Bayou Folse (120302)
Watershed Implementation Plan

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Introduction

Bayou Folse is a coastal watershed in southeastern Louisiana with several water quality impairments due to both natural and anthropogenic sources. This plan sets out to address those sources in a three-phase, adaptive management strategy to meet the ultimate goal of water quality restoration and full use support.

Part of the Barataria-Terrebonne estuary system, Bayou Folse experiences tidal influence and the watershed is characterized by complex and modified hydrology. Narrow inhabited natural levees abutting bayous bound the wetland areas between them. Some residents inhabit leveed lowland areas characterized by subsidence and use forced pumping to prevent flooding. The watershed also encompasses the Lake Fields Game and Fish Preserve.

Bayou Folse's designated uses are primary contact recreation (PCR), secondary contact recreation (SCR), fish and wildlife propagation (FWP), drinking water supply (DWS), and agriculture. According to the most recent state Integrated Report (2016), the watershed is not supporting its FWP use because of nutrients and low dissolved oxygen (DO), and not meeting its PCR use due to bacteria. Other concerns in the area include preservation of Lake Fields, located in the southern portion of the subsegment. Lake Fields is experiencing degraded water quality due to nutrient and sediment runoff upstream and there is strong stakeholder interest in restoring the wildlife habitat in this area.

Land use in the watershed is comprised primarily of wetlands (53%), pastureland (22%), urban (11%) and cropland (mainly sugarcane, 9%). Pastureland contributes to streambank erosion, and to nutrients and bacteria in Bayou Folse – cattle are commonly seen directly accessing streams. Small package plants and on-site home wastewater treatment systems, when malfunctioning, add to bacteria loading in the streams. And cropland is a source of sediment and nutrients through rainfall-runoff processes.

In 2016, the Barataria-Terrebonne National Estuary Program (BTNEP) partnered with the Louisiana Department of Environmental Quality (LDEQ) to address water quality concerns, and in 2017, BTNEP named Bayou Folse a priority watershed for restoration. BTNEP's management conference is comprised of numerous stakeholders in the estuary. One primary stakeholder, the US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) identified Bayou Folse as a National Water Quality Initiative (NWQI) watershed for targeted outreach and conservation practice implementation. Other stakeholders include the Lafourche Parish Game and Fish Commission, Lafourche Parish government, Louisiana Department of Health (LDH), Louisiana Department of Agriculture and Forestry (LDAF), South Central Planning & Development Commission, North Lafourche Levee District, Bayou Lafourche Fresh Water District, and the Lafourche-Terrebonne Soil and Water Conservation District.

This watershed plan will identify and address sources and causes of pollutant loading, practices to address those loadings, and the restoration of use support. The plan will follow the Environmental Protection Agency (EPA) 9-element watershed plan format. It is intended to be a living document with adaptive management revisions reflecting new stakeholder input, additional partnerships and opportunities expected in coming years, and improved technical approaches as necessary. This plan is not meant to limit activity in the watershed but to serve as a framework for planning measures to address pollutant loadings and to inform strategies for watershed managers in the future.

Mission Statement

This watershed implementation plan will employ individual engagement and organizational commitment to address water quality issues identified by watershed assessment and stakeholders in Bayou Folse through promoting pollution reduction activities that will restore water quality.

Element A. Causes and Sources of Pollution

This section will describe the water quality impairments in Bayou Folse, summarize both baseline and ambient water quality monitoring data, describe the geography of the watershed, and characterize the region in terms of known and potential sources of pollution.

Bacteria, low DO, nutrients, and sediment are primary causes of water quality impairment in Bayou Folse identified by LDEQ sampling data and by stakeholders in the watershed. Bacteria and nutrients can come from human beings (sewage treatment system failures), livestock, and wildlife. Cropland contributes nutrients as well, and sediment runoff. Runoff load in low-lying, leveed areas is transferred via forced drainage pumping before and during rain events. This section will discuss in detail the causes and sources of pollution in Bayou Folse.

Bayou Folse Water Quality Assessment

LDEQ uses ambient water quality data to determine use support for designated uses in Louisiana watersheds. The 2016 IR lists Bayou Folse designated use impairments along with suspected causes and sources (see Table 1).

Table 1. 2016 IR Use Support Status and Suspected Sources and Causes

Use/Support								
PCR	SCR	FWP	DWS	Impaired Use for Suspected Cause	Suspected Causes of Impairment	IR Category for Suspected Causes	TMDL Priority	Suspected Sources of Impairment
N	F	N	F	FWP	Nitrate/Nitrite as N	IRC 4a		Forced Drainage Pumping
N	F	N	F	FWP	Nitrate/Nitrite as N	IRC 4a		Package Plant or Other Permitted Small Flows Discharges
N	F	N	F	FWP	Nitrate/Nitrite as N	IRC 4a		Sanitary Sewer Overflows (Collection System Failures)
N	F	N	F	FWP	Oxygen, Dissolved	IRC 4a		Forced Drainage Pumping
N	F	N	F	FWP	Oxygen, Dissolved	IRC 4a		Package Plant or Other Permitted Small Flows Discharges
N	F	N	F	FWP	Oxygen, Dissolved	IRC 4a		Sanitary Sewer Overflows (Collection System Failures)
N	F	N	F	FWP	Phosphorus (Total)	IRC 4a		Forced Drainage Pumping
N	F	N	F	FWP	Phosphorus (Total)	IRC 4a		Package Plant or Other Permitted Small Flows Discharges
N	F	N	F	FWP	Phosphorus (Total)	IRC 4a		Sanitary Sewer Overflows (Collection System Failures)
N	F	N	F	PCR	Fecal Coliform	IRC 5	M	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
N	F	N	F	PCR	Fecal Coliform	IRC 5	M	Package Plant or Other Permitted Small Flows Discharges
N	F	N	F	PCR	Fecal Coliform	IRC 5	M	Wildlife Other than Waterfowl

The PCR criterion for fecal coliform is 400 colony forming units (cfu)/100 ml. No more than 25% samples may exceed that number for the PCR season, which is May-October. Ambient sampling data from 2014-15 show a 33% exceedance rate (see Table 2).

Table 2. Ambient fecal coliform data (PCR) 2014-15

Sampling Date	CFU/100ml
10/7/2014	112
5/12/2015	42
6/9/2015	210
7/14/2015	56
8/11/2015	660
9/16/2015	660

Exceeds standard

The criteria for DO to support FWP is 5 mg/L, with no more than 10% samples falling below that value. Bayou Folse ambient data show a 58% exceedance rate.

There are no numeric criteria for nutrients in Louisiana, but the TMDL identified nutrients as contributing to low DO. It may be assumed that when the DO impairment is removed, so will those for nitrogen and phosphorous.

Land Use

The 68,600-acre Bayou Folse watershed is comprised of two USGS-defined 12-digit HUCs: Lake Fields 08093020503 and Bayou Cut Off 080903020502 . The drainage area is more than half wetlands – 53% land cover is swamp or marsh. The primary remaining land uses are pastureland (22%), developed (11%) and cropland (9%). Spatial distribution of land use / land cover along with the water quality monitoring locations for this project can be seen in Figure 1.

The dominant crop type in Bayou Folse is sugarcane – nearly 7% of the watershed area. Sugarcane is commonly produced in a five-year cycle. In the fifth year, the field is fallow and the ground is bare. Sugarcane can contribute sediment runoff and nutrient loading. Pastureland areas can contribute sediment runoff, as well as nutrient and bacteria loading particularly where cattle can directly access streams. Developed areas where on-site sewage treatment systems are malfunctioning can cause nutrient and bacteria loading to streams.

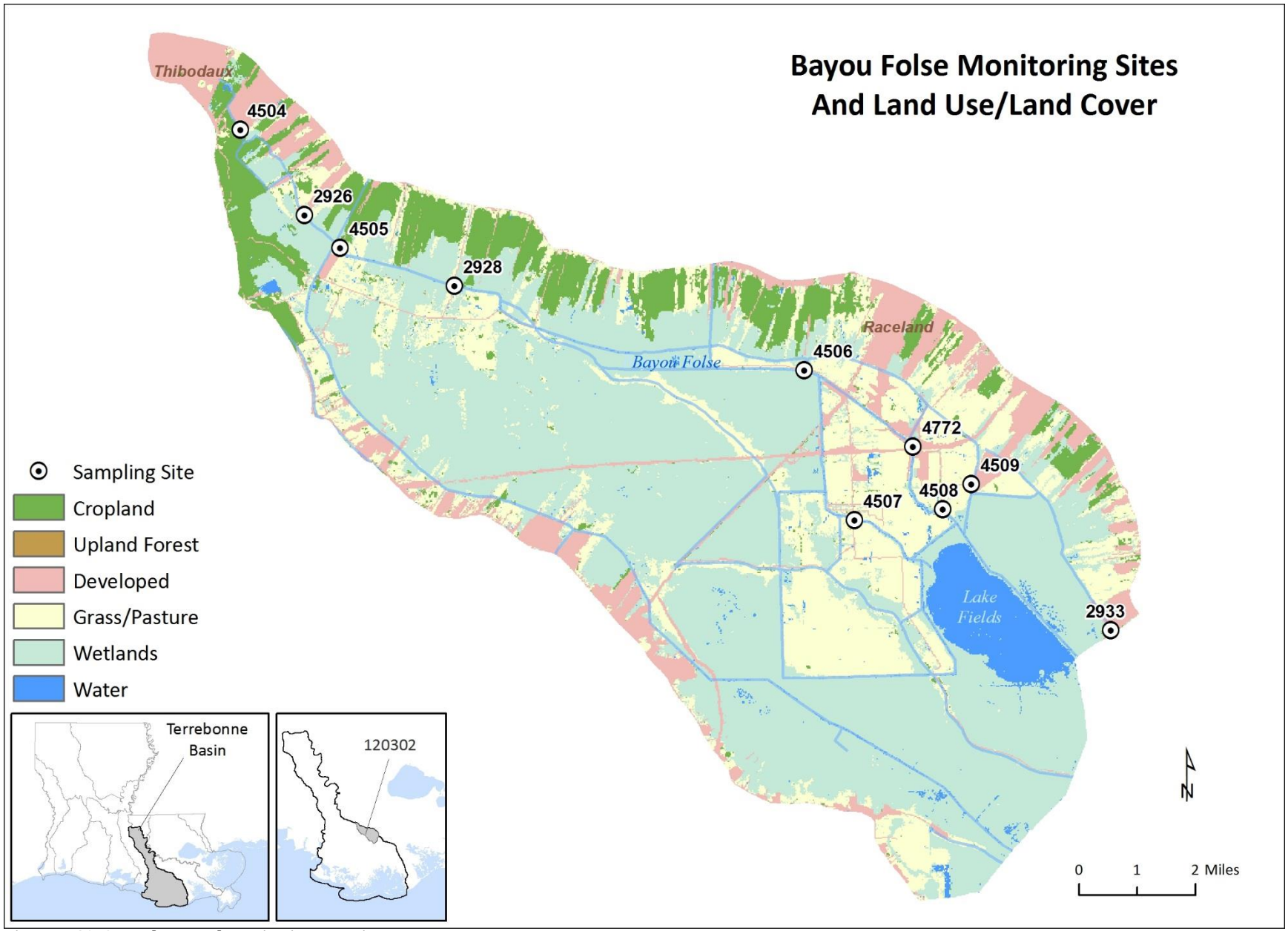

Figure 1. 2016 Land Use and Monitoring Locations

Elevation and Hydrology

The Bayou Folse subsegment is characterized by a number of low-lying leveed areas. These inhabited areas use forced pump drainage to remove stormwater for flood prevention. The elevation map below (Figure 2) shows elevation in the watershed with the location of leveed areas and pumps. These areas are of concern during storm events, when pumps are turned on and runoff is released into the receiving stream.

In typical watersheds, drainage subareas represent areas upstream of a specific location that drain to that location. In coastal Louisiana, drainage and flow function differently, and tidal influence, wind, and forced drainage pumping all influence the local hydrology to defy traditional notions of upstream and downstream flow. In the case of Bayou Folse, subarea definitions will be considered both geographically and hydrologically, and loads estimated accordingly.

Downstream flow, which occurs during lower or falling tides or during times of high rainfall drainage, represents one flow regime, and loading will be estimated during these conditions. The second flow scenario is tidal or "upstream" flow. Previous surveys and current data collection have identified a tidal influence and wind influence in Bayou Folse and neighboring waterbodies. Upstream flow is common and frequent. Runoff to Bayou Folse during these conditions will be treated as a second loading regime, and sources identified accordingly. Finally, some subareas are defined by their levees, which enclose an area with drainage regulated by pumping. Because of data gaps (data on when pumps are operational and discharge amounts), these cannot be treated as independent loading regimes. However, selected monitoring sites will help identify to what degree these drainage areas contribute NPS pollution.

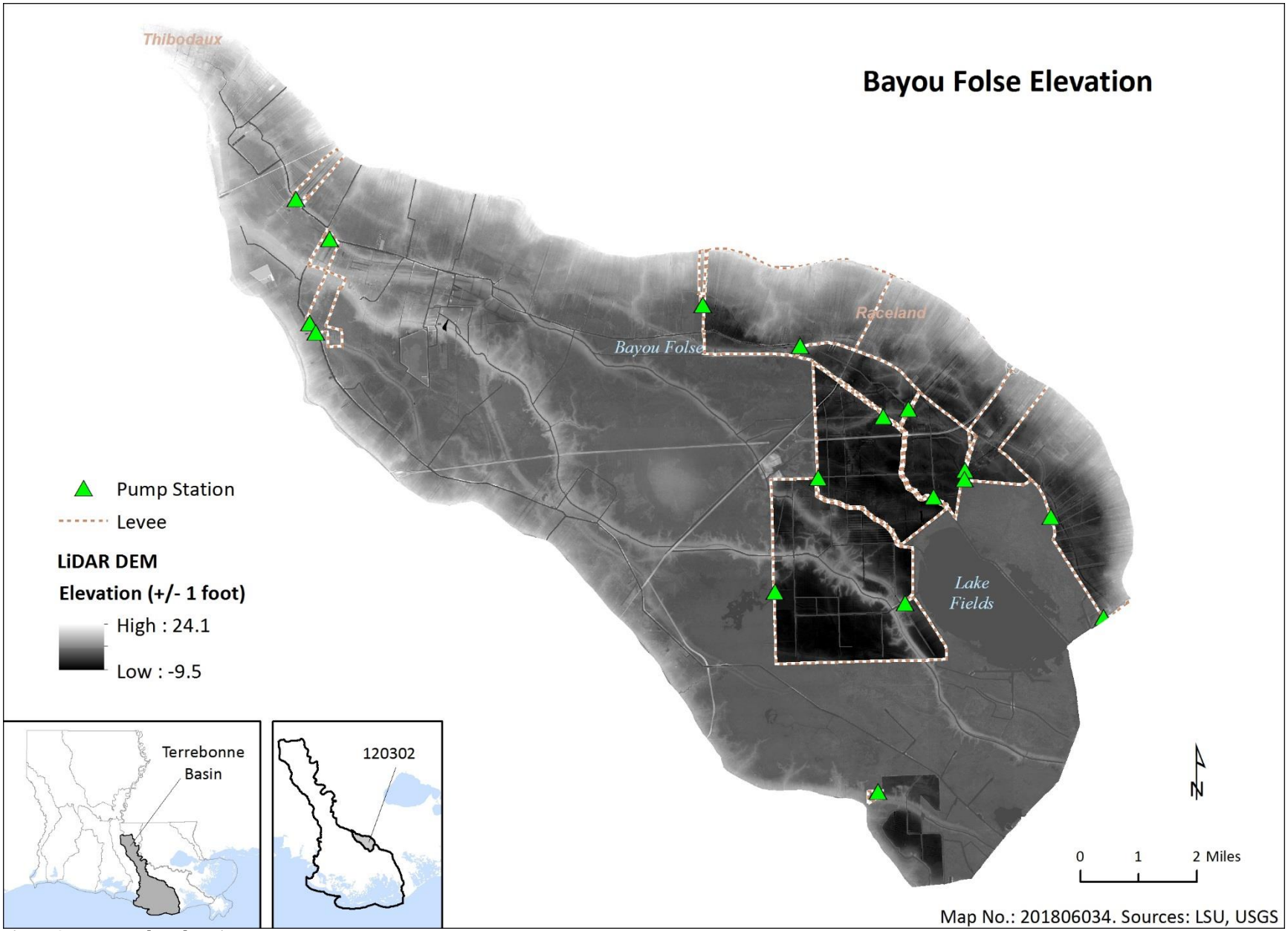

Figure 2. Bayou Folse Elevation

Population Characteristics

Approximately 33,000 people inhabit the Bayou Folse subsegment according to US Census American Community Survey ACS 2016 5-year estimates. Most developed areas lie along the natural ridges aligning waterways, and some low-lying areas contain development within ring levees. The most densely populated part of the watershed is the City of Thibodaux, located at the northernmost boundary of the watershed and near the headwaters of Bayou Folse. Lake Fields lies at the southernmost edge.

While Thibodaux is served by municipal sewage treatment, the remainder of the population uses individual home systems to treat wastewater. Maintenance of these on-site disposal systems (OSDS) has an associated cost, as well as the requirement of homeowner diligence. Poverty as well as absentee ownership will be relevant when looking at home system maintenance and cost-sharing for repairs.

An area-weighted average was used to derive demographic characteristics for Census block groups in Bayou Folse. This data is depicted with locations of home systems in Figure 3. When targeting bacteria reduction activities, priority should be given to areas with higher poverty, absentee ownership, and with high loading (see *Pollutant Load Estimates*).

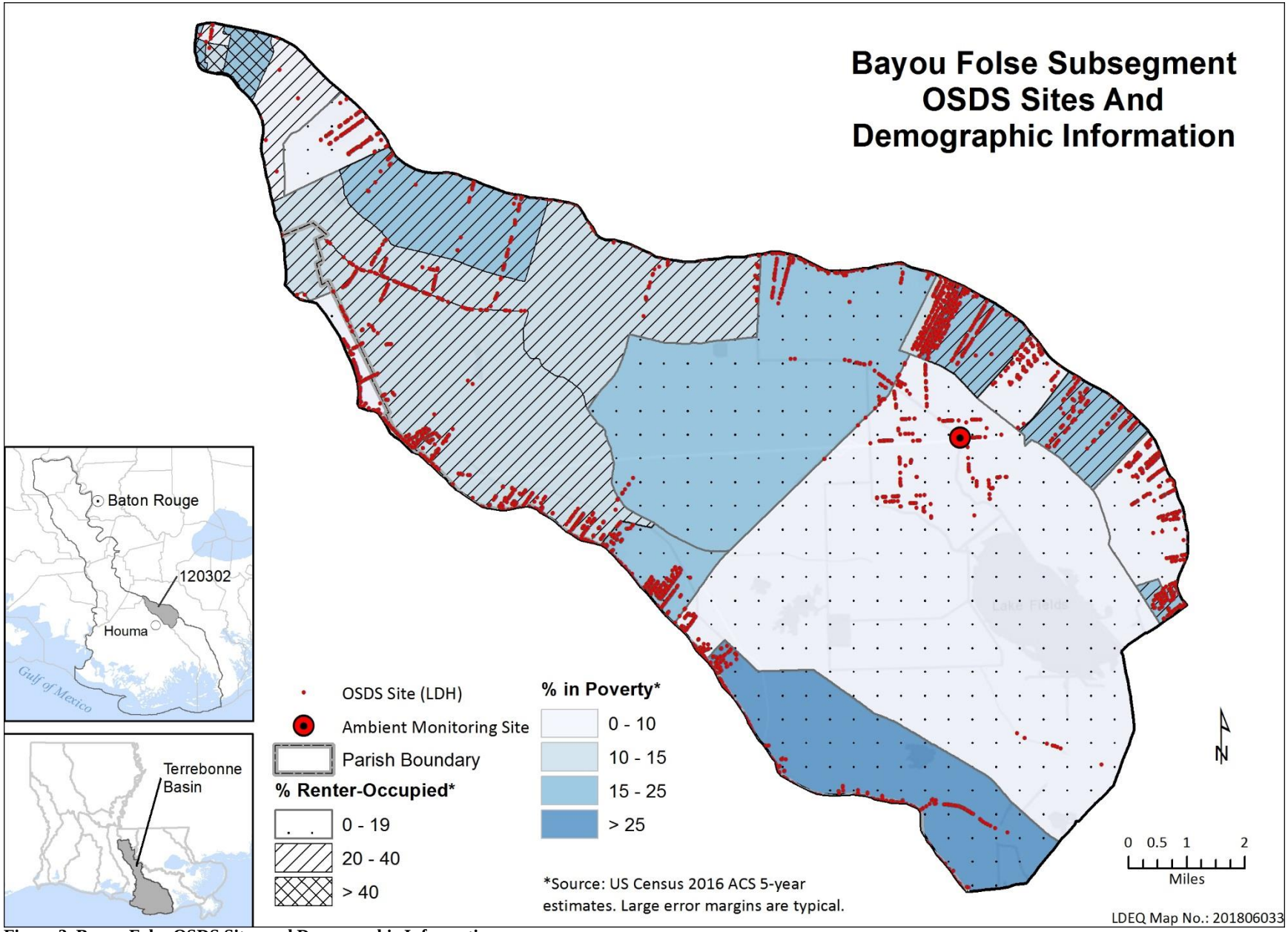

Figure 3. Bayou Folse OSDS Sites and Demographic Information

Baseline Monitoring Data

Baseline monitoring for water quality throughout the subsegment (sites depicted in Figure 1) was analyzed to help determine areas contributing the greatest loading. This analysis is useful for selecting areas to prioritize for education, outreach, and best management practice (BMP) implementation. Baseline monitoring results were examined to identify potential sources and priority areas for each parameter of concern. In cases of fecal coliform and phosphorous, data may show runoff loading spikes during intermittent events such as rainfall, or continual loading such as from malfunctioning home treatment systems. Continually high values suggest both processes may be occurring. Nitrogen and DO, however, are subject to complex cycling and distribution of results may not point to a distinct loading process. The next section provides graphs and maps of the baseline data with a summary for each parameter.

<u>Fecal Coliform Bacteria:</u>

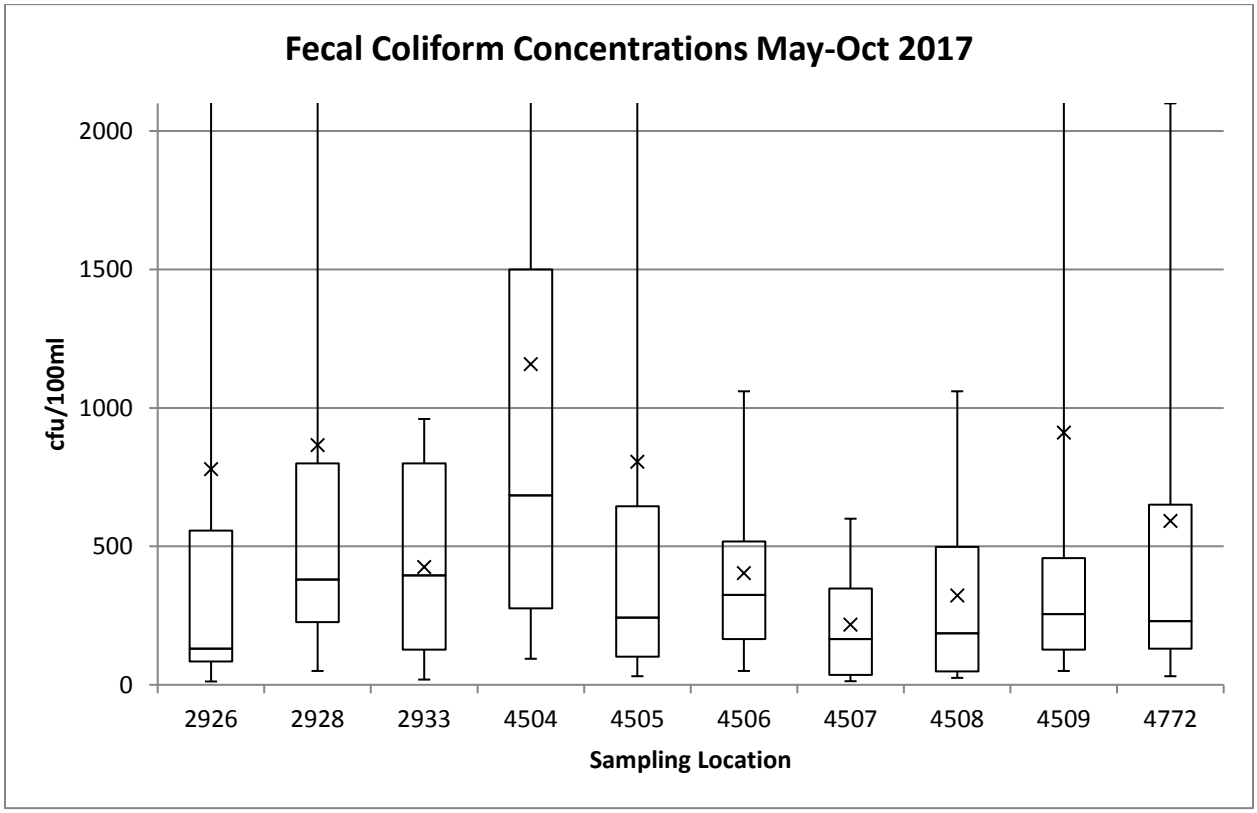

Figure 4. Boxplot of Fecal Coliform Bacteria Data During Primary Contact Recreation Months

The box-and-whiskers plot above (Figure 4) shows the range, inter-quartile range, median, and mean of the 2017 PCR baseline sampling data. The y-axis is truncated at 2,000 cfu/100ml for legibility.

Data from sites 2933, 4506, and 4507 show a relatively low standard deviation and range indicating consistent concentrations over time. Note the mean and median for these locations are close to each other in the boxplot. This consistency suggests sources with a continual flow such as home treatment systems, WWTPs and possibly cattle with direct stream access. Sites 2926, 4505, and 4509 have a large range, with intermittent spikes. The boxplot shows the range and the

separation between the mean and median. The mean is outside the inter-quartile range. The inconsistency in the concentrations indicates rainfall/runoff processes at work in both un-leveed and pumped areas. Thus, nearby grazing cattle would be one potential source of bacteria runoff for these sites. Site 4504 shows both consistently high concentrations and large spikes, indicating a high priority area of concern. Note that all sites, except 4507 and 4509, show fecal coliform excursions occurring at a rate in excess of that allowed by law for primary contact recreation purposes (See Table 3).

Table 3. Baseline Fecal Coliform Data for 2017 PCR Season

Site	Max FC	Avg FC	% FC < Standard
2926	6,000	779	33%
2928	5,500	866	42%
2933	960	425	50%
4504	4,300	1,158	58%
4505	6,000	805	42%
4506	1,060	403	42%
4507	600	218	17%
4508	1,060	322	42%
4509	6,000	910	25%
4772	2,100	592	33%

Baseline data for each site is depicted geographically in Figure 5. The y-axis shows cfu/100ml and the x-axis indicates the sampling event. Sampling occurred twice monthly May-November 2017.

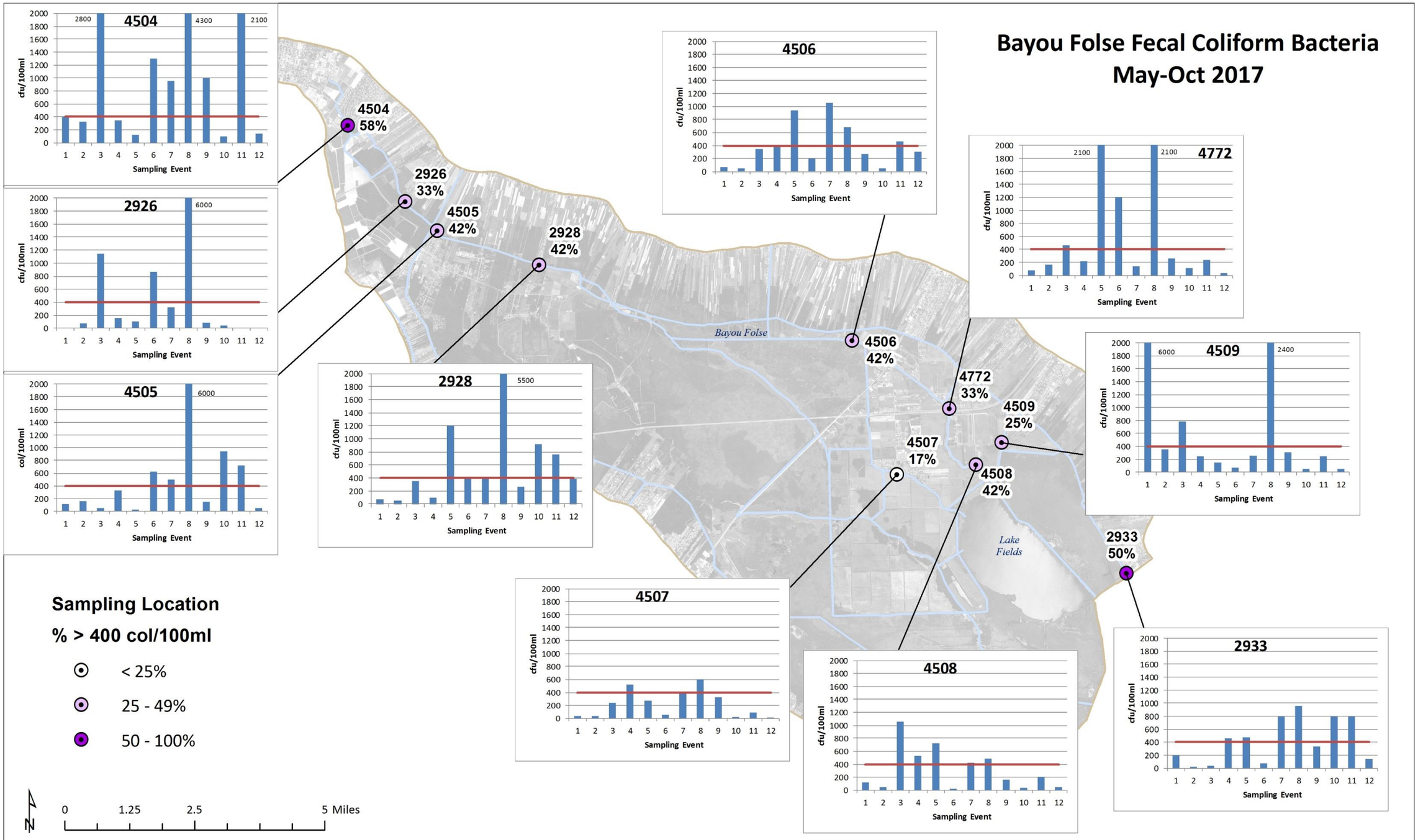

Figure 5. Bayou Folse Fecal Coliform Bacteria Map

Dissolved Oxygen:

Bayou Folse has a water quality standard for DO of 5 mg/L minimum year-round. No more than 10% samples may fall below that value or the waterbody is deemed to have impaired support of fish and wildlife propagation. LDEQ ambient water quality data used for assessing FWP use in its 2016 IR is shown below. The excursion rate is greater than 58%.

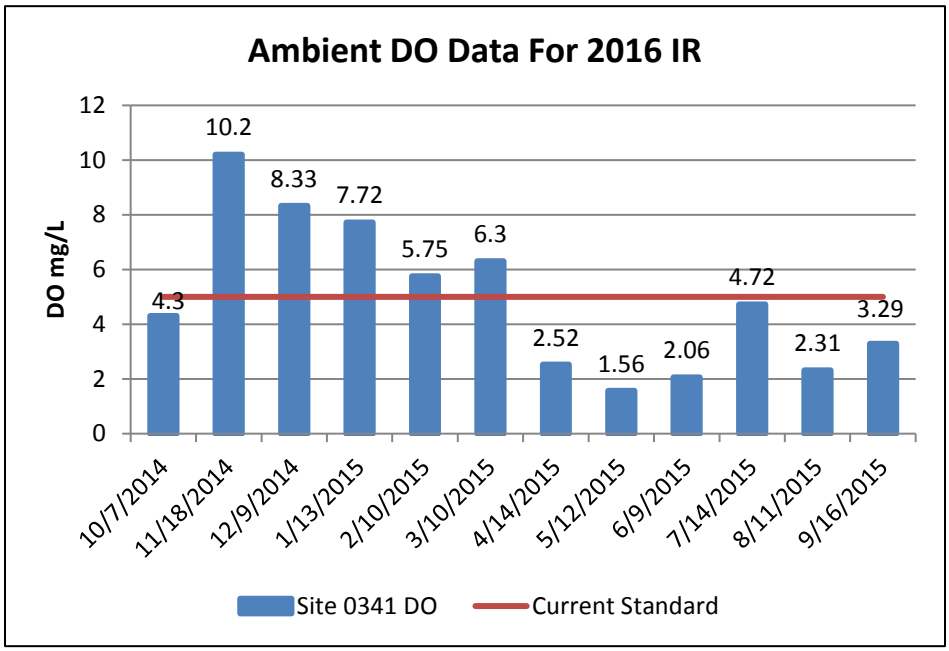

Figure 6. Ambient DO Data

Low DO is a problem that exists across the watershed. While there is some variation in the geographic distribution of DO values, no location exhibits values that meet the water quality standard. See Table 4 for summarized NPS project data.

Table 4. Summary of NPS Project Data: Dissolved Oxygen Oct 2016-Dec 2017

Site	Avg DO	Min DO	% DO < Standard
2926	3.8	0.33	71%
2928	4.0	0.35	58%
2933	5.8	0.65	50%
4504	4.0	1.31	71%
4505	4.4	1.05	50%
4506	4.0	0.31	63%
4507	4.7	0.28	42%
4508	5.3	0.26	38%
4509	4.6	0.28	63%
4772*	4.7	0.29	54%

* Replaced Site 0341 in 2016 due to safety concerns.

Bayou Folse is a tidally-influenced low-gradient stream that frequently experiences low- or reverse-flow conditions. Monthly temperatures average above 80 degrees each month from May through October. Below are selected excerpts from the DO TMDL that provide more detail on the seasonal DO fluctuation throughout the year in this area ((LDEQ, 2004):

> *"Critical conditions for dissolved oxygen were determined for Bayou Folse/Bayou Cutoff using water quality data from Bayou Folse/Bayou Cutoff water quality site number 0341 on the LDEQ Ambient Monitoring Network…. The analysis concluded that the critical conditions for stream dissolved oxygen concentrations were those of negligible nonpoint run-off and low stream flow combined with high stream temperature.*
>
> *"When the rainfall run-off (and non-point loading) and stream flow are high, turbulence is higher due to the higher flow and the temperature is lowered by the run-off. In addition, run-off coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. Reaeration rates and DO saturation are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and dissolved oxygen but not necessarily periods of high BOD decay." (Page 16).*
>
> ___
>
> *"The results of the projection modeling for subsegment 120302 show that the water quality standard of 5.0 mg/l for dissolved oxygen cannot be maintained even with a 90% reduction in non-point sources." (Page 4).*
>
> ____
>
> *"…benthic loads decay and breakdown during the year, becoming easily resuspended into the water column during the low flow/high temperature season. This season has historically been identified as the critical dissolved oxygen season." (Page 18)*
>
> ___
>
> *"This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow. … The only mechanism for changing this normal benthic blanket condition is to implement best management practices and reduce the amount of nonpoint source loading entering the stream and feeding the benthic blanket." (Page 16)*

While the TMDL called for a 90% reduction in NPS loading, it concluded that a reduction in background (benthic) load would be required to meet the criterion. It also called for revisiting the DO criterion and establishing a standard reflective of natural conditions. It is noteworthy that surrounding, similarly functioning watersheds have a different critical season criterion: 2.3 mg/L

in nearby Bayou Terrebonne (120301), Bayou des Allemands (020301), Bayou L'Eau Bleu (120303), and Bayou Black (120202). Additionally, because a source of BOD is the existing bedload, a significant time lag between stemming load input and DO response is expected.

Point Sources

The TMDL called for 0% reduction in point source discharges. This figure is based on the assumption of adherence to permit allowances. However, the IR and discharge monitoring reports (DMRs) show a number of point sources have exceeded their allowed BOD discharge. One is under federal consent decree. LDEQ enforcement is working to bring the remainder into compliance. Eight violations have yet to be resolved. These violations include inaccurate or incomplete DMRs, overflows, and effluent violations. Additionally, several companies are in violation of their permits for failure to submit DMRs. As LDEQ brings these facilities into compliance, BOD and bacteria levels in Bayou Folse should improve. Because most of these violations involve inaccurate DMRs and failure to submit DMRs, their impact on bacteria or DO in the waterbody is unknown.

Summary of Sources

The following summarizes the NPS sources for the causes identified in this section.

Bacteria

- OSDS
- Cattle
- Wildlife
- Point Sources

Nutrients

- OSDS
- Cattle
- Row Crops
- Point Sources
- Benthic Load

Sediment

- Row Crops
- Cattle
- Benthic Load

Element B. Estimated Load Reductions

This section will attempt to quantify pollutant loading to Bayou Folse as seen at the ambient monitoring site, and load reductions necessary to restore water quality.

Pollutant Load Estimates

Bayou Folse experiences tidal flows so load calculations were performed separately for downstream and upstream flows. A former USGS hydrologist measured flow with BTNEP field staff at the ambient monitoring site in May 2017. A cross-sectional area (See Figure 7), velocities, and discharge estimates were made across the bayou. Discharge in 14 zones was summed to get a total estimated discharge at the site.

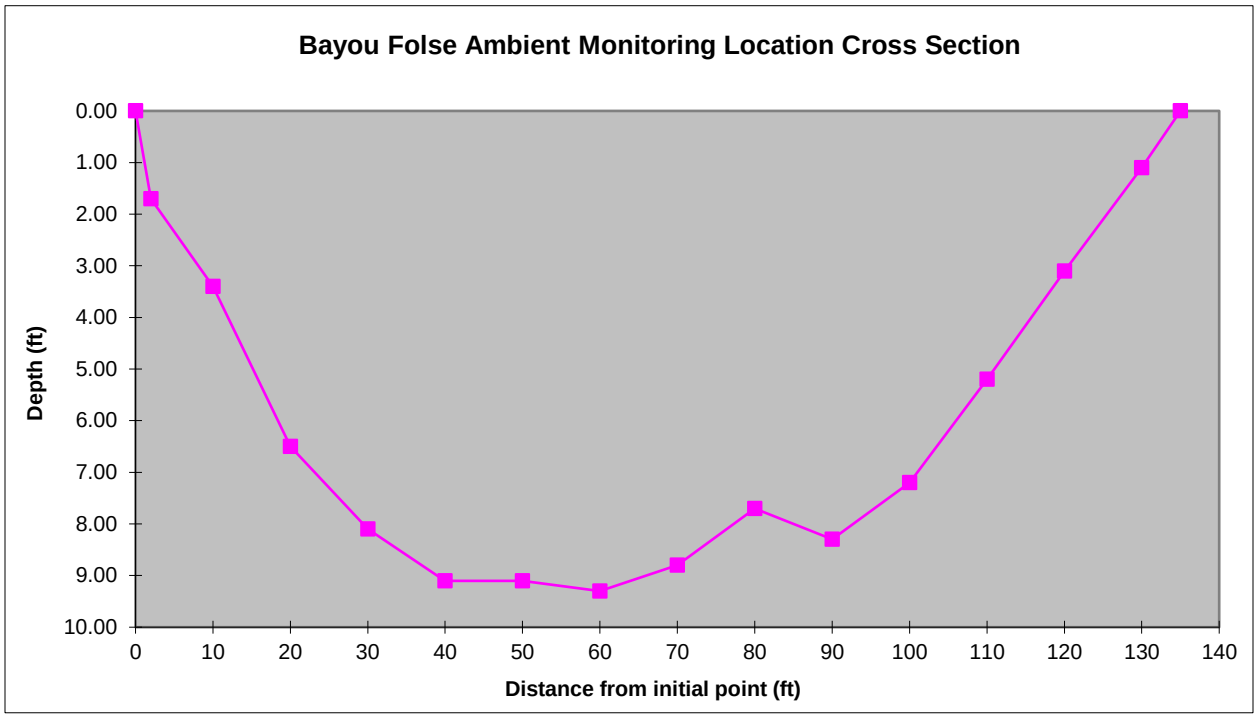

Figure 7. Bayou Folse Cross Section (East-to-West)

Subsequently, at each sampling event BTNEP staff used USGS drogue methodology (Rantz & etal, 1982) to estimate velocity, adjusting for curvature at the bridge sampling location and for change in velocity with depth. Tapedown measure provided stream depth, a parameter in calculating cross-sectional area. Velocity and area determine flow. Upstream and downstream flow calculations with pollutant concentrations allow for determination of nitrogen, phosphorous and bacteria loading from upstream sources and downstream sources. Table 5 shows these loads.

Table 5. Baseline Loads at Ambient Monitoring Location

Baseline Loads at Ambient Monitoring Location				
	Fecal Coliform	**NO_3-NO_2**	**Total P**	**TKN**
Date	cfu/day	lbs/day	lbs/day	lbs/day
Downstream Flow Loads				
6/28/2017	1.42E+12	71	639	1306
7/19/2017	6.88E+12	87	228	1770
8/16/2017	1.12E+13	60	482	1762
9/6/2017	2.67E+12	113	78298*	2218
10/18/2017	4.32E+10	15	181	400
12/6/2017	4.24E+11	39	48	756
12/20/2017	2.41E+12	124	365	506
1/3/2018	1.94E+11	66	175	1069
2/7/2018	1.85E+12	42	157	1241
3/7/2018	2.34E+11	68	258	1630
3/21/2018	3.72E+11	82	263	2461
Upstream Flow Loads				
5/17/2017	1.81E+11	12	59	394
8/2/2017	2.90E+11	23	93	788
10/4/2017	1.11E+12	112	163	1225
11/1/2017	6.45E+11	66	237	1976
11/15/2017	5.94E+11	45	67	728
2/21/2018	5.42E+12	90	168	1684

Note: PCR season is May-Nov. *potential outlier

Bacteria loading is heavier from upstream sources than from downstream sources. Bacteria reduction activities should therefore focus on upstream sources – OSDS sites and cattle. For nutrients, with the exception of one remarkably high concentration of phosphorous from an upstream source (a likely outlier), both upstream and downstream sources contribute similar loads. Nutrient reduction efforts should target areas both upstream and downstream of the ambient site. *Element A. Causes and Sources of Pollution* provides a more detailed geographic breakdown of sources.

Table 6 below provides an estimate of potential loading from specific NPS sources. While there is a degree of unquantified uncertainty in these estimates, the relative contribution of sources is informative for selecting reduction practices.

Table 6. Bacteria Loading from Specific NPS Sources

Source	Population / Units	CFU/Day	Potential Land Load: CFU/Day	% Loading to Stream[3]	Potential Stream Load CFU/Day	Relative Contribution
Cattle on Land	2,400	3.30E+10	7.92E+13	3%	2.38E+12	15%
Cattle in Stream[1]	233	3.30E+10	7.69E+12	100%	7.69E+12	47%
Horses[2]	520	4.20E+08	2.18E+11	3%	6.55E+09	0%
Dogs/Cats[2]	15,510	4.50E+08	6.98E+12	3%	2.09E+11	1%
Feral Pigs/Other Wildlife	Data Gap	1.10E+10	Data Gap	26%	Data Gap	Data Gap
Malfunctioning OSDS	3,004	2.00E+09	6.01E+12	100%	6.01E+12	37%

1 Based on proportion of Bayou Folse pasture land within 800 ft of a stream (NRCS) and adjusted to 2 hours of 24 hours per day in stream.

2 Based on American Veterinary Medical Association pet population calculator

3 Assumed rate based on California Regional Water Quality Control Board (2012)

Other Sources: USAA National Agricultural Statistical Service, US Census, field observations

Load Reduction Estimates

Bacteria load reductions are based on achieving the water quality standard and restoring use support for primary contact recreation. In the absence of nutrient criteria, nutrient reduction targets will be based on the TMDL.

Bacteria

Ambient data used in the most recent assessment was collected in water year 2014-15. There was a 40% bacteria exceedance rate, (standard limits exceedance rate to 25%). The two excursions were both 660 cfu/100ml – 40% higher than the 400cfu/100ml limit. The water quality assessment looks at all ambient samples regardless of flow direction. When estimating and targeting load reductions, flow direction is critical to identifying sources. Further, flow is required for load estimation. For these reasons, baseline data, including estimated flow, collected by BTNEP at the ambient site rather than LDEQ ambient data was used to determine load reductions.

Using baseline data, a design or capacity load was determined using flow calculations at the ambient site and the 400 cfu/100ml PCR criterion. Acceptable loads for sampled dates were determined based on those flows. The difference between the actual load and design load was used to determine reductions needed. Sampling dates were separated into those with downstream flow and those with upstream flow. In all cases, loading from downstream sources did not exceed the PCR design load. Therefore, bacteria reduction targeting will not focus on areas downstream of the ambient monitoring site. Areas upstream of the ambient site contributed the most loading.

Based on 2017 PCR season loads, a reduction of 4.59E+12 cfu/100ml daily load - 44% of the upstream load - will reduce the exceedance rate to less than 25%. Assuming 10,000 cfu/100ml from a non-functioning system with 2.7 persons per household and 70 gallons of wastewater per person, about 650 malfunctioning systems will need to be identified and repaired to achieve that reduction. Table 7 below shows the site-specific percent load reductions required to restore PCR. Figure 8 shows the cumulative total load reductions required for PCR restoration.

Table 7. Site-Specific Bacteria Reductions Required for PCR Restoration

Site	2926	2928	2933	4504	4505	4506	4507	4508	4509	4772
Required Reduction	8%	17%	45%	33%	17%	17%	0%	17%	0%	8%

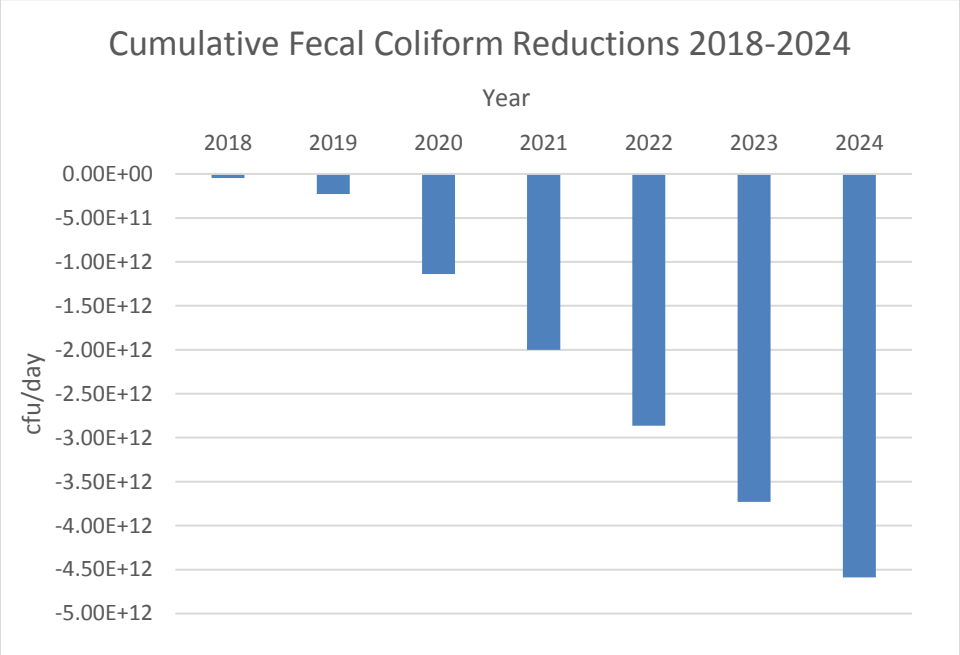

Figure 8. Projected Cumulative Yearly Fecal Coliform Load Reductions

Nutrients

For nutrients, the 2008 nutrient and DO TMDL (LDEQ, 2004) guides load reduction targets. DO is discussed in detail in this plan starting on Page 16. The TMDL recommends a 90% reduction in NPS loading but then further states benthic load will prevent achievement of the year-round 5mg/L standard. This plan will target a 90% NPS load reduction. However, an absence of data establishing a DO response linked to quantified nutrient reduction in Bayou Folse exists. This reduction target will be informed by and modified according to subsequent monitoring data as NRCS implements BMPs in the watershed.

Using load calculated with baseline data, and the 90% reduction target from the TMDL, the following nutrient reductions are required to reach the DO standard (not counting benthic load):

- NO_3-NO_2: 62.1 lbs/day
- TKN: 1,160 lbs/day
- Total P: 201.6 lbs/day

Shown in the graphs below (Figure 9 and Figure 10) are projected cumulative yearly nitrogen and phosphorous reductions calculated using average baseline loads and the TMDL reduction target of 90%.

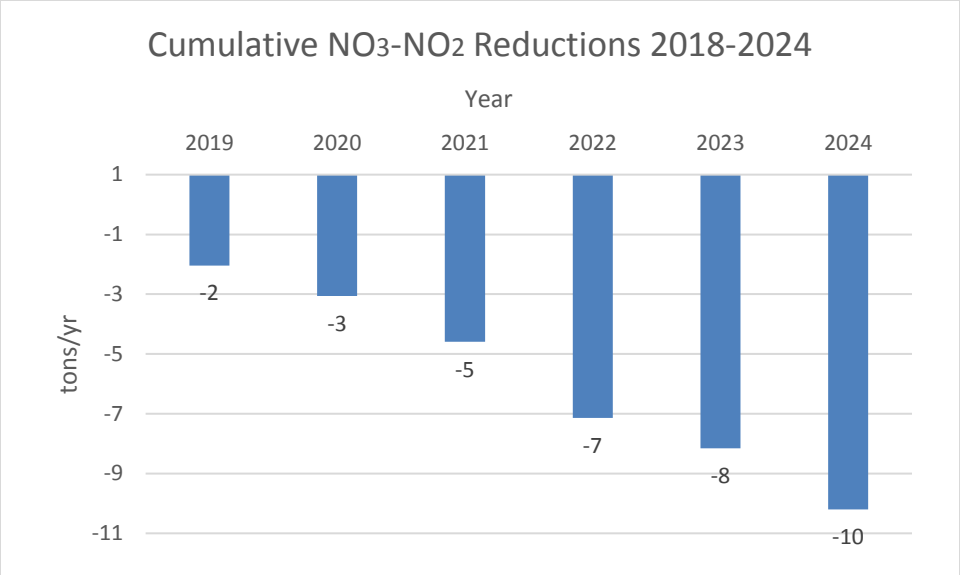

Figure 9. Projected Cumulative NO_3-NO_2 Reductions 2018-2024

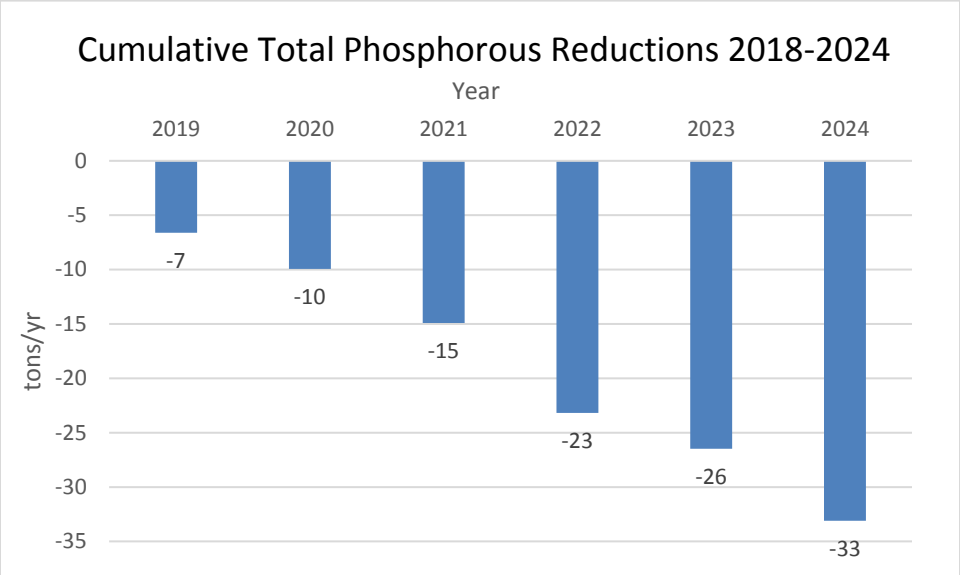

Figure 10. Projected Cumulative Total Phosphorous Reductions 2018-2024

Estimates of load reductions required to meet restoration goals are based on loading seen during baseline monitoring. Discussion on yearly load reductions tied to specific BMP acreages and counts can be found in *Element G. Interim Milestones*. Those reductions are based on STEP-L modeling, and source-specific bacteria loading from literature and watershed characterization.

Element C. Best Management Practices

This section will describe pollution reduction measures identified by key stakeholders, including LDEQ, that are selected to reduce runoff causing water quality impairments. It is understood that baseline monitoring data collected throughout the watershed will help guide geographic targeting of those measures.

For purposes of categorizing strategies to reduce NPS in Bayou Folse, LDEQ identified the following implementation program goals and phases. Responsible parties for implementation are shown below. Note that these phases may overlap in time.

Phase I – Reduce bacteria loading through OSDS outreach, education, and cost-sharing (BTNEP) – (additional education and outreach activities are discussed under *Element E. Education and Outreach*.)

Phase II – Reduce bacteria, nutrients, and sediment loading through implementation of pastureland conservation practices (NRCS)

Phase III – Reduce nutrient and sediment loading through implementation of conservation practices to stem cropland runoff (NRCS)

Other activities: Lake Fields restoration strategies (Lake Fields Game and Fish Commission: http://www.lafourchegfc.org/restorationintro.html)

Phase I – OSDS Outreach, Education, and Cost Sharing
BTNEP will contact and educate homeowners and renters in the watershed that are not tied in to municipal sewage treatment. These residents are served by individual home systems that rely on aeration units and settling compartments to treat wastewater. Soils in the area are generally poorly drained and do not support a passive septic system. These mechanical units require maintenance and upkeep, and often fall into disrepair. Based on two field surveys in the watershed, an estimated 70% of 4,292 home systems may be in some state of disrepair.

Through funding under the Clean Water Act Section 319(h), BTNEP will educate residents on the importance of maintaining their home systems and will survey systems to identify where issues may be occurring. Further, through separate funding sources, BTNEP will cost-share with residents to help fund needed repairs to malfunctioning systems.

Phase II – Practices to Stem Bacteria Loading from Pasture
The NWQI Program allows the NRCS, in partnership with state and other federal agencies, to provide technical and financial assistance to farmers for implementation of conservation systems. Under the NWQI Program, the NRCS will implement BMPs to reduce bacteria loading from cattle that access waterbodies directly, and to reduce runoff from pastureland. These BMPs are listed below (Table 8).

Table 8. Pastureland BMPs

Code	Practice	Parameters Addressed	Cost Per Unit*	Unit
382	Fence	Sediment, nutrients, bacteria	$1.91 - $2.82	Foot
528	Prescribed Grazing	Sediment, nutrients	$5.31 - $123.95	Acre
614	Watering Facility	Sediment, nutrients, bacteria	$0.49 - $4.21	Gallon
561	Heavy Use Area Protection	Sediment, nutrients, bacteria	$1.01 - $3.95	Sq Foot

*Varies with practice specifics, for further details see FY2018 EQIP cost table:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=nrcseprd1328240

Phase III – Practices to Reduce Runoff Loading from Cropland

In addition to pastureland BMPs, as part of the NWQI Program, the NRCS will implement practices to reduce runoff from cropland. Although Bayou Folse is not listed as impaired for sediment (TDS or turbidity), sedimentation is a stakeholder concern, particularly for Lake Fields, downstream of Bayou Folse. Nutrient loading from cropland will also be addressed by conservation practices. These are listed in Table 9 with the parameters of concern they address.

Table 9. Cropland BMPs

Code	Practice	Parameters Addressed	Cost Per Unit*	Unit
327	Conservation Cover	Sediment, nutrients	$79.77 - $1,325.81	Acre
328	Conservation Crop Rotation	Sediment, nutrients	$2.64 - $85.10	Acre
340	Cover Crop	Sediment, nutrients	$61.42 - $2,165.54	Acre
342	Critical Area Planting	Sediment, nutrients	$191.95 - $846.93	Acre
345	Residue and Tillage Management, Reduced Till	Sediment, nutrients	$11.37 - $17.55	Acre
386	Field Border	Sediment, nutrients	$62.57 - $1,202.46	Acre
390	Riparian Herbaceous Cover	Sediment, nutrients	$213.48 - $412.17	Acre
393	Filter Strip	Sediment, nutrients	$117.89 - $462.64	Acre
410	Grade Stabilization Structure	Sediment, nutrients	$1,250.15 - $28,247.09	Each
412	Grassed Waterway	Sediment	$1,135.62 - $2,105.93	Acre
462	Precision Land Forming	Sediment	$97.47 - $348.27	Acre
484	Mulching	Sediment	$409.28 - $1,681.04	Acre
590	Nutrient Management	Nutrients	$6.25 - $45.09	Acre
595	Integrated Pest Management		$12.90 - $256.36	Acre

*Varies with practice specifics, for further details see FY2018 EQIP cost table:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=nrcseprd1328240

Element D. Technical and Financial Assistance

This section will describe assistance provided by those partners that have committed to working in the watershed, and funding information (where available) for that assistance.

Technical assistance for Bayou Folse restoration is provided to agricultural producers by NRCS. Additional assistance is provided to the Soil and Water Conservation District (SWCD) by the Louisiana Department of Agriculture and Forestry (LDAF), working with NRCS. LDAF also is providing a technician through a coastal conservation program to assist with this NWQI project. Table 10, compiled by BTNEP, shows both dedicated and undedicated funding for specific components of Bayou Folse water quality restoration.

Table 10. Financial Assistance for Bayou Folse Restoration

Total Combined Funding for Bayou Folse Watershed Restoration					
Bayou Folse Restoration Component	**2017**	**2018**	**2019**	**2020**	**Total Dedicated Funds**
LDEQ 319(h) WQ Sampling & Education / Outreach: BTNEP (federal & match)*	$117,110	$122,110	$150,346	$150,346 projected	$539,912
Barataria-Terrebonne Estuary Foundation Low Income Home Sewage Assistance	$9,000	$0	$0	$0	$9,000
BTNEP Funds for Agricultural Technical Assistance Component	$0	$7,500	$7,500	$7,500	$22,500
NRCS Agricultural Technical Assistance	$0	$22,500	$22,500	$22,500	$67,500
LDAF OSWC/Lafourche-Terrebonne SWCD	$7,500	$15,000	$15,000	$15,000	$52,500
NRCS Financial Assistance for Private Lands Conservation	$0	$0	$150,000	$200,000	$350,000
Gulf of Mexico Program-BTEF Bayou Folse Watershed Program		$213,437	$213,437		$426,874
OSDS Survey and Education/Outreach - LDEQ 319(h) funds*	$0	$0	$37,960	$37,960 projected	$75,920
TOTAL	$133,610	$380,547	$596,743	$433,306	$1,544,206

Source: BTNEP, LDEQ, NRCS, LDAF. Note funding may be extended through 2024. *319(h) funding based on Oct – Sep cycle.

Element E. Education and Outreach

This section will describe key stakeholders in the watershed and partnerships that are essential to establishing goals and to local implementation. In addition, this section outlines current and planned education and outreach activities that will occur on a local level in the watershed.

Partners and Key Stakeholder Involvement

Stakeholders in the Bayou Folse watershed include residents, local and state government, non-governmental organizations, and businesses – primarily agricultural producers – among others. A number of stakeholders were involved in the planning and baseline data collection phase of the watershed planning process. Between 2016 and 2018, BTNEP attended more than 12 in-person partner and stakeholder meetings soliciting information about watershed concerns, sharing water quality monitoring results, and encouraging commitments for pollution mitigation activities. Initial meetings were followed up by phone calls and emails to maintain engagement. To further promote stakeholder involvement in restoring water quality in Bayou Folse, LDEQ and BTNEP will continue to share data and information, and to solicit concerns, comments, and suggestions from stakeholders in the region. LDEQ and BTNEP will continue to participate in local meetings and in public education opportunities when appropriate. Stakeholders that have played a key role in the planning process include those listed below. This list is not comprehensive.

Barataria-Terrebonne National Estuary Program (BTNEP). BTNEP serves as a partner in the Bayou Folse watershed in several capacities. BTNEP is contracted with LDEQ to collect baseline sampling, perform education/outreach activities, and work with local government to survey home wastewater treatment systems. BTNEP represents other local and statewide stakeholders insofar that those stakeholders comprise the Program's management conference and participate in program decision-making. BTNEP's management conference recently revised its management plan, which includes goals of improving water quality through reduction of sewage and agriculture pollution, and through stormwater management. These goals are congruous with LDEQ goals for water quality restoration in Bayou Folse. The management conference identified Bayou Folse as a priority watershed for restoration and for coordination of efforts among federal, state, and local agencies. A partial list of organizations represented by the conference is below, and the complete list can be found on the BTNEP page: http://www.btnep.org/BTNEP/about/managementconference/conferencemembers.aspx .

- Louisiana Department of Agriculture and Forestry
- Louisiana Department of Natural Resources
- Louisiana Department of Health
- Louisiana Department of Wildlife & Fisheries
- Louisiana Oil Spill Coordinator's Office
- Lafourche Association of Conservation Districts
- Lafourche Parish

- Lafourche Association of Levee Boards
- Nicholls State University
- South Central Planning & Development Commission
- US Fish & Wildlife Service
- USDA NRCS

BTNEP presented a summary of initial sampling results to the management conference attendees in 2017 and in subsequent meetings to additional audiences, inviting comments on issues or opportunities in the watershed. These have been incorporated into this plan. Any future comments will be included in the plan or strategy revisions.

Lafourche Parish The government of Lafourche Parish in 2018 signed a resolution supporting a survey of home sewage treatment systems that will serve to determine the status of home systems, educate homeowners on proper maintenance, and allow for BTNEP to cost-share in required repairs or upgrades.

North Lafourche Levee District (NLLD) BTNEP and LDEQ met with the District, which provided information on leveed areas throughout the watershed that have pumped drainage, and general hydrological background information for the area.

South Central Planning and Development Commission SCPDC met with BTNEP regarding potential NPS pollution from poorly maintained individual on-site disposal systems (OSDS). The Commission has an interest in the watershed, and would be a potential applicant for funding to install a community treatment system. The Commission is a potential user of NPS monitoring data, which could help inform locating such a system were funding to be obtained. Likewise, information from the Commission can in turn inform the OSDS inspection process.

Louisiana Department of Agriculture and Forestry LDAF provides assistance to local SWCDs and works with NRCS. In addition, through a separate coastal conservation program, LDAF is providing a technician to assist with the Bayou Folse NWQI effort.

Louisiana Department of Health LDH holds membership on the BTNEP management conference. In addition, LDH permits individual on-site systems and shares data with LDEQ.

Bayou Lafourche Fresh Water District The District, which includes the Bayou Folse watershed, is responsible for providing fresh water to drinking water purification facilities along Bayou Lafourche.

USDA NRCS NRCS is both a primary water quality stakeholder in Bayou Folse and one of LDEQ NPS' key partners. It holds membership on the BTNEP management conference. In

addition, NRCS has selected Bayou Folse as a National Water Quality Initiative (NWQI) watershed, targeted for multi-year agricultural BMP implementation for water quality improvement. The NWQI program is transitioning from a one-year to a three-year program, and NRCS is committed to working in Bayou Folse. A new component of NWQI under the three-year program, the "Readiness Phase," allows work to begin a year prior to watershed plan finalization. NRCS staff in Thibodaux will work with landowners and producers (both cropland and cattle) to implement conservation practices to reduce runoff.

Lafourche Game and Fish Commission (LGFC) and Louisiana Department of Wildlife and Fisheries (LDWF) The Lake Fields Game and Fish Preserve falls under the jurisdiction of these two entities. Lake Fields and the Preserve lie in the southern portion of the Bayou Folse watershed and the lake has been adversely impacted by sediment and nutrients from Bayou Folse via Bayou Folse and Bayou Dumar. The LGFC has indicated water quality degradation among its top five issues. Sediment and nutrients enter the lake readily from Bayou Folse, as seen in *Appendix A. Lake Fields Game and Fish Preserve State Lands Map*. The LGFC noted declining submerged vegetation as a concern. With input from Ducks Unlimited, the NLLD, LDWF, NRCS, BTNEP and other groups, the LGFC has developed a plan to address some of the runoff into the lake via Bayou Folse ((Lafourche Parish Game and Fish Commission, 2018). However, LDEQ recognizes this as an adaptation strategy to poor water quality in Bayou Folse. Improving water quality in the Bayou by implementing practices to prevent runoff would also benefit water quality in the lake and help restore habitat. Restoring aquatic vegetation will help increase DO as well. LGFC area is shown in *Appendix A. Lake Fields Game and Fish Preserve State Lands Map*

Other Outreach and Education Activities

In addition to stakeholder engagement described previously, between October 2016 and March 2018, BTNEP attended more than 25 educational outreach events, presenting at public events, club and group meetings, and in classrooms. Educational materials used include Bayou Folse watershed information flyers, Enviroscape NPS interactive model, and slideshows with data visualizations and maps.

A Bayou Folse web page created and hosted by BTNEP informs citizens about watershed issues. BTNEP staff use radio spots to educate the public on the importance and impacts of proper maintenance of home treatment systems and provide resources for assistance and more information. Student volunteers that accompany sampling staff during sampling events learn sampling methods, about nonpoint source pollution in general, and about runoff issues in Bayou Folse watershed specifically.

Outreach to agricultural producers is implemented by NRCS generally, and specifically through the NWQI program. NRCS staff will provide farmers and cattlemen with information about current water quality issues in Bayou Folse through locally led meetings, conservation practice sign-ups, and follow-up technical assistance and reporting.

Outreach to residents with individual sewage treatment systems is discussed in *Element C. Best Management Practices.*

Element F. Implementation Schedule

This section provides a schedule of tasks and activities required for plan implementation (see Figure 11).

Phases of implementation are:

- Phase I –OSDS outreach, education, and cost-sharing (BTNEP), begins Oct. 1, 2018. Details of this phase is provided in *Element C. Best Management Practices*.
- Phase II & Phase III – Pastureland conservation practices and conservation practices to stem cropland runoff (NRCS/NWQI), begin 2018.

NRCS project participation signups are announced in the USDA-Farm Service Agency newsletter and parish newspapers. The SWCD approves the list of potential project participants, and ensures they are selected according to priority ranking. NRCS staff in the district will provide the list of BMPs that will be used in the priority areas and meet with potential program participants to discuss participation and technical assistance needed. This process helps ensure landowners or producers implement a combination of BMPs that will provide the greatest benefit to water quality.

Bayou Folse Timeline											
			2016	2017	2018	2019	2020	2021	2022	2023	2024
GOALS	1	Project Term									
	2	Ambient Monitoring									
	3	IR Assessment									
	4	Uses Restored									
LDEQ-BTNEP	1	Assessment, Recon, Site Selection									
	3	QAPP/Sampling Plan Drafting & Approval									
	4	Baseline Sampling & Assessment									
	5	General NPS Outreach/Education									
	6	Stakeholder Meetings									
	7	WIP Development									
	8	Longterm Monitoring / Data Analysis									
	9	OSDS Survey/Outreach/Education									
	10	Home System Repair Assistance (BTNEP)									
	11	Plan Revision (if required)									
NRCS/ Partners	1	NWQI Readiness Phase (planning)									
	2	Develop Ranking Criteria/Select BMPs									
	3	Meet with Participants/Sign-Ups									
	4	Prepare Individual BMP Plans									
	5	Ag BMP Implementation									

Figure 11. Bayou Folse Project Timeline

Element G. Interim Milestones

This section lists quantitative and qualitative indicators that will be used to gauge progress of implementing the plan and its effectiveness. Feedback on achieving these milestones will come in the form of water quality data, participation rates, and stakeholder input. This information will inform any adjustments to the plan elements: scheduling, locating practices, adding or removing specific practices, and education/outreach approach.

The short-term goals of this plan are to:

- Identify areas contributing pollutant loading within the watershed,
- Reduce home sewage pollution loading through education, outreach, and cost-sharing,
- Reduce cropland and pastureland runoff in two 12-digit HUCs,
- Monitor water quality to track changes in the watershed.

The long-term goal of this plan is to restore use support in Bayou Folse.

Progress toward achieving these goals will be determined using interim indicators and milestones as depicted in Table 11. Quantitative milestones are based on baseline monitoring data, water quality criteria, and STEP-L modeling. Other sources of information used in analysis include: agricultural statistics (USDA, 2018), land use data, and the BSCL Tool (Zeckoski, R.W., 2005). Assumptions and calculations are available from LDEQ upon request. Limitations of this approach include:

- STEP-L does not represent geographic variability within the watershed,
- An additive approach to load reductions does not reflect complexities of bacteria and nutrient cycling in the natural environment,
- Response of DO to nutrient loading and nutrient ratios is unknown in Bayou Folse,
- Benthic load is not represented.

In light of these limitations, monitoring and tracking data will be key to measuring progress. In addition, because implementing BMPs on cropland and pasture relies on volunteers, acreages under implementation during a given year are difficult to predict. As implementation of this plan progresses, new information will be used to adjust activities as required. This adaptive management strategy will occur in the context of these milestones and plan adjustments will occur with continued stakeholder involvement.

Table 11. Restoration Milestones

Bayou Folse Restoration Milestones							
	2018	2019	2020	2021	2022	2023	2024
Implementation-Based Milestones							
OSDS Repaired (cumulative)	0	150	195	293	455	520	650
Acres in BMPs*	0	930	1,240	2,170	3,100	3,720	4,650
Water Quality-Based Milestones (Ambient Monitoring Site)							
Bacteria Load (cfu/day)	0	-1.06E+12	-1.38E+12	- 2.08E+12	-3.23E+12	-3.69E+12	-4.62E+12
N Load (tons/yr)	0	-2	-3	-5	-8	-9	-11
P Load (tons/yr)	0	-7	-10	-15	-23	-26	-33
Bacteria Exceedances	40%	40%	40%	40%	40%	40%	20%
DO Exceedances	58%	55%	45%	45%	35%	25%	10%

* Based on Step-L estimates

Qualitative milestones include:

- Communicating water quality issues to stakeholders and compiling a team of interested and invested local individuals and organizations (2016-2018 and continuing),
- Securing local government buy-in for home inspection and cost-sharing program (2018),
- Naming Bayou Folse a BTNEP priority and obtaining NRCS targeted implementation (2018),
- Identifying and overcoming obstacles to agricultural BMP implementation (2018-2020),
- Lafourche Game and Fish Commission reporting sedimentation improvement in Lake Fields (observational information),
- Plan adjustments as indicated by monitoring data.

Element H. Progress Determination Criteria

This section summarizes benchmarks used to determine progress and long-term success.

Data collected from water quality monitoring will be used to determine whether NPS loads are improving over time and progress is being made toward meeting water quality standards. Success will be determined using water quality data sampled at the ambient monitoring location measured against Louisiana's water quality criteria to assess the watershed's use support restoration. LDEQ formally assesses use support every two years and publishes this assessment in its biannual Integrated Report.

LDEQ water quality standards used to assess use support in this subsegment are:

- DO – 5mg/L year-round (maximum 25% excursion rate),
- Fecal coliform limits for Primary Contact Recreation – 400 col/100ml May-Oct (maximum 10% exceedance rate),
- Nutrients – no numeric criteria, tied to DO.

Continued sampling throughout the watershed will serve as a feedback mechanism and provide information needed for any plan adjustments in the future. Specifically, following each PCR season, OSDS repairs, bacteria loading estimates, and concentration data will be analyzed and compared to milestones in the previous section to assess progress. In addition, assessment of nutrient reduction progress will be determined yearly through annual analysis of acres participating in BMPs. Associated reductions will be estimated using STEP-L. Acreages and modeled reductions will be compared against milestones in the previous section to determine progress. In addition, anecdotal reports from stakeholders, particularly as related to Lake Fields sediment issues, will augment this information. Corrective action will be taken with partner and stakeholder input to adjust planned activities as indicated.

Element I. Monitoring

This section describes the purpose, method, sites, parameters, and schedule of water quality monitoring that will support this plan.

The purpose of water quality monitoring in Bayou Folse is to characterize water quality issues throughout the watershed, to help identify geographic areas contributing high NPS runoff, to inform any strategy adjustments, and to provide a quantitative tracking of water quality before, during, and after education, outreach, and BMP implementation.

Water Quality Monitoring

Water quality monitoring at the ambient site in Bayou Folse (Site Number 4772) occurs on a four-year rotation and determines use support. Through CWA Section 319(h) funding, BTNEP collects water quality samples for LDEQ NPS at the ambient location and nine additional locations throughout the watershed twice monthly. Table 12 on the following page provides further detail. On each site visit, field staff record site conditions observed during monitoring. NPS water quality data is used to identify priority areas for BMP implementation and track changes over time before, during, and after BMP implementation. NPS water quality data may be used for assessment. Data collection and analysis occur under EPA-approved QAPP #3050 and the current EPA-approved sampling plan.

Measured and Estimated Parameters

Water quality parameters are listed in Table 12. Field staff collect in situ measurements and samples are analyzed in a certified laboratory for bacteria and nutrients. Velocity is estimated using the USGS drogue method (Rantz & etal, 1982). Estimated velocity, stream surface elevation, and cross-sectional area are used to calculate an estimated flow and load at the ambient site location. Data and project progress are shared with stakeholders throughout the project term through presentations, stakeholder meetings, and outreach events.

Table 12. Bayou Folse Monitoring Sites and Parameters

LEAU Site No.	Field Site No.	Waterbody		UTM				Water Quality[2,3]		NPS Site Characterization[1]	Comments/Sample Frequency
		Subsegment	Description	East	North	Latitude	Longitude	Lab	InSitu	Seasonal and as needed	
4504	1	Bayou Folse 120302	Bayou Folse at Rue Pelletier above the Waste Water Plant, and above the Nicholls University Farm	713237	3295577	29.773347	-90.795133	X	X	X	Twice per month
2926	2	Bayou Cutoff 120302	Bayou Cutoff at south side of Hwy 1 on Supercharge Dr	714941	3293318	29.75148	-90.77723	X	X	X	Twice per month
4505	3	Bayou Cutoff 120302	Bayou Cutoff at bridge on Lefort Road	715936	3292419	29.743204	-90.767124	X	X	X	Twice per month
2928	4	Bayou Cutoff 120302	Bayou Cutoff at St. Charles Bypass, East of Bayou Vista subdivision.	719095	3291361	29.73311	-90.73469	X	X	X	Twice per month
4506	5	Bayou Folse 120302	Bayou Folse at Theriot Canal	728779	3289022	29.71027	-90.63513	X	X	X	Twice per month
4507	6	Bayou DuMar 120302	Bayou DuMar at Hwy 653	730163	3284877	29.67263	-90.62172	X	X	X	Twice per month
4508	7	Bayou Folse 120302	Bayou Folse at Lake Drive Pump Station in Raceland	732610	3285181	29.67492	-90.59638	X	X	X	Twice per month
4509	8	Bayou Cutoff 120302	Bayou Cutoff at Butch Hill Pump Station off of Hwy 652	733401	3285867	29.68096	-90.58807	X	X	X	Twice per month
2933	9	Forty Arpent Canal 120302	Forty Arpent Canal at Lockport where Barios Drive meets the Forty Arpent Canal at the outfall of the Coastal Pump Station	737286	3281805	29.64359	-90.54884	X	X	X	Twice per month
4772[4]	10	Bayou Folse 120302	Bayou Folse at U.S. 90 service road south of Raceland. (WQN Site)	731785	3286911	29.690672	-90.604533	X	X	X	Twice per month

1) Field data sheets will be completed at each sampling event and a NPS Site Characterization Form will be conducted quarterly and as needed.
2) The in situ parameters to be measured are pH, temperature, DO/percent saturation, and conductivity/salinity. A tapedown measurement and Secchi disk depth measurement will be made at each sampling event. Velocity measurements will be taken at the ambient site.
3) The water quality parameters to be collected for laboratory analysis are FC bacteria and nutrients (TKN, Nitrate-Nitrite and TP).
4) Bayou Folse Ambient Site.

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Appendix A. Lake Fields Game and Fish Preserve State Lands Map