Gulfspray</b>	<b>277</b>	<b>1</b>	<b>525</b>	<b>17</b>	<b>6.1%</b>	<b>11</b>
<b>NUE041</b>	<b>CC Beach-Gulden</b>	<b>273</b>	<b>1</b>	<b>800</b>	<b>12</b>	<b>4.4%</b>	<b>10</b>

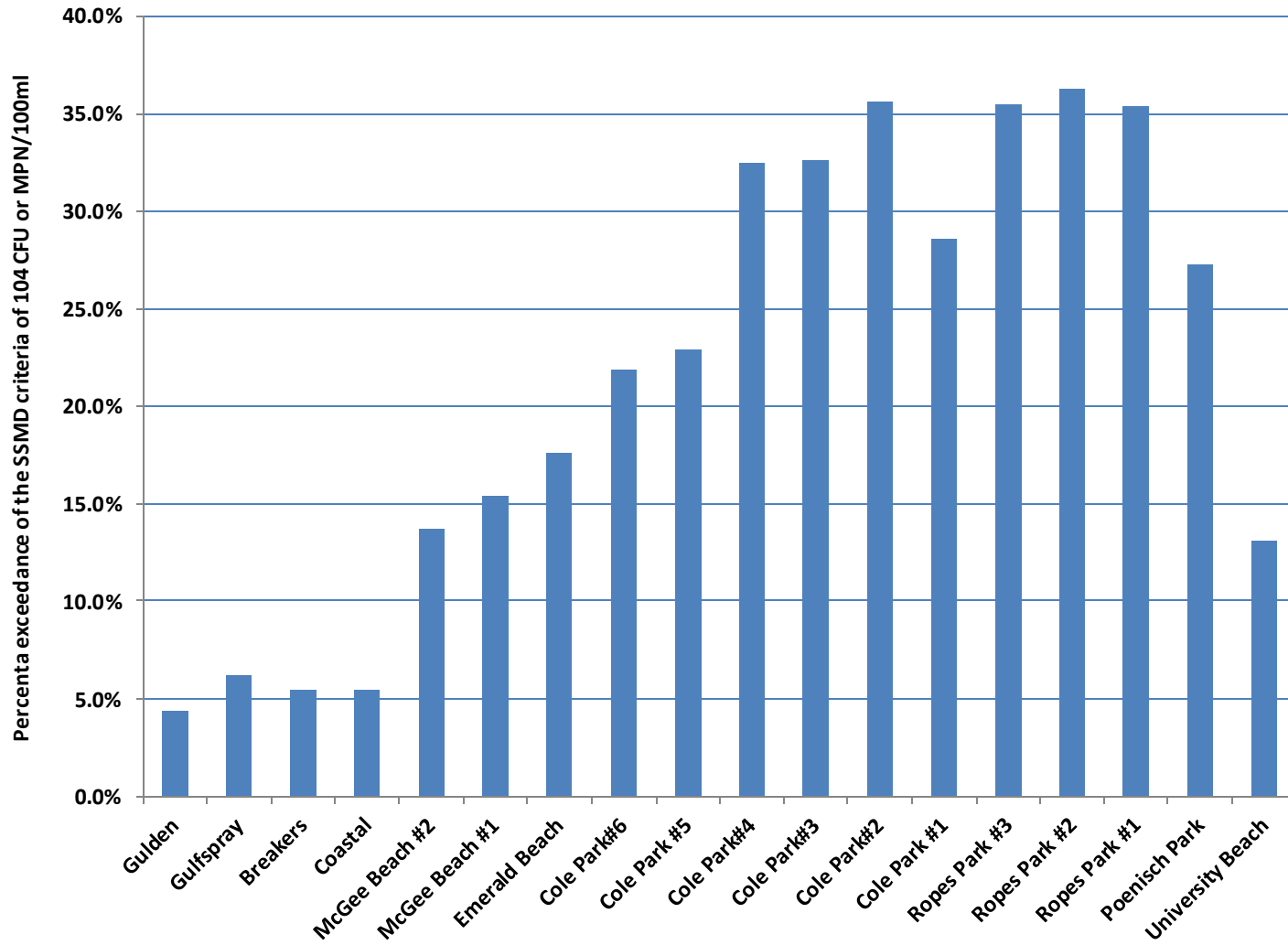


Fig. 3.2. Percent exceedance of the 104 CFU or MPN/100 ml criteria for averaged sample data from November 2003 through March 2011 at Texas Beach Watch locations in Corpus Christi Bay





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