Attachment 2

Manatee County Monitoring Program Summary
Year 5 Annual Report - NPDES Permit No. FLS000036-003

Introduction and Background

The monitoring program described herein was implemented to address the requirements of the county's National Pollutant Discharge Elimination System (NPDES) permit. Manatee County's NPDES permit authorizes Manatee County and its co-permittees to discharge stormwater from their municipally-owned separate storm sewer systems (MS4s) to waters of the State (of Florida). Pursuant to federal Clean Water Act requirements, the permit was first issued by the U.S. Environmental Protection Agency (EPA) in 1997. The Florida Department of Environmental Protection (FDEP) issued the 3rd cycle permit in 2013. Manatee County's Monitoring Program was initially approved by the EPA prior to issuance of the county's first NPDES permit, and was formally approved by the FDEP in 2004.

Manatee County's monitoring program is designed to monitor changes in the quality of Manatee County's receiving waters. Annual review and analysis of water quality data has been conducted since 2002, when the Stormwater Management Program (SWMP) element of the county's NPDES permit was first fully implemented. These historical data allow for an evaluation of long-term trends in water quality throughout Manatee County. Long-term water quality trends are indicative of the effectiveness of the county's SWMP. This report includes a description of the county's monitoring program, a summary of the data collected in Year 5 of the NPDES permit, and an analysis of the annual data accumulated since the county's first NPDES permit term. Monitoring data for the first quarter of 2018 are also included here to represent the administrative extension of time between the end of Cycle 3, Year 5 (December 31, 2018) and the beginning of the county's new Cycle 4 NPDES permit (April 1, 2018).

Monitoring Program Description

Manatee County's monitoring program was designed utilizing an amalgamation of several ongoing sampling curriculums. These sampling curriculums were implemented in the 1990s to monitor waters in constituent subsections of the county. Some stations have been added and some removed since program inception to better represent waters monitored, but for the most part, these antecedent programs have remained relatively unchanged since their implementation. The monitoring program for the county's NPDES permit relies on data collected from several of the stations established within these antecedent programs. These data are evaluated in each successive annual NPDES report to characterize water quality trends within the major receiving waters from Manatee County's urban core.

The following are summary descriptions of each of the composite sampling curriculums that together form the basis of the county's monitoring program:

RAMP Estuary Monitoring

Manatee County's ambient water quality monitoring program for its surrounding estuarine waters is the Regional Ambient Monitoring Program. The EPA's EMAP stratified random sampling design is utilized by RAMP to infer water quality trends on an areal basis. This design is insensitive to perturbations shorter than the sampling interval or smaller in size than the sampling strata, and therefore is better suited to assess changes in ambient water quality. The RAMP program design has been endorsed and approved by both the Tampa Bay

Estuary Program (TBEP) and Sarasota Bay Estuary Program (SBEP).

RAMP is implemented within Manatee County's estuaries by dividing the estuarine area into 2 strata of 24, 3.56 km^2 hexagonal sampling areas each. Each stratum is aligned to the boundaries of the Tampa Bay and Sarasota Bay estuary programs within Manatee County. The north stratum encompasses lower Tampa Bay between the northern boundary of the County and the Manatee River, including Terra Ceia Bay and the lower Manatee River below the Braden River confluence. The south stratum includes Anna Maria Sound and adjoining parts of lower Tampa Bay, Palma Sola Bay, and Sarasota Bay north of the county line. Water quality sampling points were randomly located within each hexagon at the start of the program in 1995. One-third of the sampling points in each stratum, eight points, are sampled monthly. All sampling points in a stratum are visited within each calendar quarter. Inferences on the ambient water quality within each stratum may be made on time scales of a calendar quarter or some multiple of a calendar quarter.

During the second permit cycle, the two RAMP strata were further subdivided into groups representing sections of the tidally-influenced lower Manatee River and Palma Sola Bay. The data collected from these RAMP subsets are evaluated on an annual basis to infer trends associated with contributing watersheds. The identification of trends in these areas may suggest a need to modify the county's SWMP within these contributing watersheds.

SWAMP Watershed Monitoring

Manatee County's Surface Water Ambient Monitoring Program is the ambient water quality monitoring program for the County's watersheds, rivers, and tidal creeks. The program uses a conventional, fixed-station design where all 30 stations are sampled monthly. SWAMP station locations are shown in Figure 1. Depending on monitoring sub-program and watershed, parameters can vary between stations because of legacy data commitments. Core parameters observed at each station are identical. Our SWAMP program, as with most fixed-station ambient water quality monitoring programs, generates reliable water quality status and trend assessments from the volume of data and covariate data collected rather than sophisticated design.

TBEP Benthic Biological Monitoring

The benthic community biological monitoring program was developed in 1993 in cooperation with the TBEP as a long-term trend indicator of the Tampa Bay area's water and sediment quality. This program uses a subset of the EPA Louisianan Province EMAP Benthic protocol. Manatee County samples the benthic infaunal communities in the TBEP's Manatee River, Terra Ceia Bay, and Lower Tampa Bay segments. There is one sampling episode per year, during the September-October EMAP index period. Concurrent analyses for sediment metals and organics are also completed when funding is available. Program design and data analyses use spatially-oriented statistical concepts similar to those which may be used for our RAMP Estuary Monitoring Program. Benthic program data are analyzed under a TBEP contract with the Hillsborough County Environmental Protection Commission ("EPC"). The EPC prepared an interpretive report summarizing the 1993-2004 benthic study results (Karlen, 2008), and the interim draft results for the Manatee River and Terra Ceia Bay portions of the study area were presented in the Cycle 2,Year 3 (2006) monitoring summary report.

TBEP Seagrass Monitoring Program

The TBEP-coordinated Seagrass Monitoring Program was developed in 1998 (Permit Year 1, Cycle 1) to monitor the spatial and temporal changes of established seagrass meadows and document seagrass colonization of unvegetated areas. The Manatee County Parks & Natural Resources Department (PNRD) assists the regional effort by collecting data from 14 permanent transects through shallow subtidal or intertidal seagrass meadows in

Lower Tampa Bay, Anna Maria Sound and Sarasota Bay. Transect locations are shown in Figure 2 with an inset showing the extent of two transects near Terra Ceia Bay. Sampling is once per year in September/October, approximately the time of maximum areal extent. The Braun-Blanquet technique is used to assess seagrass health and condition. Accompanying photometric measurements are taken to evaluate light transmission conditions.

Southwest Florida Water Management District Seagrass Mapping Studies

Seagrass acreage in the Tampa Bay and Sarasota Bay estuaries has been evaluated by the Southwest Florida Water Management District (SWFWMD) under their Surface Water Improvement & Management (SWIM) program since the late 1980's. Mapping is conducted on approximately a biennial basis. The extent of seagrass coverage is determined by aerial photography interpretation, with accompanying ground surveys for verification. Aerial photographs are taken during optimal conditions to maximize accuracy of the evaluation. The SWFWMD seagrass assessments are reported as total seagrass acreage gains or losses, typically by bay segment.

Rainfall & Salinities

Total annual precipitation data for the county have been included in these annual data summaries since monitoring for the NPDES permit was implemented in 2000. Water quality is affected by annual rainfall amounts, and annually summaries of these data have been beneficial in evaluating year to year water quality variations. Total annual rainfall from SWFWMD's meteorological station located at the Sarasota-Bradenton International Airport is used to represent precipitation on the western, urbanized portion of the county. The SWFWMD's area-weighted calculation of average annual rainfall for all of Manatee County is also reported here for comparison purposes. Graphs of annual rainfall data, along with annual average estuarine salinities determined from the RAMP station data, are presented as Figure 3.

Monitoring Results

The monitoring program for Year 5 presented herein include data collected in calendar year 2017. Renewal of the NPDES permit resulted in an additional three months (January 1 – March 31, 2018) added onto the Year 5 reporting requirements. Monitoring data collected in the first quarter of 2018 are included here, but annual means of the 2017 data were calculated separately from the 2018 data to avoid seasonal bias. The below discussion of results, therefore, refers only to the 2017 annual means as representative of a full year of monitoring. Future monitoring summary reports shall include annual analysis of data over a timeframe consistent with the annual NPDES report period, i.e., April 1 to March 31.

This report also includes annual mean data for select parameters and stations dating back to 2002, when the county's SWMP was fully implemented. These historical data provide a temporal basis on which to infer trends in water quality within the county's receiving waters. All monitoring data, and associated metadata, are available on the state of Florida's STORET database, and on the Manatee County Water Atlas (http://www.manatee.wateratlas.usf.edu/).

For statistical analysis, graphical representation, and year to year reporting consistency, the water quality data presented herein have been processed through several steps. These steps, or conventions, in data processing consist of the following:

1) Parameters are selected based on "Characteristic" field of the STORET database, which allows for inclusion of all appropriate data regardless of minor changes in laboratory analysis

methodology;

2) Parameters reported below method detection limits (MDL), i.e., "non-detect" were converted to a value represented by 50% of laboratory MDL (e.g., TKN = 0.025 mg/L and Nitrite/Nitrate = 0.013 mg/L); and,
3) All "J" (estimated value) and "Q" (sample held beyond the accepted holding time) quality assurance (QA)-coded laboratory results were discarded (not used);
4) All annual averages presented herein are arithmetic averages.

Estuary Monitoring

Our RAMP estuarine ambient monitoring program is designed to be interpreted by spatially grouping segments and analyzing data over some multiple of the sampling period (calendar quarter). Accordingly, annual means for both the north and south RAMP segments dating back to 2002 are presented in Table 1. For comparison purposes, averages of the 2002-2012 annual mean data for each parameter are also presented in Table 1. Graphs of select parameters over the period of collection are presented in Figure 4, and station locations are illustrated in Figure 1.

As shown in Table 1, annual mean total phosphorus (TP) concentrations in the North and South RAMP segments were reported at 0.13 mg/L and 0.09 mg/L, respectively. Both reported means represent slight increases over the 2016 reported means, but remain very close or below the long-term average of 0.12 mg/l TP for both segments. Mean chlorophyll-a (Chl-a) also was reported slightly higher than the 2016 means in both RAMP segments - 4.4 mg/m3 in the North, and 5.4 mg/m3 in the South segment. Both means, however, are below the long-term averages for the parameter of 4.7 mg/m3 and 5.5 mg/m3 in the North and South segments, respectively. Mean Total Kjeldahl Nitrogen (TKN) was also reported slightly higher in the North (0.47 mg/l) and South (0.49 mg/l) RAMP segments, both of which slightly exceed the long-term averages for the parameter of 0.44 mg/l and 0.49 mg/l in both segments (respectively). Although slight increases in these mean concentrations were noted during Year 5, long-term trends, illustrated by simple regression of annual mean concentrations for all three parameters, are decreasing (see Figure 4).

Select Waterbody Monitoring

Upper Manatee River

The Manatee River, a major tributary to Tampa Bay, has a watershed that lies almost entirely within Manatee County. The Manatee River receives significant amounts of the stormwater runoff from the urbanized areas of the county, including the cities of Bradenton and Palmetto. Several monitoring stations in both the SWAMP and RAMP monitoring programs were chosen to evaluate water quality trends within this important receiving waterbody. All the Manatee River station locations are illustrated in Figure 1.

SWAMP station LM-5, located near Ft. Hamer, is the furthest upstream monitoring location in the Manatee River. As such, this station lies upstream of the predominant urbanized portions of the county. SWAMP station LM-4 is located approximately 5 miles downstream of LM-5, near the Interstate I-75 crossing. SWAMP station LM-3 is located another mile downstream at the confluence of Manatee River with the Braden River. Annual means for select parameters from the Upper Manatee River SWAMP stations are presented in Table 2 (arranged by river mile), along with averages of annual means reported from 2006-2012 for comparison purposes. Annual mean data for select parameters are illustrated graphically in Figure 5.

As shown in Table 2, annual mean Chl-a, TKN & TP concentrations were reported highest in the most upstream location (LM-5), at 14 mg/m3, 0.79 mg/L and 0.55 mg/L, respectively, and generally decreased in the

downstream stations in the Manatee River. Although Chl-a and TP were reported slightly higher than their respective long-term averages (12.2 mg/m3 and 0.45 mg/l) in LM-5, mean TKN (0.79 mg/l) was reported in the same station below its long-term average of 0.85 mg/l. A similar relationship with the long-term averages was also observed for these same three parameters in downgradient stations LM-4 and LM-3. Additionally, mean Total Suspended Solids (TSS) and mean Inorganic nitrogen (a summation of nitrite, nitrate & ammonia) were reported below their respective long-term averages in all three Upper Manatee River stations.

Lower Manatee River

Water quality monitoring data from RAMP stations #532 & #535 ("RAMP Group #5") and stations #431, #433 & #434 ("RAMP Group #4") were averaged together (by group) to represent water quality closer to the mouth of the Manatee River. Annual means for select parameters from the Lower Manatee River RAMP station groups are presented in Table 3 (arranged by river mile) and illustrated graphically in Figure 6. For comparison purposes, 2006-2012 averages of reported annual means are also included in Table 3. Station locations are illustrated in Figure 1.

As shown in Table 3, annual means for Chl-a, TKN and TP were reported slightly higher than their respective long-term averages in both Lower Manatee River RAMP groups. As with the Upper Manatee River stations, TSS and Inorganic Nitrogen annual means in both RAMP groups were reported below their respective long-term averages.

Palma Sola Bay

Data from RAMP stations #458, #587, and #590 were combined ("RAMP Group #3") to represent water quality within Palma Sola Bay, an important receiving waterbody for western Manatee County. Station locations are illustrated in Figure 1. Results of analysis for select parameters for this station group are also shown in Table 3, and illustrated graphically in Figure 6.

As shown in Table 3, mean Chl-a (7.4 mg/l) was reported lower than its long-term average (7.8 mg/l), although both TKN (0.66 mg/l) and TP (0.09 mg/l) were reported slightly above their long-term averages (0.56 mg/l and 0.08 mg/l, respectively). As with the Manatee River monitoring stations, both mean TSS (8.9 mg/l) and Inorganic Nitrogen (0.04 mg/l) in Palma Sola Bay were reported below their respective long-term averages (14.7 mg/l and 0.09 mg/l, respectively).

Major Tributaries

Four (4) of the county's SWAMP stations monitor water quality in key tributaries and drainage features of urbanized western Manatee County. These features include: Gamble Creek (GC-2), which is located in the north-central portion of the county and flows south to the Manatee River; Frog Creek (FC-1), which is located in the northern portion of the county and flows west into Terra Ceia Bay (part of the Tampa Bay estuary); the Cedar Hammock West Drain (Station CH-1), which drains most of the central western half of Manatee County and flows west into Palma Sola Bay; and Bowlees Creek (Station BC1), which originates in the central western section of Manatee County and drains southwest, emptying into Sarasota Bay.

Both the Gamble Creek and Frog Creek watersheds continue to undergo transformation from predominantly agricultural to residential over the past several years. The Cedar Hammock Drain (CH-1) drains the western, predominantly urban residential areas of Manatee County, including a significant portion of the City of Bradenton. Bowlees Creek (BC-1) drains through the older, predominantly industrial and commercial areas of southwestern Manatee County. Annual means for select parameters within these major tributary monitoring stations are presented in Table 4, and illustrated graphically in Figure 7. Station locations are illustrated in

Figure 1. Annual mean averages for the period of 2006-2012 are also shown in Table 4 to represent long-term averages for the parameters listed (monitoring of BC1 did not begin until 2011 and therefore long-term mean averages were not calculated).
As shown in Table 4, mean parameter concentrations continue to reflect temporal variability in each of the major tributaries. Mean Chl-a (4.8 mg/m2) and TP (0.44 mg/l) concentrations slightly exceeded their respective long-term averages (3.2 mg/m3 and 0.35 mg/l, respectively) in Gamble Creek (GC-2), however mean TKN (0.86 mg/l) was reported at the same station slightly below its long-term average (0.88 mg/l). In Frog Creek (station FC-1), all three parameters (Chl-a, TP & TKN) were reported below their respective long-term averages. At the Cedar Hammock West monitoring station (CH-1), mean Chl-a was reported at 8.4 mg/m3, which exceeds the long-term mean average of 5.5 mg/m3, but both TKN (0.75 mg/l) and TP (0.27 mg/l) were reported below their long-term averages of 0.84 mg/l and 0.3 mg/l, respectively, at this monitoring station.

Seagrass & Benthic Surveys

TBEP Benthic Biological Monitoring Program

In February, 2015, the EPC published a report entitled "Twenty Year Trends in the Benthic Community and Sediment Quality of Tampa Bay" 1993-2012 (Karlen, et. al, 2015) prepared for the Tampa Bay Estuary Program. The report summarized trends in chemical composition and faunal community in the benthos of Tampa Bay over the study period. Annual data were evaluated and the health of various segments of the bay graded. The bay segments included Lower Tampa Bay, the Manatee River, and Terra Ceia Bay in Manatee County. The benthic habitat generally rated poorer in the northern reaches of the bay, but a poor grade was also given to Terra Ceia Bay and the Manatee River in Manatee County. The report concluded that the benthic communities bay-wide tended to be in fair to poor health, with more study needed in the tidal river tributaries of the watershed. An interpretative report of the benthic data was released in June, 2015, and is summarized here. Manatee County anticipates continued participation in the benthic sample collection activities and will report on benthic data summaries as they become available.

TBEP Seagrass Monitoring Program

The TBEP Seagrass Monitoring Program is conducted locally in Terra Ceia Bay, Lower Tampa Bay, the Manatee River, and Sarasota Bay. Transect locations are shown in Figure 2. The seagrass transect methodology has its strength in the identification of seagrass bed composition and distribution changes. Transects provide a valuable "snapshot" of seagrass bed health on an annual basis. A summary of the data collected through 2008 was presented in the second cycle of the NPDES permit; any future interpretative reports of the data will be reported here as they become available.

SWFWMD Seagrass Coverage Evaluation

The SWFWMD's Surface Water Improvement and Management (SWIM) Program has been conducting assessments of seagrass coverage in both the Tampa Bay and Sarasota Bay estuaries since the late 1980s. The biennial coverage estimates are based on aerial photograph interpretation and verified by field surveys. Over the past five assessments, SWFWMD has reported the following seagrass acreage changes in Tampa Bay (SWFWMD 2016):

- 2008: An increase of 1,300 acres (4.5%);
- 2010: An increase of 3,250 acres (11%);
- 2012: An increase of 1,745 acres (5.3%);
- 2014: An increase of 5,652 acres (16.3%);

- 2016: An increase of 1,360 acres (3.4%).

Total seagrass coverage in Tampa Bay is now reported at 41,655 acres, which exceeds the TBEP's target restoration acreage of 38,000 acres.

In Sarasota Bay, including the Upper Sarasota Bay segment which receives drainage from most of southwest Manatee County, SWFWMD reported seagrass acreage changes as follows:

- 2008: All of Sarasota Bay increase of 2,786 acres (28%); Upper Sarasota Bay increase of 32%;
- 2010: All of Sarasota Bay increase of 51 acres (0.4%); Upper Sarasota Bay increase of 3.3%;
- 2012: All of Sarasota Bay decrease of 105 acres (0.8%); Upper Sarasota Bay no change;
- 2014: All of Sarasota Bay increase of 701 acres (5.6%); Upper Sarasota Bay increase of 2.9%
- 2016: All of Sarasota Bay increase of 180 acres (1.4%); Upper Sarasota Bay increase of 0.7%.

Total seagrass coverage in Sarasota Bay is now reported at 13,473 acres, which exceeds the SBEP's target restoration acreage of 9,738 acres (FWRI, 2016). Results of SWFWMD's next biennial survey (2018) will be included in next year's annual report.

Discussion and Conclusions

Manatee County's ambient water quality monitoring programs provide a unique opportunity to observe shorter-term water quality changes occurring in the riverine receiving waters with the longer-term changes occurring in Manatee County's estuarine receiving waterbodies. The data comparison and interpretation benefits from sampling stations surrounding Manatee County's urbanized area (Figure 1). The intent is to evaluate longer term environmental quality changes within the receiving waterbodies of the county's MS4, rather than rely on end-of-pipe monitoring.

An area-weighted average value of just over 51 inches of rain fell on the county in 2017, which is a decrease from last year's total (56") and approximately 2 inches below the long-term average for Manatee County. Approximately 69 inches of rain were recorded at the Sarasota-Bradenton Airport rainfall station (SWFWMD, 2016), substantially more than what has been reported at this station in the past two years. Annual rainfall totals and average annual salinities in the estuaries since 2002 are illustrated graphically in Figure 3. A discernable relationship between higher annual area-weighted average rainfall and lower average annual estuarine salinities is observable in Figure 3.

Water quality data for the Manatee River and the major receiving tributaries of Manatee County is quite variable, and evidence suggests that annual rainfall has a strong influence on annual mean water quality within these inland water bodies. Data indicates water quality in the county's most urbanized drainage basins is similar, if not better, than water quality in its upstream, more agricultural watersheds. Mean data reported from the county's estuaries (both the north and south RAMP segments) continue to reflect downward trends in the important indicator parameters TKN, TP, and Chl-a.

A 20-yr study of the benthos of Tampa Bay, released in 2015, concluded that bay-wide benthic communities are in fair to poor health. Data suggests generally poorer sediment conditions in the more northern reaches of the bay, not unexpected given the concentrated development and older industrialized areas located within the watersheds of these bay segments. The chemical parameters evaluated in the benthic study included metals and pesticides, several of which have been banned (e.g., DDT) or are no longer in wide-spread use (e.g., lead in leaded gasoline). The detection of these parameters in the benthos may be more indicative of their resistance to

degradation than from a recurring non-point pollution source.

Historical results of the TBEP's seagrass transect studies indicate that areal extent and species composition in Manatee County's coastal waters vary annually, but the most recent report suggested expanding seagrass growth is occurring in Tampa Bay over time, including regions adjacent to Manatee County. In its most recent assessment, SWFWMD announced that seagrasses in Tampa Bay increased more than 1,360 acres in 2016 alone. With the reported increase, the Tampa Bay estuary now harbors over 41,655 acres of seagrass (SWFWMD 2016), which exceeds the Tampa Bay Estuary Program's restoration goal of 38,000 acres. Similar seagrass growth exceeding restoration goals has been reported in the Upper Sarasota Bay estuarine segment, which receives surface water runoff from southwest Manatee County.

Long-term downward trends in key water quality parameters within Manatee County's estuaries, along with seagrass acreage restoration in nearby bay segments, suggest that improvements in water quality are occurring over time in Manatee County's receiving waters. These improvements, in turn, indicate that the county's SWMP is having a positive effect on reducing stormwater pollutant loads county-wide. Evidence also suggests that current activities such as implementation and enforcement of its fertilizer ordinance (with summertime nitrogen blackout) and increased land-use conversion to residential (with associated stormwater treatment systems) are also having a positive long-term effect on surface water quality within Manatee County. Additionally, future Manatee County initiatives, such as the recently adopted stormwater infrastructure tax supporting stormwater projects, are also likely result in water quality improvements.

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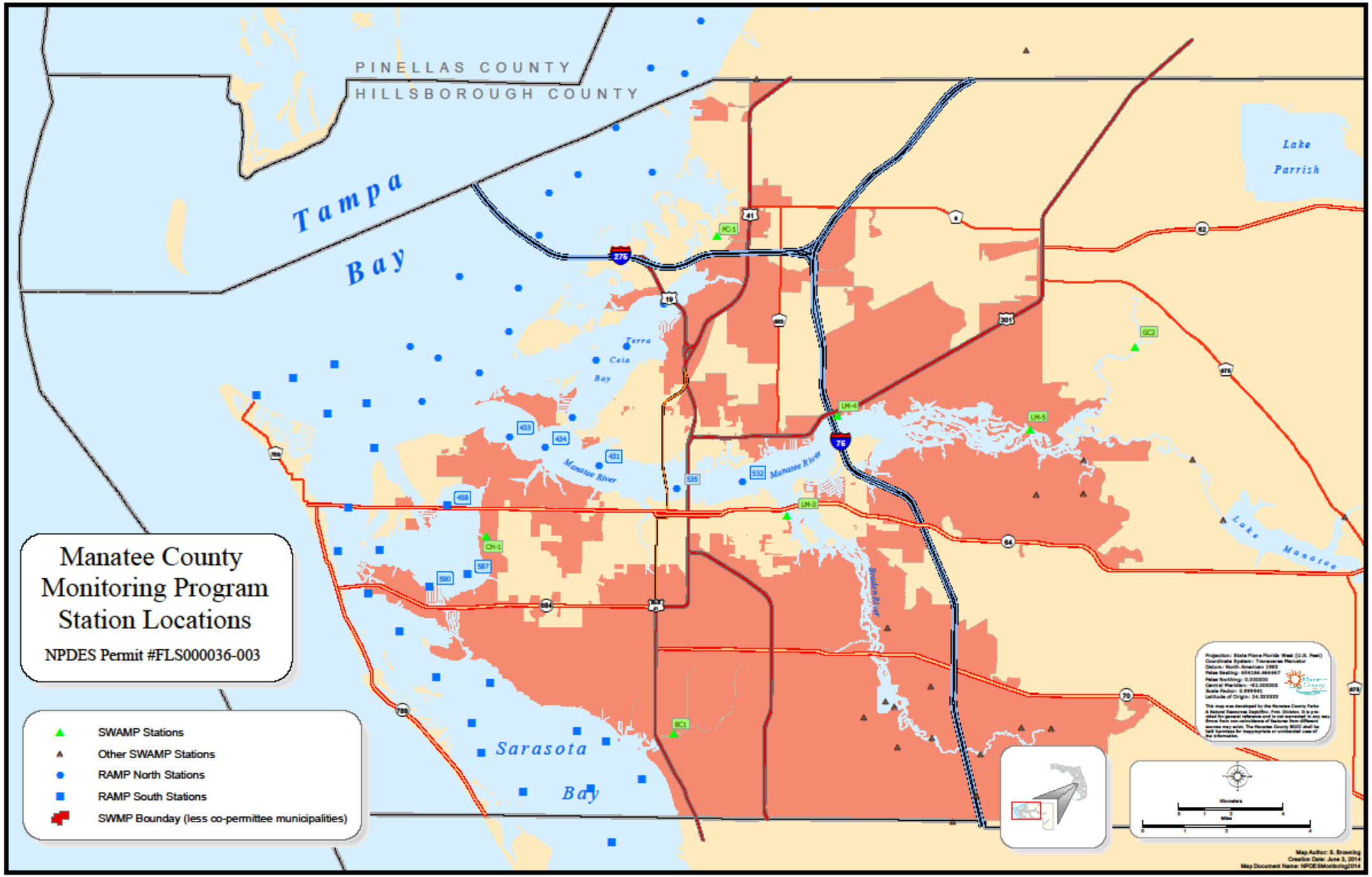
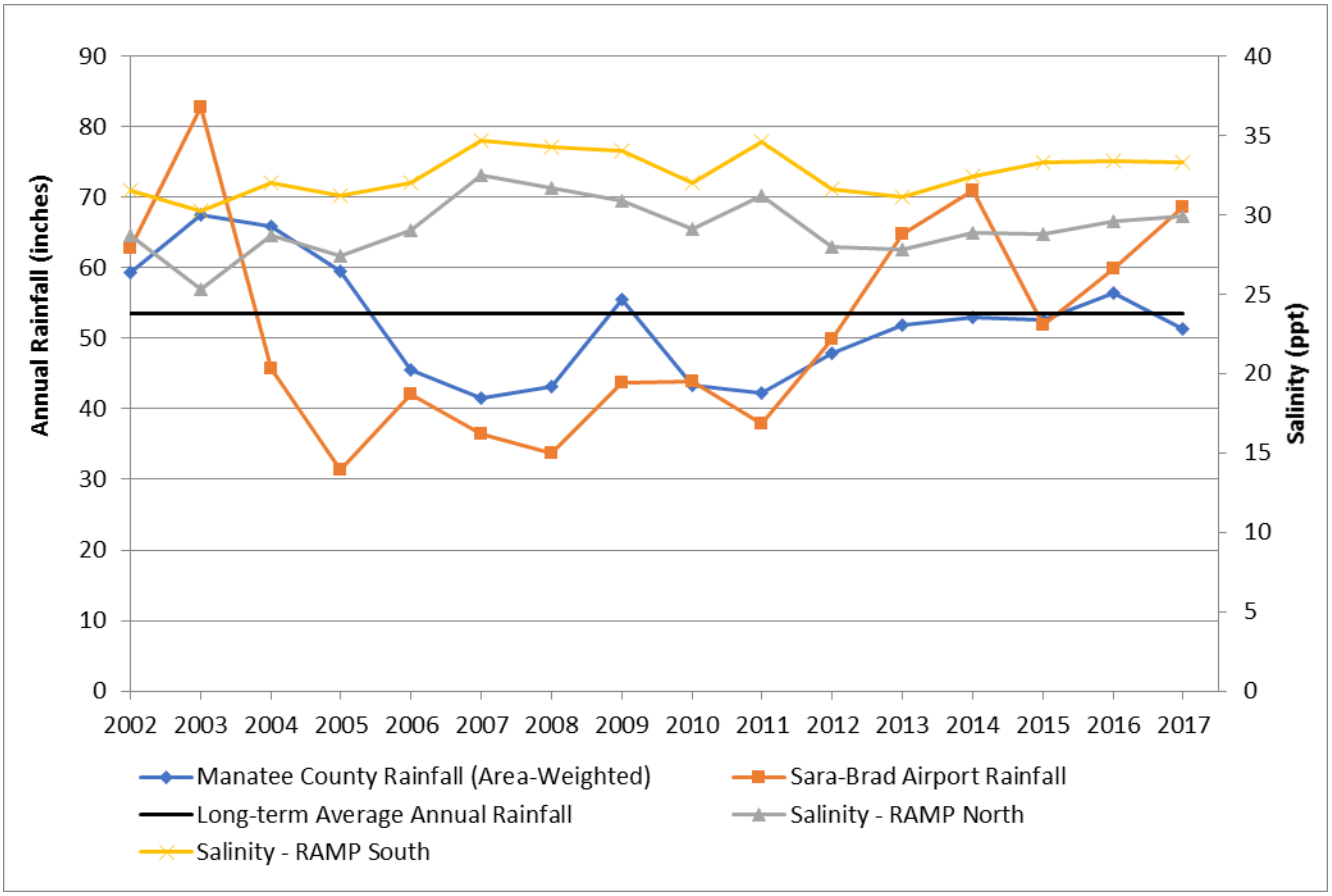


Figure 1. Monitoring Program Station Locations, Manatee County

Figure 2. Seagrass Transect Locations & Assessment Areas

Figure 3. Rainfall and Salinities - Manatee County



Data Source: Southwest Florida Water Management District, 2016

Table 1
Manatee County Estuaries(RAMP)
Water Quality (Annual Means)

Bay Segment	Year	Parameter						
		Chlorophyll-a (mg/m3)	Salinity (ppt)	T. Kjeldahl Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total S. Solids (mg/L)	Turbidity (NTU)	Inorganic Nitrogen (mg/L)
RAMP North	2002	4.6	28.7	0.55	0.24	NR	NR	NR
	2003	8	25.3	0.54	0.16	NR	NR	NR
	2004	6	28.7	0.41	0.14	NR	NR	NR
	2005	3.2	27.4	0.5	0.11	NR	NR	NR
	2006	4.3	29	0.29	0.03	32.6	1.99	NR
	2007	3.9	32.5	0.5	0.14	10.2	2.65	0.08
	2008	3.4	31.7	0.44	0.14	10.2	2.1	0.11
	2009	4.3	30.9	0.45	0.1	9.8	2.3	0.09
	2010	3.9	29.1	0.36	0.05	10.2	2.3	0.08
	2011	4.4	31.2	0.41	0.13	10.9	2.4	0.08
	2012	6.1	28	0.41	0.09	10.7	2.4	0.08
	2002-2012 Mean	**4.7**	**29.3**	**0.44**	**0.12**	**13.5**	**2.3**	**0.09**
	2013	5.3	27.8	0.33	0.04	15.5	1.6	0.09
	2014	3.9	28.9	0.24	0.03	19.9	1.5	0.08
	2015	5	28.8	0.28	0.14	20.6	2.1	0.08
	2016	1.4	29.6	0.37	0.04	16.2	2	0.08
	2017	4.4	29.9	0.47	0.13	6.6	1.6	0.05
	2018 (1st Qtr)	3.3	30.9	0.37	0.04	5.5	1.8	0.04
RAMP South	2002	5.1	31.5	0.55	0.41	NR	NR	NR
	2003	9.4	30.2	0.52	0.19	NR	NR	NR
	2004	6.4	32	0.5	0.11	NR	NR	NR
	2005	4	31.2	0.58	0.06	NR	NR	NR
	2006	4	32	0.25	0.03	39.3	1.64	NR
	2007	6.8	34.7	0.57	0.04	11.8	2.7	0.08
	2008	3.8	34.3	0.49	0.06	11.5	2.5	0.11
	2009	5.2	34	0.5	0.1	10.4	2.6	0.09
	2010	4	32	0.37	0.06	10.9	2.3	0.08
	2011	4.2	34.6	0.51	0.13	11.2	2.3	0.08
	2012	8	31.6	0.51	0.09	10.8	2.5	0.08
	2002-2012 Mean	**5.5**	**32.6**	**0.49**	**0.12**	**15.1**	**2.4**	**0.09**
	2013	6.2	31.1	0.34	0.07	16.9	1.7	0.09
	2014	4.6	32.4	0.31	0.03	21.6	1.6	0.08
	2015	5.2	33.3	0.4	0.26	24.6	2.1	0.08
	2016	2.7	33.4	0.47	0.08	20.2	2.9	0.07
	2017	5.4	33.3	0.54	0.09	8.3	2.1	0.04
	2018 (1st Qtr)	5.1	33.4	0.43	0.03	7.6	2.9	0.04

Table 1 Notes:

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Each RAMP segment consists of 24 stations collected quarterly. Inclement weather, equipment malfunctions, etc., may have resulted in some years not including all four quarters of data from all stations; see STORET for details. Annual data reported for 2002-2011 representative of NPDES permit annual timeframe (Mar-Feb); data reported after 2012 coincident w/calendar year. 2018 data represents first quarter only (Jan 1 through Mar 31).

NR - not reported

Chlorophyll-a = Pheophytin-free chlorophyll-a; Total S. Solids = Total Suspended Solids; and Inorg. Nitrogen = Nitrite ($N0_2$) + Nitrate (NO_3) + Ammonia (NH_3)

Table 2
Upper Manatee River Water Quality (Annual Means)

Station	Location	Parameter	Units	Year													
				2006	2007	2008	2009	2010	2011	2012	2006-12 Average	2013	2014	2015	2016	2017	2018 (1st Qtr)
LM-5	Ft Hamer (River Mile 14.4)	Chlorophyll-a	mg/m^3	13.6	12.2	12.1	11.2	13.3	11.7	11.1	**12.2**	9.6	14.1	19.1	19.6	14	13.8
		Dissolved Oxygen	mg/L	6.1	5	5.4	5.9	5.8	7.7	7.9	**6.3**	7.8	7.4	7.9	8.3	7	8.5
		Salinity	ppt	11.6	14.2	10.2	5.7	7.5	8.7	8.3	**9.5**	7.9	6.2	6.3	5.1	12.6	15.4
		TKN	mg/L	1.09	0.68	0.74	0.89	0.94	0.76	0.87	**0.85**	0.76	0.83	1.12	1.5	0.79	0.4
		Total Phosphorous	mg/L	0.39	0.38	0.36	0.41	0.54	0.46	0.59	**0.45**	0.35	0.38	0.43	0.39	0.55	0.24
		Total S. Solids	mg/L	11.8	16.3	9.3	7.5	9.4	9.2	7.9	**10.2**	9.4	10.5	18.2	10.6	7.5	6.4
		Inorg. Nitrogen	mg/L	NR	0.12	0.08	0.17	0.11	0.14	0.14	**0.13**	0.15	0.12	0.12	0.21	0.05	0.03
LM-4	I-75 Crossing (River Mile 9.3)	Chlorophyll-a[1]	mg/m^3	4.7	3	3.7	3	6	6.4	4.6	**4.5**	8	5.8	5.9	9.8	4.8	2.6
		Dissolved Oxygen	mg/L	6.1	5.2	5.3	5.8	5.5	7.3	7.9	**6.2**	7.4	7.5	7.4	7.4	7	8.58
		Salinity	ppt	19.3	21.4	19.1	14.5	14.4	17.3	14.5	**17.2**	16.8	15.4	15.3	20.1	18.6	23
		TKN	mg/L	1.06	0.7	0.59	0.75	0.67	0.75	0.75	**0.75**	0.62	0.57	0.94	0.99	0.6	0.41
		Total Phosphorous	mg/L	0.29	0.29	0.36	0.44	0.47	0.55	0.66	**0.44**	0.3	0.27	0.45	0.42	0.46	0.15
		Total S. Solids	mg/L	12.8	8.8	10.4	8.9	13	12.6	14.3	**11.5**	13.5	12.4	12.7	13.9	9.3	6.5
		Inorg. Nitrogen	mg/L	NR	0.12	0.11	0.13	0.19	0.12	0.13	**0.13**	0.12	0.09	0.14	0.17	0.08	0.04
LM-3	Braden River Confluence (River Mile 8.3)	Chlorophyll-a[1]	mg/m^3	3.1	3.2	2.8	3.1	5.3	6.5	4.9	**4.1**	10.4	6.2	4.1	3	4.3	3.2
		Dissolved Oxygen	mg/L	6.3	4.7	5	5.3	5.9	7.1	7.7	**6**	6.8	6.9	7	6.8	6.7	7.8
		Salinity	ppt	20.4	23.6	23.4	16	17.7	18.3	15.9	**19.3**	20.9	17.2	19.5	21.9	19.3	23.7
		TKN	mg/L	1.02	0.72	0.78	0.82	0.84	0.69	0.75	**0.8**	0.58	0.59	0.66	1.1	0.72	0.37
		Total Phosphorous	mg/L	0.42	0.29	0.33	0.41	0.39	0.73	0.69	**0.47**	0.27	0.25	0.36	0.31	0.4	0.12
		Total S. Solids	mg/L	14	11.9	9.7	9.4	10.1	17.5	9.1	**11.7**	12.4	12.6	25.5	10.9	5.6	4.7
		Inorg. Nitrogen	mg/L	NR	0.13	0.1	0.14	0.12	0.14	0.12	**0.13**	0.18	0.17	0.18	0.13	0.1	0.06

Table 2 Notes:
Stations sampled monthly. Inclement weather, equipment malfunctions, etc., may have resulted in some years not including all twelve months of data; see STORET for details.
Annual data reported for 2002-2011 representative of NPDES permit annual timeframe (Mar-Feb); data reported after 2012 coincident w/calendar year. 2018 data represents first quarter only (Jan 1 through Mar 31).
NR - not reported.
Chlorophyll-a = Pheophytin-free chlorophyll-a; Total S. Solids = Total Suspended Solids; and Inorg. Nitrogen = Nitrite ($N0_2$) + Nitrate (NO_3) + Ammonia (NH_3)

Table 3
Lower Manatee River *& Palma Sola Bay
Water Quality (Annual Means)

Station Group	Location	Parameter	Units	Year													
				2006	2007	2008	2009	2010	2011	2012	2006-12 Average	2013	2014	2015	2016	2017	2018 (1st Qtr)*
RAMP Group #5	Lower Manatee River (US 41 Crossing; River Mile 5.8)	Chlorophyll-a	mg/m^3	4	4.1	6.3	8	7.4	4.8	7.3	**6**	6.7	8.1	7	2.6	7.1	3
		Dissolved Oxygen	mg/L	6.4	5.7	6.3	5.8	7.2	6.7	6.9	**6.4**	6.8	7.4	6.8	7.4	6.9	8.1
		Salinity	ppt	24.3	28.9	26	24	22.6	26.2	23.6	**25.1**	18.4	23.6	22.6	23.9	23.6	28.4
		TKN	mg/L	0.35	0.54	0.45	0.61	0.47	0.65	0.5	**0.5**	0.61	0.37	0.34	0.46	0.6	0.46
		Total Phosphorous	mg/L	0.14	0.24	0.25	0.18	0.17	0.17	0.13	**0.18**	0.1	0.05	0.12	0.05	0.23	0.08
		Total S. Solids	mg/L	34.5	14.4	8.6	9.1	11.2	10.7	10.8	**14.2**	14.4	17.5	14.5	15	6.8	4.4
		Inorg. Nitrogen	mg/L	NR	0.11	0.09	0.12	0.08	0.08	0.1	**0.1**	0.13	0.08	0.13	0.06	0.07	0.05
RAMP Group #4	Lower Manatee River (Snead Island/ Desoto Nat. Memorial; River Mile 1.9)	Chlorophyll-a[1]	mg/m^3	8	5.3	5	6.8	5.4	6.2	7.1	**6.3**	7	6.9	10.3	2	9.6	4.3
		Dissolved Oxygen	mg/L	6.4	6	6.6	6.4	7.5	7	6.7	**6.7**	7.2	7.8	7.4	7.3	6.9	7.7
		Salinity	ppt	27.2	31.2	30.5	28.5	26	29.8	24.2	**28.2**	26.6	26.9	25.6	28.6	28.2	29.7
		TKN	mg/L	0.37	0.51	0.5	0.53	0.34	0.35	0.39	**0.43**	0.4	0.35	0.42	0.45	0.56	0.35
		Total Phosphorous	mg/L	0.11	0.16	0.08	0.1	0.11	0.19	0.07	**0.12**	0.06	0.04	0.11	0.05	0.17	0.04
		Total S. Solids	mg/L	28.7	8.9	9.9	9.9	10.2	10.8	9.5	**12.6**	14.7	18.9	18.5	15.9	7.1	4.4
		Inorg. Nitrogen	mg/L	NR	0.08	0.1	0.1	0.08	0.08	0.08	**0.09**	0.11	0.08	0.09	0.1	0.05	0.03
RAMP Group #3	Palma Sola Bay	Chlorophyll-a[1]	mg/m^3	5.6	9.9	6.8	7.2	5.3	7.3	12.8	**7.8**	9.5	9.5	8.5	4.1	7.4	7.3
		Dissolved Oxygen	mg/L	5.7	6.3	6.7	6.3	7.8	7.3	7.3	**6.8**	7.5	7.3	7.1	7.4	7.4	7.7
		Salinity	ppt	31.7	34.2	33.8	33.3	32.1	33.9	30.8	**32.8**	29.8	31.5	32	32.5	32.8	32.7
		TKN	mg/L	0.25	0.71	0.73	0.54	0.45	0.61	0.66	**0.56**	0.4	0.41	0.54	0.58	0.66	0.52
		Total Phosphorous	mg/L	0.08	0.06	0.06	0.11	0.06	0.14	0.08	**0.08**	0.03	0.03	0.36	0.05	0.09	0.03
		Total S. Solids	mg/L	35.4	13	11.9	11.1	11.1	10.1	10.5	**14.7**	16.9	20.1	22.6	17.3	8.9	7.1
		Inorg. Nitrogen	mg/L	NR	0.08	0.13	0.09	0.08	0.08	0.08	**0.09**	0.08	0.08	0.08	0.07	0.04	0.04

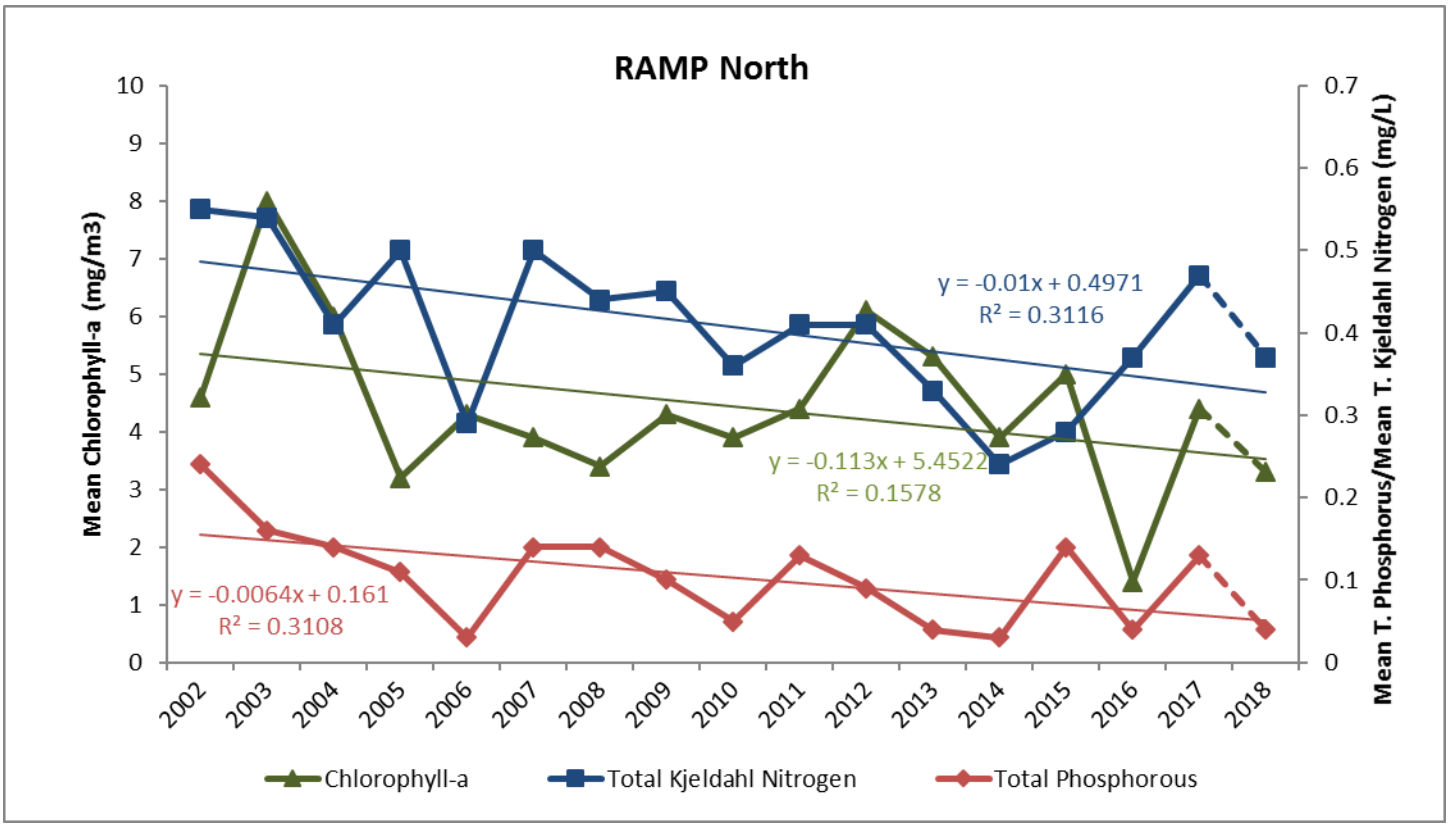
Table 3 Notes:
Stations sampled monthly. Inclement weather, equipment malfunctions, etc., may have resulted in some years not including all twelve months of data; see STORET for details.
Annual data reported for 2002-2011 representative of NPDES permit annual timeframe (Mar-Feb); data reported after 2012 coincident w/calendar year. 2018 data represents first quarter only (Jan 1 through Mar 31).
NR - not reported.
Chlorophyll-a = Pheophytin-free chlorophyll-a; Total S. Solids = Total Suspended Solids; and Inorg. Nitrogen = Nitrite ($N0_2$) + Nitrate (NO_3) + Ammonia (NH_3)

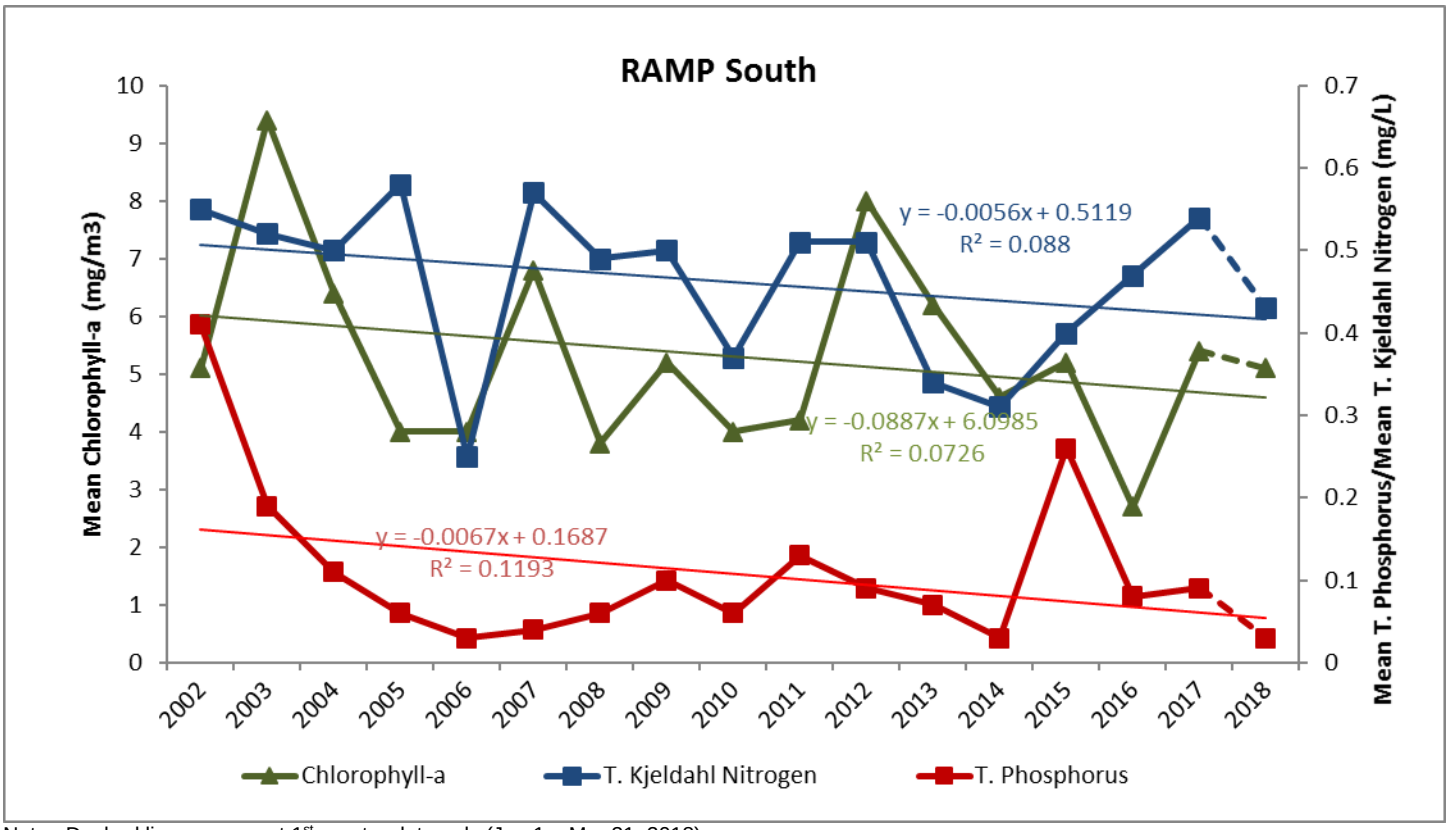
Table 4
Major Tributaries - Manatee County
Annual Mean Water Quality

Station	Location	Parameter	Units	Year													
				2006	2007	2008	2009	2010	2011	2012	2006-12 Average	2013	2014	2015	2016	2017	2018 (1st Qtr)
GC-2	Gamble Creek	Chlorophyll-a	mg/m^3	2.1	4.8	3.4	2	3.7	4.3	2	**3.2**	3.6	1.6	0.9	2.4	4.8	3
		Dissolved Oxygen (DO)	mg/L	7.1	6.7	6.6	6.9	7.3	8.6	8.5	**7.4**	8.2	7.8	8.8	8.4	7.4	9.8
		Salinity	ppt	NR	NR	NR	0.19	0.29	0.23	0.24	**0.24**	0.25	0.19	0.25	0.22	0.23	0.28
		TKN	mg/L	0.87	0.55	0.71	0.96	1.24	0.84	0.99	**0.88**	0.95	0.93	0.81	1.1	0.86	0.59
		Total Phosphorous	mg/L	0.33	0.29	0.34	0.39	0.4	0.32	0.38	**0.35**	0.39	0.44	0.4	0.68	0.44	0.32
		Total S. Solids	mg/L	5	10.7	7	5.4	3.7	3.3	4.7	**5.7**	16.2	6.22	26.1	32.6	3.4	0.93
		Inorg. Nitrogen	mg/L	NR	0.4	0.44	0.44	1.1	0.27	0.31	**0.49**	0.26	0.42	0.37	0.46	0.27	0.37
FC-1	Frog Creek	Chlorophyll-a[1]	mg/m^3	5.1	11.6	11.7	4.3	7.2	8.5	4.1	**7.5**	22.3	4.6	6.3	3.4	7	33.2
		Dissolved Oxygen	mg/L	6	5.3	5	5.5	5.6	6.9	6.5	**5.8**	6.6	7.3	7.3	6.9	6.3	9
		Salinity	ppt	9.4	10	3.8	7.1	1.5	5.4	6	**6.2**	3	0.48	1.2	1.9	6.9	1.6
		TKN	mg/L	1.17	0.7	0.93	1.16	1.27	0.98	1.1	**1.04**	1.51	1.03	0.96	1.2	0.97	0.81
		Total Phosphorous	mg/L	0.53	0.51	0.47	0.66	0.89	0.58	0.61	**0.61**	0.53	0.5	0.52	0.43	0.54	0.38
		Total S. Solids	mg/L	4.8	6.3	5.1	4	6.6	14.3	17.3	**8.3**	8	6.9	5.4	4.8	4.1	6
		Inorg. Nitrogen (mg/l)	mg/L	NR	0.49	0.45	0.49	0.56	0.48	0.51	**0.5**	0.74	0.59	0.53	0.47	0.27	0.08
BC-1	Bowlees Creek	Chlorophyll-a[1]	mg/m^3	NR	NR	NR	NR	NR	NR	18.2	-	17.2	13.3	13.5	17.5	22.3	28.3
		Dissolved Oxygen	mg/L	NR	NR	NR	NR	NR	NR	6.8	-	7	7.1	6.7	7.4	6.8	7.9
		Salinity	ppt	NR	NR	NR	NR	NR	NR	14.7	-	14.5	10.3	13.3	15.2	15.1	14.2
		TKN	mg/L	NR	NR	NR	NR	NR	NR	0.93	-	0.87	0.72	0.86	1.05	0.71	0.78
		Total Phosphorous	mg/L	NR	NR	NR	NR	NR	NR	0.51	-	0.3	0.19	0.31	0.41	0.36	0.21
		Total S. Solids	mg/L	NR	NR	NR	NR	NR	NR	7.8	-	10.2	9.5	10.9	8.4	8.4	5.2
		Inorg. Nitrogen	mg/L	NR	NR	NR	NR	NR	NR	0.14	-	0.14	0.2	0.14	0.17	0.16	0.13
CH-1	Cedar Hammock West	Chlorophyll-a[1]	mg/m^3	5.5	7.8	6.7	6.7	5	3.2	3.3	**5.5**	4.7	5.7	5.2	11.4	8.4	2.6
		Dissolved Oxygen	mg/L	7.3	4.6	4.5	4.6	7.1	6.7	7.4	**6**	7.3	7.2	6.9	7.1	6.7	8.2
		Salinity	ppt	10.9	12.4	6.1	11.8	4.4	NR	3.2	**8.1**	2.3	3.5	6.1	6.9	9.2	2.2
		TKN	mg/L	0.91	0.68	0.68	0.82	0.97	0.97	0.88	**0.84**	0.9	0.7	0.87	1.1	0.75	0.86
		Total Phosphorous	mg/L	0.24	0.27	0.29	0.34	0.26	0.39	0.34	**0.3**	0.26	0.22	0.29	0.37	0.27	0.37
		Total S. Solids	mg/L	5.4	5	3.7	4.4	3	3.9	3.7	**4.2**	3.5	4.3	5.7	7.9	3.8	16.5
		Inorg. Nitrogen	mg/L	NR	0.26	0.3	0.3	0.34	0.37	0.35	**0.32**	0.36	0.31	0.31	0.4	0.29	0.39

Table 4 Notes:
Stations sampled monthly. Inclement weather, equipment malfunctions, etc., may have resulted in some years not including all twelve months of data; see STORET for details.
Annual data reported for 2002-2011 representative of NPDES permit annual timeframe (Mar-Feb); data reported after 2012 coincident w/calendar year. 2018 data represents first quarter only (Jan 1 through Mar 31).
NR - not reported.
Chlorophyll-a = Pheophytin-free chlorophyll-a; Total S. Solids = Total Suspended Solids; and Inorg. Nitrogen = Nitrite ($N0_2$) + Nitrate (NO_3) + Ammonia (NH_3)

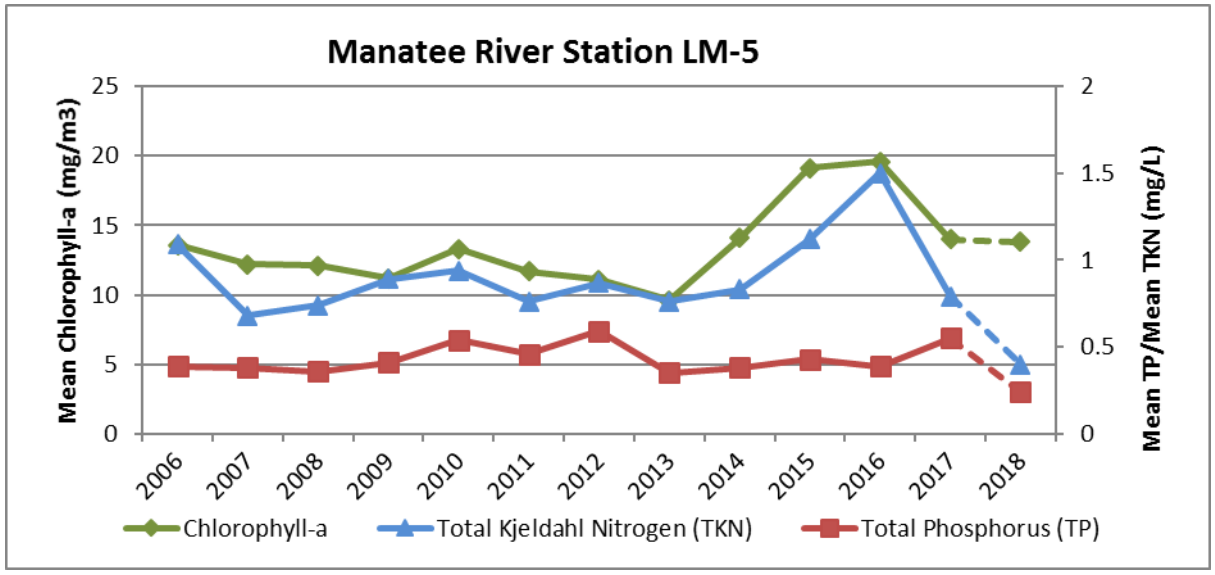
Figure 4. Manatee County Estuaries (RAMP Segments) Annual (& 1st Qtr 2018) Means

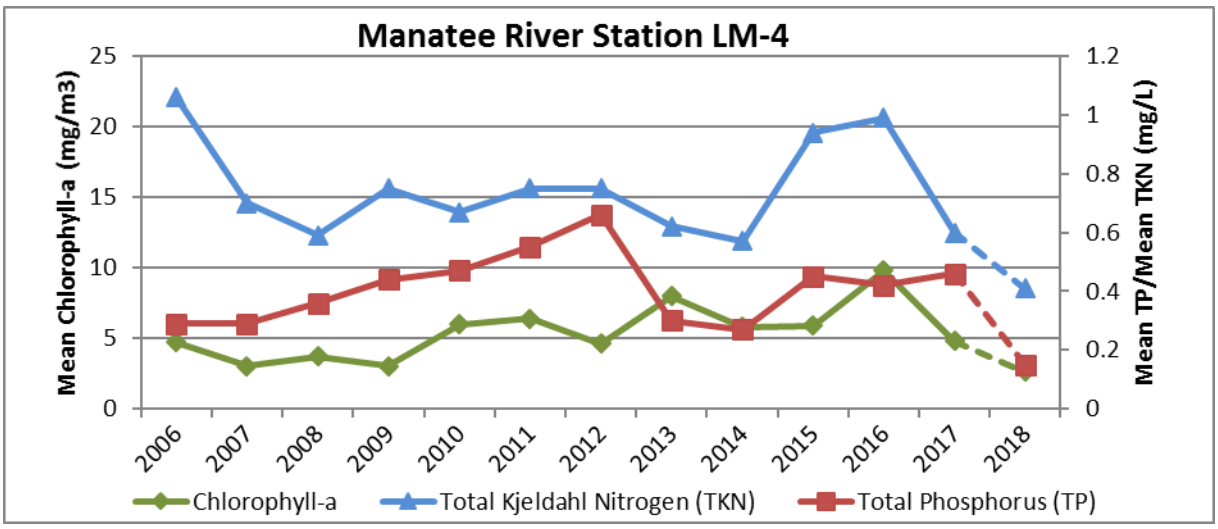


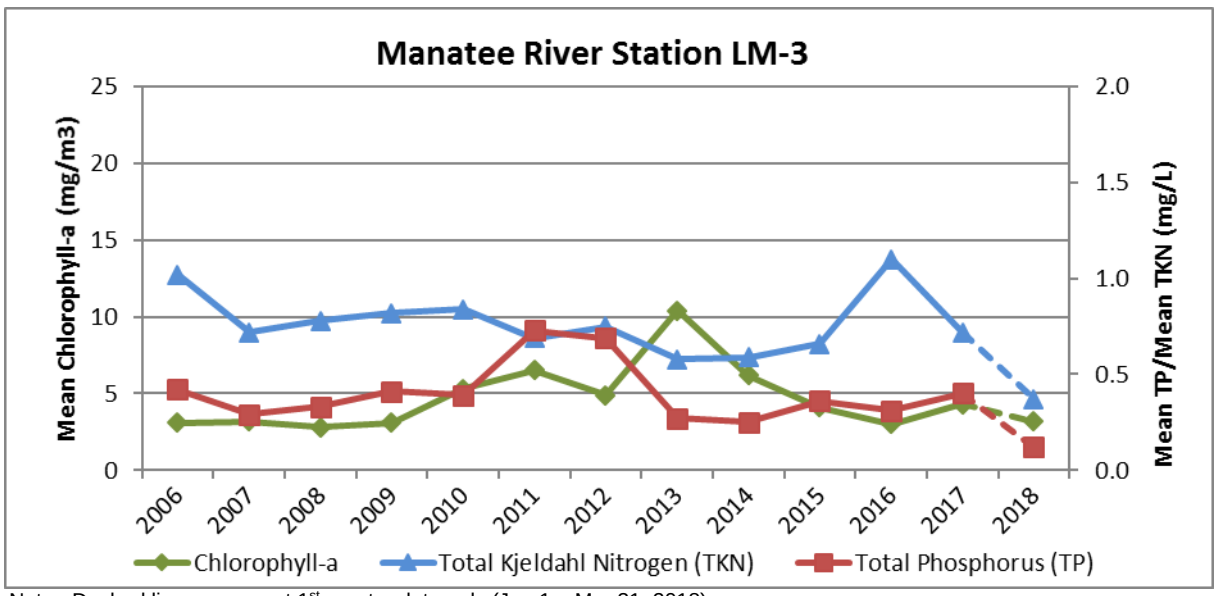


Note: Dashed lines represent 1st quarter data only (Jan 1 – Mar 31, 2018)

Figure 5. Manatee River (SWAMP Stations) Annual (& 1st Qtr 2018) Means

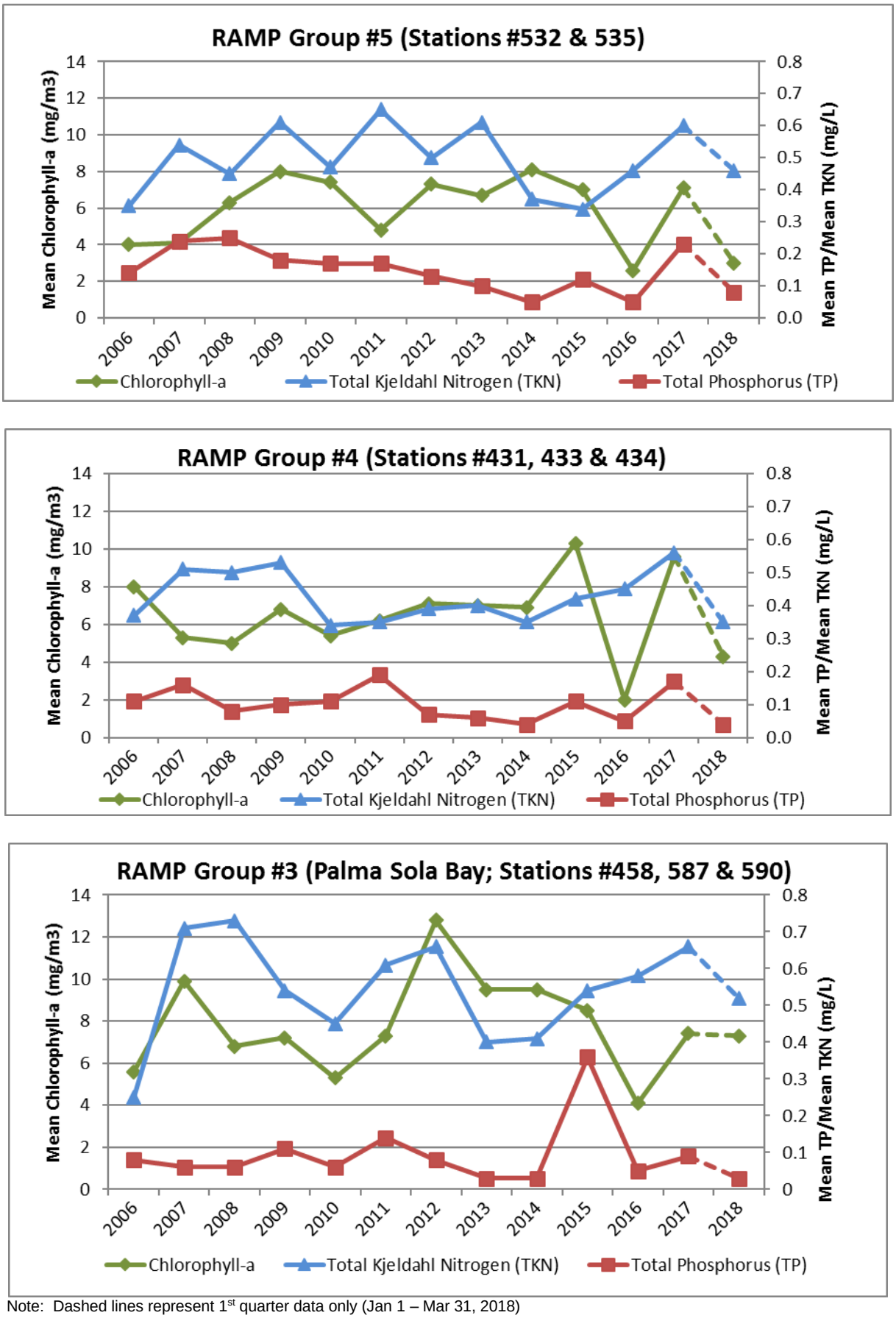






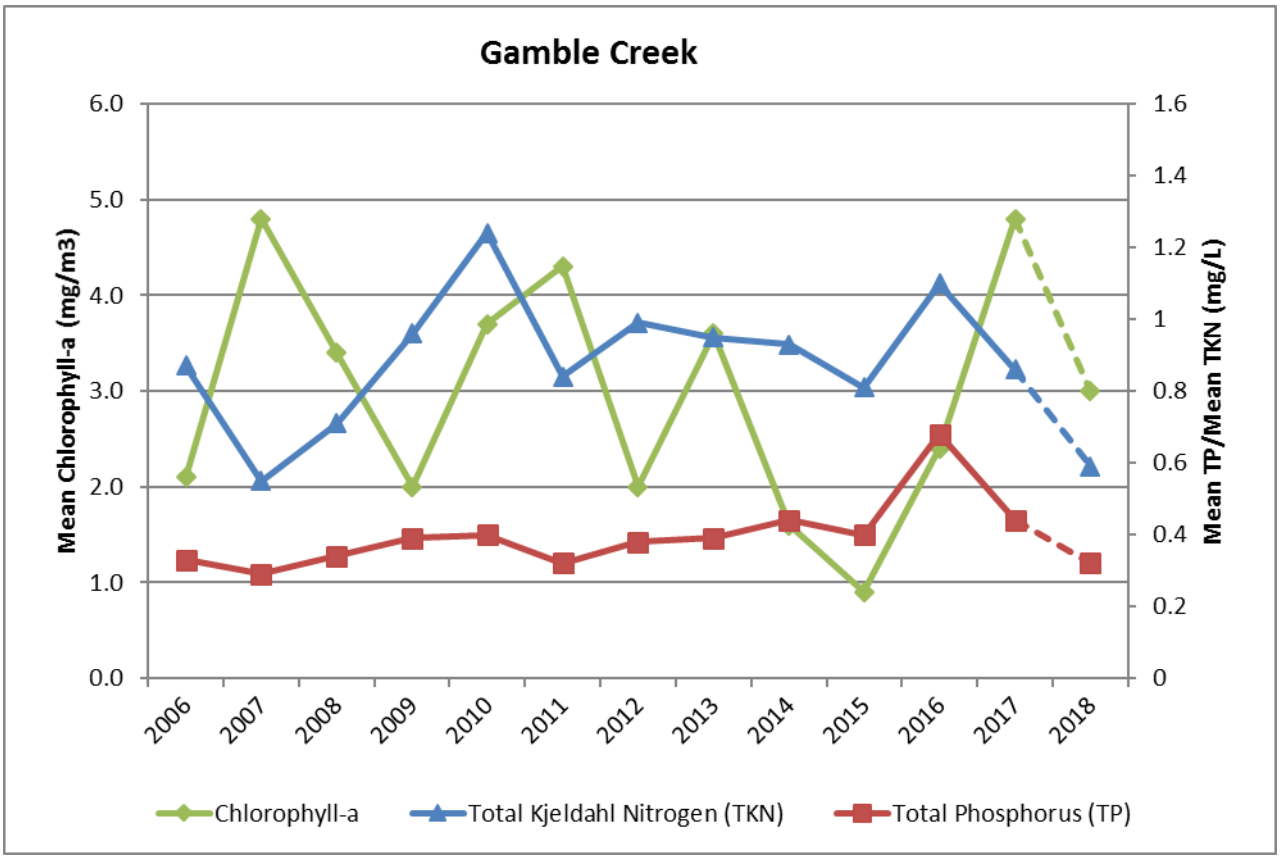
Note: Dashed lines represent 1st quarter data only (Jan 1 – Mar 31, 2018)

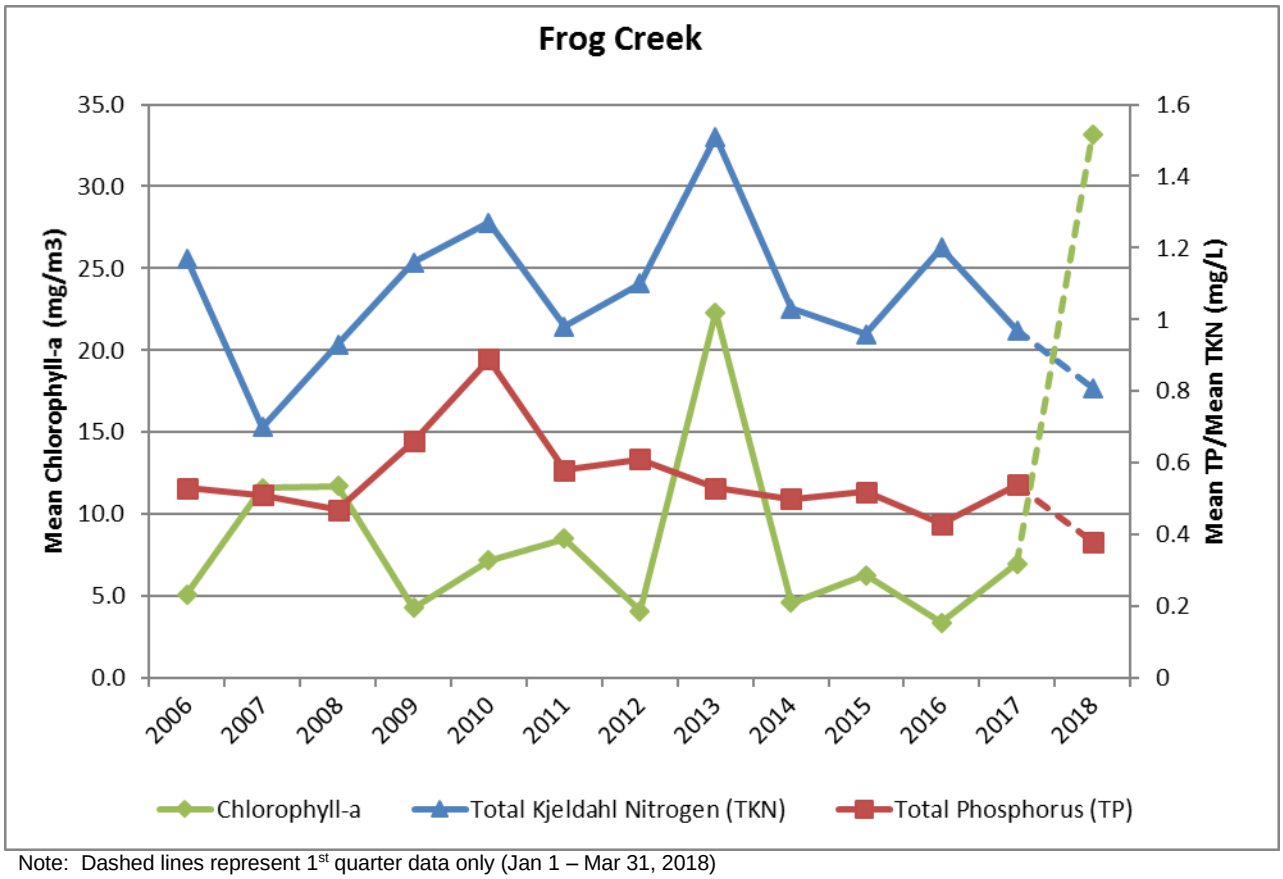
Figure 6. Manatee River (RAMP Station Groups) Annual (& 1st Qtr 2018) Means



Note: Dashed lines represent 1st quarter data only (Jan 1 – Mar 31, 2018)

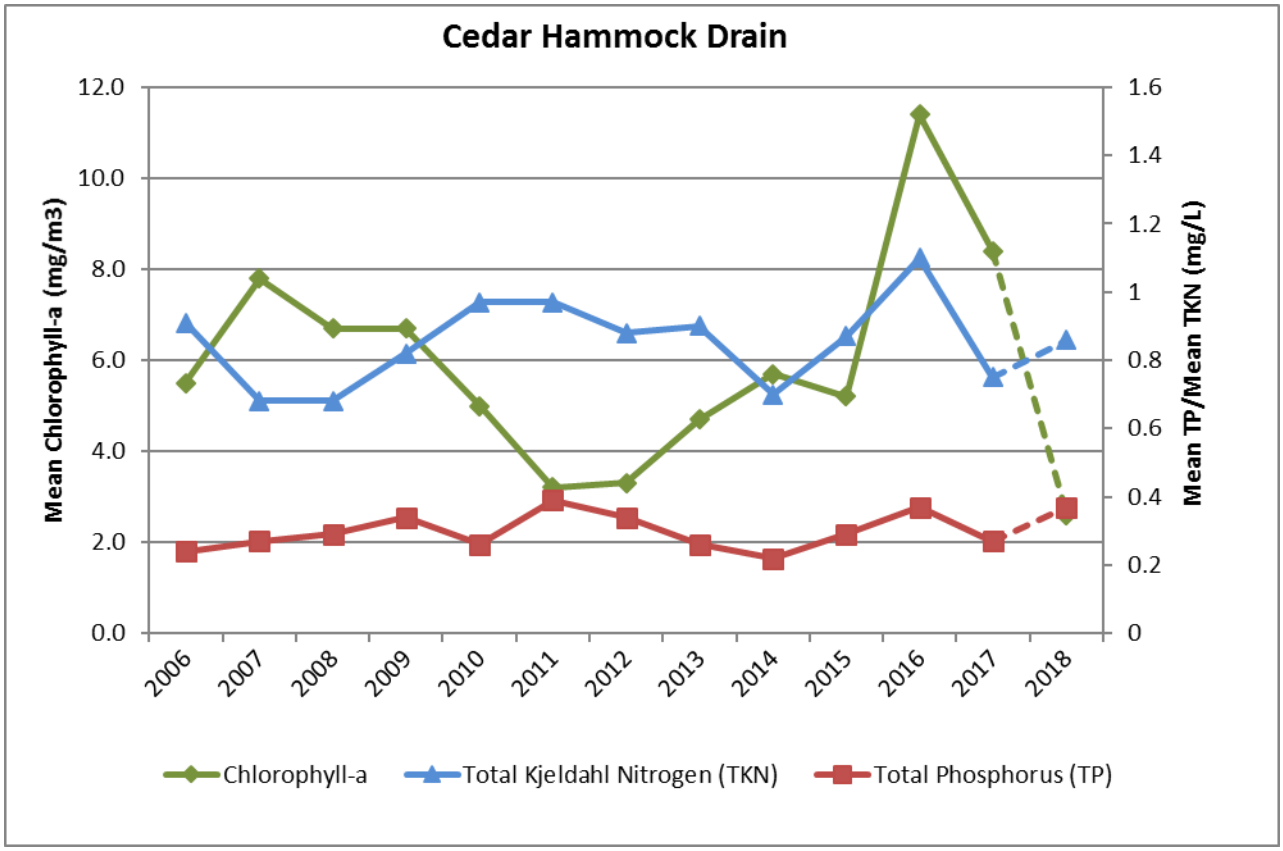
Figure 7. Major Creeks of Manatee County Annual (& 1st Qtr 2018) Means

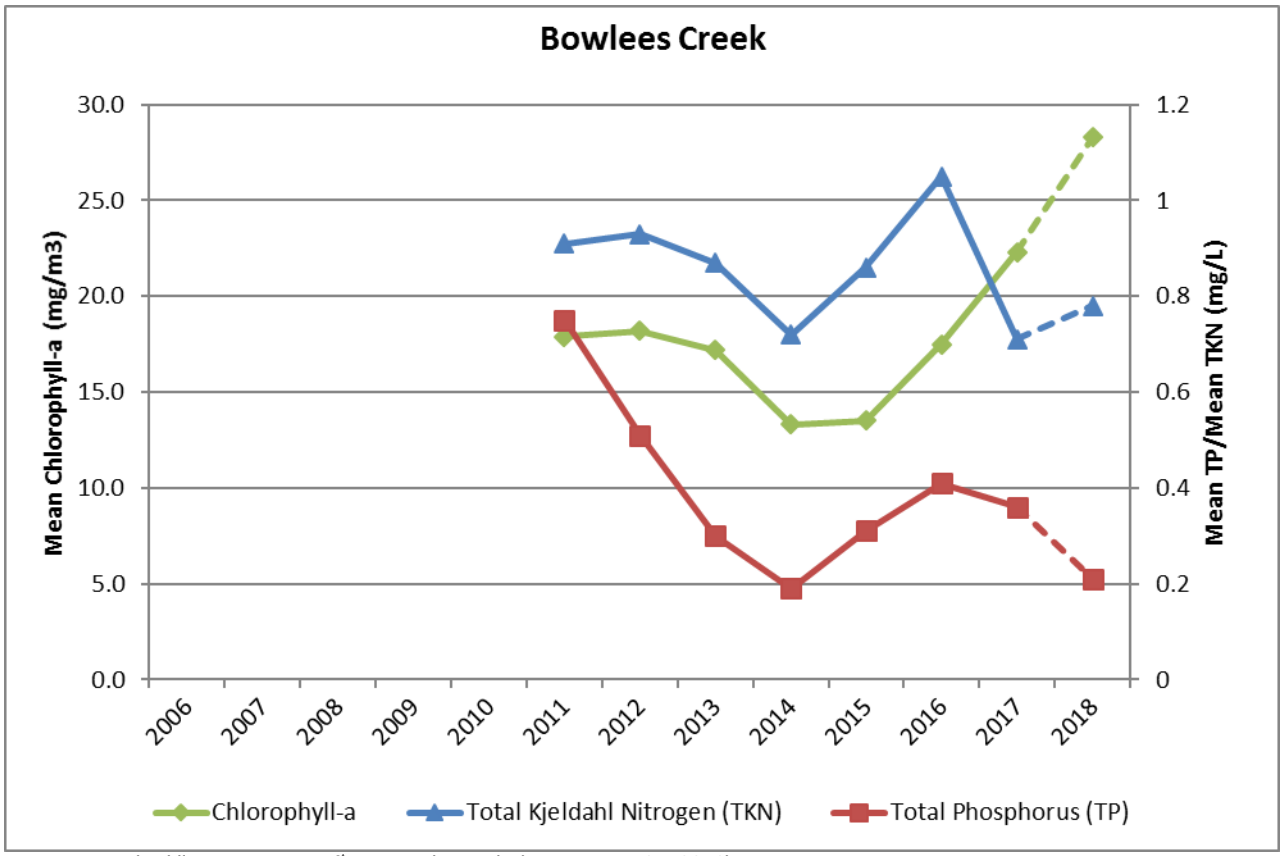




Note: Dashed lines represent 1st quarter data only (Jan 1 – Mar 31, 2018)

Figure 7 (cont'd). Major Creeks of Manatee County Annual (& 1st Qtr 2018) Means





Notes: Dashed lines represent 1st quarter data only (Jan 1 – Mar 31, 2018)
Collection of data at Station BC-1 (Bowlees Creek) began in 2011.