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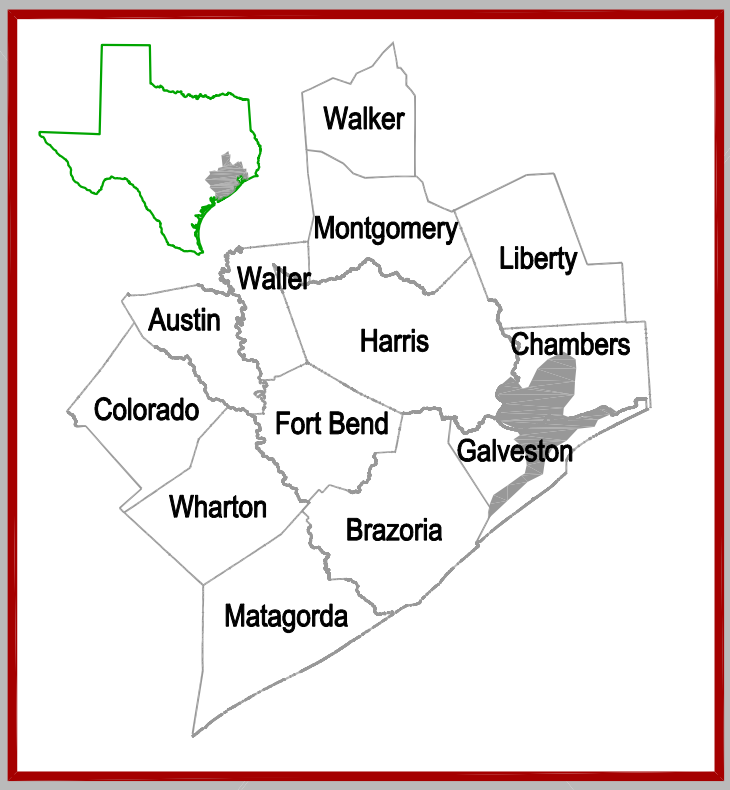

WATER QUALITY DATA ANALYSES MARCH 2000

THIS DOCUMENT WAS PREPARED IN COOPERATION WITH THE TEXAS NATURAL RESOURCE CONSERVATION COMMISSION UNDER THE AUTHORIZATION OF THE CLEAN RIVERS ACT

PREPARED BY

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APPENDIX A

INTRODUCTION

This report presents a water quality data review for the freshwater and tidal streams in the Trinity – San Jacinto Coastal Basin (Basin 9), the San Jacinto River Basin (Basin 10), and the San Jacinto – Brazos Coastal Basin and the (Basin 11). The basins are located in southeast Texas, namely in the Houston metroplex and surrounding counties.

The water quality data reviewed include data collected by the Texas Natural Resource Conservation Commission (TNRCC), U.S. Geological Survey (USGS), the Galveston County Health District, the City of Houston, and the San Jacinto River Authority. All data that were evaluated meet the TNRCC quality assurance requirements; and all data are, or will be, part of the TNRCC permanent water quality database. Data from the TNRCC and USGS have traditionally been the major source of water quality data available for water quality assessments. This assessment is the first assessment that combines data from the USGS and TNRCC with data collected by the local entities.

While local entities have been collecting data for many years, the data have traditionally not been included the TNRCC water quality database. The Houston-Galveston Area Council (H-GAC) has entered into cooperative agreements with local entities, which has resulted in data being collected using TNRCC and U.S. Environmental Protection Agency (EPA) approved methodologies under a single quality assurance project plan (QAPP). The QAPP provides for a data collection effort that meets both the TNRCC and EPA requirements. Because the data will be included in the TNRCC and H-GAC database, it will be accessible to the public and regulators. The cooperative effort between H-GAC and other local entities collecting data was made possible through the funding by the Clean Rivers Program (CRP). The first samples collected under the requirements of the QAPP and included in the database were obtained in 1998.

The screening was performed using a simplified version of the screening utilized by the TNRCC to establish the 303(d) list. The data were screened against water quality criteria and screening levels developed by the TNRCC. Some parameters are associated with more than one criterion, in those cases the most stringent criteria or screening level was used for the screening. The following describes the source of the criteria and screening levels:

1) Standards for Aquatic Life Protection published in the Texas Surface Water Quality Standards

2) Standards for Human Life Protection published in the Texas Surface Water Quality Standards

3) Site-specific Criteria for Classified Segments published in the Texas Surface Water Quality standards

4) Maximum Contaminant Levels for Organic Chemicals in Public Drinking Water Supplies published in the Texas Drinking Water Standards

5) Nutrient limits published in the Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data

The screening was performed by station and then parameter. At each station a minimum of nine measurements for a parameter were required to perform the screening for that parameter. If less than nine measurements were reported for a parameter at a station, the station was considered to have insufficient data to perform the screening for that parameter.

All data reported below the detection limit were considered to be less than the screening value or criteria. However, the data reported below the detection limit were considered in the determination of whether a minimum of nine measurements were reported.

Any parameter with ten percent or more of the values exceeding the screening level was analyzed further. Further analyses included a review of the trend for the parameters identified by the screening, and review of other parameters that may impact or may be impacted by the parameter identified. The extent of the additional analyses were dependent on the conclusions of each step, and the availability of data to conduct analyses. Based on the analyses, conclusions about the water quality were made, if possible. If appropriate, recommendations for future monitoring activities were made.

The 1999 303(d) list was also reviewed for this assessment. The 303(d) list, named after the relevant section of the Clean Water Act, identifies threatened or impaired water bodies. The data were analyzed to determine whether the listing is justified and whether additional monitoring needs exist.

Database

The database reviewed for this effort includes data from 1992 to 1999 and has a total of over 80,000 records. The data include conventional parameters such as dissolved oxygen (DO), nutrients, total dissolved solids (TDS), and chlorophyll as well as data for toxic parameters such as metals and pesticides.

The sampling effort in the different basins varied significantly. Basin 9, with only 2 segments, had only one station in each segment. Basin 10, in contrast, has 17 segments with a total of 197 stations in the database. Segment coverage ranged from one station in Segment 1015 to 57 stations in Segment 1007. Basin 11 has 11 segments with a total of 47 stations. Segment coverage ranged from one to 12 stations per segment.

Stations included in the database have data reported in the period between 1992 and early 1999, but not all stations are actively monitored at this time, and not all stations have a continuous record over the whole period. Some stations have data for a single monitoring event. Figure 1 shows all stations and indicates the relative number of records in the database associated with each station.

Review of Screening Results

Because of the large data set included for the three basins, it was necessary to use a preliminary step to identify stations and parameters for review. The screening program identified these stations and parameters and the following sections provide a review of the data based on the output of the screening.

The screening results are summarized in Table 1 for conventional parameters and Table 2 for toxic parameters. The data were not screened to identify segments and stations with insufficient data. In three of the 31 segments screened, the screening did not identify any parameters for further analysis.

The initial step of the data review included a review of the trend over time. In some cases a decreasing trend of the concentration over time was observed and noted. Increasing trends were observed in very few cases. Conclusions on trends were based primarily on visual inspection. In some cases, a least squares analysis was used to

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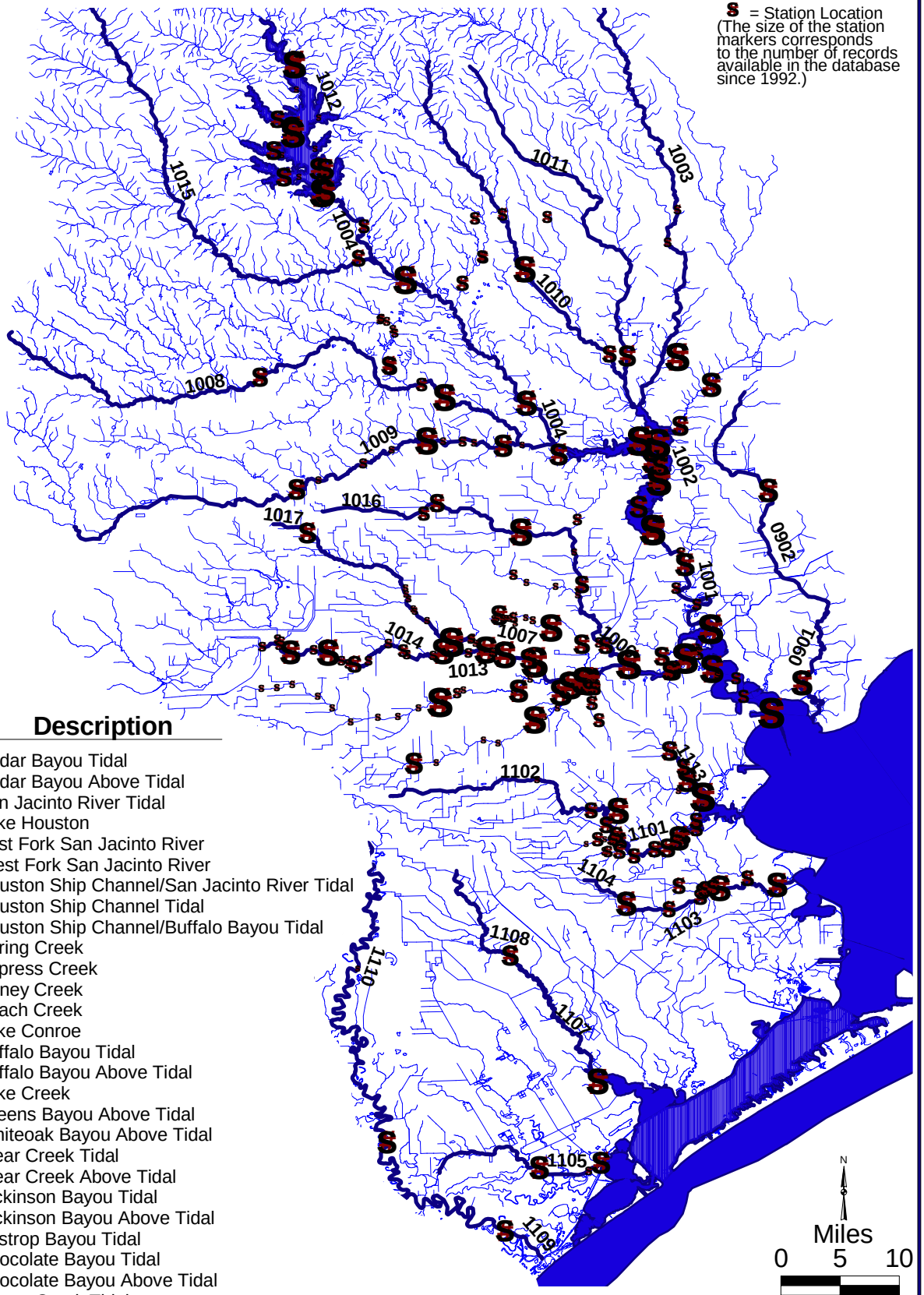

Segment Number	Description
0901	Cedar Bayou Tidal
0902	Cedar Bayou Above Tidal
1001	San Jacinto River Tidal
1002	Lake Houston
1003	East Fork San Jacinto River
1004	West Fork San Jacinto River
1005	Houston Ship Channel/San Jacinto River Tidal
1006	Houston Ship Channel Tidal
1007	Houston Ship Channel/Buffalo Bayou Tidal
1008	Spring Creek
1009	Cypress Creek
1010	Caney Creek
1011	Peach Creek
1012	Lake Conroe
1013	Buffalo Bayou Tidal
1014	Buffalo Bayou Above Tidal
1015	Lake Creek
1016	Greens Bayou Above Tidal
1017	Whiteoak Bayou Above Tidal
1101	Clear Creek Tidal
1102	Clear Creek Above Tidal
1103	Dickinson Bayou Tidal
1104	Dickinson Bayou Above Tidal
1105	Bastrop Bayou Tidal
1107	Chocolate Bayou Tidal
1108	Chocolate Bayou Above Tidal
1109	Oyster Creek Tidal
1110	Oyster Creek Above Tidal
1111	Old Brazos River Channel Tidal
1113	Armand Bayou Tidal

Figure 1
Houston-Galveston Area Council
Water Quality Monitoring Database
Station Locations & Number of Records

Table 1
Screening Results for Conventional Parameters
Percent of Values Above the Screening Criteria
Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

		Parameter										
Segment	**Station ID**	**Dissolved Oxygen**	**Chlorophyll-a**	**Ammonia**	**Nitrate**	**Ortho-phosphate**	**Phosphorus**	**Total Dissolved Solids**	**Chloride**	**Sulfate**	**pH**	**Fecal Coliform**
901	11111											40%
902	11120	18%		17%				50%				73%
1001	11193											27%
	11198											20%
	11200		13%									35%
	11201											27%
	16622											20%
1002	11187	31%										
	11204	18%			18%		15%	17%				27%
	11208	16%	12%				35%	30%				20%
	11211	15%	16%				42%	20%				27%
	11212	25%										
	11213		11%	16%	73%		84%	64%				80%
	13610	38%										
	13942	34%										
	13945	35%										
	13948	33%										
	13951	31%										
	13954	41%										
	13957	24%					68%					
1004	11245							45%	38%			
	13611								19%			
1005	11252	11%										31%
	11258	11%										38%
	16618											14%
	16619											25%
	16621											27%
1006	11126			89%			67%					83%
	11264			17%								48%
	11271	14%		37%								72%
	11272		36%	18%			18%				14%	
	11273			17%								
	11275			36%			36%					
	15858											71%
	15863			88%								94%
	16617			38%								73%

Table 1
Screening Results for Conventional Parameters
Percent of Values Above the Screening Criteria
Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

		Parameter										
Segment	**Station ID**	**Dissolved Oxygen**	**Chlorophyll-a**	**Ammonia**	**Nitrate**	**Ortho-phosphate**	**Phosphorus**	**Total Dissolved Solids**	**Chloride**	**Sulfate**	**pH**	**Fecal Coliform**
1007	11293			17%								100%
	11128		33%	11%								
	11135			22%			58%					82%
	11139			57%		33%	17%					56%
	11283			63%								73%
	11284			48%								69%
	11287	13%		40%								92%
	11292	24%		63%	31%		17%					74%
	11294	22%										
	11296			12%	15%		21%					100%
	11299	13%		96%			14%					91%
	11302		14%	83%			14%					92%
	11307	17%		64%								78%
	11309			76%								88%
	15841											100%
	15861			44%								63%
	15873			44%								100%
	16620			56%								64%
1008	11312		12%	17%		18%		36%	17%			
	11314	36%										
	16481	48%										22%
	16482	33%										11%
	16483	35%										22%
	16484	15%										44%
	16627	40%		91%								
	16628	21%		92%								
	16629			36%								
	16631			33%								36%
	16632			36%								
	16633			40%			20%					
	16634			27%								18%
1009	11324		11%	26%	30%		68%	70%	26%			40%
	11328		24%	46%	40%	56%	60%		32%			91%
	11332	12%		24%			19%					55%

Table 1
Screening Results for Conventional Parameters
Percent of Values Above the Screening Criteria
Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

		Parameter										
Segment	**Station ID**	**Dissolved Oxygen**	**Chlorophyll-a**	**Ammonia**	**Nitrate**	**Ortho-phosphate**	**Phosphorus**	**Total Dissolved Solids**	**Chloride**	**Sulfate**	**pH**	**Fecal Coliform**
1012	11342	35%	14%									
	11343	13%	27%									
	11344	21%	29%									
	13914	54%										
	13915	54%										
	13916	45%										
	13917	42%										
	13918	36%										
	13919	39%										
	13920	27%										
	13921	29%										
	13922	32%										
1013	11345	14%			30%		29%					87%
	11351			12%								96%
	15843											100%
	16646											100%
1014	11163			64%								73%
	11353			50%								92%
	11354			44%								94%
	11357			58%								83%
	11358			73%			27%					
	11359			75%								92%
	11360			63%								92%
	11361			17%								92%
	11362		22%	49%	27%		35%					79%
	11363			42%								75%
	11364			33%								75%
	15844			45%								91%
	15845			42%								92%
	15846			75%								92%
	15847			17%								83%
1016	11369		27%	40%	18%		64%		36%			64%
	13778		17%	83%			92%			33%		
1017	11387			48%		56%	57%	13%				78%
	11398		22%	28%			22%	50%				82%
	15826			58%								100%
	16636	11%										89%

Table 1
Screening Results for Conventional Parameters
Percent of Values Above the Screening Criteria
Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

		Parameter										
Segment	**Station ID**	**Dissolved Oxygen**	**Chlorophyll-a**	**Ammonia**	**Nitrate**	**Ortho-phosphate**	**Phosphorus**	**Total Dissolved Solids**	**Chloride**	**Sulfate**	**pH**	**Fecal Coliform**
1101	11446		31%									82%
	11447											48%
	11448	19%										70%
	16472											74%
	16493											86%
	16572											56%
	16573											44%
	16575			12%								44%
	16576			17%								58%
	16577			16%								50%
1102	11449	40%		50%								80%
	11450			35%			50%	44%	13%			90%
	14229			38%								90%
	16473			30%								89%
	16477			35%								76%
	16478	21%		43%								79%
1103	11436			11%								79%
	11455											29%
	11460	32%	21%									70%
	11462											65%
	11464	40%										68%
	16469	25%		11%								95%
	16470			11%								100%
	16471											84%
	16679			11%								61%
1104	11467		27%	18%				33%				93%
1105	11475	11%	25%									64%
1107	11478	11%	25%									17%
1108	11484							33%	20%	60%		
1109	11485		11%									55%
1110	11489	35%		45%				14%				91%
1111	11498	17%										
1113	11404	24%										100%
	11503		39%	17%								46%
	11505	52%										

Table 2
Screening Results for Toxic Parameters
Percent of Values Above the Screening Criteria
San Jacinto River Basin and San Jacinto - Brazos Coastal Basin

		Parameter					
Segment	**Station ID**	**Aluminum**	**Cadmium**	**Copper**	**Lead**	**Mercury**	**Nickel**
1001	11193			17%		47%	
1002	11204	12%	11%	11%	17%	64%	
1005	11252			29%		67%	14%
1006	11264			24%		53%	29%
	11271			21%		46%	21%
1007	11129				50%		
	11132				61%		
	11139				44%		
	11292			17%		47%	13%
1012	11342					30%	
1013	11345			44%		45%	
1016	11371		17%		22%		
1017	11387		22%		17%		
1111	11498					20%	

identify trends. In many cases trends cannot be reliably identified because of the scarcity of data or the relatively short time frame over which data were collected.

The relationship between upstream and downstream stations was examined for locations where it was deemed useful. This proved most insightful for the evaluation of total dissolved solids data. The relationship between parameters was examined for dissolved oxygen, nutrients, pH, and chlorophyll-*a* in order to determine the existence or extent of impaired water condition. The following sections provide a discussion of the three basins and the results of the data review.

TRINITY- SAN JACINTO COASTAL BASIN, BASIN 9

Basin 9 has two segments, Segments 901 and 902 of Cedar Bayou. Segment 902 is upstream of Segment 901. Segment 901 is a tidal segment that flows into the Upper Galveston Bay. Figure 2 provides a map of Basin 9, including the location of monitoring stations.

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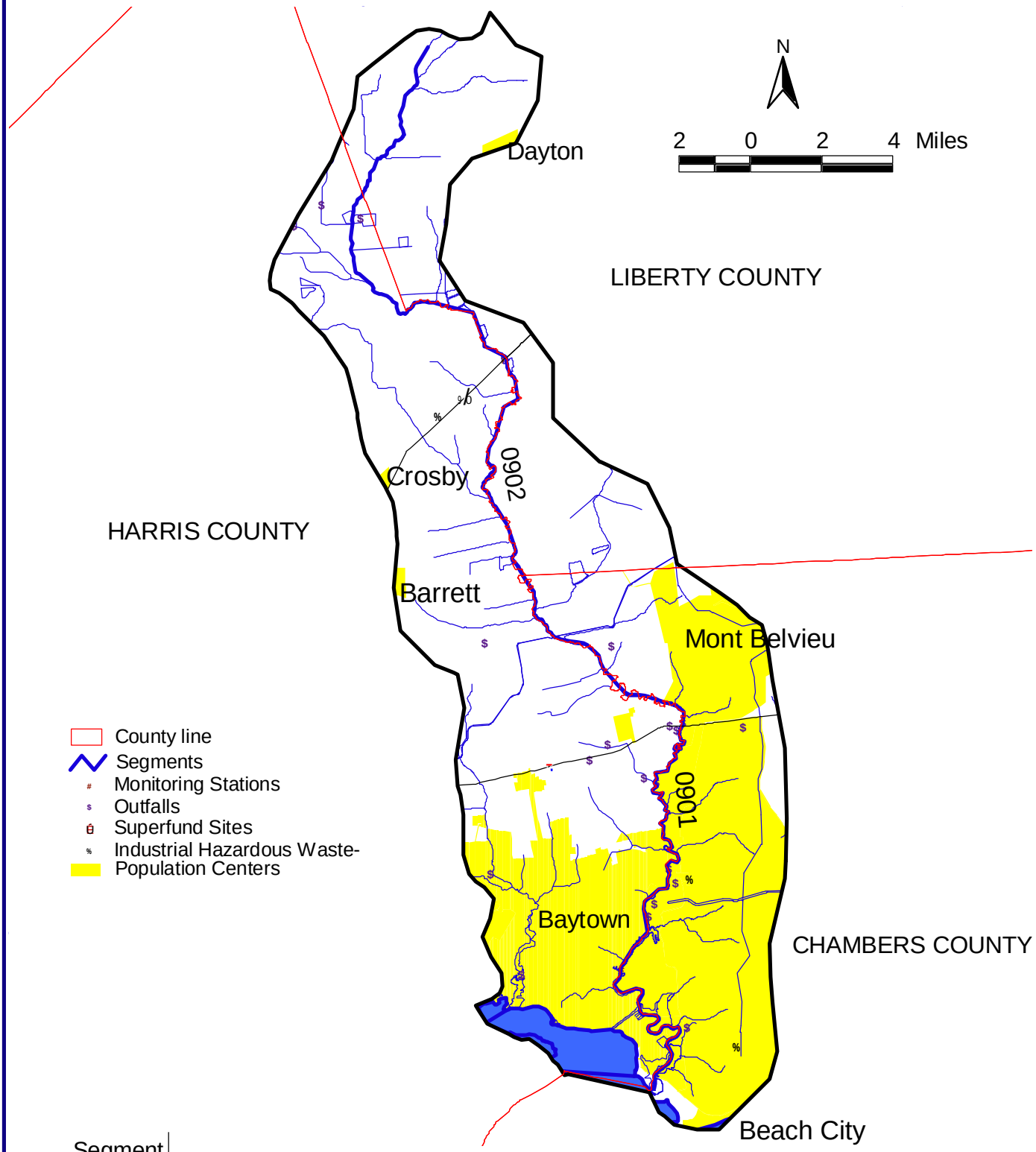


Segment Number	Description
901	Cedar Bayou Tidal
902	Cedar Bayou above Tidal

Figure 2
Trinity - San Jacinto Coastal Basin
General Location Map

SEGMENT 901 – CEDAR BAYOU TIDAL

Segment 901 extends from the confluence with Galveston Bay 1.0 kilometer (0.6 mile) downstream of Tri-City Beach Road in Chambers County to a point 2.2 kilometers (1.4 miles) upstream of Interstate Highway 10 in Chambers/Harris County. The total length is 19 miles. Segment 901 contains the following station:

STATION ID NUMBER	LOCATION	Number of Records in Database
11111	Cedar Bayou at Roseland Park boat ramp, 400 meters upstream from Spur 55	640

The segment is included on the 303(d) list because of elevated levels of bacteria. The screening identified fecal coliform for further analyses.

Fecal Coliform

The database includes 10 measurements of fecal coliform, collected between 1992 and 1995. None of the data were collected at the frequency specified in the stream standard — 5 measurements in a 30-day period. No trend is apparent, and additional data are required to determine the stream standard compliance. It should be noted that a stream standard revision for bacteria in ambient water is currently under review. The revised standard may have an impact on the determination whether the stream segment is impaired. Rescreening the data after adoption of the new standard is recommended.

SEGMENT 902 – CEDAR BAYOU ABOVE TIDAL

Segment 902 extends from a point 2.2 kilometers (1.4 miles) upstream of Interstate Highway 10 in Chambers/Harris County to a point 7.4 kilometers (4.6 miles) upstream of Farm-to-Market Road 1960 in Liberty County. The total length is 25 miles. Segment 902 contains the following station:

Station ID Number	Location	Number of Records in Database
11120	Cedar Bayou at US 90 Northeast of Crosby	519

The segment is included on the 303(d) list because of elevated levels of bacteria and total dissolved solids. The screening identified DO, ammonia-nitrogen (NH_3), TDS, and fecal coliform for further analyses.

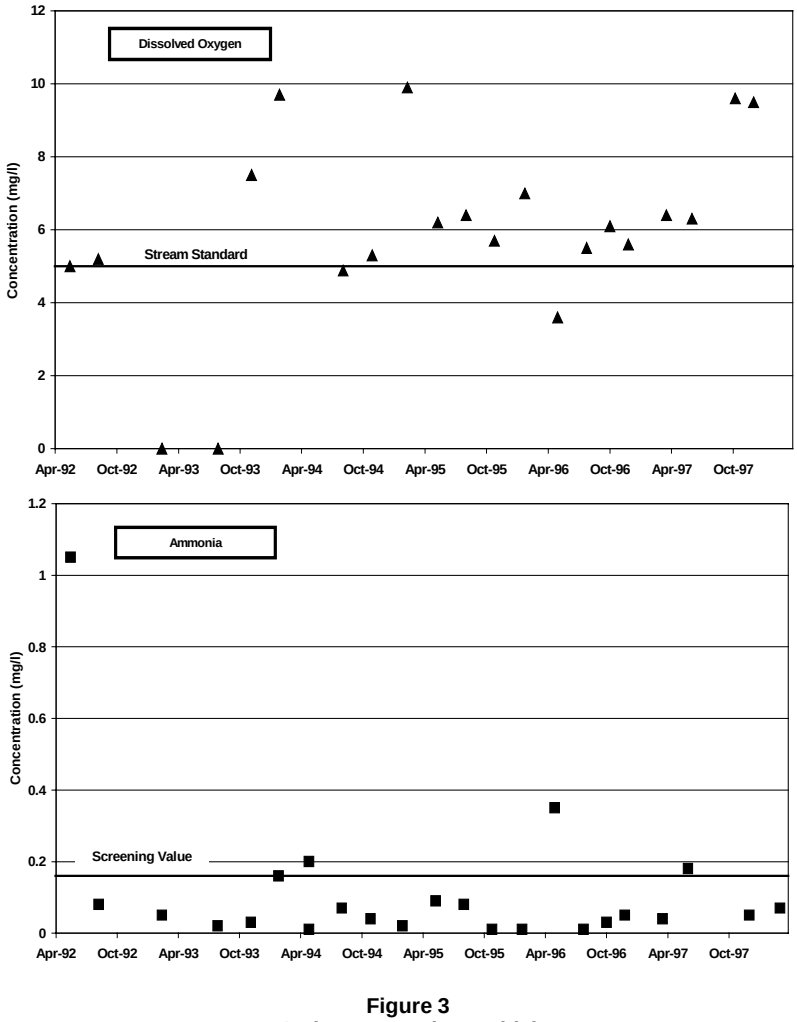


Figure 3
Cedar Bayou Above Tidal
Dissolved Oxygen and Ammonia

Dissolved Oxygen

The database contains 22 measurements of DO, of which four measurements are below the stream standard of 5 mg/l. The data are presented in Figure 3. Two of these measurements, dated February and August 1993, are reported at 0 mg/l. Comments associated with these two extreme measurements are inconclusive, but may indicate

that an acute water quality concern existed. One comment refers to foam being present during sampling, and the other indicates that no aquatic life was observed. Conductivity data for the sample collected in February 1993 is significantly lower than all other measurements, but the August11, 1993 sample has a conductivity value that is the range of the remaining measurements. The twenty data points collected since1993 include two values below the stream standard. In August 1994 DO concentration was reported as 4.9 mg/l, and in May 1996, the concentration was 3.6 mg/l. Because of the infrequent accuracy of low DO concentrations, the data do not indicate a concern with regard to DO. There may be an increasing trend in the DO concentration since 1996, however, insufficient data are available to ascertain that this trend is not due to other factors such as differences in sampling conditions.

Ammonia

The screening identified ammonia because five values out of 24 exceeded the screening criteria. The data are presented in Figure 3. None of the other nutrients exceeded the criteria; neither did chlorophyll-a. Dissolved oxygen data and chlorophyll-a do not indicate that eutrophication is occurring. There does not appear to be concern for ammonia at this station.

Fecal Coliform

Eight of 11 measurements of fecal coliform exceed the stream standard of 200 colony forming units. The data indicate a concern, but the most recent data were collected in 1995. It is suggested that additional data be collected to determine whether a concern is still justified.

Total Dissolved Solids

The screening identified TDS because 9 of 18 individual measurements exceeded the numeric value of the stream standard. However, the stream standard value applies to the annual average of at least four measurements; so, the data were further evaluated based on annual average values. Table 3 and 4 present a summary of the data. It is evident

Table 3
Total Dissolved Solids
Cedar Bayou above Tidal - NE of Crosby

Year	Annual Average (mg/l)	Number of values used to calculate annual average
1994	330	5
1995	398	4
1996	587	5
1997	180	3
1998	532	1

from Table 3 that the stream standard of 400 mg/l was exceeded once (1996), and the average was very close to the standard in 1995. Only one data point is available for 1998. Figure 4 demonstrates that there is no apparent trend. A possible explanation for the elevated TDS levels may be that the segment is occasionally impacted by high tides, resulting in prolonged periods of elevated total dissolved solids concentrations. Chloride data show a very similar trend to the TDS data, but annual averages for chlorides do not exceed the stream standard.

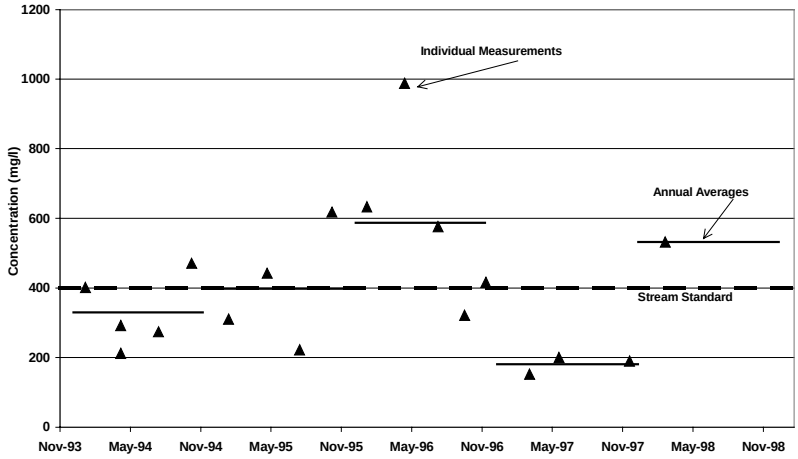
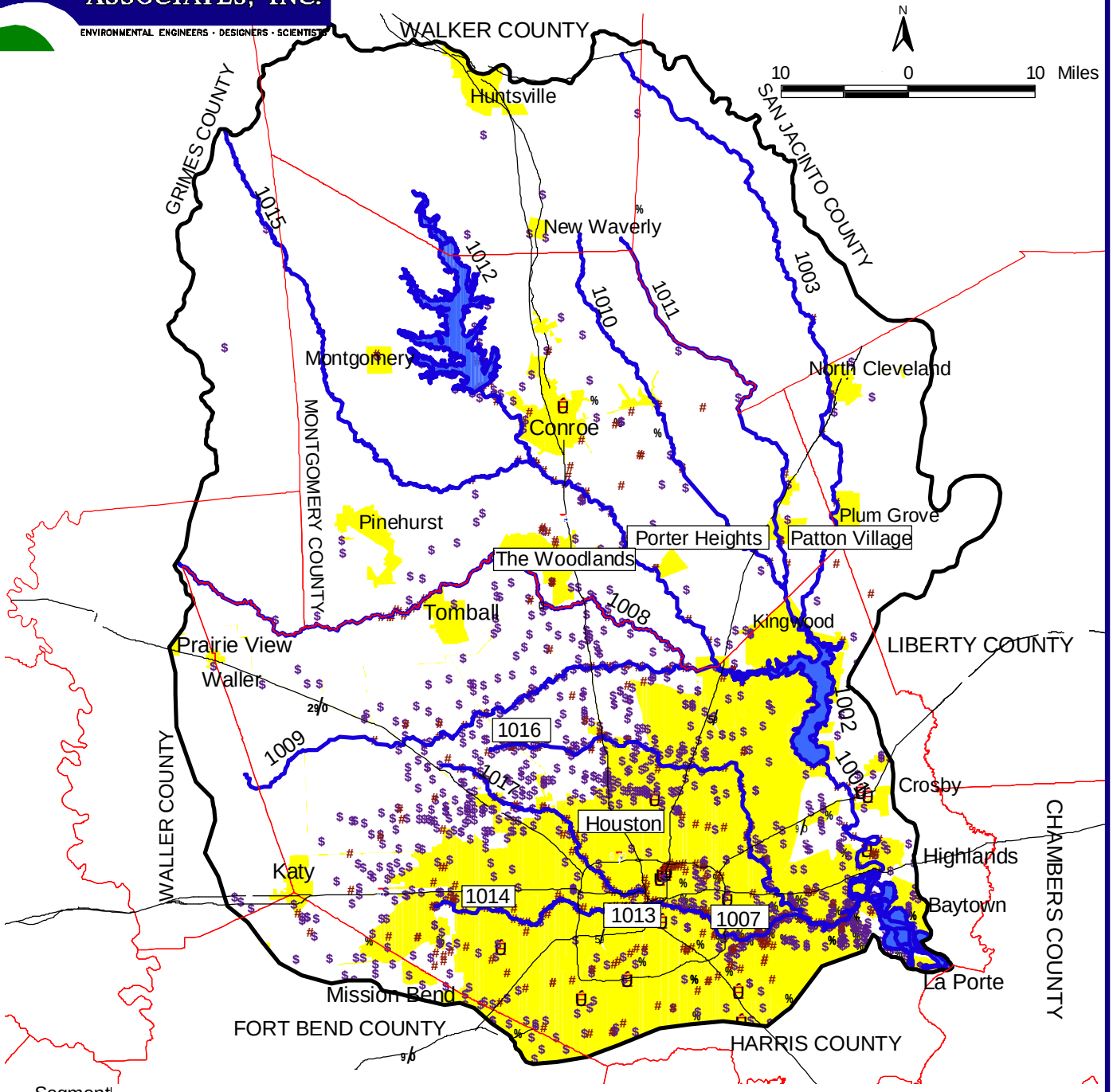


Figure 4
Cedar Bayou Above Tidal
Total Dissolved Solids

SAN JACINTO RIVER, BASIN 10

Basin 10 consists of seventeen classified segments. In comparison to most watersheds in the state, the basin has a high density of water quality monitoring stations and, correspondingly, has a significant amount of water quality data. The basin includes major water supplies to the Houston metropolitan area, as well as discharge routes for municipal and industrial wastewater treatment facilities. A map of the basin is shown on Figure 5.



Segment Number	Description
1001	San Jacinto River Tidal
1002	Lake Houston
1003	East Fork San Jacinto River
1004	West Fork San Jacinto River
1005	Houston Sip Channel/San Jacinto River Tidal
1006	Houston Ship Channel Tidal
1007	Houston Ship Channel/Buffalo Bayou Tidal
1008	Spring Creek
1009	Cypress Creek
1010	Caney Creek
1011	Peach Creek
1012	Lake Conroe
1013	Buffalo Bayou Tidal
1014	Buffalo Bayou above Tidal
1015	Lake Creek
1016	Greens Bayou above Tidal
1017	Whiteoak Bayou above Tidal

- County Line
- Segment
- # Monitoring Station
- $ Outfall
- Superfund Site
- % Industrial Hazardous Waste
- Population Center

Figure 5
San Jacinto River Basin
General Location Map

SEGMENT 1001 – SAN JACINTO RIVER TIDAL

Segment 1001 extends from a point 100 meters (110 yards) downstream of Interstate Highway 10 (IH-10) in Harris County to Lake Houston Dam in Harris County. Segment 1001 contains the following stations:

Station ID Number	Location	Number of Records in Database
11201	San Jacinto River at Magnolia Gardens	148
16622	San Jacinto River at Banana Bend	149
11193	San Jacinto River at IH10 Bridge east of Channelview	1621
11198	San Jacinto River at End of Wallisville road	149
11200	San Jacinto River at US 90 bridge east of Sheldon	495

The segment is included on the 303(d) list because of elevated levels of mercury and bacteria. The screening identified chlorophyll-a, fecal coliform, mercury and copper for further analyses.

Chlorophyll-a

Chlorophyll-a data were reported at two stations in the segment and are shown in Figure 6. One station, located on the San Jacinto River at the US 90 bridge east of Sheldon (Station 11200), has two measurements that exceed the screening criteria. The two measurements, out of a total of 15, are the first and last measurements in the database (November 1992 and August 1996). Station 11193, downstream of Station 11200, has 24 measurements for chlorophyll-a in the database.

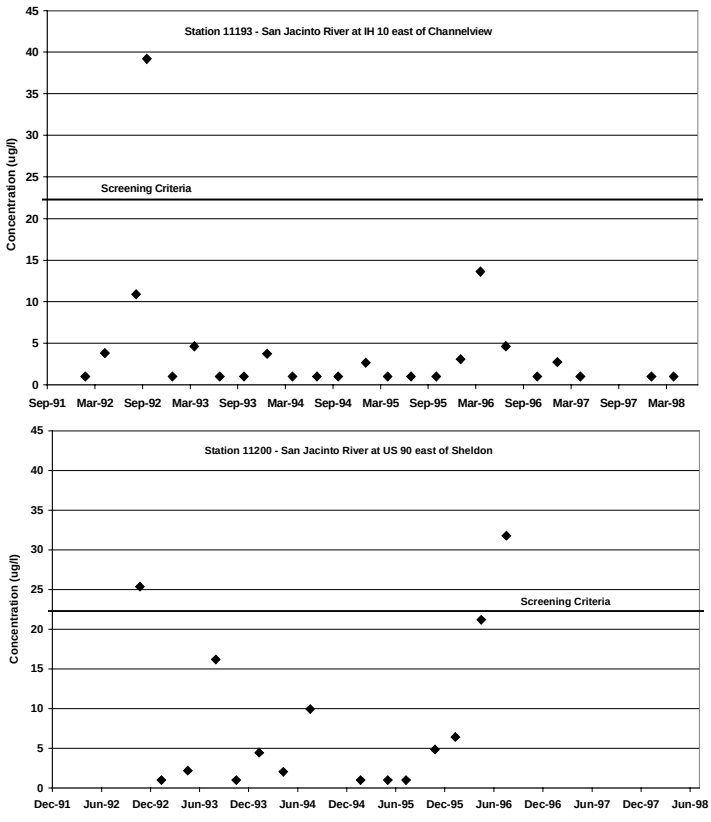


Figure 6
San Jacinto River Tidal
Chlorophyll-a

One measurement in 1992 exceeded the criteria. The data do not indicate an increasing or decreasing trend for chlorophyll. In addition, a total of 216 DO data points at five stations in the segment indicate that the segment is meeting the DO standard. Based on these factors chlorophyll-a does not appear to be a concern.

Fecal Coliform

The screening identified fecal coliform for further evaluation at all five stations with data in this segment. Twenty to 35 percent of the values exceed the stream standard at each station. Much of the data were collected monthly. Because of the frequent detection of elevated levels, fecal coliform concentrations appear to be a concern in this segment.

Copper

The screening program identified copper for further evaluation because 4 of 23 measurements at Station 11193 exceed the stream standard. The values exceeding the criteria were reported in 1992, 1993, and 1994. All fourteen values reported since 1994 have been below the detection limit, and the detection limit is below the stream standard. These data indicate that water quality has improved, and the concern for copper is no longer warranted.

Mercury

A review of the mercury data indicates that mercury levels were frequently detected above the stream standard at Station 11193 (San Jacinto River at IH-10). The measurements (Table 4) that are above the detection limit are very close to the detection limit. Typically, values reported very close to the detection limit have appreciable uncertainty associated with them. Additional data with more sensitive sampling and analytical tools may aid in better describing the extent of the mercury concern in this segment.

Table 4
San Jacinto River Tidal at IH-10 Bridge East Of Channelview

Date	Mercury (ug/l) Dissolved		Total	
1/12/1993		0.2		
7/13/1993	<	1		
8/26/1993		0.79		
10/14/1993	<	0.06		
1/11/1994		0.28		
4/18/1994				0.06
7/21/1994	<	0.34	<	0.34
10/11/1994		0.05		0.05
1/25/1995		0.32		0.09
4/19/1995	<	0.12	<	0.12
7/18/1995	<	0.01	<	0.01
10/23/1995		0.034		0.044
1/24/1996	<	0.01		0.018
4/10/1996	<	0.01	<	0.01
7/16/1996	<	0.01	<	0.01
11/14/1996	<	0.01	<	0.01
1/30/1997		0.025		0.03
4/29/1997		0.011		0.013
1/27/1998	<	0.01	<	0.01
4/22/1998	<	0.01	<	0.01

SEGMENT 1002 – LAKE HOUSTON

Segment 1002 extends from Lake Houston Dam in Harris County to the confluence of Spring Creek on the West Fork San Jacinto Arm in Harris/Montgomery County and to the confluence of Caney Creek on the East Fork San Jacinto Arm in Harris County, up to the normal pool elevation of 44.5 feet (impounds San Jacinto River). The total length is 21 miles and the lake covers 12,230 acres. Segment 1002 contains 13 stations. Following are the ten stations with the largest number of records:

Station ID Number	Location	Number of Records in Database
11204	Lake Houston 300 m upstream from dam	1097
11208	Lake Houston North side of Missouri-Pacific railroad bridge	594
11211	Lake Houston At FM 1960, East End Pass Bridge	657
11213	Lake Houston At US 59	447
13610	Luce Bayou in Tricontinental pipeline right of way, 6.3 miles NE of Huffman, 1.1 mile upstream of Key Gully	588
13942	Lake Houston USGS site AC	1842
13945	Lake Houston USGS site BC	448
13948	Lake Houston USGS site CC	1296
13954	Lake Houston USGS site EC	1470
13957	Lake Houston USGS site FC	1407

The segment is included on the 303(d) list because of elevated levels of mercury. The screening identified DO, ammonia, nitrate, phosphorus, chlorophyll-a, fecal coliform, TDS, aluminum, cadmium, copper, lead, and mercury for further analyses.

Dissolved Oxygen, Nutrients and Chlorophyll-*a*

The screening identified twelve stations in Lake Houston and its tributaries with depressed dissolved oxygen data. However, the screening included subsurface DO measurements. Excluding measurements below the surface, the list of stations with DO concentrations that do not achieve the stream standard is reduced to five in the lake, plus two stations on Luce Bayou, a tributary to Lake Houston.

Three of the five stations with low DO measurements in surface samples are mid-lake stations in Lake Houston. Each of these stations has 22 measurements over a period from 1993 to 1997. The data were collected by the USGS. Data collection procedures appear to have been very consistent over this period. The stations were always sampled in the same sequence, and they were always monitored between 9:30 a.m. and 1:30 p.m. Usually the DO concentration was higher at the last station sampled than at the first station sampled. It is possible that this increasing dissolved oxygen concentration is due to photosynthetic activity. It is a common phenomenon that DO concentrations are lowest early in the morning and increase as the sunlight promotes photosynthetic activity. However, this increase observed between the stations is not consistent (Figure 7) and does not provide an explanation for the few values below the stream standard. The data do show that DO concentrations are not chronically low and the lowest dissolved oxygen concentrations occur during the summer months. The measurements below the 24-hour average stream standard were collected in July and August of 1993, August 1996, and August 1997. Diurnal measurements during the month of August may provide useful information about the ability of the lake to meet the 24-hour average stream standard.

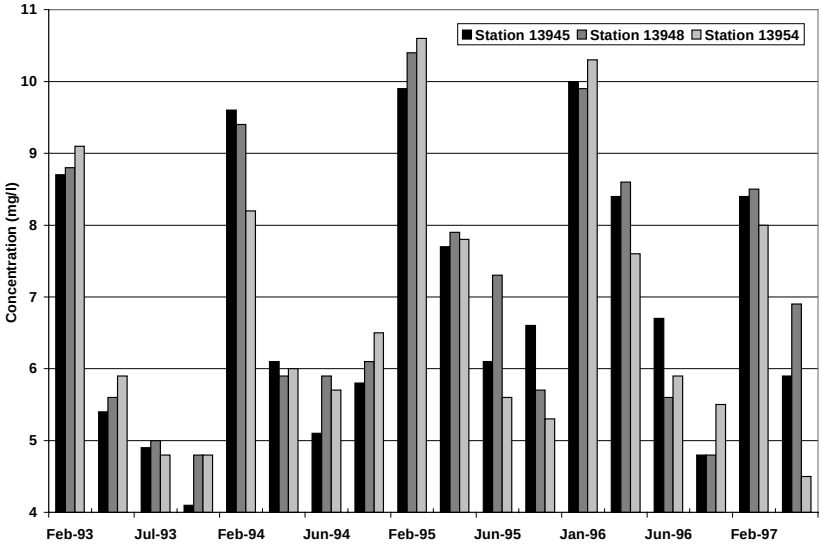


Figure 7
Lake Houston
Dissolved Oxygen at Three Mid-lake Stations

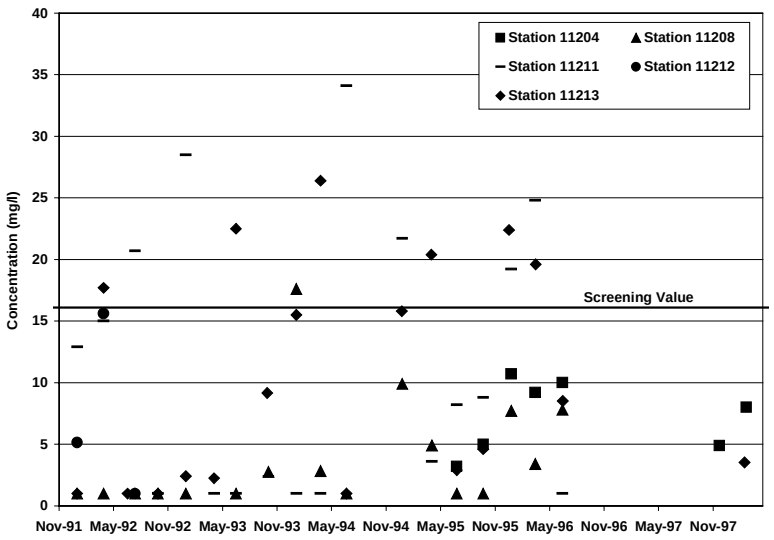


Figure 8
Lake Houston
Chlorophyll-a

Chlorophyll-a can be indicative of eutrophic conditions. The screening identified chlorophyll-a as needing further evaluation in Segment 1002 because 13 measurements in the lake exceeded the screening criteria. The 13 measurements were collected at three different stations (Figure 8).

The screening identified several nutrients that exceed the screening criteria. Elevated nutrients can produce accelerated eutrophication. While the DO data analyses are inconclusive, the chlorophyll-a data suggest eutrophication may be a concern. Therefore, these observed concentrations indicate nutrients may be a concern. The phosphorus data are presented on Figure 9.

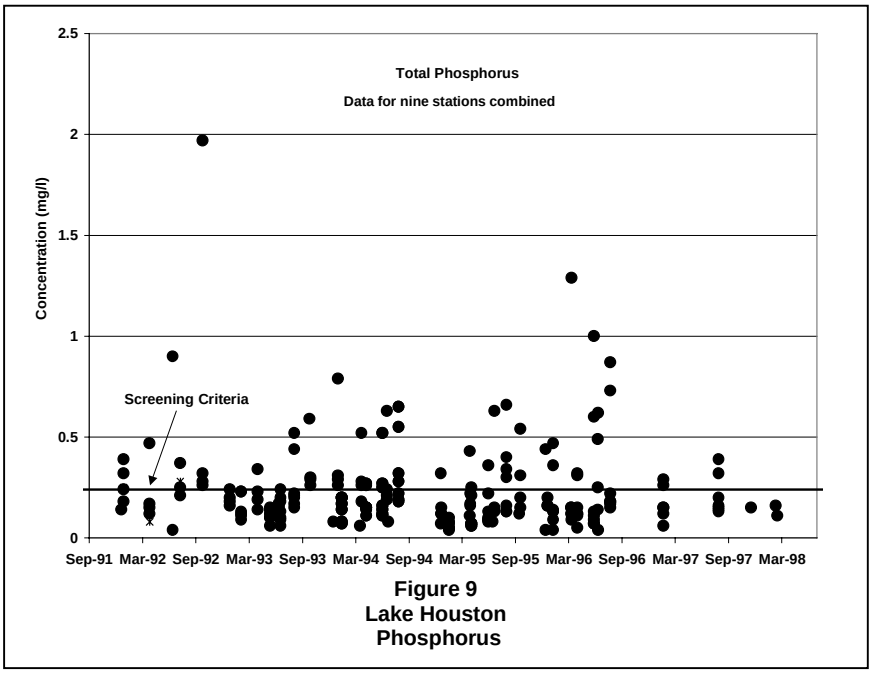


Figure 9
Lake Houston
Phosphorus

Total Dissolved Solids

The screening program identified four stations in the lake as exhibiting total dissolved solids values that exceed the screening criteria. These stations were evaluated further to determine if the exceedances of the screening criteria are indicative of exceedances of stream standards. The screening criteria are applied to discrete measurements. However, the stream standard for total dissolved solids applies to the annual average of at least four values. In 1994 only four values were reported at all four stations. Only one station (Station 11213) had an average above the stream standard. In 1995 all four stations had only three reported values, and the average for each station is above the stream standard. In 1996, 1997, and 1998, data were collected even less frequently.

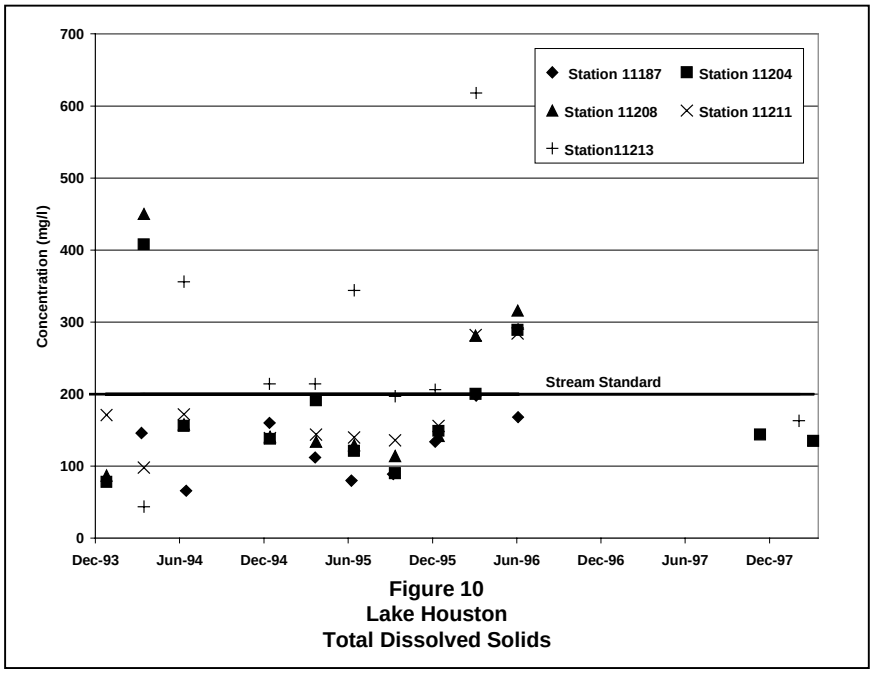


Figure 10
Lake Houston
Total Dissolved Solids

The database includes two values, collected at Stations 11204 and 11208 that appear to be erroneous. They were both collected on April 11, 1994. The values reported are above 4,000 mg/l, while all other values are less than 650 mg/l. The two stations with the outliers are not in close proximity, which would indicate that a significant part of the lake would have had to be impacted to have elevated concentrations at both stations. Data collected that same day at two other stations found the concentration to be less than 100 mg/l. Subsequent data collected in July of 1994 show values below 400 mg/l at all stations. In addition, chloride and sulfate concentrations, which usually are a significant fraction of the TDS, were not elevated in April of 1994. Conductivity data, which usually tracks variation in TDS concentration very closely are not elevated in April 1994. The data were disregarded in further analyses, and are not included in Figure 10.

Neither the average concentrations for chloride or sulfate appear to be reaching the level of the stream standard. There appears to be a possible concern for TDS in the lake. Further data collection may aid in determining whether a concern is justified or whether the stream standard may be inappropriate.

Cadmium

The screening identified cadmium as requiring further evaluation because two of 18 values were reported above the stream standard. The samples were collected in April and October of 1992. All data collected after 1992, 13 values, were reported below the detection limit. Based on the non-detection of cadmium in recent years, cadmium appears not to be a concern.

Aluminum

The screening identified aluminum as requiring further evaluation because two of 17 values reported are above the stream standard. All other values are reported below the stream standard (Figure 11). The two values were reported in 1992 and 1997. The value collected in 1992 is four times larger than the next highest value for this station and appears to be an outlier. There may be an increasing trend over time in the concentration and increased monitoring frequency may aid in determining whether a concern is justified.

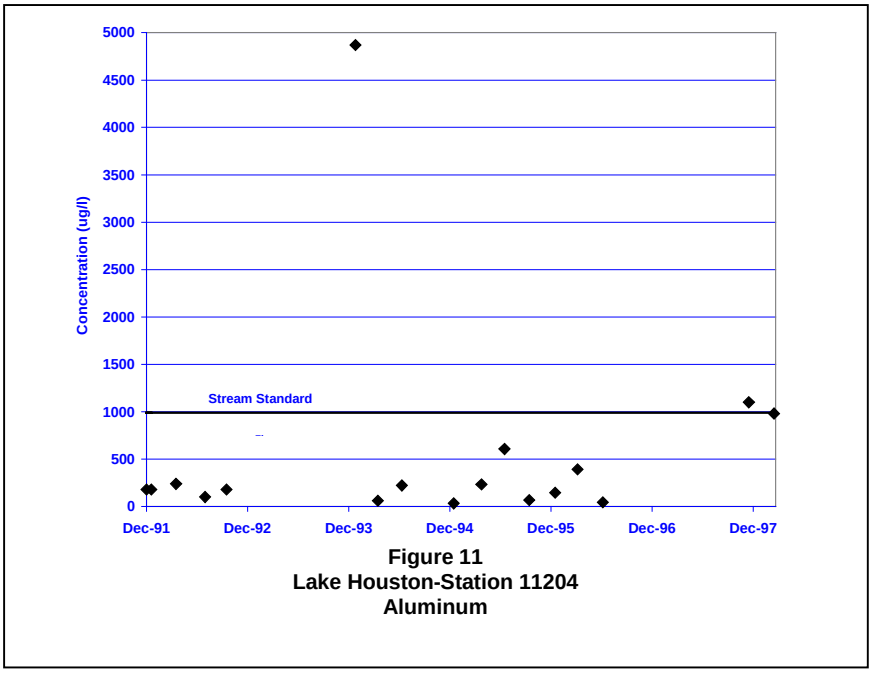


Figure 11
Lake Houston-Station 11204
Aluminum

Mercury

The screening identified mercury for further evaluation because seven of 11 measurements exceed the stream standard (Figure 12). The seven measurements coincided with the only measurements reported above the detection limit. The remaining four measurements were reported below the detection limit. The seven data points above the detection limit do indicate a decreasing trend. However, seven data points are very limited to make such a determination. More sensitive sampling and analytical techniques may provide a better understanding of the mercury concentrations within the segment.

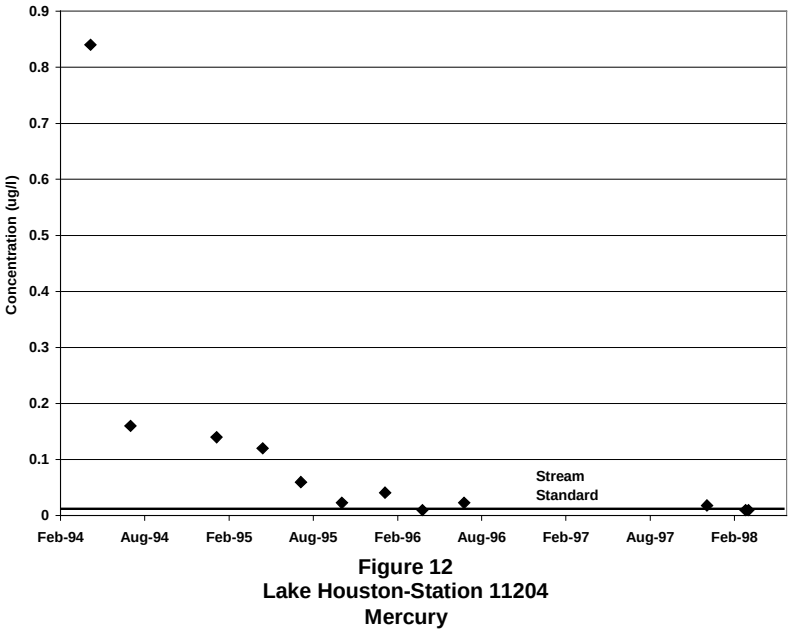


Figure 12
Lake Houston-Station 11204
Mercury

Copper

The screening identified copper as requiring further evaluation because two out of 18 measurements were reported to be above the stream standard. The two samples that are reported as exceeding the stream standard were collected in 1992. Sixteen measurements performed since 1992 are all below the stream standard. No trend since 1992 is apparent because most of the reported values are at or below the detection limit. The data do not indicate a concern for copper.

Lead

The screening process identified lead as requiring further evaluation because three out of 18 measurements are above the stream standard. The three samples for which lead was reported as exceeding the stream standard were all collected in 1992. All sixteen measurements performed since 1992 indicate that the concentration of lead is below the detection limit, which is below the screening criteria. The data do not indicate a concern for lead. However, the detection limit for most measurements in the database is very near the

stream standard. Therefore, it would be desirable to collect additional samples using a more sensitive analytical method.

SEGMENT 1003 – EAST FORK SAN JACINTO RIVER

Segment 1003 extends from the confluence of Caney Creek in Harris County to US 190 in Walker County. The total length is 75 miles. Segment 1003 contains the following stations:

Station ID Number	Location	Number of Records in Database
11235	East Fork San Jacinto at FM 1485	1083
11238	East Fork San Jacinto on SH 105 south of Cleveland	66
14242	East Fork San Jacinto at US 59	79

The segment is not included on the 303(d) list. The screening did not identify any parameter(s) that exceed the standard criteria.

The database does not contain any data for toxic parameters in Segment 1003. A review of dissolved oxygen data and nutrient data indicates that the water quality is good, and concentrations appear to be steady.

SEGMENT 1004 – WEST FORK SAN JACINTO RIVER

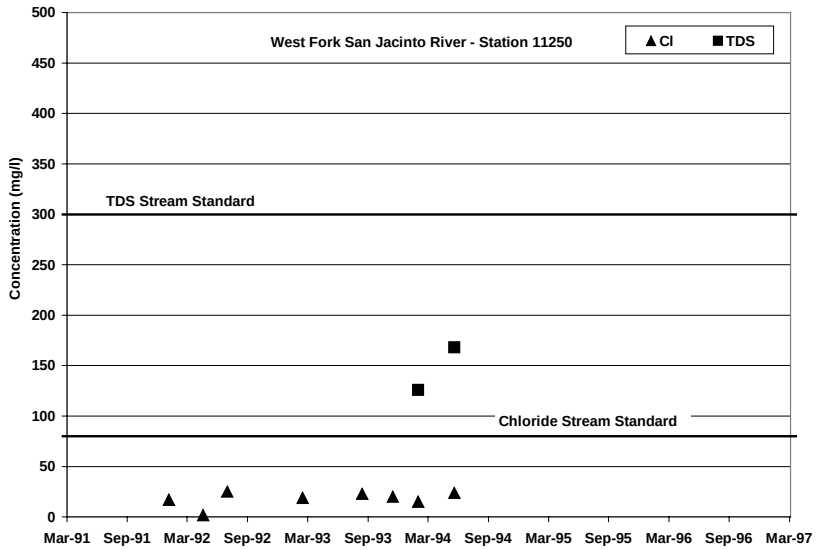
Segment 1004 extends from the confluence of Spring Creek at the Harris/Montgomery County line to Conroe Dam in Montgomery County. The total length is 40 miles. Segment 1004 contains the following stations:

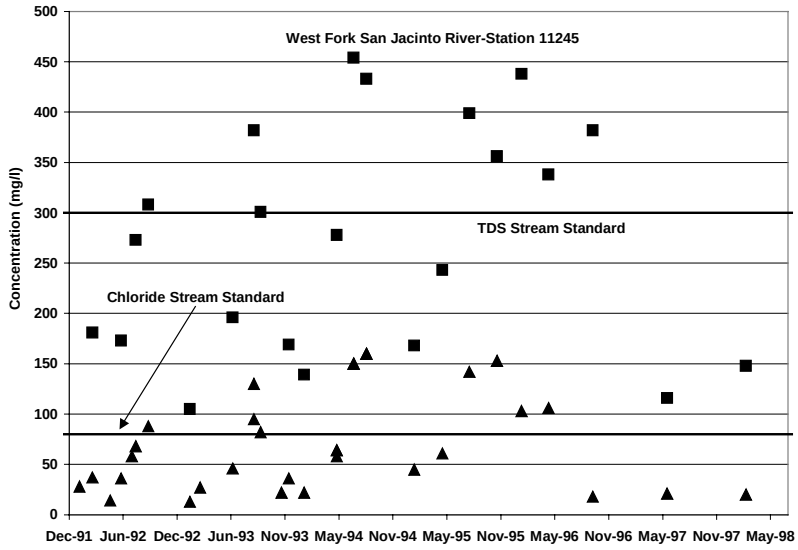
Station ID Number	Location	Number of Records in Database
11181	Crystal Creek at FM 1314 bridge	212
11245	West Fork San Jacinto River bridge on IH 45 south of Conroe	1062
11250	West Fork San Jacinto River FM 2854 west of Conroe	169
13611	West Fork San Jacinto River 4.4 miles SW of Porter, 5 miles upstream of Spring Creek, 6.2 miles NW of Humble	644
15803	East Fork Crystal Creek at SH 105	155
15804	East Fork Crystal Creek at FM 3083	155
15805	West Fork Crystal Creek at FM 3083	155

Segment 1004 is not on the 303(d) list. The screening identified TDS and chloride for further evaluation.

Total Dissolved Solids and Chloride

The screening identified total dissolved solids and chloride as requiring further evaluation at two stations in Segment 1004. The stations are Station 11245 on the West Fork San Jacinto River at the IH-45 bridge south of Conroe and Station 13611 on the West Fork San Jacinto River southwest of Porter. The data are summarized in Figure 13. The TNRCC is reviewing the stream standards for TDS and chloride in this segment to determine whether they are appropriate. It is evident from the graph for Station 11245, that TDS and chloride concentrations are frequently above the criteria. This may be a natural condition at this site.





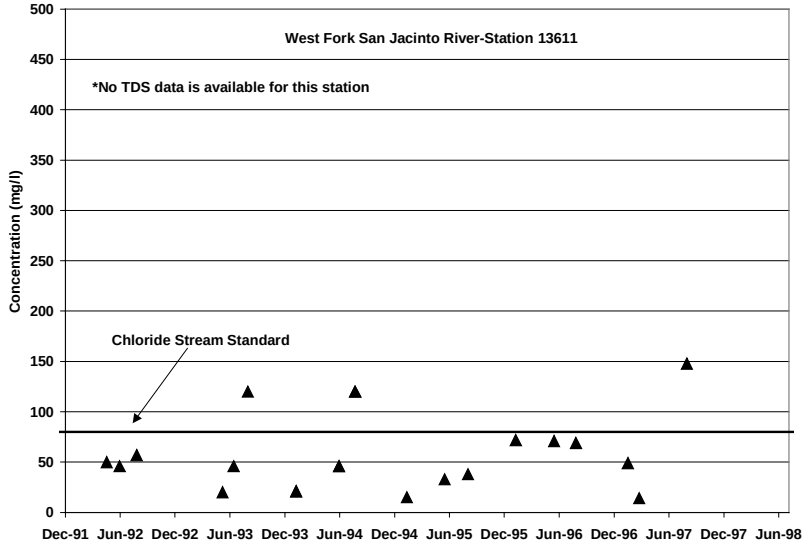


Figure 13
West Fork San Jacinto River
Chloride and Total Dissolved Solids

SEGMENT 1005 – HOUSTON SHIP CHANNEL TIDAL

Segment 1005 extends from the confluence with Galveston Bay at Morgan's Point in Harris/Chambers County to a point 100 meters (110 yards) downstream of IH-10 in Harris County. The total length is 12 miles. Segment 1005 contains the following stations:

Station ID Number	Location	Number of Records in Database
16621	San Jacinto River at mouth at HSE	152
16618	Houston Ship Channel at Exxon Docks	152
16619	Houston Ship Channel at Lynchburg Ferry Inn	163
11252	Houston Ship Channel at CM 91, Morgan's Point	2701
11254	Houston Ship Channel at Baytown Tunnel (CM 103)	160
11258	Houston Ship Channel at CM 120	1059
11261	Houston Ship Channel/San Jacinto River at Lynchburg Ferry	19
15897	Houston Ship Channel at 96GB002, near mouth of HL&P intake inlet	16

Segment 1005 is on the 303(d) list because of elevated levels of mercury, nickel, and dioxin. The screening identified DO, fecal coliform, copper, mercury, and nickel for further analyses.

Dissolved Oxygen

The screening was conducted on all DO measurements, including subsurface measurements. All of the DO measurements that were below 4 mg/l, which is the water quality standard, were collected at depths greater than 5 meters. DO is not identified as a concern by the screening program when measurements in the mixed surface layer, as defined by the TNRCC, are used to calculate daily average DO concentrations.

Fecal Coliform

The screening identified fecal coliform as requiring further evaluation at five of the six stations with fecal coliform data. None of the bacteria data were collected at the frequency specified in the stream standard, five samples over 30 days. There is no apparent trend in the fecal coliform levels. The TNRCC is currently reviewing the appropriateness of the fecal coliform stream standards and changes are being considered that may alter the results of the data screening. Any action with respect to bacterial levels in Segment 1005 should be deferred until the results of the re-evaluation of the bacteriological standard criteria are complete.

Mercury

Mercury was identified by the screening program as requiring further evaluation because 8 of 12 measurements of total mercury exceed the stream standard. The stream standard for mercury applies to the dissolved mercury. However, when concurrent measurements of total and dissolved mercury are performed, the measurements indicate that mercury is predominantly present in the dissolved form (see Table 5). All samples analyzed for mercury in this segment were collected near Channel Marker 91. The data support a continued concern for mercury in this segment.

Table 5

Houston Ship Channel at CM 91 (Morgan's Point) Station Mercury

	Total Mercury (ug/l)		Dissolved Mercury (ug/l)	
2/12/92			<	0.2
4/27/92				0.3
8/25/92			<	0.2
10/6/92			<	0.2
1/12/93			<	0.2
7/13/93			<	1
10/14/93			<	0.06
1/11/94				0.4
4/18/94		0.26		
7/21/94			<	0.6
10/11/94		0.05		0.05
1/25/95		0.08		0.1
4/19/95	<	0.12	<	0.12
7/18/95				0.013
7/18/95		0.03		
10/23/95		0.043		0.04
1/24/96		0.021		0.012
4/10/96	<	0.01	<	0.01
7/16/96		0.011	<	0.01
11/14/96	<	0.01	<	0.01
1/30/97		0.03		0.027
4/29/97		0.02	<	0.01

Copper

The screening identified copper as requiring further evaluation because 6 of 21 reported values were above the stream standard. The last 11 measurements, collected between 1994 and 1997, are all below the detection limit, with the exception of one value (October 1995). The one detection appears to be an isolated event. It appears that there may no longer be a water quality concern for copper at this station, however, additional data are needed to adequately evaluate the water quality at this station.

Nickel

The screening program identified nickel for further evaluation because 3 of 21 measurements at Houston Ship Channel at Morgan's Point exceed the stream standard. A review of the data shows that all of the values exceeding the criteria were reported in 1992. The fifteen samples analyzed in 1993 and later are all below the detection limit. These data indicate that water quality has improved, and the concern for nickel is no longer warranted.

SEGMENT 1006 – HOUSTON SHIP CHANNEL TIDAL

Segment 1006 extends form the confluence of the Houston ship Channel with the San Jacinto River in Harris County to a point immediately upstream of Greens Bayou in Harris County, including the tidal portions of tributaries. The total length is 6 miles. Segment 1006 contains 14 stations. The following are the ten stations with the largest number of records.

Station ID Number	Location	Number of Records in Database
11264	Houston Ship Channel at San Jacinto Park	161
16617	Houston Ship Channel at Cargill Terminal	163
11126	Halls Bayou at Jensen Dr in Houston	351
11264	Houston Ship Channel at Carpenter Bayou Confluence Near San Jacinto Monument at the Powerline Above Battleship Texas	2595
11266	Houston Ship Channel Diamond Shamrock (Deer Park Plant) Intake Screens on the Houston Ship Channel, mile 11.5	349
11271	Houston Ship Channel at Confluence with Greens Bayou (CM 152)	1496
11272	Carpenter Bayou Tidal at South Sheldon Rd. in Channelview	300
11273	Patrick Bayou Tidal immediately Upstream of Bridge leading to Occidental Chemical Intake Station on Houston Ship Channel	268
11275	Greens Bayou Tidal at IH 10 Bridge East of Houston	236
15858	Greens Bayou Tidal at Normandy Dr in East Houston	102

Segment 1006 is included on the 303(d) list because of elevated levels of mercury, dioxin, and nickel. Patrick Bayou, a tidal tributary of the Houston Ship Channel is included on the 303(d) list because of elevated levels of copper, metals, and organics in sediment; ambient water toxicity; water temperature; and sediment toxicity. The screening identified DO, ammonia, total phosphorus, chlorophyll-a, pH, fecal coliform, copper, mercury, and nickel for further evaluation.

Dissolved Oxygen

The screening program identified DO at Station 11271 (Houston Ship Channel at the confluence with Greens Bayou) because 21 of 145 data points were below the stream standard. Most of data below the standard are subsurface measurements. If only measurements within one meter of the surface are considered, 2 of 145 measurements

are below the stream standard. It appears the stratification results in depressed oxygen levels in subsurface layers.

The TNRCC defines the mixed surface layer in tidal segments as the portion of the water column from the surface to the depth at which the specific conductance is 6,000 uhms. DO data on the mixed surface layer are averaged to determine compliance with the stream standard. Based on this, daily averages were calculated for all measurements collected within the mixed surface layer. On 17 of the 42 days with data, only surface measurements were reported. Three of the daily averages are below the stream standard of 2 mg/l. The daily averages in the mixed surface layer are shown in Figure 14. The data show that DO concentration typically meet the standards and that a concern is not warranted.

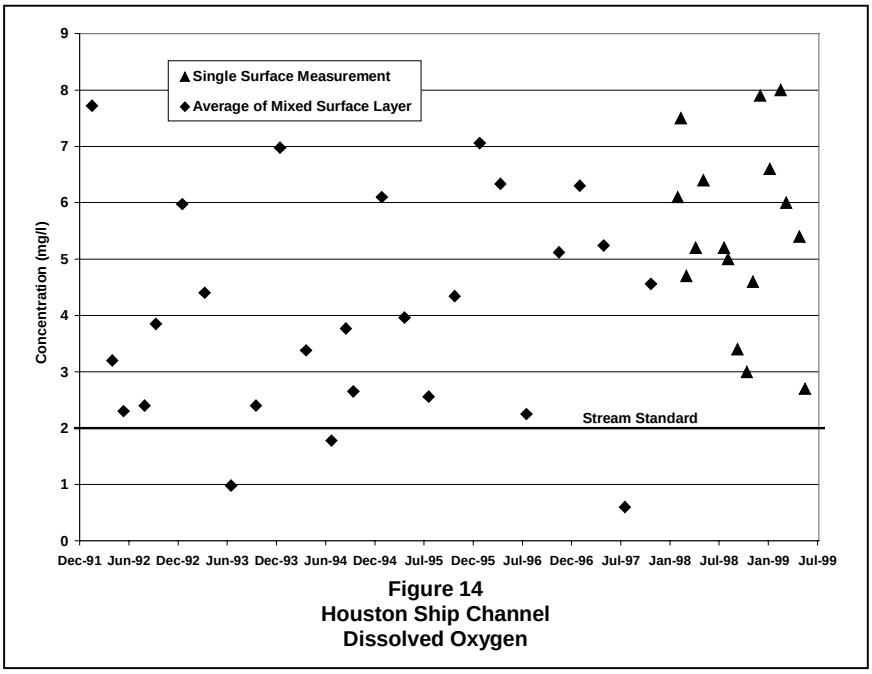


Figure 14
Houston Ship Channel
Dissolved Oxygen

pH

The screening program identified pH because 3 of 22 measurements at Station 11272 were above the stream standard. The three measurements were taken in 1993 on the same day at three different depths. No other values exceeded the stream standard. The elevated levels appear to have been associated with an isolated event and do not indicate a concern related to pH at this station.

Nutrients

The screening program identified ammonia, nitrate, phosphorus, and phosphate. Given that the segment has no aquatic life use, and a DO criterion of only 2 mg/l, the nutrient screening criteria may not be appropriate. There is no apparent decreasing or increasing trend in nutrient concentrations in the segment. The segment is upstream of Segment 1005, the Houston Ship Channel-San Jacinto River. Segment 1005 was also

identified by the screening program because of elevated levels of nutrients. While nether of these two segments may be detrimentally impacted by the elevated levels of the nutrients, the levels may negatively impact the water quality in the downstream bays. The water quality of the bays was not reviewed as part of this report.

Chlorophyll-a

The screening program identified chlorophyll-a for further evaluation because 4 of 11 measurements exceeded the screening value at Station11272 (Carpenter Bayou Tidal at South Sheldon Rd). Figure 15 shows the concentration of both DO and chlorophyll-a at Station 11272. The figure shows that there is a possible correlation between chlorophyll-a and DO concentrations. However, the data are inconclusive as to whether a water quality concern exists.

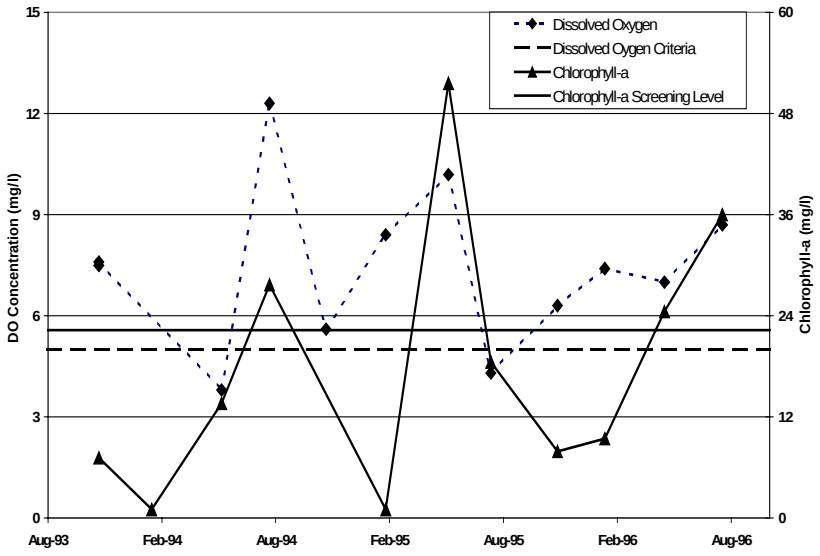


Figure 15
Carpenter Bayou at South Sheldon Road
Dissolved Oxygen & Chlorophyll-a

Fecal Coliform

The screening program identified fecal coliform as requiring further evaluation in Segment 1006. However, the bacterial water quality standard for Segment 1006 is based on enterococci. However, the frequent detection of elevated levels indicates a water quality concern for bacteria.

Copper

The screening program identified copper at Station11271 (Houston Ship Channel) at the confluence with Greens Bayou) and Station 11264 (Houston Ship Channel at the confluence with Carpenter Bayou) as requiring further evaluation. In both cases the last eight measurements (after 1995) are reported as below the detection limit. Copper may have been a concern prior to 1996, but the more recent data indicate no concern. Continuing monitoring is suggested to provide sufficient evidence that water quality has improved and that a concern in no longer warranted.

Nickel

The screening program identified nickel as requiring further evaluation at Station 11271 and Station 11264. The data are presented in Table 6. A study to determine a Total Maximum Daily Load (TMDL) for nickel is in progress.

Mercury

The screening program identified mercury for further evaluation at Station 11271 and Station 11264.

The data, presented in Table 6, indicate that most of the mercury is present in the dissolved form. There are no apparent trends in the data set. The data justify a concern with regard to mercury in Segment 1006. A TMDL to determine the extent and severity of mercury contamination in this segment is underway.

Table 6
Houston Ship Channel
Mercury

	Mercury (ug/l)				
	Houston Ship Channel at Carpenter Bayou			Houston Ship Channel at Greens Bayou	
Date		Dissolved	Total	Dissolved	Total
02/12/92	<	0.2			
04/27/92				< 0.3	
08/25/92				< 0.2	
10/06/92	<	0.2		< 0.2	
01/12/93	<	0.2		< 0.2	
07/13/93	<	1		< 1	
10/14/93	<	0.1		< 0.1	
01/11/94	<	0.12		< 0.4	
04/18/94			< 1.2		< 0.6
07/21/94	<	0.34	< 0.34	< 0.34	< 0.34
10/11/94	<	0.18	< 0.15	< 0.1	< 0.1
01/25/95	<	0.12	< 0.143	< 0.102	< 0.106
04/19/95	<	0.2	< 0.06	< 0.2	< 0.2
07/18/95	<	0.013	< 0.011	< 0.01	< 0.014
10/23/95	<	0.045	< 0.049	< 0.052	< 0.049
01/24/96	<	0.016	< 0.033	< 0.01	< 0.018
04/10/96	<	0.01	< 0.01	< 0.01	< 0.01
07/16/96	<	0.01	< 0.01	< 0.01	< 0.01
11/14/96	<	0.01	< 0.011	< 0.01	< 0.01
01/30/97	<	0.021	< 0.036	< 0.024	< 0.031
04/29/97	<	0.014	< 0.025	< 0.01	< 0.012
01/27/98	<	0.01	< 0.013		
04/22/98	<	0.01	< 0.015		

SEGMENT 1007 – HOUSTON SHIP CHANNEL/BUFFALO BAYOU TIDAL

Segment 1007 extends from a point on the Houston Ship Channel Immediately upstream of Green's Bayou in Harris County to a point in Buffalo Bayou Tidal that is 100 meters (110 yards) upstream of US Highway 59 in Harris County, including the tidal portions of the tributaries. The total length of the segment is 14 miles. Segment 1007 contains 57 stations. The following are the ten stations with the largest number of records:

Station ID Number	Location	Number of Records in Database
11129	Hunting Bayou at N Loop E (Loop 610) in Houston	1029
11132	Sims Bayou at Telephone Rd (SH 35) in Houston	1026
11139	Brays Bayou at S Main St in Houston	1450
11284	Houston Ship Channel/Buffalo Bayou near FL 165, 440 yards below Vince Bayou	1064
11287	Houston Ship Channel/Buffalo Bayou at confluence with Sims Bayou	1059
11292	Houston Ship Channel/Buffalo Bayou in middle of turning basin	2875
11296	Buffalo Bayou tidal at Hirsch and York St bridge	830
11299	Vince Bayou 300 yards upstream of the Houston Ship Channel confluence	1014
11302	Sims Bayou at Lawndale Ave in Houston	709
11307	Brays Bayou at IH 45 SE of Houston	468

Segment 1007 is included on the 303(d) list because of elevated levels of mercury, dioxin, and nickel. Vince Bayou, a tidal tributary of the Houston Ship Channel, is included on the 303(d) list because of ambient sediment toxicity. The screening identified DO, ammonia-nitrogen, nitrate-nitrogen, total phosphorus, chlorophyll-a, fecal coliform, copper, lead, mercury, and nickel as requiring further analyses.

Dissolved Oxygen

The screening program identified DO at four stations in the segment and tributaries as requiring further analyses. The screening program screened all values, including subsurface measurements. Compliance with the stream standard is based on the average DO concentration in the mixed surface layer. The mixed surface layer

is defined at the water column to the depth at which the specific conductance is 6,000 uhms greater than the surface. Based on the averages in the mixed surface layer, DO is not a concern in this segment. The DO data are shown in Table 7.

Nutrients

The screening program identified ammonia, nitrate, phosphorus and phosphate as requiring further analyses in Segment 1007. The segment has no aquatic life use, and it has a DO criteria of 1 mg/l. Since the primary use impacted by excessive nutrients is aquatic life use, the nutrient screening criteria does not appear to be relevant. There is no apparent decreasing or increasing trend in nutrient concentrations in the segment.

Fecal Coliform

The screening program identified fecal coliform at 15 stations as requiring further evaluation in this segment. However, the bacterial water quality standard for Segment 1006 is based on enterococci. Therefore, evaluation of fecal coliform data in this segment is not relevant. The frequent detection of elevated levels indicates a water quality concern for bacteria.

Table 7
Dissolved Oxygen Concentration
Houston Ship Channel
Depth Profiles

		Dissolved Oxygen (mg/L)			
		Station			
Date	Sampling Depth	16481	16482	16483	16484
15-Jan-97	0.3	9.2	9.7	9.7	10.5
	1.2	8.6			10.6
	1.4		9.5	9.8	
	2.4	8.5			10.8
	2.7		9.5	9.6	
16-Apr-97	0.3	7	7.2	7.2	5.5
	1.2	5.7			5.2
	1.4		6.8	6.8	
	2.4	4			4.6
	2.7		4.1	4.6	
15-Jul-97	0.3	8.2	8	7.3	7.8
	1.2	3.4			7.5
	1.4		7.9	6.5	
	2.4	0.4			3.9
	2.7		0.3	0.2	
15-Oct-97	0.3	5.4	5.6	4.6	5.6
	1.2	4.5			5.6
	1.4		5.4		
	2.4	0.3			5.3
	2.7		4.2	2.7	
27-Jan-98	0.3	7.5	8.1	7.8	7.8
	1.2	7.2			7.6
	1.4		7.8	7.7	
	2.4	4.7			6.7
	2.7		8.3	8.3	
15-Apr-98	0.3	6.5	5.4	6.5	7
	1.2	5.1			7
	1.4		4.7	6	
	2.4	3.1			6.8
	2.7		3.9	2.7	
15-Jul-98	0.3	4.8	4.7	5.2	6
	1.2	4.2			5.1
	1.4		3.1	3.7	
	2.4	2.1			1.8
	2.7		3	3.1	
28-Oct-98	0.3	5.13	5.67	5.62	5.83
	1.2	4.04			5.27
	1.4		5.26	2.48	
	2.4	1.31			2.61
	2.7		1.09	1.83	
20-Jan-99	0.3	9.3	7.5	8.4	8.1
	1.1		7.1		5.5
	1.4	6.3			
	1.5			8.1	
	2.1		6.3		5.2
	2.7	4.9			
	3.1			5.1	

Mercury and Nickel

The screening identified mercury and nickel at Station 11292, the Houston Ship Channel/Buffalo Bayou in the middle of the Turning Basin, because 7 of the 15 mercury data points and 3 of the 23 nickel data points exceeded the stream standard. The data have a similar pattern as observed in Segment 1006. A TMDL is underway to determine the extent of the water quality concern.

Copper

Copper was identified by the screening program as requiring further evaluation because 4 of 23 values at Station 11292 were above the stream standard. Three of the 4 values above the stream standard were reported in 1992, a fourth was reported in 1995. Since 1995, eight measurements were reported below the stream standard. It appears that the water quality has improved and that a concern for copper is not warranted.

Lead

The screening identified lead as requiring further analyses at three stations: Stations 11129, 11132, and 11139. The lead data are shown in Table 8. The lead stream standard is 5 ug/l. Almost half of the values reported are above this level. Therefore, lead levels are a concern in this segment.

Table 8
Lead
Houston Ship Channel
Segment 1007

	Lead (ug/l)		
	Hunting Bayou at Loop 610	**Sims Bayou at Telephone Rd.**	**Brays Bayou at South Main St.**
08-Feb-93	< 10		
09-Feb-93		< 10	20
02-Jun-93	< 10		
03-Jun-93		< 10	< 10
23-Aug-93	< 10		
24-Aug-93		< 10	< 10
15-Feb-94	< 10	10	
16-Feb-94			< 10
03-May-94	10		
04-May-94		20	10
02-Aug-94	< 10		
03-Aug-94		20	< 10
14-Mar-95	20		
15-Mar-95		< 10	20
22-May-95	30		
23-May-95		30	10
02-Aug-95	20		
03-Aug-95		20	< 10
26-Feb-96	30		
27-Feb-96		20	40
29-May-96	< 10		
30-May-96		30	10
26-Aug-96	< 10		
27-Aug-96		< 10	< 10
26-Feb-97	20		
27-Feb-97		< 10	< 10
14-May-97	14.903		
19-May-97		< 10	16.629
18-Aug-97	27.642		
19-Aug-97		14.337	< 10

SEGMENT 1008 — SPRING CREEK

Segment 1008 extends from the confluence of Spring Creek with the West Fork San Jacinto River in Harris/Montgomery County to the most upstream crossing of FM 1736 in Waller County. The total length is 69 miles. Segment 1008 contains 15 stations. The following are the ten stations with the largest number of records:

Station ID Number	Location	Number of Records in Database
16631	Upper Panther Branch @ Bear Branch Bridge (third)	65
16628	Lower Panther Branch downstream of WWTP 1	265
16627	Lower Panther Branch upstream of WWTP 1	265
11312	Spring Creek at Riley Fussel Rd	962
11313	Spring Creek bridge on IH 45, 20 miles north of Houston	162
11314	Spring Creek at FM 149	315
16481	Lake Woodlands #3	97
16482	Lake Woodlands #4	97
16483	Lake Woodlands #2	97
16484	Lake Woodlands #1	97

Segment 1008 is included on the 303(d) list because of elevated levels of bacteria. The screening identified DO, ammonia-nitrogen, ortho-phosphate, chlorophyll-a, pH, fecal coliform, TDS, and chloride as requiring further analyses.

Dissolved Oxygen

The screening program identified DO as requiring further analyses at several stations on the main stem and its tributaries. The main stem station on Spring Creek at FM149, Station 11314, has 5 of 14 measurements that are reported as below the stream standard. The lower values are typically reported during summer months between 9:00 a.m. and 10:00 am. It is possible that the lower concentrations are a result of respiration that occurred during the night. The data do not conclusively provide evidence of a water quality concern. It is recommended that DO data be collected over a 24-hour period in order to obtain a better understanding of the water quality condition.

Station 16627 (Panther Branch upstream of WWTP 1) and Station 16628 (Panther Branch downstream of WWTP 1) were identified as requiring further analyses because 40% and 21% of the reported measurements, respectively, were below the assumed stream standard of 5 mg/L. Panther Branch is an unclassified water. When there has not been a site-specific study to determine the aquatic life use classification of a stream, the DO standard is assumed to be 5 mg/L. The data, shown in Figure 16, show significant seasonal fluctuation at both the station above the effluent discharge and the station below the effluent discharge.

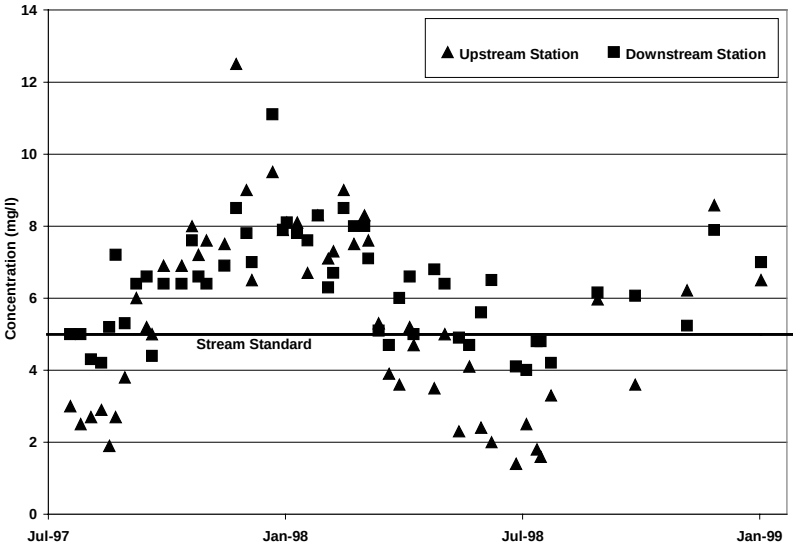


Figure 16
Segment 1008-Upstream and Downstream of WWTP #1
Dissolved Oxygen

Figure 17 shows the difference in the concentration between the upstream and downstream stations. A positive value indicates a high concentration downstream and a negative value shows that the upstream concentration is higher. The figure demonstrates that in the summer

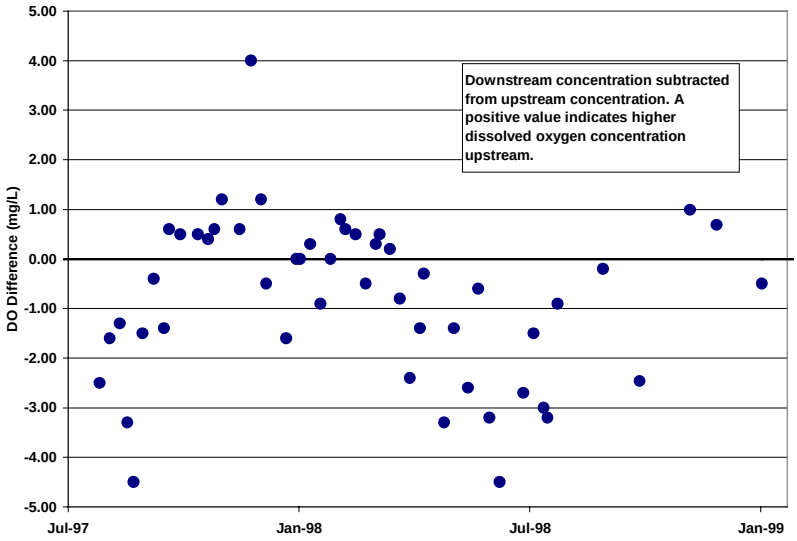


Figure 17
Difference in Dissolved Oxygen Concentrations
Segment 1008-Upstream & Downstream of WWTP #1

months, the DO concentration is higher downstream, while the opposite is generally true in the winter months. The water quality with regard to DO is generally better downstream rather than upstream. The data suggest that the default assumption of 5 mg/L may not be appropriate for Panther Branch. Only some of the data have information about the time of day when sampling occurred. When data are available, the data typically show that sampling occurred between 8:00 a.m. and 10:00 am. The low concentrations reported during the summer may reflect depressed DO levels that can occur in the morning as a result of algal respiration during the night. A study to determine the appropriate aquatic life use classification and stream standard is recommended. The study should include DO measurements over a 24-hour period in order to determine whether significant daily fluctuations occur.

Four stations in Lake Woodlands are identified for further evaluation because of depressed oxygen levels. Three of the four stations do not pass the screening methods if daily averages within the mixed surface layer are screened. Further review indicates that, at times, the DO concentration decreases significantly between the surface and a 2-meter depth, or lower. This stratification in DO concentration usually occurred in the summer months. The samples collected in January 1997, 1998 and 1999 show no, or only slight, indications of stratification. A study should be conducted to determine whether a site-specific stream standard is appropriate, and whether the water quality concern is justified.

Total Dissolved Solids and Chloride

The screening program identified both chloride and TDS as requiring further evaluation because several values exceeded the screening criteria at Station 11312 (Spring Creek at Riley Fussel Rd.) The water quality standards for chloride and TDS apply to an annual average of at least four measurements.

The database for Station 11312 includes at least six chloride measurements per year between 1992 and 1996. The average for 1996 (85 mg/L) exceeds the stream standard of 80 mg/L. Only one measurement was reported in 1997 and again in 1998. Both measurements (40 mg/L and 25 mg/L) are well below the stream standard.

The database includes only one year, 1995, with at least four TDS measurements. The average TDS concentration in 1995 is 308 mg/L, which is just above the stream standard of 300 mg/L. Three measurements in 1996 exhibit an average concentration of 421 mg/L. One measurement was made each year in 1997 and 1998. Each of these concentrations (192 mg/L and 180 mg/L) was well below the stream standard.

The data indicate that concentrations of TDS and, to a lesser extent, chloride were higher in 1995 and 1996 than they were before or have been since (see Figure 18). However, this observation is based on very little data during the period after 1995.

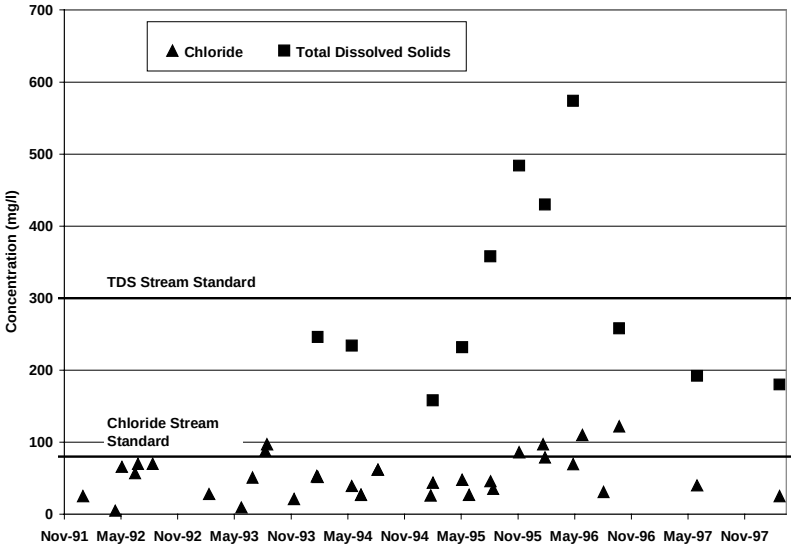


Figure 18
Spring Creek at Riley Fussel Road –Station 11312
Total Dissolved Solids and Chloride

Concentrations of dissolved salts can vary significantly as flow regimes vary from low flow, to normal flow, to high flow conditions. More frequent data collection, at least four measurements each year, is needed to evaluate conditions at this station. Data on flow should also be obtained so it can be determined if variations in flow significantly affect salt concentrations at this location.

Fecal Coliform

The screening identified fecal coliform as requiring further evaluation at four stations in Lake Woodlands. Each of the stations has nine measurements, and the number of measurements exceeding the screening criteria at each station ranges from 1 to 4. None of the data were collected in accordance to the stream standards requirement for five samples over 30 days. Also, the database contains no information with regard to weather conditions. Runoff is known to contain significant densities of fecal coliform. The data are not sufficient to determine whether fecal coiform is a concern, and more monitoring is recommended.

A similar fecal coliform data set exists for three stations on Upper Panther Branch (Stations 16631, 16632, and 16633). The conclusions stated in the previous paragraph are also applicable to Panther Branch. The TNRCC is considering changing the bacterial indicator in the water quality standards, and future monitoring programs should address the changes, if they are adopted.

Nutrients

The screening program identified ammonia-nitrogen and ortho-phosphate as requiring further evaluation. However, sufficient data to perform a meaningful evaluation are not available. Much of the data were collected over the last two years. Therefore, it cannot be used to determine trends.

Nutrient data are mainly utilized to identify sites with excessive growths of algae and aquatic vegetation. The previous evaluation of the DO data resulted in a recommendation that additional monitoring be conducted. The monitoring program should be structured so that it can also provide information as to whether nutrients are causing a water quality problem.

SEGMENT 1009 – CYPRESS CREEK

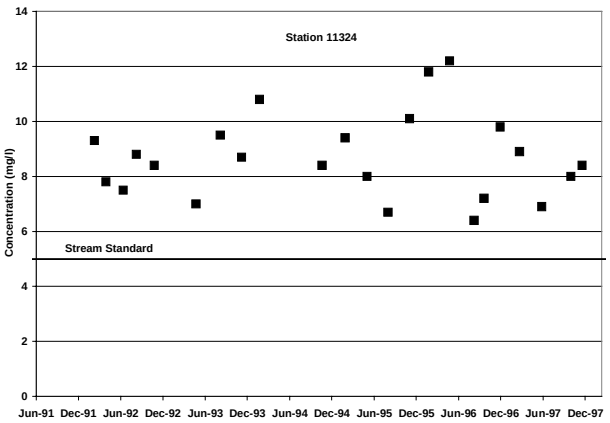
Segment 1009 extends from the Cypress Creek confluence with Spring Creek in Harris County to the confluence of Cypress Creek with Snake Creek and Mound Creek in Waller County. The total length is 53 miles. Segment 1009 contains the following stations:

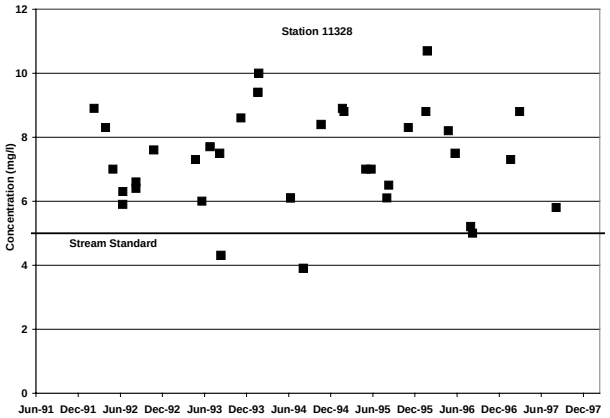
STATION ID NUMBER	LOCATION	Number of Records in Database
11324	Cypress Creek at Cypresswood Dr bridge	463
11325	Cypress Creek at Treschwig Rd	34
11326	Cypress Creek at Aldine-Westfield Rd	91
11327	Cypress Creek at the Hardy Toll Rd located on the west side of the southbound feeder road (Hardy St) approx 18 miles north of FM 1960W	33
11328	Cypress Creek bridge on IH 45, 15 miles north of Houston	1000
11329	Cypress Creek at Kuykendahl Rd in Houston	34
11330	Cypress Creek at Steubner-Airline Rd in Houston	92
11331	Cypress Creek at FM 149	33
11332	Cypress Creek at Grant Rd near Cypress	384

Segment 1009 is included on the 303(d) list because of elevated levels of bacteria, TDS, and DO. The screening identified DO, ammonia-nitrogen, nitrate-nitrogen, total phosphorus, ortho-phosphate, chlorophyll-*a*, fecal coliform, TDS, and chloride as requiring further evaluation.

Dissolved Oxygen

The screening identified DO at Station 11132 (Cypress Creek near Cypress) as requiring further evaluation because two of 17 values are less than the screening criteria. The two low concentrations are the two most recent measurements for that station. The measurements were made in May and August of 1996.





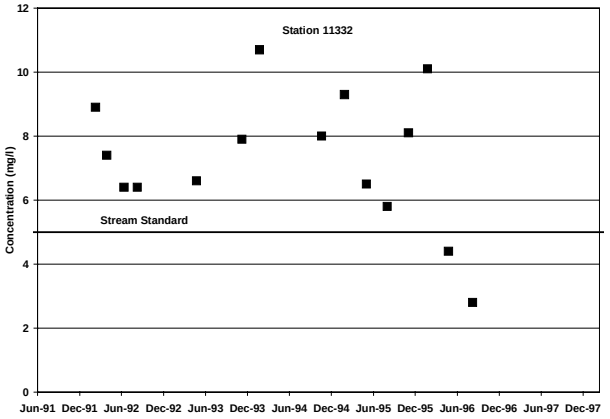


Figure 19
Cypress Creek
Dissolved Oxygen

There are two stations on Cypress Creek that are downstream of Station 11132. There are a significant number of DO measurements (see Figure 19 at both of these stations. Neither of the downstream stations is identified for further evaluation by the screening criteria.

Neither chlorophyll-a nor flow data provide a satisfactory explanation for the low DO levels observed in May and August 1996. However, observed densities of duckweed may account for the depressed oxygen concentrations. Comments for the August 1996 sampling event include the statement that duckweed was covering the surface. The DO concentration recorded at 8:20 in the morning in August is 2.8 mg/L. This depressed concentration could be the result of a reduction in reaeration due to the duckweed covering the surface or, it may be more likely the result of plant respiration during the night. However, additional data are needed to determine whether a degradation of water quality is occurring at Station 11332 or whether the two low concentrations observed were an aberration.

Chlorophyll-a

The screening program identified chlorophyll-a, at Station 11324 (Cypress Creek at Cypresswood Dr.) and Station 11328 (Cypress Creek bridge on IH 45) as requiring further evaluation. The chlorophyll-a data for the three stations with significant amount of data on Cypress Creek (Stations 11332, 11328, and 11324) are shown in Figure 20. The

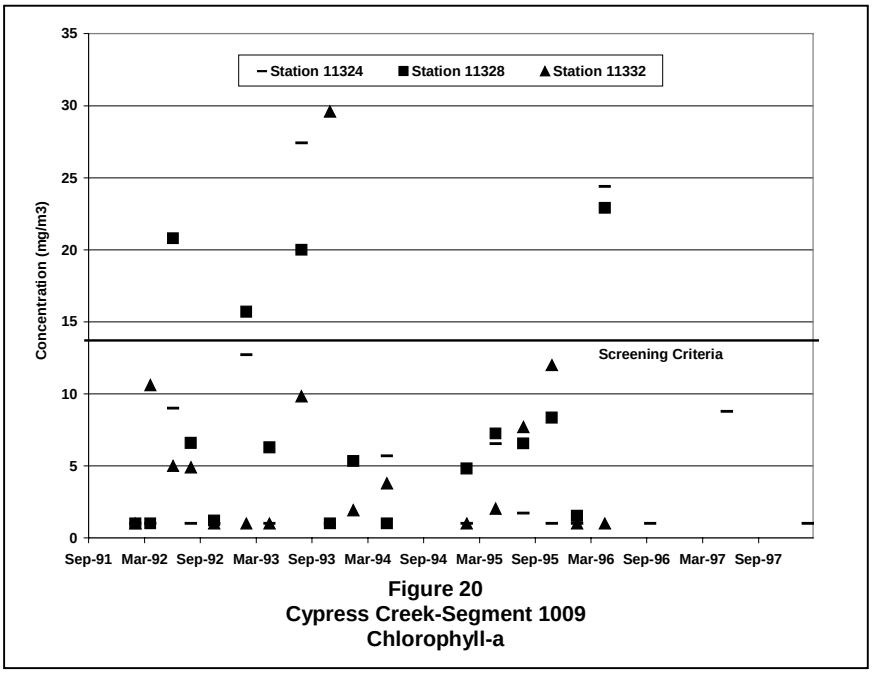


Figure 20
Cypress Creek-Segment 1009
Chlorophyll-a

data show that chlorophyll-a concentrations vary over time, but no decreasing or increasing trend over time is apparent. The boxplot for chlorophyll-a in Figure 21, summarize the relative concentrations of chlorophyll-a at the three stations and compare them to nutrient concentrations at the three stations. The chlorophyll-a concentrations tend to increase and decrease as concentrations of ammonia and phosphorus increase and decrease. The previous evaluation of DO at the three stations on Cypress Creek identified only Station 11332 as requiring further evaluation. Of the three stations, Station 11332 has the lowest overall concentrations of chlorophyll-a and nutrients. It appears that chlorophyll-a concentrations are not a significant concern in this segment, because the primary adverse impact on uses associated with chlorophyll-a is impacts on aquatic life uses due to low DO concentrations. The DO data indicate there are no concerns at either of the two downstream stations.

Nutrients

The screening identified nutrients (ammonia, phosphorus, and nitrate) at several stations in the segment as requiring further evaluation. Figure 21 demonstrates how nutrient concentrations increase from upstream to downstream. However, there is no apparent trend for increasing or decreasing nutrient concentrations over time. Nutrients can impact water quality by promoting algal growth. As discussed in the DO section, additional data collection efforts are desirable to obtain a better understanding of the water quality in the segment.

Fecal Coliform

The screening program identified three stations for further evaluation of fecal coliform. The most recent data for any station on Cypress Creek was collected in 1995. All data are shown in Table 9.

The screening criteria of 200 cfu/100 ml was exceeded fairly frequently at most stations. It is recommended that additional data be collected to determine whether current conditions are a concern.

Chloride and TDS

The screening program identified chloride as requiring further evaluation at Stations 11328 and 11324. Approximately 30% of the measurements at each station were

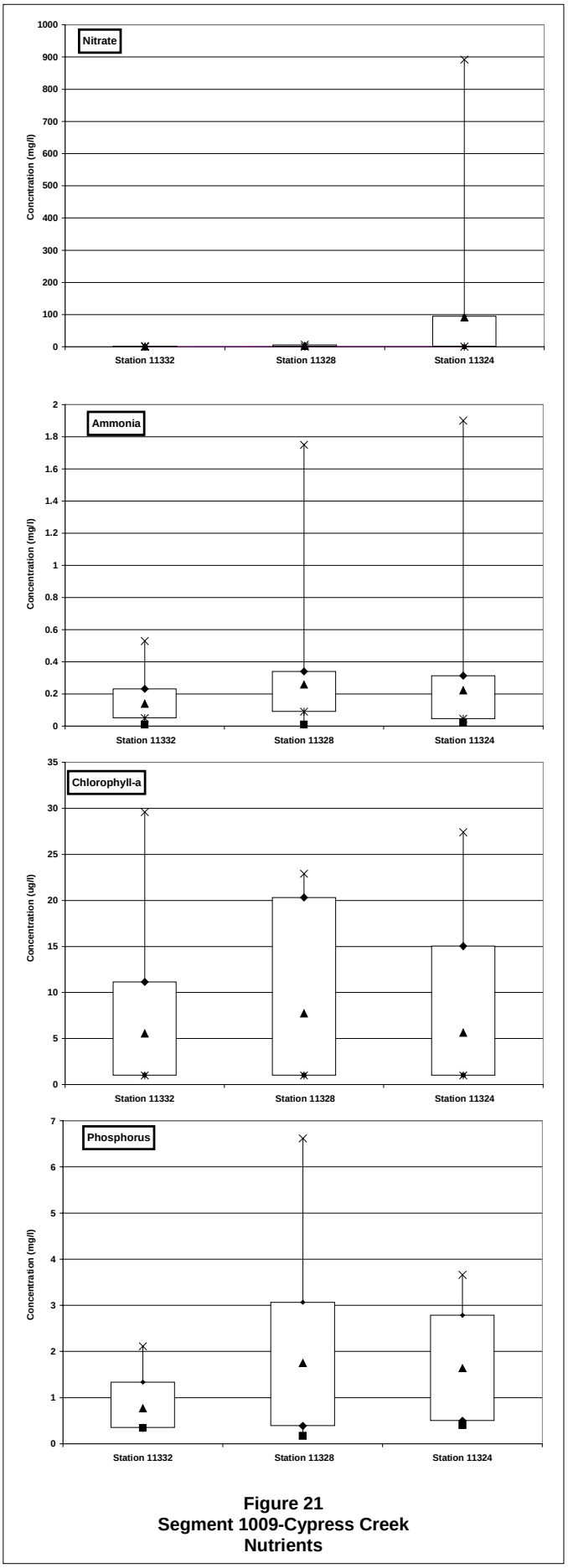


Figure 21
Segment 1009-Cypress Creek
Nutrients

Table 9
Fecal Coliform (cfu)
Segment 1009-Cypress Creek

Date	Fecal coliform (cfu) Cypress Creek at Cypresswood Dr. Bridge	at Aldine Westfield Rd	at Bridge on IH 45	at Steubner Airline Rd.	at Grant Rd.
2/19/92	10	20	40	270	30
4/8/92	10	10	400	1000	400
6/22/92	90	400	9500	2200	90
8/19/92	80	60	2000	10	22000
11/4/92	45		2400		1400
2/17/93	5200		2700		5400
5/4/93	3000		2200		1500
8/17/93	460		1400		85
2/3/94			785		670
5/24/94	1500		2700		200
5/15/95	35		230		30

above the screening criteria. Total dissolved solids concentrations exceeded the screening criteria at Station 11324 also.

The data do not present an increasing or decreasing trend for chloride or TDS concentrations. It is recommended that additional data be collected to determine if changes in concentrations of dissolved salts vary as a result of variation in flow, this will provide a better understanding of the dissolved salt concentrations in this segment.

SEGMENT 1010 – CANEY CREEK

Segment 1010 extends from the confluence of Caney Creek with the East Fork San Jacinto River in Harris County to SH 150 in Walker County. The total length is 57 miles. Segment 1010 contains the following stations:

Station ID Number	Location	Number of Records in Database
11334	Caney Creek at FM 1485	238
11335	Caney Creek bridge on FM 2090 west of Splendora	790
14241	Caney Creek at SH 105	154

Segment 1010 is not listed on the 303(d) list. The screening did not identify any parameter(s) that exceed standard criteria.

SEGMENT 1011 – PEACH CREEK

Segment 1011 extends from the confluence of Peach Creek with Caney Creek in Montgomery County to SH 150 in Walker County. The total length is 52 miles. Segment 1011 contains the following stations:

Station ID Number	Location	Number of Records in Database
11336	Peach Creek at FM 1485	408
11338	Peach Creek at SH 105 west of Cleveland	153

Segment 1011 is not on the 303(d) list. The screening did not identify any parameter(s) that exceed standard criteria.

SEGMENT 1012 – LAKE CONROE

Segment 1012 extends from Conroe Dam in Montgomery County up to the normal pool elevation of 201 feet above mean sea level (impounds West Fork San Jacinto River). The total length is 27 miles. It has a surface area of 20,979 acres. Segment 1012 contains 22 stations. The following are the ten stations with the greatest number of records:

Station ID Number	Location	Number of Records in Database
11342	Lake Conroe at Dam	843
11343	Lake Conroe at FM 1097 in the main channel	544
11344	Lake Conroe at FM 1375 in the main channel	422
13914	Lake Conroe USGS site AC	1254
13915	Lake Conroe USGS site AL	500
13916	Lake Conroe at USGS site BC	300
13917	Lake Conroe USGS site CC	440
13918	Lake Conroe USGS site CL	380
13919	Lake Conroe USGS site DC	304
13920	Lake Conroe USGS site EC	1108

Segment 1012 is included on the 303(d) list because of elevated mercury levels. The screening identified DO, chlorophyll-a, copper, mercury and zinc for further evaluation.

Dissolved Oxygen

The screening identified several stations at which low DO concentrations were reported. Much DO data have been collected in Lake Conroe, including many depth profiles. A summary of depth profiles obtained in the months of February and August is presented in Figure 20. The lake is well mixed in February but is stratified in August. TNRCC applies the stream standard to the average DO concentration in the

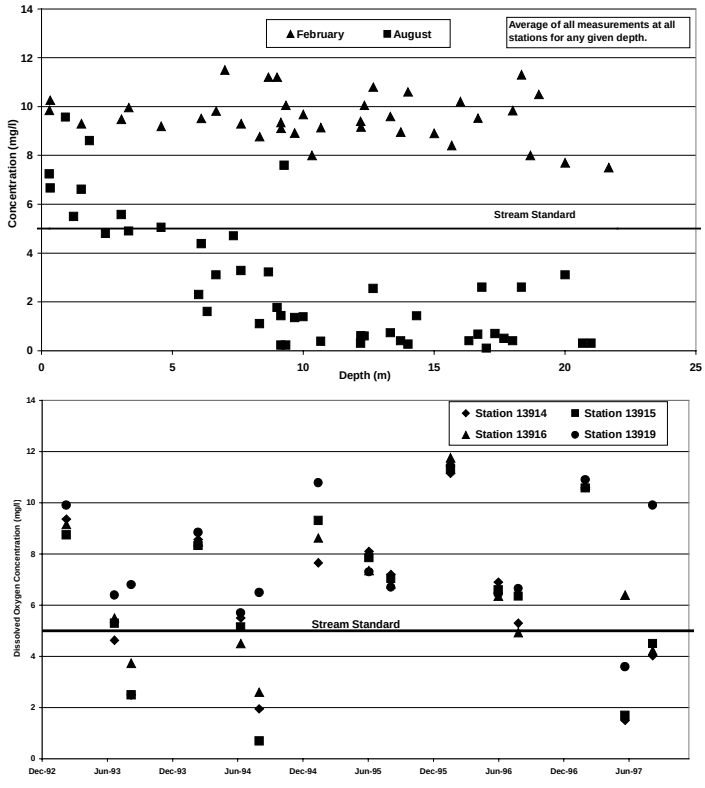


Figure 22
Lake Conroe
Dissolved Oxygen

Table 10
Chlorophyll-a
Lake Conroe-Segment 1012

Date	Chlorophyll-a (ug/l)			
	Lake Conroe at the dam	Lake Conroe at FM 1097 in the main channel	Lake Conroe at FM 1375 in the main channel	Chlorophyll-a (mg/l) Branch Creek arm of Lake Conroe
11-Feb-92	12.8	24	9.1	
4-Aug-92	21.6	24.6	52	
11-Feb-93	4.6	1	4.2	
16-Aug-93	31.5	32.7	39.9	
28-Feb-94	1	2.17	1	
25-Aug-94	13.4	19.6	23.2	
8-Nov-94	12.5	6.41	20.7	
7-Feb-95	6	1	1	
23-May-95	1	11	9.21	
10-Aug-95	18.8	15	1	
7-Nov-95	2.72	19.1	1.08	
9-Nov-95				8.66
7-Feb-96	9.19	17.1	15.6	
9-May-96	16.5	12	12.6	

mixed surface layer only. It is defined as the water column to the depth of at which the temperature varies from the surface by more than 0.5 degrees Celsius (ºC). Four stations in the lake are identified by the screening program if the only DO measurements on the mixed surface are screened. The data are shown in Figure 22. It appears that DO is a concern in this lake, because of the reoccurring depressed levels.

Chlorophyll a

The screening program identified chlorophyll-a as requiring further evaluation at two lake stations. These stations are not the same as the stations identified above as having low DO levels. Therefore, there is no evidence that the chlorophyll-a concentrations present are adversely impacting water uses. However, the chlorophyll data set is relatively small, and it includes no data after 1996. The complete chlorophyll-a data set for the segment is presented in Table 9. The screening criteria (22.3 mg/L) was exceeded a total of ten times. Nine of the exceedances occurred during the month of August. One of the exceedances occurred in February. It is recommended to expand the future monitoring program to include chlorophyll-a so that a more in-depth assessment can be made regarding whether there is a relationship between DO concentrations and algal/plant growth in Lake Conroe.

Table 11
Mercury
Lake Conroe at Dam

	Dissolved	Total
2/11/92	< 0.2	
8/4/92	< 0.2	
2/28/94		< 0.06
8/25/94	< 0.06	< 0.06
11/8/94	< 0.06	< 0.06
2/7/95	< 0.06	< 0.06
5/23/95	< 0.06	< 0.05
8/10/95	< 0.01	< 0.01
11/7/95	0.051	0.038
2/7/96	0.017	0.015
5/9/96	< 0.01	0.011
8/12/96	0.015	0.016

Mercury

The screening program identified mercury for further evaluation because three of 11 measurements of total mercury are above the screening criteria. The data are presented in

Table 11. As is seen in the table, most measurements are reported as non-detectable. The measurements reported above the detection limit are very low concentrations. The measurements are near the detection limit for mercury and below the minimum analytical level. Therefore, there is uncertainty regarding the accuracy of the data. Additional monitoring that include additional stations, sediment monitoring, and tissue monitoring may provide more insights into the presence and significance of mercury in Lake Conroe.

Zinc

The screening program identified zinc for further evaluation because one of 10 measurements at Station 11342 exceeded the screening criteria. The data are presented in Table 12. A single exceedance is not considered sufficient to confirm a water quality concern because of the possibility of sampling error, analytical error, or an anomalous condition. However, additional monitoring is recommended.

Table 12
Zinc (Dissolved)
Lake Conroe at Dam

Date		Zinc (ug/L)
2/28/94		52
8/25/94		71
11/8/94	<	3
		35
5/23/95		28
8/10/95		32
11/7/95	<	3
2/7/96	<	3
5/9/96	<	3
8/12/96		7

SEGMENT 1013 – BUFFALO BAYOU TIDAL

Segment 1013 extends from a point on Buffalo Bayou (110 yards) upstream of U.S. Highway 59 in Harris County to a point 400 meters (440 yards) upstream of Shepherd Dr. in Harris County. The total length is 4 miles. Segment 1013 contains the following stations:

Station ID Number	Location	Number of Records in Database
16646	Buffalo Bayou @ Girard (confluence of Buffalo and White Oak Bayous)	72
16647	White Oak Bayou @ Girard; UH Downtown (before confluence with Buffalo Bayou)	23
11345	Buffalo Bayou Tidal at McKee St	903
11351	Buffalo Bayou Tidal at Shepherd Dr in Houston	742
15825	Whiteoak Bayou at Crockett Ave, immediately East of IH 45 (IH 10) in Houston	24
15843	Buffalo Bayou Tidal at Sabine Ave, North of Allen Parkway in Houston	72

Segment 1013 is included on the 303(d) list because of elevated levels of mercury, bacteria and copper. The screening identified DO, nitrate-nitrogen, total phosphorus, fecal coliform, ammonia-nitrogen, copper and mercury as requiring further evaluation.

Dissolved Oxygen

The screening program identified DO for further evaluation because nine of 64 measurements at Station 11345 (Buffalo Bayou Tidal at McKee St.) are below the screening criteria. The data screened included surface and subsurface measurements. When the surface and subsurface measurements are averaged for each sampling event at each station, the screening program no longer identifies a need for further evaluation of DO. Therefore, DO does not appear to be of concern in this segment.

Nutrients

The screening program identified nitrate as requiring further evaluation because 3 of 10 nitrate measurements exceeded the screening criteria at Station 11345 (Buffalo Bayou Tidal at McKee St.). Nitrate and nitrate-nitrite data were reviewed. These data are shown in Table 13. The table shows that the most recent data were collected in 1995, and the measured concentrations have fluctuated significantly.

Table 13
Nitrate (mg/l as N)
Segment 1013 - Buffalo Bayou

Date	Buffalo Bayou Tidal at McKee Street	Buffalo Bayou Tidal at Shepherd Drive
2/24/92	0.36	0.21
5/26/92		0.56
8/3/92	0.41	0.34
11/19/92	4.5	
2/11/93	0.86	
5/5/93		1.6
5/6/93		1.1
5/20/93	0.91	
5/23/93		1.5
5/24/93		0.09
6/19/93		0.43
6/20/93		0.38
8/16/93	3.56	
11/9/93	2.17	
2/8/94	3.18	
5/4/94	1.23	
8/18/94	0.87	
11/8/94	0.12	
2/8/95	3.12	
5/24/95	1.97	
8/3/95	0.59	
11/6/95	2.63	

The screening identified total phosphorus for further evaluation because 6 of 21 values exceeded the screening criteria at Station 11345. The phosphorus data are presented in Table 14.

Table 14
Total Phosphorus (mg/l)
Segment 1013 - Buffalo Bayou

Date	Buffalo Bayou Tidal at McKee Street	Buffalo Bayou Tidal at Shepherd Drive
2/24/92	0.39	0.34
5/26/92		0.48
8/3/92	0.46	0.35
11/19/92	1.88	
2/11/93	0.75	
5/20/93	0.48	
8/16/93	1.32	
11/9/93	0.94	
2/8/94	1.82	
5/4/94	0.34	
8/18/94	0.37	
11/8/94	0.32	
2/8/95	0.57	
5/24/95	0.72	
8/3/95	0.38	
11/6/95	0.7	
1/29/96	1.33	
5/8/96	5.96	
10/8/96	0.66	
2/10/97	0.76	
8/5/97	0.86	
5/7/98	1.14	

The screening program identified ammonia at Station 11352 (Buffalo Bayou at Shepherd Drive) for further evaluation. The three measurements above the screening levels are isolated events; and, in each case, the next month the concentration was 0.1 mg/L, well below the screening criteria of 0.44 mg/L.

Chlorophyll-a data for this station do not indicate the presence of excessive algal growth. Neither does the DO data indicate that nutrients cause a water quality concern at this station. Therefore, nitrate, ammonia, and total phosphorus are concluded to not be a concern in this segment.

Fecal Coliform

The screening program identified fecal coliform for further evaluation at four stations. All reported fecal coliform levels are above the screening criteria of 200 cfu/100 ml; the lowest value

reported is 210 cfu/100 ml. The median concentration of all values reported is 4000 cfu/100 ml. The fecal coliform levels are a concern for this segment.

Copper and Mercury

Copper and mercury were identified by the screening program. Seven of 16 copper values and five of 11 mercury values exceed the screening criteria at Station 11345. Copper may be a concern in this segment. However, before this conclusion is adopted, a study to determine whether the statewide default stream standard for copper is appropriate for this segment may be appropriate. Studies in other tidal segments in Texas have determined that a site-specific standard is appropriate; and, in each case, the site-specific standard is higher than the statewide default standard.

Most of the reported mercury concentrations in Segment 1013 of Buffalo Bayou are near the detection limit of the analytical method. This affects the accuracy of the results as demonstrated by the value reported for total mercury and dissolved mercury in November 1995 and October 1996. In both instances, it is reported that the concentration of dissolved mercury is higher than the concentration of total mercury (Table 15). This does not indicate poor sampling or analytical technique. Rather, it demonstrates the uncertainty associated with measurements at such low levels. However, a water quality concern for mercury continues to exist. Continued monitoring is important.

Table 15
Buffalo Bayou Tidal at McKee Street
Mercury

Date	Dissolved ug/l		Total ug/l	
24-Feb-92	<	0.2		
03-Aug-92	<	0.2		
16-Aug-93	<	0.6		
09-Nov-93	<	0.1		
08-Feb-94				2.06
04-May-94			<	1.2
08-Nov-94	<	0.06	<	0.12
08-Feb-95	<	0.06	<	0.06
24-May-95	<	0.06		
03-Aug-95	<	0.01		0.014
06-Nov-95		0.063		0.042
29-Jan-96		0.014		0.018
08-May-96		0.013		0.018
08-Oct-96		0.029		0.012
10-Feb-97	<	0.01		0.011
05-Aug-97	<	0.01	<	0.01

SEGMENT 1014 – BUFFALO BAYOU ABOVE TIDAL

Segment 1014 extends from a point on Buffalo Bayou 400 meters (440 yards) upstream of Shepherd Drive in Harris County to SH 6 in Harris County. The length is 24 miles. Segment 1014 contains 15 stations. The following are the ten stations with the greatest number of records:

Station ID Number	Location	Number of Records in Database
11353	Buffalo Bayou at IH 610 in Houston	72
11354	Buffalo Bayou at Woodway Dr	159
11357	Buffalo Bayou at San Felipe St	72
11358	Buffalo Bayou at Piney Point Rd, 4.3 miles West of IH 610 in West Houston	228
11359	Buffalo Bayou at Gessner Dr	72
11360	Buffalo Bayou at West Belt in Houston	813
11361	Buffalo Bayou at Wilcrest Dr	72
11362	Buffalo Bayou at Dairy Ashford Rd West of Houston	569
11363	Buffalo Bayou at Eldridge St in Houston	72
11364	Buffalo Bayou at SH 6	72

Segment 1014 is included on the 303(d) list because of elevated bacteria levels. The screening identified ammonia-nitrogen, nitrate-nitrogen, total phosphorus, chlorophyll-a, and fecal coliform for further evaluation.

Nutrients and Chlorophyll-a

The screening program identified ammonia for further evaluation at all fifteen stations in the segment. The data for ammonia concentrations in Segment 1014 are summarized in Figure 23. In addition, phosphorus was identified at two stations. Elevated nutrients can lead to

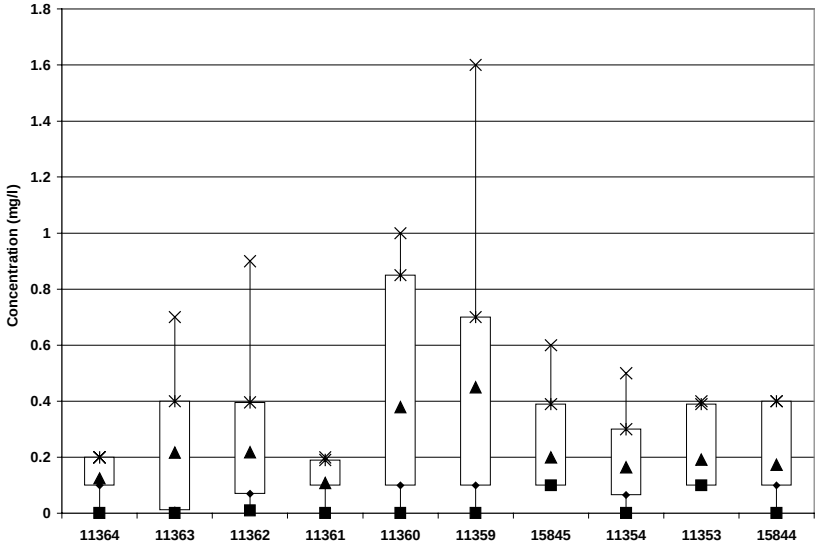


Figure 23
Segment 1014-Buffalo Bayou Above Tidal
Ammonia

deterioration of water quality by promoting the growth of excessive algae or aquatic vegetation.

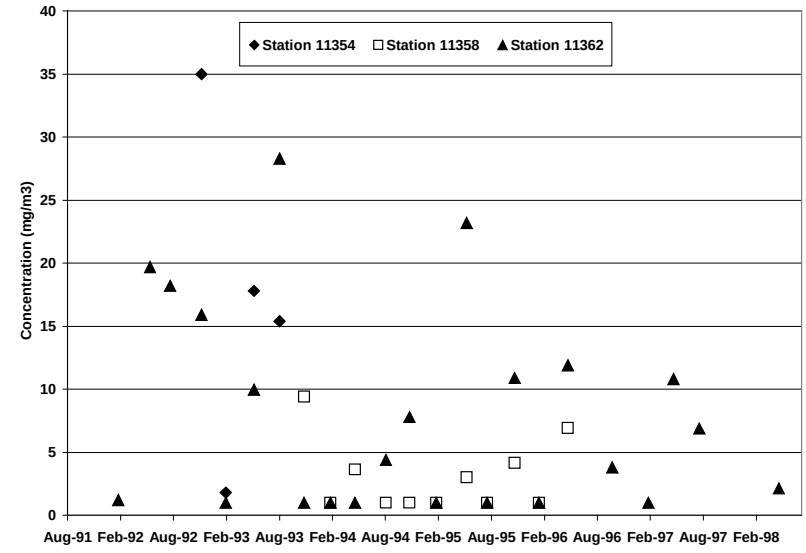


Figure 24
Segment 1014-Buffalo Bayou Above Tidal
Chlorophyll-a

The screening program identified chlorophyll-a as requiring further evaluation because five measurements at Station 11362, Buffalo Bayou at Dairy-Ashford Rd., exceed the screening criteria. Four of the five values exceeding the criteria were measured in 1992 and 1993. The fifth value was measured in 1995. Figure 24 presents the chlorophyll-a data. As evident from the figure, it appears that chlorophyll-a concentrations may be decreasing over time.

Dissolved oxygen data for the segment (Figure 25) do not indicate impairment of water quality in the segment. Some stations have an occasional reading below the stream standard; however, this does not appear to be a concern. The depressed readings occurred in the summer months and only occurred in 8 measurements out of a total of 225.

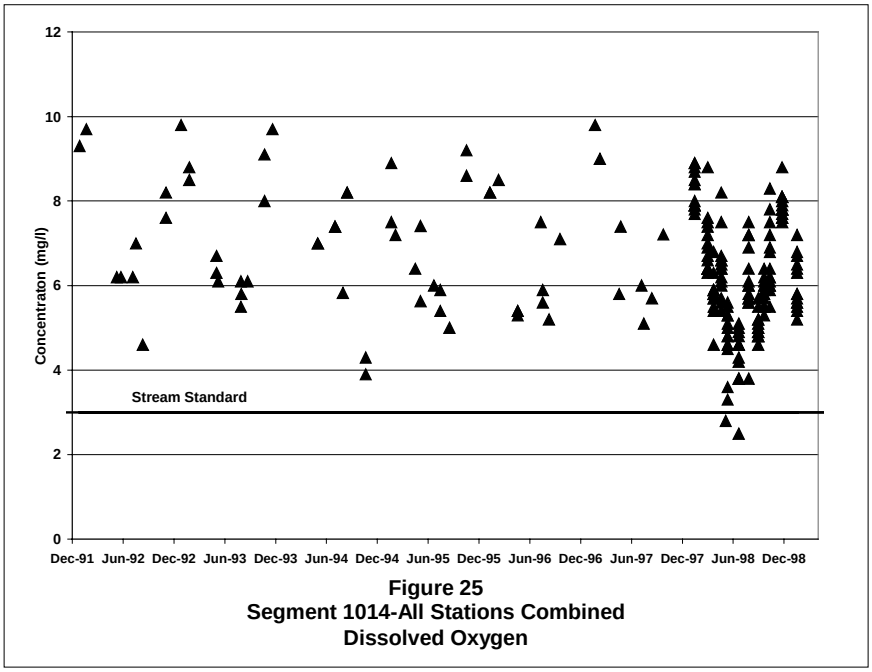


Figure 25
Segment 1014-All Stations Combined
Dissolved Oxygen

The data do not suggest a water quality problem associated with nutrients or chlorophyll-a at this time. The data do suggest a possible decreasing trend of chlorophyll-a concentrations.

Fecal Coliform

The screening program identified fecal coliform at fourteen stations in the segment for further evaluation. The levels of fecal coliform are consistently elevated at all stations. The data on the main stem of the segment are summarized in Figure 26 The figure shows the data from upstream to downstream. Most of the data were collected in 1998; and, therefore, cannot be used to determine trends over time. However, the data do indicate that elevated levels of fecal coliform are a concern.

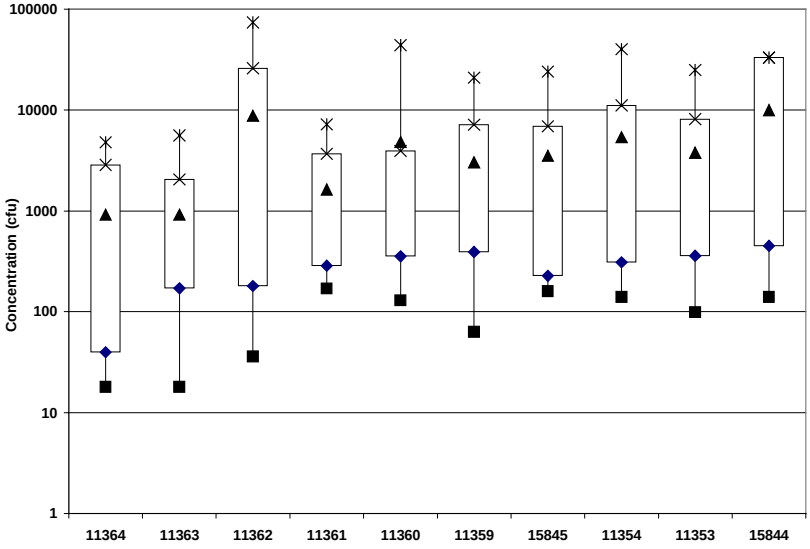


Figure 26
Segment 1014-Buffalo Bayou Above Tidal
Fecal Coliform

SEGMENT 1015 – LAKE CREEK

Segment 1015 extends from the confluence of Lake Creek with the West Fork San Jacinto River in Montgomery County to a point 4.0 kilometers (2.5 miles) upstream of SH 30 in Grimes County. The total length is 48 miles. Segment 1015 contains the following station:

The segment is not included on the 303(d) list. The screening program did not identify any parameter(s) that exceed the standard criteria.

STATION ID NUMBER	LOCATION	Number of Records in Database
11366	Lake Creek at Smith-Stowe Road, 2 miles upstream of the West Fork San Jacinto River	226

SEGMENT 1016 – GREENS BAYOU ABOVE TIDAL

Segment 1016 extends from a point on Greens Bayou 0.7 kilometer (0.4 mile) above the confluence of Halls Bayou in Harris County to a point 100 meters (110 yards) above FM 1960 in Harris County. The total length is 24 miles. Segment 1016 contains the following stations:

Station ID Number	Location	Number of Records in Database
11125	Garners Bayou at North Belt (Lockwood Road)	150
11369	Greens Bayou at Tidwell Rd in Harris County	250
11370	Greens Bayou at Mt Houston Parkway	24
11371	Greens Bayou at US 59 North of Houston	1029
11376	Greens Bayou at West Greens Parkway	179
13778	Greens Bayou at Knobcrest St, 600 feet downstream from IH 45	283

Segment 1016 is included on the 303(d) list because of elevated levels of bacteria and lead. A TMDL is being prepared for DO. The screening identified ammonia-nitrogen, nitrate-nitrogen, total phosphorus, chlorophyll-a, fecal coliform, sulfate, chloride, cadmium, and lead as requiring further evaluation.

Nutrients and Chlorophyll-a

The screening program identified nutrients and chlorophyll-a for further evaluation at Station 11369 and Station 13778. Dissolved oxygen was not identified, however, the 303(d) indicated that a TMDL is being prepared for DO in this segment. Nutrients are frequently above the screening levels, but the limited chlorophyll-a data do not indicate continuous excessive algae growth. Additional data are needed to adequately assess this segment.

Chloride

The screening program identified chloride for further evaluation. The most recent data at Station 11369 (Green Bayou at West Greens Parkway) was reported in 1994. More recent data is needed to assess a concern for chloride.

Sulfate

The screening program identified sulfate for further evaluation at Station 13778 (Greens Bayou at Knobcrest Street). The stream standard for sulfate applies to the annual average, and there must be a minimum of four measurements during the year. As shown in Table 16, the only years for which four measurements were available were 1995 and 1996. During these years, Segment 1016 was compliant with the standard in 1995 and exceeded the standard slightly in 1996. The annual average concentration did not exceed the standard in 1994 or 1997, but four measurements were not available in these years. Sulfate is probably not a concern in Segment 1016 but additional data collection is needed to obtain a better understanding of the sulfate concentrations that are present.

Table 16
Sulfate
Segment 1016-
Greens Bayou at
Knobcrest Street

Date	Sulfate (mg/l)
2/2/94	52
5/25/94	55
8/10/94	45
2/13/95	61
5/25/95	78
8/1/95	25
11/16/95	57
1/31/96	80.6
5/6/96	70.8
8/7/96	73
10/3/96	49
6/11/97	42

Fecal Coliform

Fecal coliform was identified by the screening program for further evaluation at Station 11369 (Greens Bayou at West Greens Parkway) (Figure 27). Most of the measurements reported are above the screening criteria. Fecal coliform levels appear to be a concern in this segment. Other stations in the segment were not identified by the screening program as requiring further evaluation because there are insufficient data points to screen at these stations. However, the fecal coliform levels observed are similar to those observed at Station 11369.

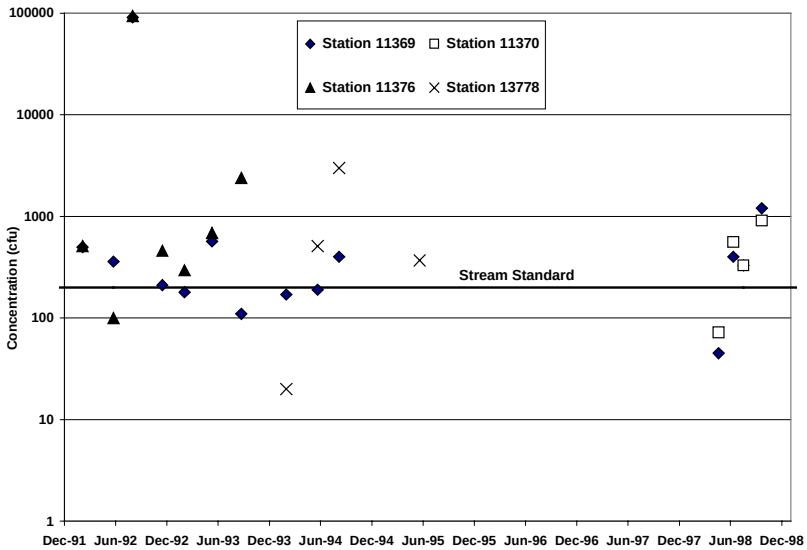


Figure 27
Segment 1016-Green's Bayou
Fecal Coliform

Cadmium

The screening program identified cadmium as requiring further evaluation because two of fifteen measurements are above the screening criteria. The two values above the criteria are the only two values reported

above the analytical detection limit. The reported values are very close to the detection limit and are below the minimum analytical level (MAL) specified by the TNRCC. The MAL specifies the minimum concentration at which a reported value is considered to be analytically reliable. Therefore, the data do not indicate a water quality concern because of cadmium.

Lead

The screening program identified lead for further evaluation because four of fifteen reported values are above the screening criteria. The lead data are presented in Table 17. The data suggest a concern for lead because of the repeated detection of lead above the screening criteria.

Table 17
Segment 1016-Green's Bayou
Green's Bayou at US 59 North of Houston

Date	Lead (ug/l)	
2/8/93	<	10
6/2/93	<	10
8/23/93	<	10
2/15/94	<	10
5/3/94	<	10
8/2/94	<	10
3/14/95	<	10
5/22/95		20
8/2/95	<	10
2/26/96	<	10
5/29/96		40
8/26/96	<	10
2/26/97	<	10
5/14/97		17
8/18/97		20.3

SEGMENT 1017 – WHITE OAK BAYOU ABOVE TIDAL

Segment 1017 extends from a point on White Oak Bayou 100 meters (110 yards) above Interstate Highway 45 in Harris County to a point 3.0 kilometers (1.9 miles) above FM 1960 in Harris County. The total length is 23 miles. Segment 1017 contains the following stations:

Station ID Number	Location	Number of Records in Database
16637	White Oak Bayou @ T.C. Jester	24
16636	Little White Oak Bayou @ Wrightwood	54
11387	White Oak Bayou at Heights Blvd in Houston	1462
11388	White Oak Bayou at Houston Ave	67
11390	White Oak Bayou at West 34th St in Houston	24
11398	White Oak Bayou at Jones Rd	395
15826	White Oak Bayou at Studemont Ave, immediately North of US 90 in Houston	72
15829	White Oak Bayou at West 43rd St in NW Houston	24
15830	White Oak Bayou at Watonga in NW Houston	24
15831	White Oak Bayou at W. Tidwell in NW Houston	24

Segment 1017 is included on the 303(d) list because of elevated levels of bacteria and lead concentrations. The screening identified DO, ammonia-nitrogen, total phosphorus, ortho-phosphate, chlorophyll-a, fecal coliform, TDS, cadmium and lead as requiring further evaluation.

Nutrients, Chlorophyll-a, and Dissolved Oxygen

The screening program identified ammonia at four stations, and phosphorus at two stations as requiring further evaluation. Chlorophyll-a and DO were identified at one station. The data for these parameters are shown in Figure 28. The nutrient data, phosphorus and ammonia, do not indicate clear trends over time, and values above the screening level are frequent. The graph of the ammonia data shows the impact of the additional data provided

by local entities. DO data show that only two of 74 values reported for the segment are below the stream standard. As can been seen in Figure 28, DO concentrations at Station 11387 (White Oak Bayou at Heights Blvd) are consistently higher than at Station 11398 (White Oak Bayou at Jones Rd). This same pattern, higher concentrations at Station 11387 compared to Station 11398 can also be seen, though less pronounced, for ammonia, phosphorus, and chlorophyll-a. This seems to indicate that the nutrient levels may be impacting the chlorophyll-a levels.

A review of the time of day DO sampling occurred, indicates that the two low values were measured early in the morning. Early morning readings are frequently lower than readings later in the day because respiration by algae over night depletes

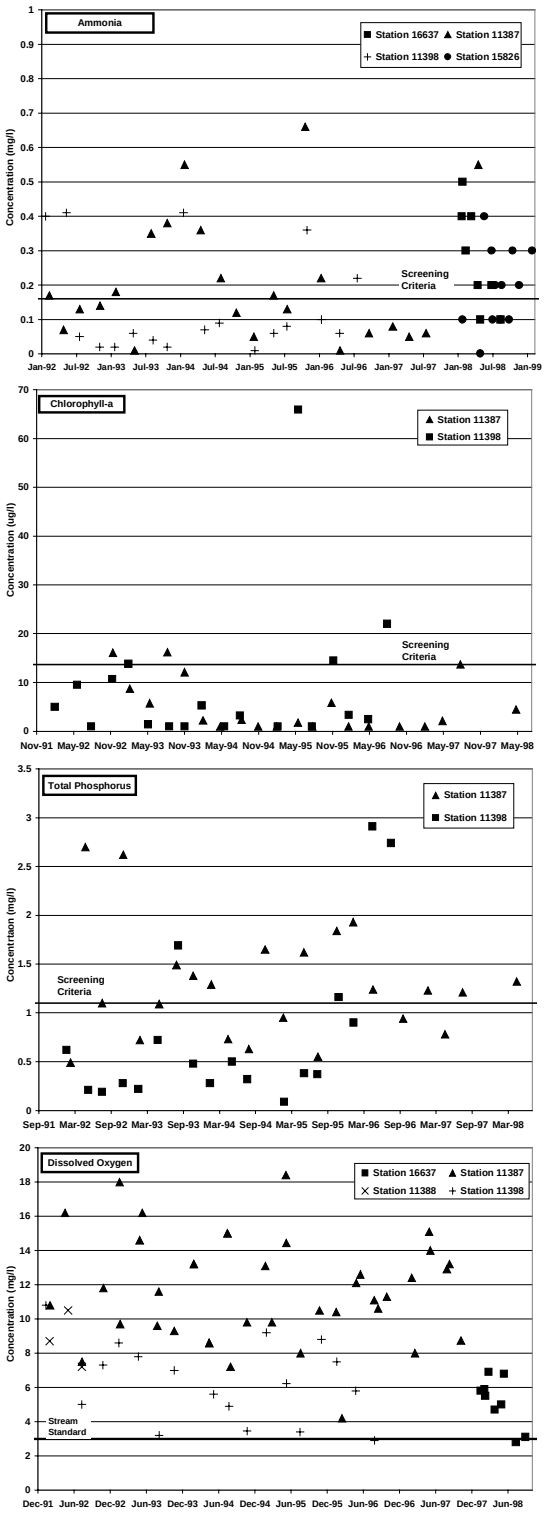


Figure 28
White Oak Bayou Above Tidal
Ammonia, Chlorophyll-a, Total Phosphorus and Dissolved Oxygen

DO. Figure 29 shows that DO data were usually collected earlier in the day at station 11398 than at station 11387. This explains some of the differences between the two stations. The nutrient and chlorophyll-a levels are not impacting DO levels to a degree that DO is a concern. It is therefore concluded that neither nutrients nor chlorophyll-a are a concern.

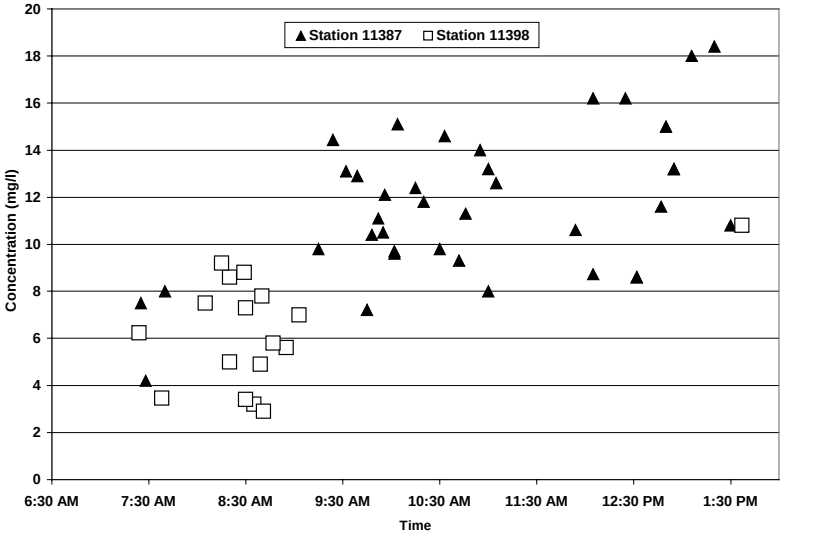


Figure 29
White Oak Bayou Above Tidal
DO Over Time

Fecal Coliform

The screening program identified fecal coliform for further evaluation at four stations in the segment. Most of the measurements reported were above the screening criteria. Because the bacteria concentrations are consistently elevated it appears that bacteria levels may be a concern in this segment. This conclusion should be reviewed if TNRCC changes the water quality standards related to bacterial quality.

Total Dissolved Solids

The screening program identified total dissolved solids at Station 11398 for further evaluation. Only one other station in the segment, Station 11387, has TDS data. The data for both stations are shown in Figure 30. As is

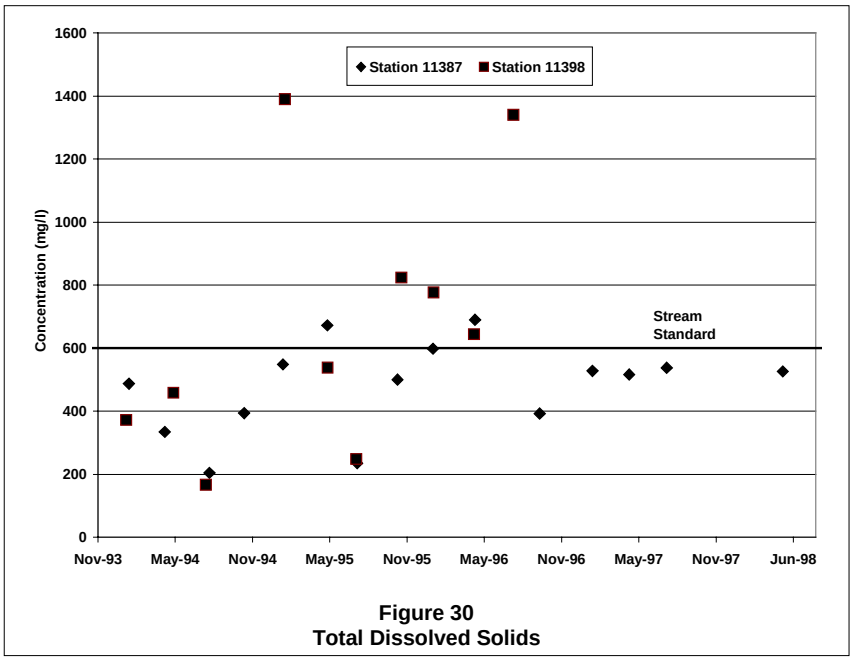


Figure 30
Total Dissolved Solids

evident from the graph, the database has more records for Station 11387, which is downstream of Station 11398. The data is more scattered at Station 11398, and the data may have an increasing trend over time. However, the increasing trend is based on a very limited number of data points. It is suggested to sample for total dissolved solids more frequently, and to collect a minimum of four samples per year. Four samples per year are the minimum number of samples specified in the stream standard to determine compliance. Combining the data sets of both stations and calculating the average, provides for an annual average concentration above the stream standard in 1995 and 1997. This indicated a water quality concern with regard to TDS in this segment.

Cadmium and Lead

The screening program identified cadmium and lead for further evaluation because 3 of 15 measurements of each of these parameters exceeded the screening criteria. All other measurements were reported as below the detection limit (Table 18). The reported values are very close to the detection limit. Measurements are less accurate near the detection limit. The detection limit is higher than the stream standard. Therefore, the data are insufficient to determine whether a water quality concern exists. Analyses should be performed using more sensitive analytical methods to determine whether a water quality concern exists in this segment for cadmium and/or lead.

Table 18
Cadmiun and Lead
Segment 1017-White Oak Bayou
Above Tidal
White Oak Bayou at Heights Blvd.
In Houston

Date	Cadmium (ug/l)	Lead (ug/l)
2/8/93	< 1	< 10
6/2/93	< 1	< 10
8/23/93	< 1	< 10
2/15/94	1	< 10
5/3/94	< 1	< 10
8/2/94	< 1	< 10
3/13/95	1	30
5/22/95	< 1	30
8/3/95	< 1	< 10
2/27/96	< 1	10
5/29/96	< 1	< 10
8/26/96	< 1	< 10
2/26/97	< 1	< 10
5/14/97	1.023	< 10
8/18/97	1	< 10

BASIN 11 — SAN JACINTO – BRAZOS COASTAL BASIN

Basin 11 has eleven segments including seven segments classified as tidal segments. The basin is located in portions of Brazoria, Fort Bend, and Galveston and Harris Counties. Figure 31 provides a map of the basin, including the location of monitoring stations.

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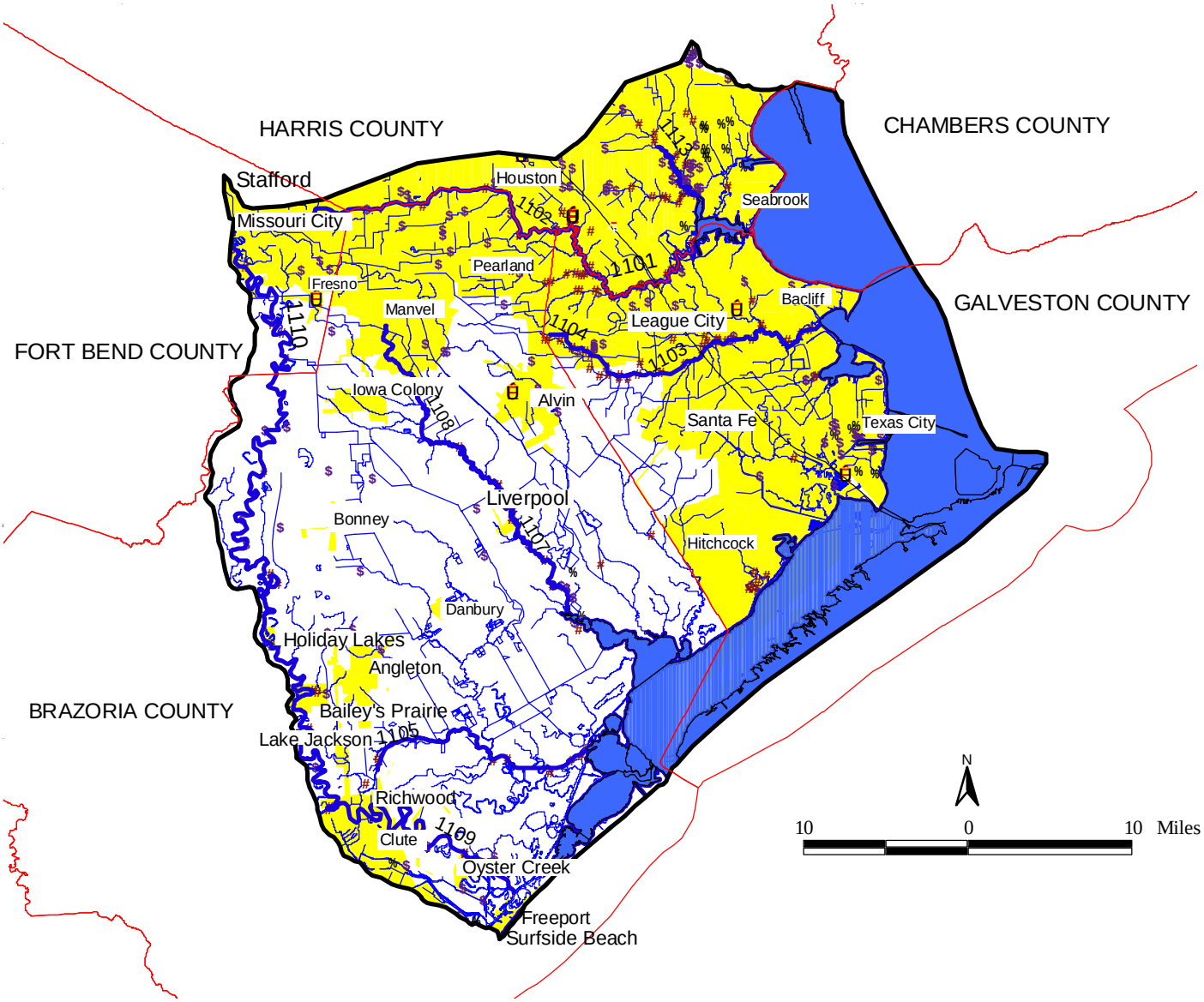

Segment Number	Description
1101	Clear Creek Tidal
1102	Clear Creek above Tidal
1103	Dickinson Bayou Tidal
1104	Dickinson Bayou above Tidal
1105	Bastrop Bayou Tidal
1107	Chocolate Bayou Tidal
1108	Chocolate Bayou above Tidal
1109	Oyster Creek Tidal
1110	Oyster Creek above Tidal
1111	Old Brazos River Channel Tidal
1113	Armand Bayou Tidal

County Line
Segments
Monitoring Stations
$ Outfalls
Superfund Sites
% Industrial Hazardous Waste
Population Centers

Figure 31
San Jacinto - Brazos Coastal Basin
General Location Map

SEGMENT 1101 – CLEAR CREEK TIDAL

Segment 1101 extends from the confluence of Clear Lake in Galveston/Harris County to a point 100 meters (110 yards) upstream of FM 528 in Galveston/Harris County. The total length is 12 miles. Segment 1101 contains 12 stations. The following are the ten stations with the greatest number of records:

Station ID Number	Location	Number of Records in Database
11446	Clear Creek Tidal at SH 3 Near Webster	596
11447	Clear Creek Tidal at IH 45 East of Friendswood	302
11448	Clear Creek Tidal at FM 528 East of Friendswood	256
16472	Chigger Creek at Oak Drive Bridge. Polly Ranch Subdivision in East Friendswood	211
16572	Clear Creek at the Mouth of Robinson's Gully, Approximately 100' from the Sign for Preserve Lakeside Luxury Subdivision.	214
16573	Clear Creek just Inside the Creek Entrance at the Speed Limit Sign.	214
16575	Clear Creek at the Boat Ramp Pier at Walter Hall County Park.	212
16576	Clear Creek Adjacent to Circle Drive in Countryside Park in Canoe Launching Area.	209
16577	Clear Creek at Challenger Park Boat Ramp Pier.	220

Segment 1101 is included on the 303(d) list because of elevated levels of bacteria in water, and dichloroethane, trichloroethane, carbon disulfide and chlordane in fish tissue. The screening identified DO, ammonia-nitrogen, chlorophyll-a, and fecal coliform as requiring further evaluation.

Dissolved Oxygen

The screening program identified DO for further evaluation at Station 11448 (Clear Creek Tidal east of Friendswood) because 5 of the 26 measurements were reported below the stream standard. The measurements were collected in the summers of 1997 and 1998. No chlorophyll-a data are available for this station. As shown in Figure 32, the data show that the depressed levels are not chronic conditions during the summer. In order to determine whether a water quality concern exists 24-hour DO measurements should be collected.

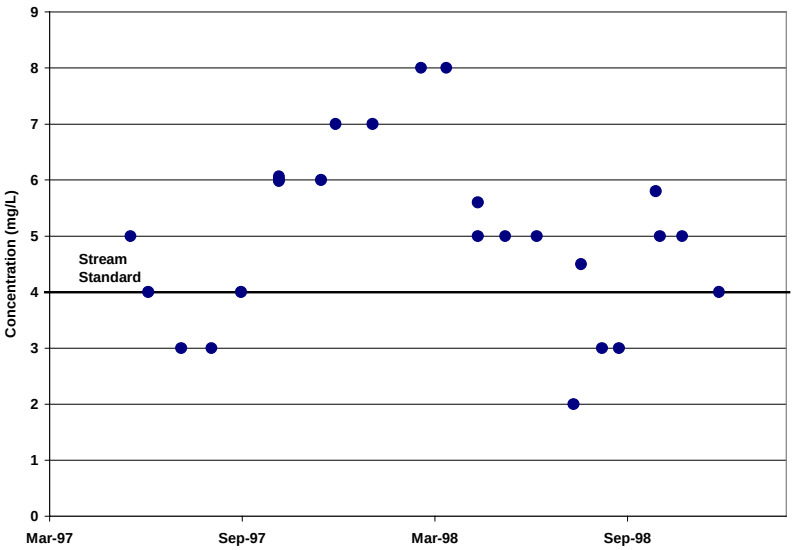

Figure 32
Segment 1101-Clear Creek Tidal at FM 528, East of Friendswood
Dissolved Oxygen

Ammonia

The screening program identified ammonia for further evaluation at three stations in the segment. No other nutrients were identified. Most of the ammonia data were collected in 1997 and 1998 on a monthly schedule. It is possible that some of the fluctuation (see Figure 33) in ammonia concentrations is due to runoff conditions. The exceedances of the screening criteria occur infrequently. The data do not suggest a water quality concern for ammonia.

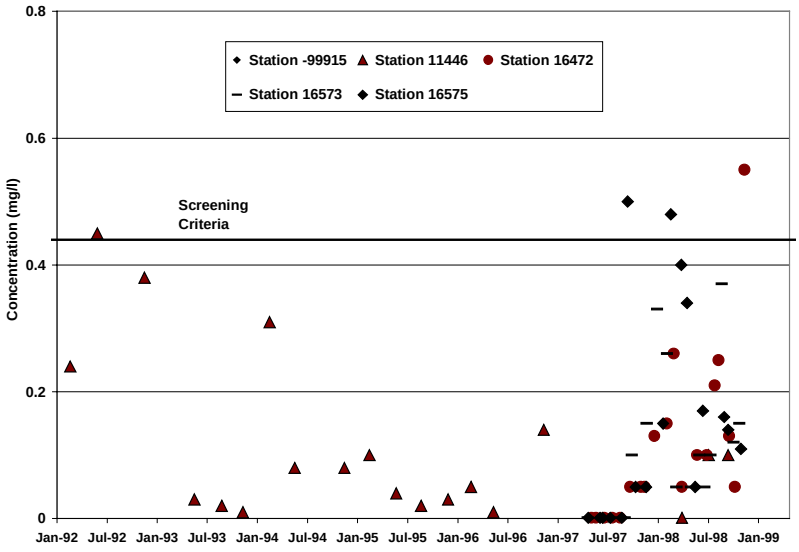

Figure 33
Segment 1101
Ammonia-Nitrogen

Chlorophyll-a

The screening program identified chlorophyll-a for further evaluation at Station 11446. Station 11446 is the only station with chlorophyll-a data in the segment. As shown in Figure 34, chlorophyll-a levels are highest and sometimes exceed the screening level, in the summer. DO data at this station, however, do not indicate a concern. Based on this, it appears that chlorophyll-a levels are not a concern at this station.

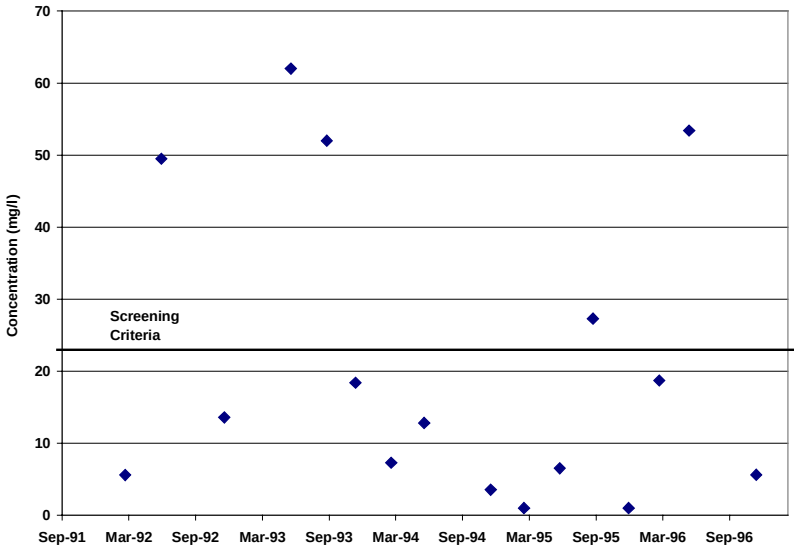

Figure 34
Segment 1101-Clear Creek Tidal at SH 3 Near Webster
Chlorophyll-a

Fecal Coliform

The screening program identified fecal coliform for further evaluation at eleven stations in the segment. The concentrations reported are frequently above the stream standard and indicate a concern in this segment. This conclusion should be reviewed if TNRCC changes the water quality standards related to bacterial quality.

Toxicants

Four toxicants are included on the 303(d) list, dichloroethane, trichloroethane, carbon disulfide, and chlordane. These toxicants were found in fish tissue. Only very few data points for these parameters in water are included in the database. An evaluation was therefore not performed.

SEGMENT 1102 – CLEAR CREEK ABOVE TIDAL

Segment 1102 extends from a point on Clear Creek 100 meters (110 yards) upstream of FM 528 in Galveston/Harris County to Rouen Road in Fort Bend County. The total length is 30 miles. Segment 1102 contains the following stations:

Station ID Number	Location	Number of Records in Database
16678	Cowards Creek @ Baker Road Bridge near Brazoria County Line	11
16677	Cowards Creek @ Castlewood Drive Bridge	11
11425	Cowards Creek @ FM 518 Bridge	60
11449	Clear Creek at Friendswood Link Rd at Friendswood	222
11450	Clear Creek at Clear Lake City Blvd (FM2351) near Friendswood	813
11452	Clear Creek at Telephone Rd (SH35) in South Houston	25
14229	Clear Creek at Dixie Farm Rd (FM1959) Near Friendswood	216
16473	Mary's Creek at Mary's Crossing Bridge in North Friendswood.	221
16477	Cowards Creek at Sunset Drive in Friendswood.	187
16478	Cowards Creek in Timberfield Subdivision Park Off of Arbre Lane.	151

Segment 1102 is included on the 303(d) list because of elevated levels of bacteria in water, dichloroethane, trichloroethane, carbon disulfide, and chlordane in fish tissue. The screening criteria identified DO, ammonia-nitrogen, total phosphorus, fecal coliform, total dissolved solids, and chloride as requiring further evaluation.

Dissolved Oxygen

The screening program identified DO for further evaluation at Station 11449 (Clear Creek at Friendswood Link Road) and Station 16478 (Cowards Creek in Timberfield Subdivision). As shown in Figure 35, the DO concentrations

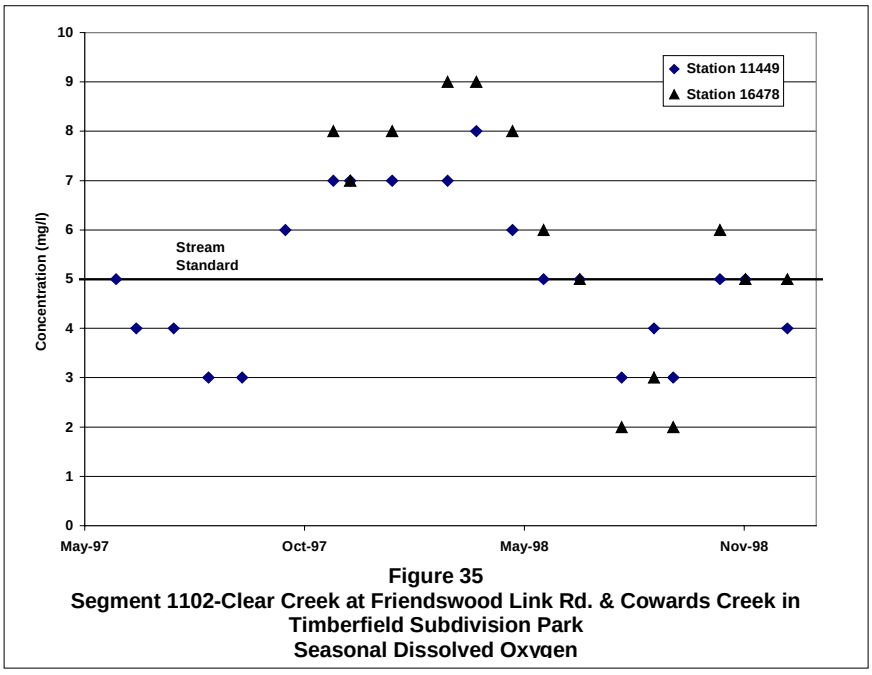

Figure 35
Segment 1102-Clear Creek at Friendswood Link Rd. & Cowards Creek in Timberfield Subdivision Park
Seasonal Dissolved Oxygen

are depressed in the summer months at both stations. The data indicate a concern for both stations.

Ammonia and Phosphorus

The screening program identified ammonia for further evaluation at six stations in the segment. The screening program also identified total phosphorus for further evaluation at Station 11450 (Clear Creek at Clear Lake Boulevard.) Most of the data were collected in 1997 and 1998 on a monthly schedule. At two of the six stations, DO appears to be a concern (Station 11449, Clear Creek at Friendswood Link Road, and Station 16478, Cowards Creek in Timberfield Subdivision) and the frequency of exceeding the screening value indicates a possible concern. However, DO data at this station do not indicate a concern, indicating that nutrients do not have a detrimental impact.

Fecal Coliform

The screening program identified fecal coliform for further evaluation at six stations in the segment. Most of the measurements were above the screening criteria and indicate a water quality concern in this segment. This conclusion should be reviewed if a TNRCC changes the water quality standards related to bacterial quality.

Chloride and Total Dissolved Solids

The screening program identified chloride and TDS for further evaluation at Station 11450 (Clear Creek at Clear Lake Boulevard). A single measurement of TDS concentrations in 1995 and 1996 exceeded the screening criteria and, measurements of chloride in 1996 exceeded the screening criteria. The stream standard, however, is based on the average of a minimum of four measurements per year. The average TDS concentration in 1996 is 474 mg/l, which is below the stream standard. There are only two measurements each of chloride and TDS in 1996. All four measurements exceed the numerical value of their respective stream standards. The data are insufficient to determine whether a water quality problem exists. More frequent monitoring is recommended.

Toxicants

Four toxicants are included on the 303(d) list, dichloroethane, trichloroethane, carbon disulfide, and chlordane. These toxicants were found in fish tissue. Only very few data

points for these parameters in water are included in the database. Therefore, an evaluation was not performed.

SEGMENT 1103 – DICKINSON BAYOU TIDAL

Segment 1103 extends from the confluence of Dickinson Bayou with Dickinson Bay 2.1 kilometers (1.3 miles) downstream of SH 146 in Galveston County to a point 4.0 kilometers (2.5 miles) downstream of FM 517 in Galveston County. The total length is 15 miles. Segment 1103 contains the following stations:

Station ID Number	Location	Number of Records in Database
16679	Dickinson Bayou at Lot Adjacent to 4529 Mariners Mooring.	216
11436	Gum Bayou at FM 517 East of Dickinson	215
11455	Dickinson Bayou Tidal at SH 146 Bridge East of Dickinson	610
11460	Dickinson Bayou Tidal at SH 3 Bridge in Dickinson	670
11462	Dickinson Bayou Tidal at IH 45	218
11464	Dickinson Bayou Tidal at Arcadia-Cemetery Rd North of Arcadia	217
16469	Bordens Gully at Bridge on FM 517 Bridge, 0.10 Mile Upstream of Confluence of Dickinson Bayou in Dickinson.	216
16470	Giessler Bayou at Bridge on FM 517 Bridge, 0.15 Miles Upstream of Dickinson Bayou in Dickinson.	216
16471	Bensons Bayou on Wagon Road South of FM 517 0.10 Miles Upstream of Dickinson Bayou in Dickinson.	216

Segment 1103 is included on the 303(d) list because of elevated levels of bacteria and low concentrations of DO. The screening program identified DO, chlorophyll-a, fecal coliform, and ammonia-nitrogen as requiring further evaluation.

Dissolved Oxygen

The screening program identified DO for further evaluation at three stations: Station 11460, Station 11464, and Station 16469. A review of the data at Station 11460 (Dickinson Bayou Tidal at SH 3 Bridge in Dickinson) indicates that the screening database includes numerous depth profiles of DO. It is normal to observe lower DO concentrations in the lower layer when stratification exists. A second screening evaluation was performed using the daily average of all DO data collected at various depths. The screening no longer identified the station for further evaluation.

The other two stations identified by the screening program for further evaluation are Station 11464 (Dickinson Bayou north of Arcadia) and Station 11469 (Bordens Gully near confluence with Dickinson Bayou). Both stations have exhibited frequent low DO concentrations, as shown in Table 19, especially in the summer months. Additional data collection is recommended, especially for Bordens Gully, to determine whether the DO criteria are appropriate for this water body.

Table 19
Dissolved Oxygen
Segment 1103-Dickinson Bayou Tidal

Date	Dissolved Oxygen (mg/l)	
	Dickinson Bayou Tidal at Arcadia Cemetery Rd.	Bordens Gully at FM 517 Bridge
5/30/97	4	2
6/20/97	2	3
7/17/97	2	5
8/5/97	3	4
9/17/97	2	3
10/7/97	3	6
11/18/97	8	6
12/9/97	6	6
1/6/98	5	6
2/26/98	6	8
4/1/98	3	4
4/23/98	6	5
5/20/98	3	5
6/30/98	4	3
7/28/98	3	2
8/10/98	4	6
9/2/98	5	4
10/19/98	5	4
11/16/98	6	6
12/16/98	9	8

Ammonia

The screening program identified ammonia for further evaluation at four stations in the segment. The data were collected on a monthly schedule between May of 1997 and November of 1998. At each station two values exceeded the criteria. Variations in ammonia concentrations are normal, especially under runoff conditions. It, therefore, does not appear that ammonia concentrations are a concern at these stations.

Fecal Coliform

The screening identified fecal coliform for further evaluation at nine stations in the segment. Most of the values reported are above the screening criteria. Most of the data were collected between May 1997 and November 1998; so, it is not appropriate to conduct a trend analysis. It is concluded that a water quality concern exists. However, this conclusion should be reviewed if TNRCC changes the water quality standards related to bacterial quality.

SEGMENT 1104 – DICKINSON BAYOU ABOVE TIDAL

Segment 1104 extends from a point on Dickinson Bayou 4.0 kilometers (2.5 miles) downstream of FM 517 in Galveston County to FM 528 in Galveston County. The total length is 7 miles. Segment 1104 contains the following station:

Station ID Number	Location	Number of Records in Database
11467	Dickinson Bayou at FM 517 east of Alvin	586

Segment 1104 is included on the 303(d) list because of elevated levels of bacteria. The screening program identified the following parameter(s) as requiring further evaluation: ammonia-nitrogen, chlorophyll-a, fecal coliform, and TDS.

Ammonia and Chlorophyll-a

The screening program identified ammonia as requiring further analysis because 6 of 34 measurements in the segment were above the screening value. Reported DO data concentrations are consistently above the stream standard at this station. This indicates that ammonia does not present a water quality problem at this station.

The screening program identified chlorophyll-a for further analyses because 4 of 15 measurements exceed the screening criteria. The four exceedances occurred prior to 1995, and only limited data exist between 1995 and 1998. The DO data do not indicate a concern.

Fecal Coliform

The screening program identified fecal coliform as requiring further evaluation because 26 of 28 measurements exceed the screening criteria. No trend is apparent. The reported levels indicate a concern for fecal coliform concentrations. This conclusion should be reviewed if TNRCC changes the water quality standards related to bacterial quality.

Total Dissolved Solids

The screening program identified TDS for further evaluation because 3 of the 9 reported values are above the screening criteria. The data are shown in Table 20. The table shows that the two highest values are the last to be reported. However, no data were collected according to stream standard requirements, which specify a minimum of four measurements per year.

Table 20
Total Dissolved Solids
Segment 1104-Dickinson Bayou at FM 517 East of Alvin

Date	TDS (mg/l)
3/9/94	203
6/8/94	342
12/7/94	408
3/8/95	237
6/14/95	384
9/13/95	658
12/19/95	151
3/13/96	728
6/3/96	772

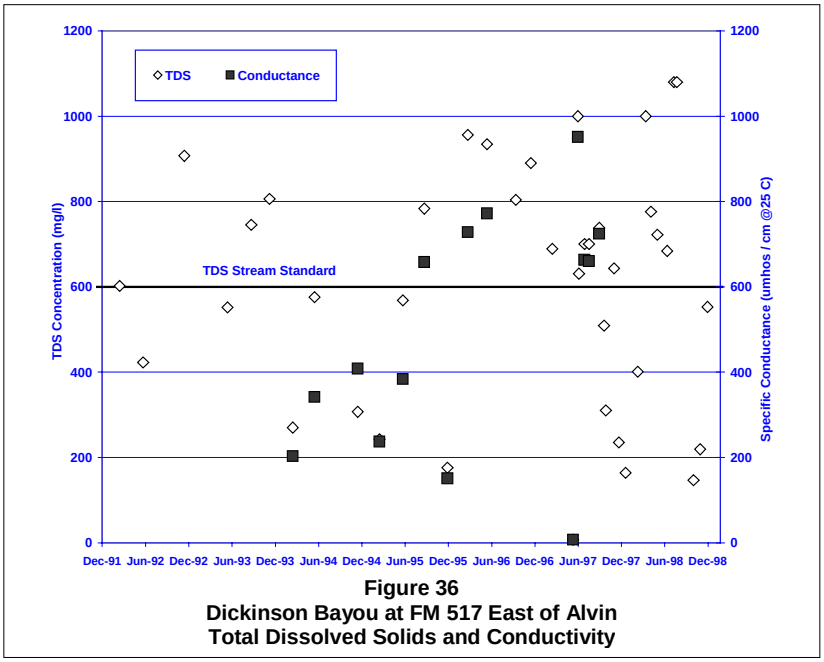

Figure 36
Dickinson Bayou at FM 517 East of Alvin
Total Dissolved Solids and Conductivity

Conductivity data is frequently used to estimate TDS concentrations. Using the average TDS conductivity ratio from the nine events that have both conductivity and TDS data, it is estimated that TDS concentrations exceeded the stream standard in 1996, 1997 and 1998. TDS and conductivity data are shown in Figure 36. A possible water quality concern exists in this segment and more frequent sampling is recommended, with a minimum of four measurements per year. This will allow better determination whether the water quality standard is being met.

SEGMENT 1105 – BASTROP BAYOU TIDAL

Segment 1105 extends from the confluence with Bastrop Bay 1.1 kilometers (0.7 mile) downstream of the Intracoastal Waterway in Brazoria County to Old Clute Road at Lake Jackson in Brazoria County for a total of 25 miles.

Segment 1105 contains the following stations:

Station ID Number	Location	Number of Records in Database
11474	Bastrop Bayou Tidal in Intracoastal Canal at Intersection of Bayou and Bay	443
11475	Bastrop Bayou Tidal at CR 227 near Mims	497
14652	Bastrop Bayou Tidal at Lost Lake	52

Segment 1105 is not included on the 303(d) list. The screening identified DO, chlorophyll-a, and fecal coliform for further analysis.

Dissolved Oxygen

The screening program identified DO for further evaluation because 4 of 35 measurements at Station 11475 (Bastrop Bayou near Mims) exceed the screening criteria. One of the measurements was a depth measurement. When daily averages are calculated, 3 of 24 averages are below the stream standard. Two of the depressed values were reported in 1994 (Figure 37), and one low value was reported in 1996. The low DO concentrations are very infrequent and do not indicate a water quality concern at this station.

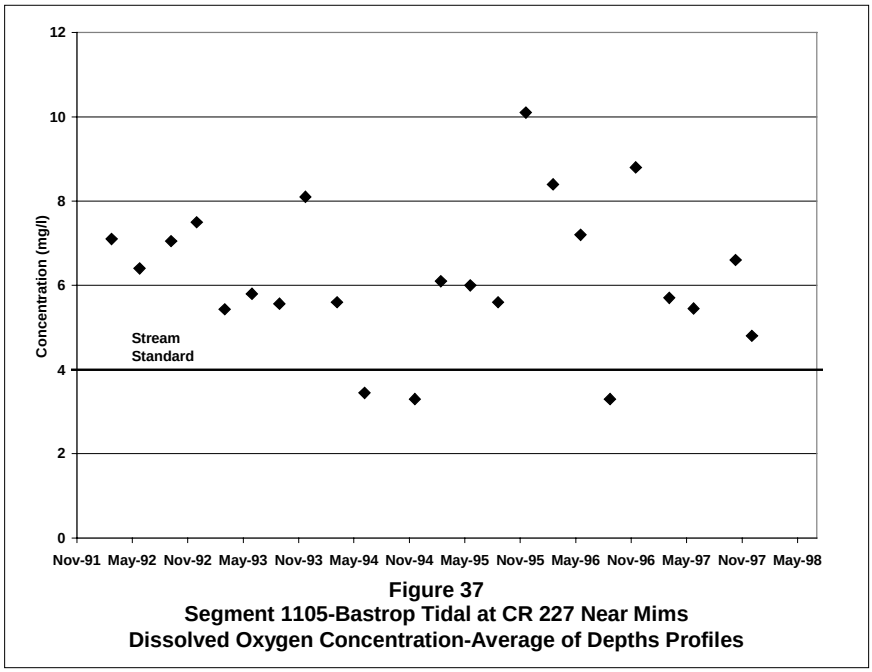

Figure 37
Segment 1105-Bastrop Tidal at CR 227 Near Mims
Dissolved Oxygen Concentration-Average of Depths Profiles

Chlorophyll-a

The screening program identified chlorophyll-a for further analysis because 5 of the 25 chlorophyll-a measurements at Station 11475 (Bastrop Bayou near Mims) exceed the screening criteria. Since DO data do not indicate a water quality concern, it appears that the chlorophyll-a levels are not a water quality concern.

Fecal Coliform

The screening program identified fecal coliform for further evaluation at Station 11475 (Bastrop Bayou near Mims). The most recent data available were obtained in 1994. A water quality concern may exist, but more current data are needed to determine the condition of this segment.

SEGMENT 1107 – CHOCOLATE BAYOU TIDAL

Segment 1107 extends from the confluence with Chocolate Bay 1.4 kilometers (0.9 mile) downstream of FM 2004 in Brazoria County to a point 4.2 kilometers (2.6 miles) downstream of SH 35 in Brazoria County for a total of 14 miles. Segment 1107 contains the following station:

Station ID Number	Location	Number of Records in Database
11478	Chocolate Bayou at the FM 2004 Bridge South of Alvin	741

Segment 1107 is not included on the 303(d) list. The screening identified DO, chlorophyll-a, and fecal coliform as requiring further evaluation.

Dissolved Oxygen

The screening program identified DO because 9 of 84 measurements at Station 11478 (Chocolate Bayou Tidal South of Alvin) exceed the screening criteria. The database included depth profiles of DO. Daily averages were calculated for the days with depth profiles. Consequently, the revised database is summarized in Figure 39. One value (4% of all values) is below the stream standards. Therefore, it is concluded that no water quality concern for DO exists.

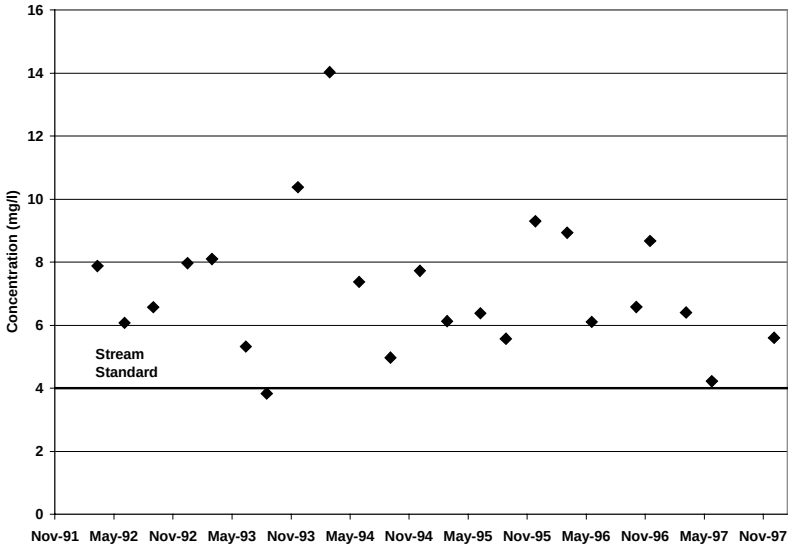

Figure 38
Chocolate Bayou Tidal South of Alvin
Dissolved Oxygen

Chlorophyll-a

The screening program identified chlorophyll-a at Station 11478 for further evaluation because 5 of 15 measurements exceed the screening criteria. The DO data analyses concluded that there is not a concern related to DO levels at this station. It appears that chlorophyll-a is not a concern either.

Fecal Coliform

The screening identified fecal coliform at Station 11478 for further evaluation because 2 of 12 measurements exceed the screening criteria. It appears that these two elevated levels are isolated events. However, the most recent data were collected in 1994. More data are needed to assess the water quality at this station.

SEGMENT 1108 – CHOCOLATE BAYOU ABOVE TIDAL

Segment 1108 extends from a point 4.2 kilometers (2.6 miles) downstream of SH 35 in Brazoria County to SH 6 in Brazoria County for a total length of 22 miles. Segment 1108 contains the following station:

Segment 1108 is included on the 303(d) list because of elevated levels of bacteria. The screening identified TDS, sulfate and chloride for further analysis.

Station ID Number	Location	Number of Records in Database
11484	Chocolate Bayou at FM 1462 west of Alvin	369

Total Dissolved Solids, Sulfate, and Chloride

The screening program identified TDS, sulfate, and chloride at Station11484 for further evaluation. The data are summarized in Figure 39. No trends are apparent in the data. A water quality concern exists for this segment, for elevated dissolved salts. Future monitoring activities should provide for additional monitoring stations to better assess the extent of this concern. It should also be verified, even though classified above tidal, that the segment is not impacted by high tides.

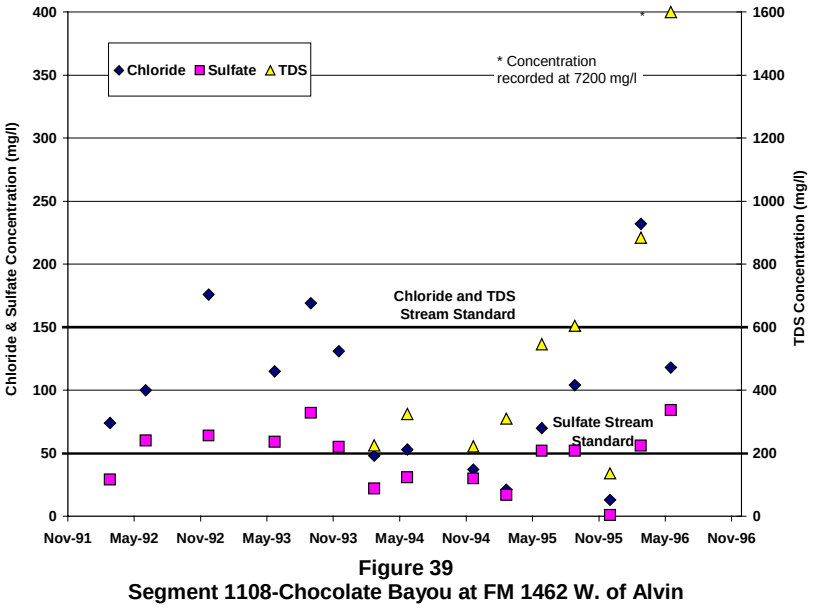

Figure 39
Segment 1108-Chocolate Bayou at FM 1462 W. of Alvin
Total Dissolved Solids, Sulfate, & Chloride Concentrations

Fecal Coliform

The 303(d) list includes this segment because of elevated levels of bacteria. The screening did not identify this segment for elevated bacteria levels because the database included only eight values below the minimum requirement by the screening program.

SEGMENT 1109 – OYSTER CREEK TIDAL

Segment 1109 extends from the confluence with the Intracoastal Waterway in Brazoria County to a point 100 meters (110 yards) upstream of FM 2004 in Brazoria County for a total length of 25 miles. Segment 1109 contains the following station:

Station ID Number	Location	Number of Records in Database
11485	Oyster Creek at Fm 523 southeast of Angleton	438

Segment 1109 is included on the 303(d) list because of elevated levels of bacteria. The screening identified chlorophyll-a and fecal coliform for further analysis.

Chlorophyll-a

The screening program identified chlorophyll-a for further evaluation because 2 of 18 measurements at Station 11485 (Oyster Creek Tidal southeast of Angleton) exceeded the screening criteria. The three values were recorded in 1992 and 1994 (see Figure 40). Data in 1995 and 1996 do not exceed the criteria. Dissolved oxygen data at this station is consistently above the stream standard. This suggests that chlorophyll-a levels are not a concern at this station.

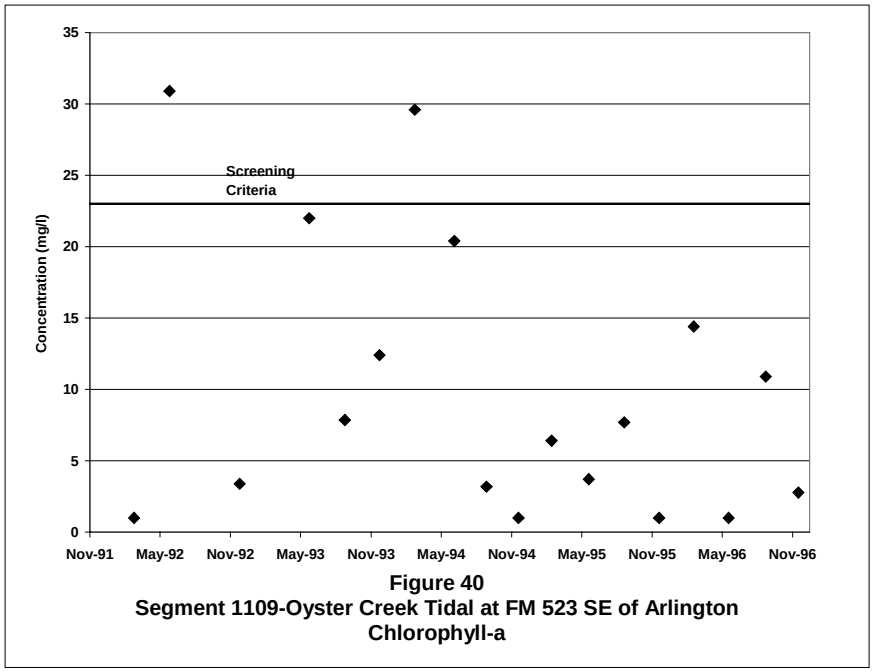

Figure 40
Segment 1109-Oyster Creek Tidal at FM 523 SE of Arlington
Chlorophyll-a

Fecal Coliform

The screening program identified fecal coliform at Station 11485 for further evaluation because 6 of 11 measurements are above the stream standard. The data were reported in 1992, 1993 and 1994. A water quality concern may exist but more recent data are needed to assess a concern for fecal coliforms.

SEGMENT 1110 – OYSTER CREEK ABOVE TIDAL

Segment 1110 extends from a point on Oyster Creek 100 meters (110 yards) upstream of FM 2004 in Brazoria County to the Brazos River Authority diversion dam 1.8 kilometers (1.1 miles) upstream of SH 6 in Fort Bend County. The total length is 77 miles. Segment 1110 contains the following stations:

Station ID Number	Location	Number of Records in Database
11489	Oyster Creek at Walker St Near Ward Lake	466
11493	Oyster Creek at FM 1462 West of Rosharon	11

Segment 1110 is included on the 303(d) list because of elevated levels of bacteria and low concentrations of DO. The screening program identified DO, ammonia-nitrogen, fecal coliform, and TDS as requiring further evaluation.

Dissolved Oxygen and Ammonia

The screening program identified DO at Station 11489 (Oyster Creek near Ward Lake) for further evaluation because 9 of 16 measurements are below the screening criteria. The data are shown in Figure 41. The figure shows that depressed levels were observed intermittently in the months of June, September, October, and December. The seasonal trend is apparent from the graph.

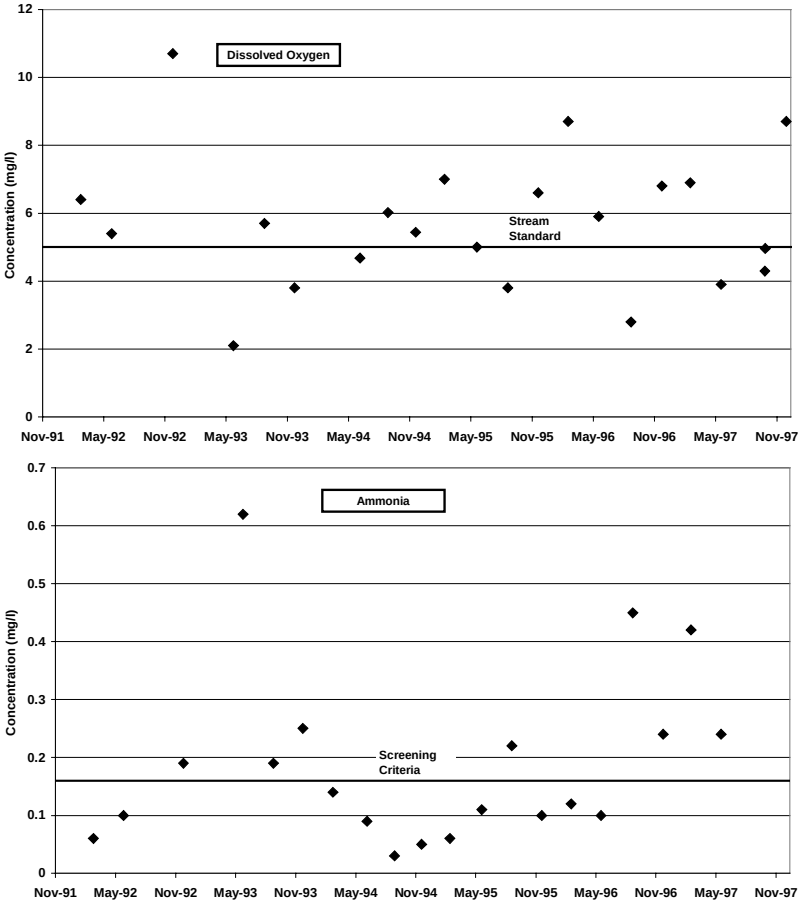

Figure 41
Segment 1110-Oyster Creek at Walker St. Near Ward Lake
Dissolved Oxygen and Ammonia

The screening program also identified ammonia for further evaluation at this station. Several of the elevated ammonia levels coincide with depressed DO measurements. It is possible that an upstream discharge occasionally impacts the DO concentrations. The concern for DO and ammonia is justified.

Fecal Coliform

The screening program identified fecalcoliform at Station 11489 for further evaluation because 10 of 11 reported measurements are above the screening criteria. The most recent measurements were made in 1994. In order to assess whether a water quality concern exists, more recent data are needed.

Total Dissolved Solids

The screening program identified TDS at Station 11489 (Oyster Creek near Ward Lake) for further evaluation because 2 of 14 measurements are above the screening criteria. The data are presented in Table 21

Table 21
Total Dissolved Solids
Oyster Creek Near Ward Lake

Date	TDS (mg/l)
03/10/94	318
06/21/94	324
09/13/94	486
12/05/94	175
03/01/95	2590
06/06/95	314
09/06/95	554
12/06/95	646
03/05/96	662
06/04/96	696
09/09/96	280
12/10/96	876
03/05/97	330
06/05/97	320

As is apparent from the table, the measurement reported for March 1995 is significantly higher than any of the other measurements. The measurements of chloride and sulfate on the same date are also elevated. Conductivity, however, is below normal. Since conductivity is a measure of dissolved salt concentrations, there appears to be a problem with some of the data for March 1995.

The second measurement above the screening criteria was performed in December 1996. The numerical value for the stream standard for TDS applies to an annual average, which is based on a minimum of four samples. The annual average concentration of TDS did not exceed the stream standard in 1996. Since the March 1995 sample is of questionable validity and the stream standard was not exceeded in 1996, it is concluded that TDS are not a water quality concern at this station.

SEGMENT 1111 – OLD BRAZOS RIVER CHANNEL

Segment 1111 extends from the confluence with the Intracoastal Waterway in Brazoria County to SH 288 in Brazoria County for a total length of 6 miles. Segment 1111 contains the following station:

STATION ID NUMBER	LOCATION	Number of Records in Database
11498	Old Brazos River Channel mid-way between the mouth and the terminus	1081

Segment 1111 is included on the 303(d) list because of elevated levels of mercury. The screening identified DO, cadmium, copper, and mercury for further analysis.

Dissolved Oxygen

The screening program identified DO at Station 11498 (OldBrazos River Channel midway between Mouth and Terminus) for further evaluation. Daily averages were calculated for each day that depth profiles were reported. Based on these averages DO is not a concern in this segment.

Cadmium, Copper and Mercury

The screening program identified cadmium, copper and mercury at Station 11498 because one of ten values of cadmium and copper and two of ten mercury values exceeded the screening criteria. As shown in Table 22 most measurements were reported below the detection limit. The data above the stream standards appear to be isolated events.

Table 22
Toxic Metal Concentrations
Segment 1111 - Old Brazos River Channel Midway Between Mouth and Terminus

Date	Cadmium (ug/l)	Copper (ug/l)	Mercury (ug/l)
9/20/94	< 4	< 4	< 0.12
12/20/94	6	< 4	< 0.06
3/14/95	< 4	< 4	0.182
6/26/95	< 4	< 4	< 0.06
9/13/95	< 4	5	0.011
12/13/95	< 4	< 4	0.024
3/21/96	< 4	< 4	< 0.01
6/5/96	< 4	< 4	< 0.01
10/21/96	< 4	< 4	< 0.01
12/3/96	< 4	< 4	< 0.01

Cadmium and copper have only a single measurement above the stream standard, and it was reported very close to the detection limit. It appears that cadmium and copper are not a concern at this station. Mercury has been reported above the stream standard

several times, each time near the analytical limit. In the absence of data with a lower detection limit, mercury is considered a concern in this segment.

SEGMENT 1113 – ARMAND BAYOU TIDAL

Segment 1113 extends from the confluence of Armand Bayou with Clear Lake in Harris County to a point .8 kilometers (0.5 miles) downstream of Genoa-Red Bluff Road in Pasadena in Harris County. The total length is 8 miles. Segment 1113 contains the following stations:

Station ID Number	Location	Number of Records in Database
11404	Armand Bayou at Genoa-Red Bluff Rd NE of Ellington AFB	342
11409	Horsepen Bayou at Bay Area Blvd North of NASA	18
11499	Armand Bayou Tidal at NASA 1 Bridge	7
11500	Armand Bayou Tidal Lower Mud Lake , 1.4 Km Upstream of NASA 1 Bridge	1324
11503	Armand Bayou Tidal at Bay Area Blvd North of NASA	583
11505	Armand Bayou Tidal at Unnamed Road 1.1 Km Downstream of Spring Gully	231

The tidal and non-tidal portions of Segment 1113 are included on the 303(d) list because of elevated levels of bacteria and low concentrations of DO. The screening program identified DO, ammonia-nitrogen, chlorophyll-a, and fecal coliform as requiring further evaluation.

Dissolved Oxygen, Ammonia and Chlorophyll-a

The screening program identified DO as requiring further evaluation at two stations and the data for all stations are presented in Figure 42 The data indicate a possible water quality concern because of low DO levels. A TMDL effort is currently in advanced stages and addresses the DO, ammonia and chlorophyll-a concentrations at this station. As part of the TMDL effort, a significant amount of additional data have been collected that are not yet included in the database. Therefore, no further evaluation of nutrients and chlorophyll-a was conducted.

Fecal Coliform

The screening program identified fecal coliform at Station 11404 and Station 11503 (Armand Bayou Tidal north of NASA and Armand Bayou tidal northeast of Ellington Airforce Base) for further evaluation. Eleven

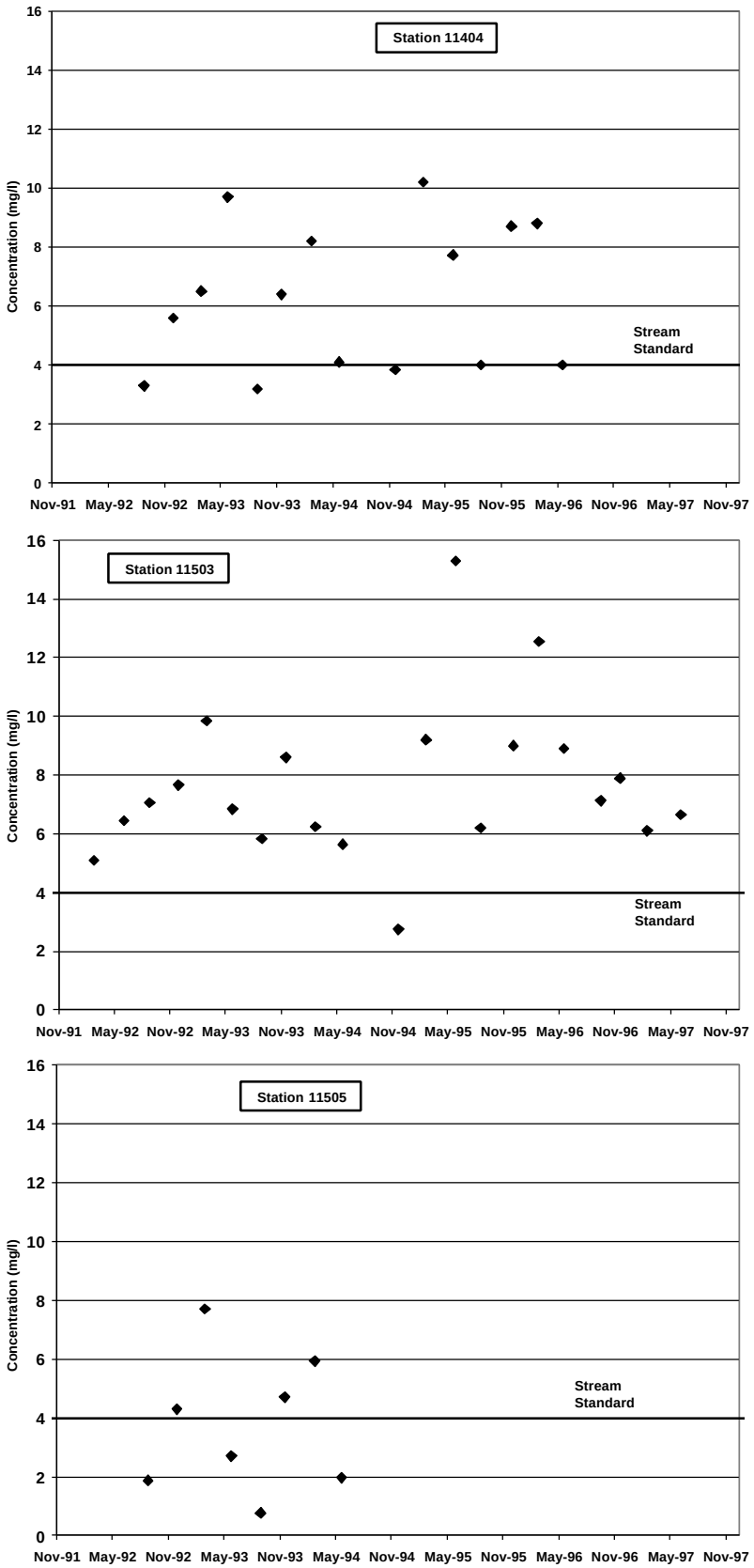

Figure 42
Segment 1113-Armand Bayou Tidal
Dissolved Oxygen Concentration

measurements are reported atStation 11404, all of which are above the screening criteria. Eleven of 24 measurements at Station 11503 are above the screening criteria. Both data sets are presented in Figure 43. While it appears that a concern exists at Station 11404, it is not clear whether a concern exists for Station 11503. If TNRCC revises the bacterial stream standard, the data should be reassessed to determine if the concern for bacterial quality is confirmed based on the revised standard.

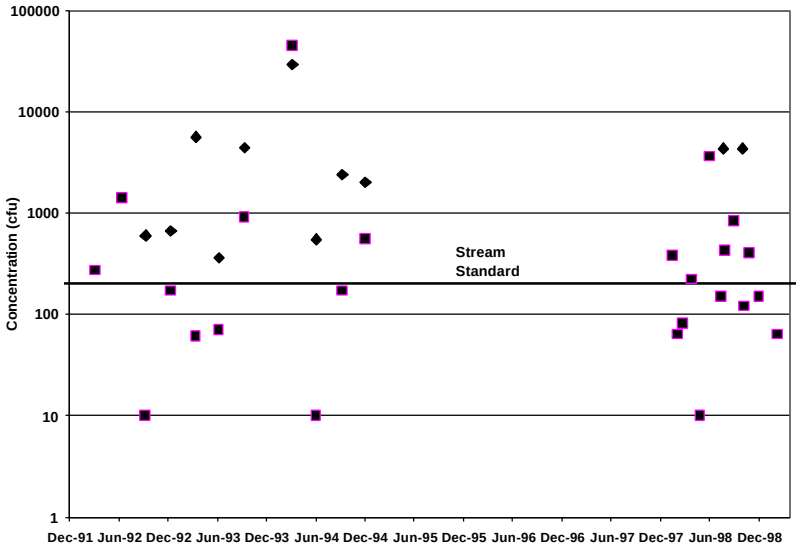

Figure 43
Segment 1113-Stations 11404 and 11503
Fecal Coliform

Summary of Findings

Water quality data for the Trinity-San Jacinto Coastal Basin, the San Jacinto River Basin, and the San-Jacinto-Brazos Coastal Basins were reviewed. A screening program was utilized to compare the existing water quality data against screening criteria established by the TNRCC. Most criteria matched the water quality standards, however, screening criteria for nutrients and chlorophyll-a were established by the TNRCC based on best professional judgment. No stream standards for nutrients or chlorophyll-a exist in Texas at this time. The results of the screening program were used to identify stations and parameters for further evaluations. Further evaluations included trend analyses, spatial analyses, and examination of relationships between parameters.

The summary of the detailed review are presented in Table 23 and Table 24. Eight conventional parameters, in this summary nutrients are considered a single parameters, and seven metals were identified by the screeningprogram No other toxic parameters, such as organic pollutants were identified. Pollutants were not identified for further evaluation if they had insufficient number of data points in the database (minimum of nine data points), orif 90% of the data met the screening criteria.

Basin 9 — Trinity-SanJacinto Coastal Basin

The Trinity-San Jacinto Coastal Basin water quality database contains mostly data of conventional parameters. The detailed review identified total dissolved solids and fecal coliform in segment 902, Cedar Bayou above Tidal, as parameters of concern.

Basin 10 — San-Jacinto River Basin

The database for the SanJacinto River Basin is was the largest of the three basins reviewed. Fecalcoliform was identified as a concern most frequently. It was concluded to be a concern in nine of the seventeen segments in the basin. Mercury, the second most frequently identified concern, was concluded to be concern in six segments. For many parameters the data were inconclusive, and it was determined that additional data are needed to determine whether a water quality concern exists.

Table 23
Summary of Evaluation of Conventional Parameter Data
Trinity-San Jacinto River Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

Segment	Parameter							
	Dissolved Oxygen	Chlorophyll-a	Nutrients	Total Dissolved Solids	Chloride	Sulfate	pH	Fecal Coliform
Trinity-SanJacinto Coastal Basin								
901								AD
902	NC		NC	C				C
SanJacinto River Basin								
1001		NC						C
1002	C	C	C	C				C
1003								
1004				AD	AD			
1005	NC							C
1006	NC	AD	NC	NC			NC	C
1007	NC		C					C
1008	AD	AD	AD	AD	AD			AD
1009	NC	NC	NC	C	C			AD
1010								
1011								
1012	C	AD						
1013	NC		NC					C
1014		NC	NC					C
1015								
1016	AD	AD	AD		AD	AD		C
1017	NC	NC	NC	C				C

Continued

Table 23
Summary of Evaluation of Conventional Parameter Data
Trinity-San Jacinto River Basin, San Jacinto River Basin, and San Jacinto-Brazos Coastal Basin

Segment	Parameter							
	Dissolved Oxygen	Chlorophyll-a	Nutrients	Total Dissolved Solids	Chloride	Sulfate	pH	Fecal Coliform
SanJacinto-Brazos Coastal Basin								
1101	AD	NC	NC					C
1102	C		C	AD	AD			C
1103	AD	AD	NC					C
1104			NC	C				C
1105	NC	NC						AD
1107	NC	NC						AD
1108				C	C	C		
1109		NC						AD
1110	C		C	NC				AD
1111	NC							
1113	AD	AD	AD					C

Legend

AD	Additional data required to assess water quality condition.
NC	Evaluation of water quality data concluded that no water quality concern exist.
C	Evaluation of water quality data concluded that a water quality concern exist.
	Not identified by screening program for further evaluation.

Table 24
Summary of Evaluation of Toxic Metals Data
San Jacinto River Basin and San Jacinto - Brazos Coastal Basin

Segment*	Parameter						
	Aluminum	Cadmium	Copper	Lead	Mercury	Nickel	Zinc
SanJacinto River Basin							
1001			NC		C		
1002	AD	NC	NC	AD	AD		
1005			AD		C	NC	
1006			AD		C	C	
1007			NC	C	C	C	
1012					C		AD
1013			AD		C		
1016		NC		C			
1017		AD		AD			
SanJacinto-Brazos Coastal Basin							
1111		NC	NC		C		

* Only segments where metals were identified for further evaluations are listed. No segments in the Trinity-San Jacinto River Coastal Basin were identified.

Legend

AD	Additional data required to assess water quality condition.
NC	Evaluation of water quality data concluded that no water quality concern exis
C	Evaluation of water quality data concluded that a water quality concern exis
	Not identified by screening program for further evaluation

Basin 11 — San Jacinto-Brazos Coastal Basin

The San Jacinto-Brazos Coastal Basin water quality database contains predominantly conventional parameters, but includes some metals data. Fecalcoliform, the most frequently identified concern, was determined to be of concern in five of the eleven segments in the basin.

Dissolved Oxygen, Nutrients, and Chlorophyll-a

Dissolved oxygen was identified by the screening program for further evaluation more than any other parameter. As is evident from the review, there is significant consistency within the database for DO data. Besides the expected consistency of seasonal trends and depth profiles, there was also a consistency of sampling time. A review of DO data within a segment would sometimes show, that samples were always collected on the same day, and always in the same order. This would result in the first station to be monitored during the early morning, and the last usually close to noon. Since data for DO shows that it is sensitive to the time of day, it would help in the interpretation of the data if the order in which sampling stations are visited on any giving day be modified routinely. The additional information gained could provide information about the extent to which DO concentrations change during the course of the day. Since the stream standard for DO is based on a 24-hour average, such information would aid in determining whether the stream standard is met.

The review of nutrient impacts on the water quality was assessed in terms of the nutrients promoting algal growths. To determine algal activity, chlorophyll-a data and DO data were used to the extent available. In numerous cases the review determined that additional data are needed to determine whether a water quality concern exists. Variation in sampling time discussed earlier, and occasional measurements of diurnal DO concentrations, especially during the summer months, would provide more conclusive evidence about the water quality at the stations monitored.

Dissolved Salts

The stream for total dissolved solids, chloride and sulfate is based on the average of at least four measurements per year. In many cases the dissolved salts were reported only once or twice a year at a station. Since dissolved salt concentrations can be impacted by flow

conditions, a few measurements during a dry summer or wet spring may result in a determination of an annual average value that is biased. More frequent sampling during various flow conditions is recommended. Collection of conductivity data, because it usually correlates closes to the concentration of total dissolved solids can also provide useful information.

Fecal Coliform

As is evident, fecal coliform dominate the list of water quality concerns. It should be noted that the TNRCC is preparing to revise the stream standards. A study was conducted to determine a more appropriate of assessing water quality with regards to bacterial contamination. As a result of this study, modifications to the stream standard for fecal coliform have been proposed. It is recommended that the fecal coliform data be reviewed after adoption of the new stream standard, utilizing the revised standard to assess the data.

Metals

Much of the metals data were reported very close to the detection limit, which increases the likelihood that false positive values are reported. Data collected since 1992 were reviewed for this assessment, and no attempt was made to eliminate data because of uncertainty associated with it. However, with the implementation of quality assurance project plans specifying specific sampling processes, analytical methods, and quality control measures, data that is being collected now should no longer have this significant uncertainty associated with them. The results of these efforts will aid in future assessments and decision-making.