

## 4 - WATERSHED ANALYSIS

### HYDROLOGY

The San Bernard River Watershed drains approximately 900 square miles, the river flows southeast to form the boundary between Austin and Colorado counties, then flows between Wharton and Fort Bend County and through Brazoria County before flowing into the Gulf of Mexico. The San Bernard River comprises two stream segments defined by TCEQ. Stream segment 1302 is the San Bernard River above-tidal, which flows from the city of New Ulm in Austin County to a point 2.0 mi upstream of State Highway 35 in Brazoria County. Stream segment 1301 is San Bernard River tidal, which flows from 2.0 mi upstream of State Highway 35 in Brazoria County to the Gulf of Mexico. There are concerns about dissolved oxygen levels and nutrients, and the river is listed as impaired for bacteria on the 303d list.

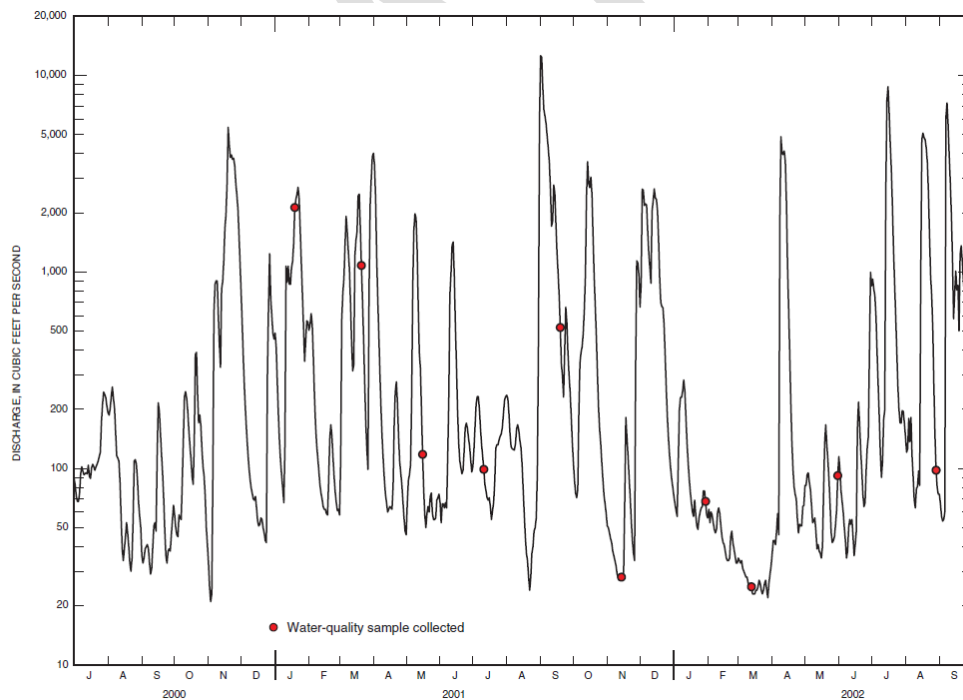


In the upper portions of the watershed, the river has had minimal flow for most of the year over the past 20 years, however there used to be a more significant flow. A number of factors have contributed to the lack of flow, including recent drought, creation of retention ponds, more impervious surfaces which reduce inflow, and because of increased vegetation and tree cover along the river banks.

The tidal and non-tidal portions of the watershed are separated by the salt barrier dam. This small dam is located on the river near West Columbia about one mile north of Highway 35. The purpose of the dam is to prevent saltwater from the Gulf from reaching the upper portions of the river that are used for water supply for industrial uses. There is also a diversion area on the Wharton-Fort Bend County line called the New Gulf Reservoir, it is owned by the Texas Gulf Sulfur Company and is used for municipal supply and irrigation.

The mouth of the San Bernard River has migrated about two miles to the southwest since the 1929 construction of the Diversion Channel and the 1940 construction of the Gulf Intercoastal Water Way (GIWW), and almost closed at the Gulf of Mexico due to sand accretion from the delta formed by the Diversion Channel. Accretion has accelerated over the last ten years due to a number of factors, including flooding on the Brazos River. The result of the sediment buildup caused the river discharge to be insufficient to flush the shoaling at the mouth of the river and keep it open to the Gulf. The blockage of the river's mouth diverted flow into the GIWW, raising concerns for barge traffic along the GIWW (Kraus, 2002). The Galveston District, USACE, has received reports that barge tows traveling along the GIWW between the San Bernard and Brazos Rivers can experience an eastward flowing current that is sufficiently strong to pose a potential navigation hazard. To allow for a more effective, safe, and efficient waterway, the proposed restoration of the mouth of the San Bernard River would reduce treacherous currents resulting from diverted flow into the GIWW and Brazos River Floodgates.

In 2002, a study by the U.S. Army Engineer Research and Development Center (ERDC) addressed how to improve navigation safety and efficiency on the GIWW in the vicinity of the San Bernard River. The purpose of the project was to reconnect the San Bernard River with the Gulf of Mexico at its historic location. The conclusion of the study was that dredging a shorter, deeper channel to the Gulf would increase the hydraulic efficiency of the river sufficiently to keep the mouth open and flowing for perhaps 6 to 12 years, before longshore transport of sediment from the Brazos River would again overtake the channel.



**FIGURE 1 - HYDROGRAPH OF DAILY MEAN DISCHARGE AND TIME OF WATER-QUALITY SAMPLING ON SAN BERNARD NEAR BOLING, JULY 2000 - SEPTEMBER 2002 (USGS STUDY)**

## WATERBODY AND WATERSHED CONDITIONS

### WATER QUALITY SAMPLING

Eight water quality monitoring stations are currently located in the San Bernard Watershed. Five of the monitoring stations are located on the main stem of the San Bernard River and three are located on tributaries of the San Bernard River. Five of the stations are monitored by Clean Rivers Partners and three are monitored by TCEQ.

#### **Five Established Monitoring Sites:**

San Bernard Tidal @ FM 2611 # 12146

San Bernard Tidal @ Hwy 35 # 20460

San Bernard @ FM 442 # 12147

San Bernard @ US 90A # 16373

San Bernard @ FM 3013 #16370

#### **Three Newer Monitoring Sites:**

Mound Creek @ CR 450 # HG187

Peach Creek @CR 117 # HG186

West Bernard Creek @ CR 225 # HG185

The San Bernard River is a water body connecting Segment 1301, San Bernard River Tidal with Segment 2501-05, Gulf of Mexico Area between Freeport and Port Aransas. Water body uses of these segments are: Aquatic Life Use (ALU); Recreation Use; General Use; and Fish Consumption Use. Based on the most recent data (TCEQ, 2008), the TCEQ determined that ALU in Segment 1301 is high. There are no direct industrial or municipal discharges in the vicinity that could degrade water quality. However, Recreation Use is not supported in Segment 1301 because of bacteria impairment (TCEQ, 2008).



A data study was completed by USGS in 2002, and data collection at six stations began in late summer of 2000. One monitoring meter was installed in the non-tidal portion of the watershed to collect data continuously (every thirty minutes). This allowed scientists to monitor the levels of dissolved oxygen under varying conditions. Other parameters collected included pH, conductivity, and temperature. Additional water quality monitoring sites were sampled monthly and included the parameters listed above as well as Biological Oxygen Demand, nitrogen and phosphorus compounds, dissolved solids, bacteria, and flow. Recordings from a permanent USGS station near Boling supplied continuous flow measurements. (USGS Study)

Habitat and biological data collected along the San Bernard River and its tributaries have been summarized and compared with similar data from other streams in southeast Texas. Measures of stream habitat compare closely with other riverine settings, as opposed to tidally influenced, coastal bayous. Similarly, measures of aquatic insect and fish population diversity are similar to water bodies with minimally impacted watersheds. Based on these biological data, along with selected water chemistry and water-quality data that were also collected during 2000-2002, the San Bernard River does not exhibit significant water quality problems. The river has been removed from the list of water bodies not meeting designated standards for high aquatic life use due to low dissolved oxygen concentrations.



### 303(D) LIST

From the 2008 303d list:

<b>SegID: 1301 San Bernard River Tidal</b>			
From the confluence with the Intracoastal Waterway in Brazoria County to a point 3.2 km (2.0 miles) upstream of SH 35 in Brazoria County			
<u>Area</u>		<u>Category</u>	<u>Year First Listed</u>
1301_01	Entire Segment bacteria	5c	2006

<b>SegID: 1302 San Bernard River Above Tidal</b>			
From a point 3.2 km (2.0 miles) upstream of SH 35 in Brazoria County to the county road southeast of New Ulm in Austin County			
<u>Area</u>		<u>Category</u>	<u>Year First Listed</u>
1302_01	Lower 25 miles of segment bacteria	5a	2002
1302_02	25 miles from just upstream of FM 442 to downstream of US 90A bacteria	5a	2002
1302_03	25 miles from downstream of US 90A to upstream of FM 3013 bacteria	5a	2002

<b>SegID: 1302A Gum Tree Branch (unclassified water body)</b>			
From the confluence with West Bernard Creek near Wharton CR 252 to the headwaters approximately 15 miles upstream near RR 102			
<u>Area</u>		<u>Category</u>	<u>Year First Listed</u>
1302A_01	The entire 15 miles of the segment bacteria	5c	2006

SegID: 1302B West Bernard Creek (unclassified water body)  
 From the confluence with the San Bernard River Above Tidal downstream of US highway 59 to the headwaters approximately 40 miles upstream near FM 1093

<u>Area</u>		<u>Category</u>	<u>Year First Listed</u>
1302B_01	Lower 15 miles of segment depressed dissolved oxygen	5c	2006
1302B_02	Upper 25 miles of segment bacteria	5c	2006

## POLLUTANT SOURCES

### POINT SOURCES

Point source pollution comes from known sources such as outfalls that flow into the river. Along the San Bernard River, there are 6 industrial outfalls and 17 domestic outfalls from sources such as cities and schools. There are a total of 23 known outfalls into the San Bernard.

### NONPOINT SOURCES

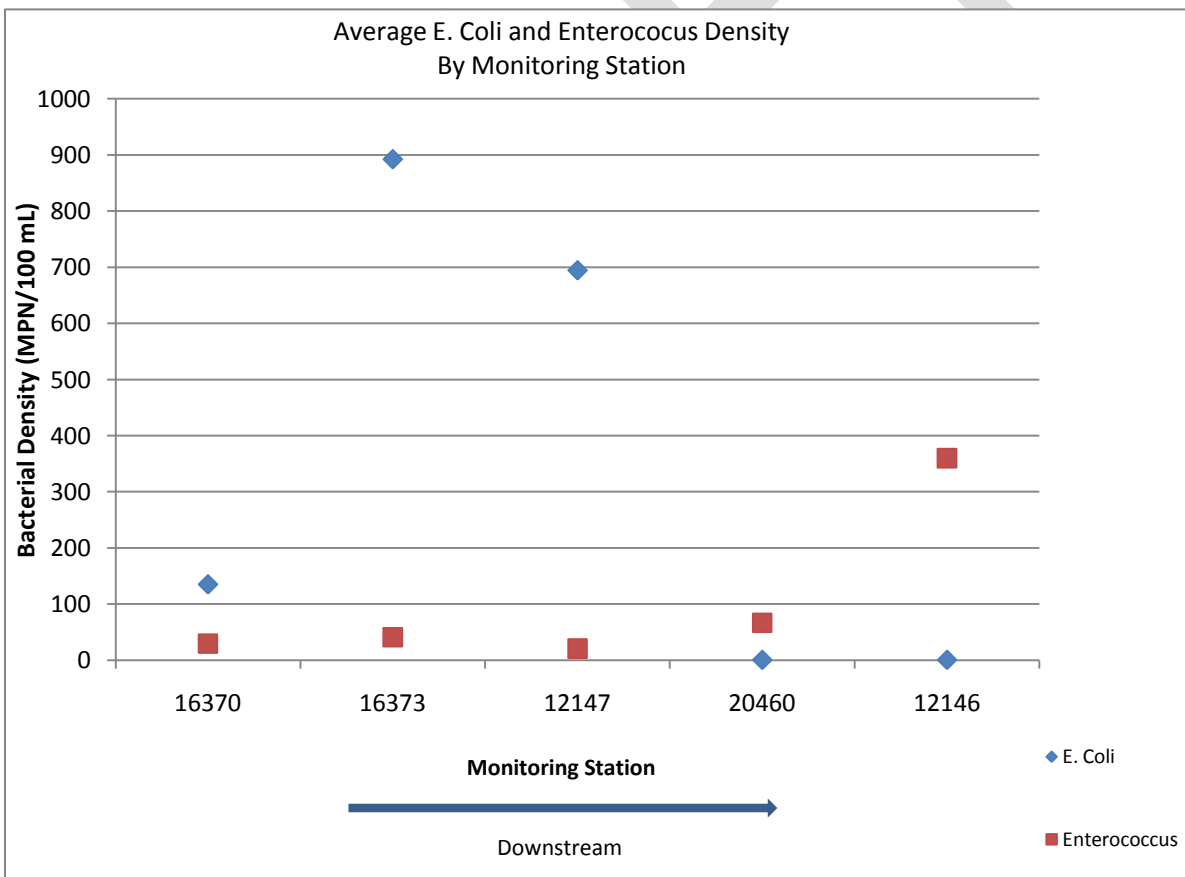
Nonpoint source pollution is the combination of all other sources that are carried into the river as water runs across the land and into the waterways. Common sources of nonpoint source pollution include: malfunctioning septic systems, construction site runoff, agricultural sources, and runoff from streets and yards. Bacteria is the primary cause of water quality problems in the San Bernard River. Possible sources of bacteria include: humans, livestock, domestic animals, and other wildlife and non-domestic animals. Other sources of pollution include nutrients, sediment, and toxic and hazardous substances.

### BACTERIA

Portions of the San Bernard River do not meet standards for contact recreation due to elevated levels of bacteria. The standard for contact recreation is 126/200 per 100mL. In the San Bernard watershed, bacteria levels average just over 126 and maximum levels are in the 400s. Although these numbers are higher than acceptable levels, they are not exceedingly high and can be managed to reach acceptable levels. Below are a table and a chart of bacteria levels for 5 monitoring stations along the San Bernard River. In the tidal portion of the river the criteria is for enterococcus and the above tidal criteria is for E. coli.

**TABLE 1 - BACTERIA LEVELS FOR SAN BERNARD WATERSHED MONITORING STATIONS**

Station	Criteria			
		Min	Max	Average
16370	126	10	413	99
16373	126	30	369	168
12147	126	41	243	135
20460	35	1	201	64
12146	35	0	86	46



**FIGURE 2 - AVERAGE E. COLI AND ENTEROCOCCUS DENSITY BY MONITORING STATION**

## NUTRIENTS

In addition to high levels of bacteria, there are also higher levels of nutrients found in the San Bernard River. Maximum nutrient levels allowed in a stream or river are <1.95 mg/L nitrate nitrogen and <0.69 mg/L total phosphorous. Both nitrogen and phosphorous are found in the natural environment, but they are also found in fertilizers added by humans. They are necessary for plant growth, but at high levels they can cause overgrowth of plants. Below are two tables, the first one showing nitrate + nitrite levels at two monitoring stations over the course of twenty years. The second table shows average nutrient concentrations for 5 stations.

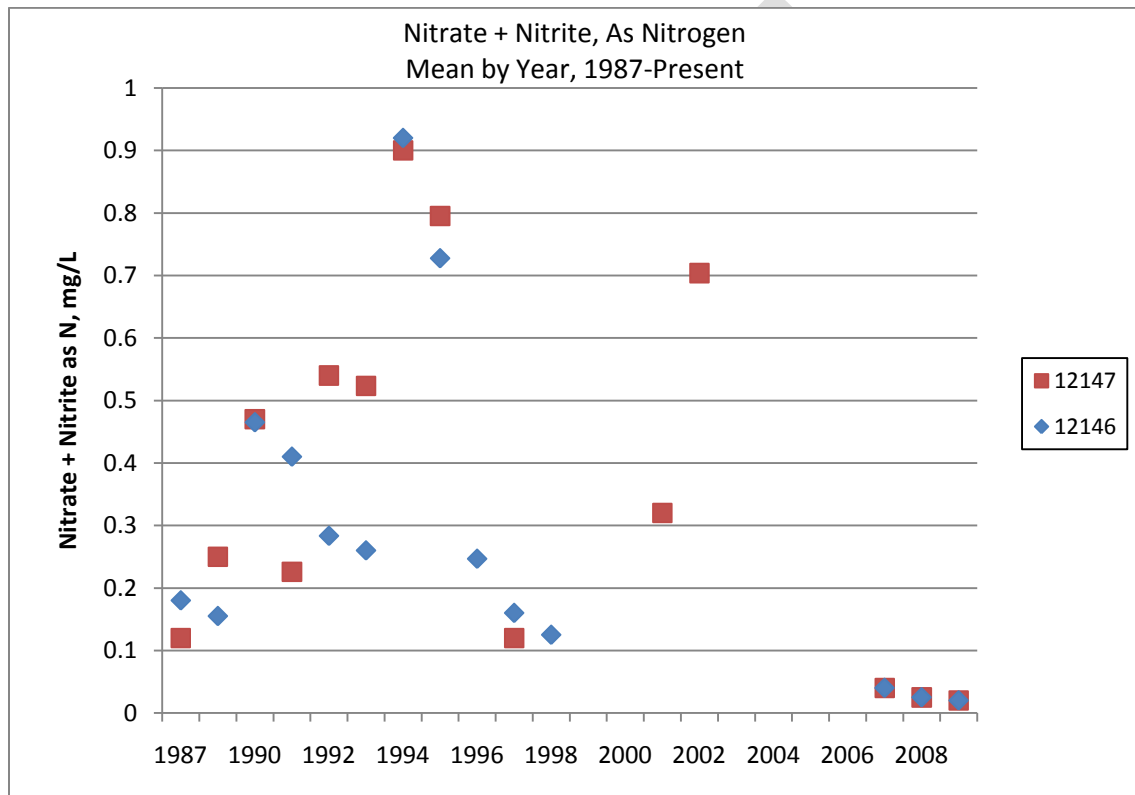


FIGURE 3 - NITRATE + NITRITE, AS NITROGEN MEAN BY YEAR, 1987 - PRESENT

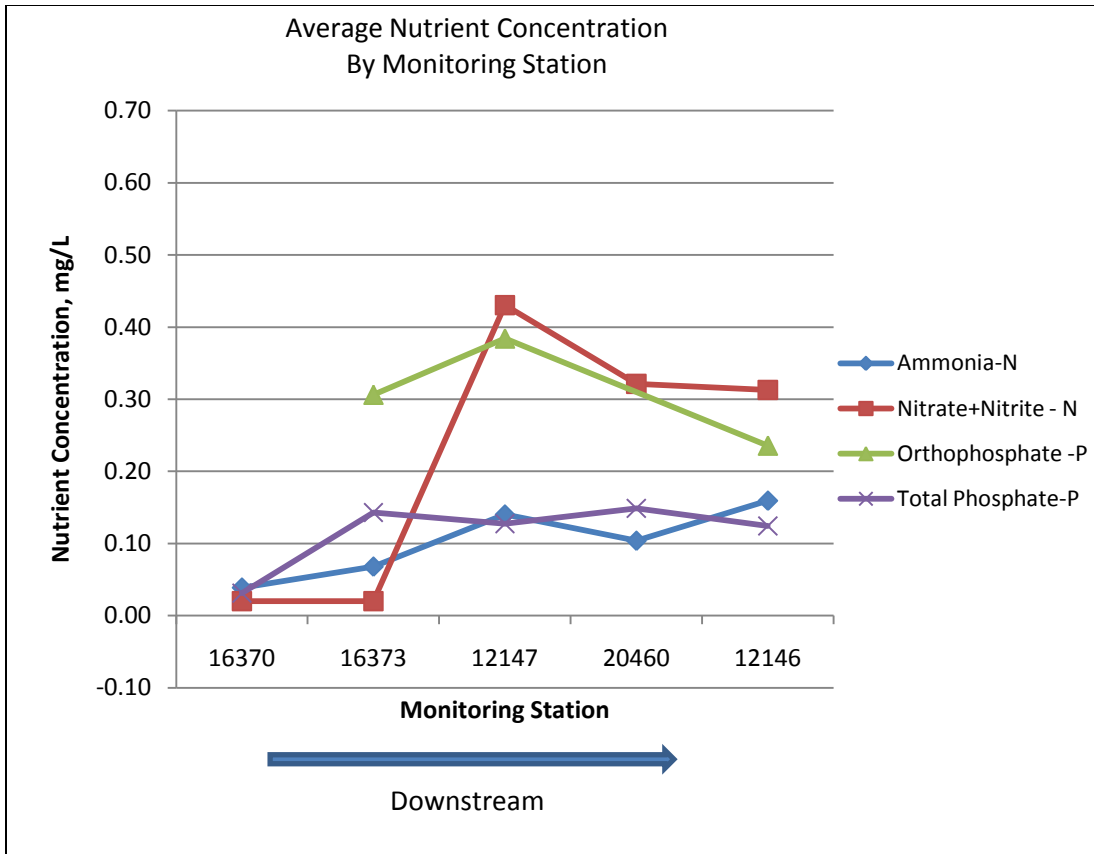


FIGURE 4 - AVERAGE NUTRIENT CONCENTRATION BY MONITORING STATION

#### DISSOLVED OXYGEN

The San Bernard River has also had low dissolved oxygen levels, although DO levels have been returning to normal since the opening of the mouth of the river in March 2009. Below are standard DO levels and those found in the San Bernard River.

1-2 mg/L = very polluted

3-5 mg/L = somewhat polluted

6-9 mg/L = moderately clean

10+ mg/L = very good

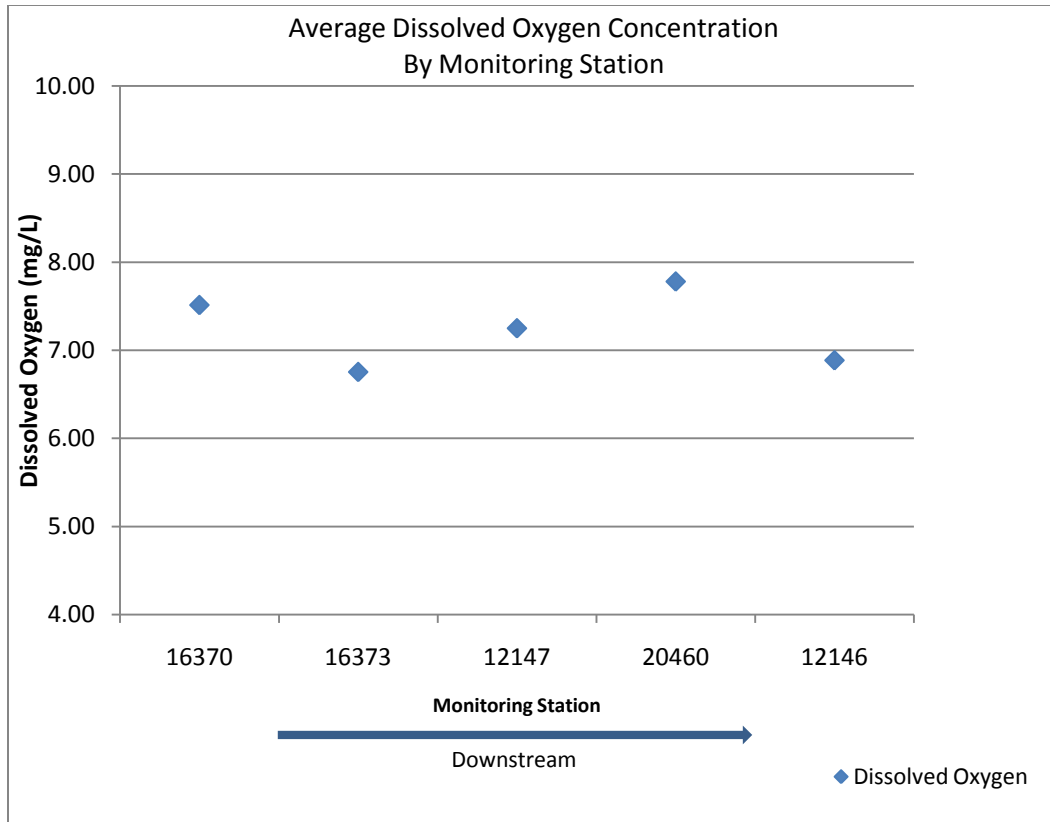


FIGURE 5 - AVERAGE DISSOLVED OXYGEN CONCENTRATION BY MONITORING STATION

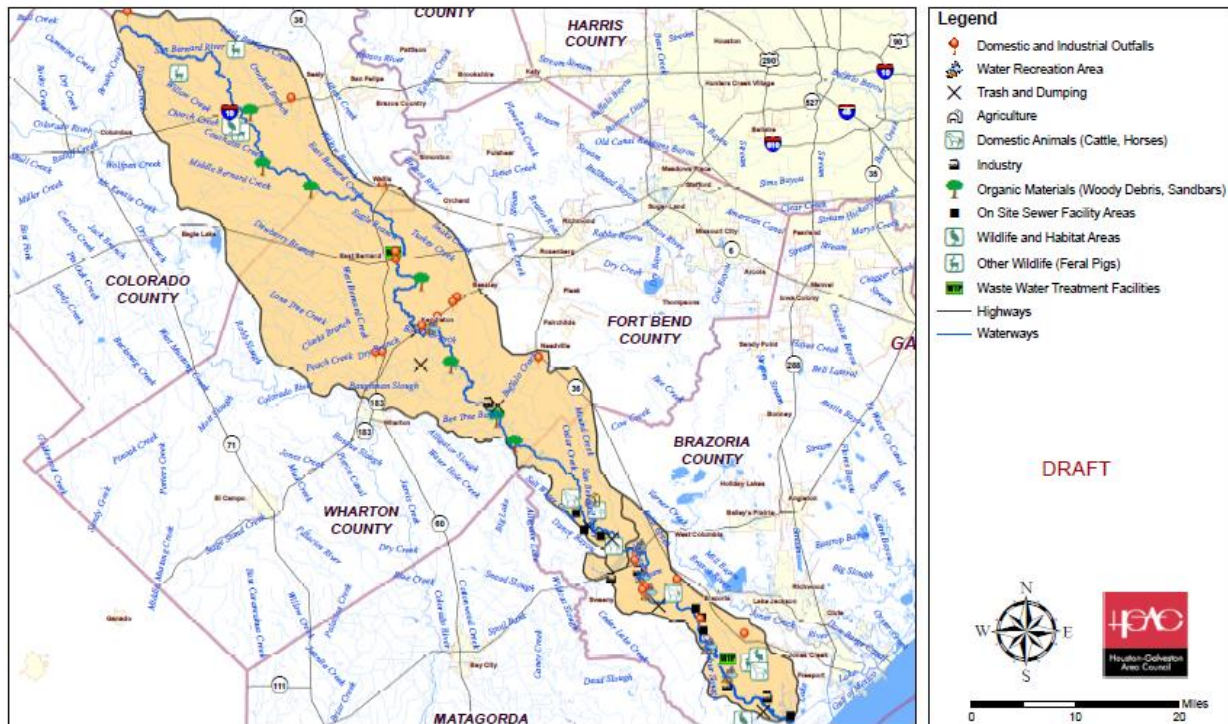
## IDENTIFICATION OF CAUSES AND SOURCES

During the series of open houses, participants were asked to include their comments and observations on a map of the San Bernard River Watershed regarding causes and sources of pollutants. In the northern portion of the watershed in Colorado and Austin Counties, it was noted that there are a number of small man made ponds and ditches that have been diverted to these ponds. This diversion of water could cause lower flows in the main San Bernard River, and could cause a buildup of bacteria that would be flushed out during a rainfall event. In the southern part of Colorado County just north of Wharton County it was noted that there are sludge applications adjacent to the river, it was unclear if this was a sludge drying process or application of already dried sludge. It was noted that just south of Kendleton there is a dump site on the west side of the river.

At the confluence of Bee Tree Creek and the San Bernard River in Wharton County it was noted that the creek has been cleaned out and there is only bare soil on the banks and that a sandbar is forming in the river. In the area north of the saltwater dam in Brazoria County, it was noted that there is an area where trash is being dumped and cars and appliances are being dumped. It was also noted that along this stretch of river that animal carcasses are sometimes found, that cattle water in the river, there is fish dumping, and there are a number of residential areas with potentially failing septic systems.



In the vicinity of Riverbend and 344 south of Sweeny it was noted that there are drainage and garbage problems and that cattle are watering in the river. At the very southern end of the watershed, it was noted that there are some oil and gas drilling operations, some abandoned sunken vessels, and a raw sewage leak near River's End.



At this time, all causes and sources of the pollutants are unknown, but information received from stakeholders and public meetings have helped guide further identification of areas that may be sources of bacteria to the San Bernard River. Additional monitoring will be implemented to further identify causes and sources of pollutants, and once identified, BMPs will be applied to lessen the amount of pollutants being carried into the San Bernard River.

## WATER QUALITY AND FLOW

TABLE 2 - WATER QUALITY MONITORING DATA

Monitoring Station	Parameter	Number of Samples	Minimum	Maximum	Mean	Sampling Period
12146	Ammonia-N	169	0.01	1.9	0.14	1969-2010
	Dissolved Oxygen	180	2.9	18.1	7.5	1969-2010
	Enterococci	37	5	10462	385	1969-2010
	Nitrate-N	189	0.01	2.12	0.28	1969-2010
	Orthophosphate-P	147	0.02	1.66	0.18	1969-2010
	pH	138	6.5	9.9	7.7	1969-2010
	Total Phosphorus	166	0.01	6.18	0.29	1969-2010
	Total Suspended Solids	170	2	359	38	1969-2010
12147	Ammonia-N	165	0	3	0.14	1970-2011
	Dissolved Oxygen	188	3.8	12.5	7.3	1968-2011
	E. Coli	44	10	9804	765	2001-2011
	Nitrate-N	187	0.01	3.26	0.43	1970-2011
	Orthophosphate-P	143	0.03	1.44	0.18	1973-2011
	pH	124	6.2	8.8	7.6	1973-2010
	Total Phosphorus	159	0.07	4.18	0.27	1970-2011
	Total Suspended Solids	162	1	320	61	1970-2011
16370	Ammonia-N	13	0.05	0.05	0.05	2007-2010
	Dissolved Oxygen	12	3.8	9.4	6.6	2007-2010
	E. Coli	13	10	2000	257	2007-2010
	Nitrate-N	13	0.02	0.02	0.02	2007-2010
	Orthophosphate-P	13	0.02	0.05	0.02	2007-2010
	pH	12	6.9	7.9	7.5	2007-2010
	Total Phosphorus	13	0.03	0.41	0.12	2007-2010
	Total Suspended Solids	13	1	18	6	2007-2010
16373	Ammonia-N	35	0.03	0.3	0.07	2001-2010
	Dissolved Oxygen	40	4.1	10.9	6.8	2001-2010
	E. Coli	37	62	3076	388	2001-2010
	Nitrate-N	37	0.02	1.17	0.29	2001-2010
	Orthophosphate-P	35	0.02	0.26	0.13	2001-2010
	pH	41	6.4	8	7.5	2001-2010

	Total Phosphorus	36	0.03	0.49	0.22	2001-2010
	Total Suspended Solids	34	2	109	33	2001-2010
<b>Monitoring Station</b>	<b>Parameter</b>	<b>Number of Samples</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Sampling Period</b>
20460	Ammonia-N	12	0.05	0.6	0.1	2007-2010
	Dissolved Oxygen	13	3.8	11.1	7.4	2007-2010
	Enterococci	12	5	410	116	2007-2010
	Nitrate-N	12	0.02	2.33	0.22	2007-2010
	Orthophosphate-P	12	0.02	0.27	0.15	2007-2010
	pH	13	7.5	8.3	7.8	2007-2010
	Total Phosphorus	12	0.09	0.94	0.33	2007-2010
	Total Suspended Solids	12	4	85	22	2007-2010
20721	Ammonia-N	5	0.05	0.2	0.08	2010
	Dissolved Oxygen	5	4.3	9.6	5.8	2010
	E. Coli	5	41	170	96	2010
	Nitrate-N	5	0.02	0.37	0.24	2010
	Orthophosphate-P	5	0.09	0.23	0.16	2010
	pH	5	7.3	7.5	7.5	2010
	Total Phosphorus	5	0.22	0.49	0.35	2010
	Total Suspended Solids	5	11	84	44	2010
20722	Ammonia-N	5	0.05	0.05	0.05	2010
	Dissolved Oxygen	5	3.4	8.8	5.1	2010
	E. Coli	5	31	290	135	2010
	Nitrate-N	5	0.02	0.16	0.11	2010
	Orthophosphate-P	5	0.19	0.41	0.27	2010
	pH	5	7.4	7.5	7.4	2010
	Total Phosphorus	5	0.23	0.56	0.37	2010
	Total Suspended Solids	5	8	49	26	2010
20723	Ammonia-N	5	0.05	0.05	0.05	2010
	Dissolved Oxygen	5	1.3	10.2	4.4	2010
	E. Coli	3	5	150	62	2010
	Enterococci	2	120	1300	710	2010
	Nitrate-N	5	0.02	0.07	0.04	2010
	Orthophosphate-P	5	0.11	0.3	0.16	2010
	pH	5	7.3	7.9	7.7	2010
	Total Phosphorus	5	0.17	0.42	0.27	2010
	Total Suspended Solids	5	3	101	31	2010

TABLE 3 - SAN BERNARD RIVER AND TRIBUTARIES MONITORING STATIONS (USGS STUDY)

Station Number	Station Name	Drainage Area (sq mi)	Population Density (people per sq mi)	Data Collection Activity
294036096165001	Coushatta Creek at Attwater Prairie Chicken NWR	39.9	10	Bimonthly water-quality sampling/ Biological sampling
293211096110301	West Bernard Creek at CR 252	22.1	39	Bimonthly water-quality sampling/ Biological sampling
293123096073001	Gum Tree Branch at CR 252	35.1	29	Bimonthly water-quality sampling/ Biological sampling
292939096014001	San Bernard River at FM 2919	375	24	Bimonthly water-quality sampling/ Biological sampling
08117500	San Bernard River near Boling	727	30	Continuous stream flow/ Continuous water-quality monitoring/ Bimonthly water-quality sampling/ Biological sampling
290935095455601	San Bernard River at FM 1301	825	32	Continuous stream flow/ Continuous water-quality monitoring/ Bimonthly water-quality sampling/ Biological sampling

### RAINFALL INFORMATION

Weather data for the simulation was collected from five weather stations in and around the San Bernard Watershed: Brenham, Bellville, Wharton, Wharton Airport, and Freeport. Specific information on each type of weather data is provided in more detail subsequently.

Although precipitation data were collected from the five stations noted previously, three stations (Bellville, Wharton, and Freeport) are located closest to the watershed. Therefore, data from these three stations were used preferentially to generate most of the precipitation input for SWAT. If there were gaps in the data during the simulation period the other two stations were used to complete these gaps.

### SOURCES OF INFORMATION

USGS in Cooperation with the Houston-Galveston Area Council and the Texas Commission on Environmental Quality; Hydrologic, Water-Quality, and Biological Data for Three Water Bodies, Texas Gulf Coastal Plain, 2000-2002; Open File Report 03-459

2008 Texas 303(d) List, March 19, 2008, Texas Commission on Environmental Quality

US Army Corps of Engineers, Galveston District; Draft Environmental Assessment – Restoration of the Mouth of the San Bernard River to the Gulf of Mexico, Brazoria County, Texas, June 2008

Halff Associates, Inc; San Bernard Watershed Flood Protection Planning Study Final Report, July 15, 2009.

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