Joe's Creek

Dissolved Oxygen/Nutrients TMDL Implementation Plan

(WBID 1668A)

Pinellas County NPDES MS4 Permit No. FLS000005-003

June 2017

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1.0 Background

1.1 Purpose

The United States Environmental Protection Agency (EPA) established a Total Maximum Daily Load (TMDL) for nutrients and dissolved oxygen in St. Joe Creek (referred to hereafter as "Joe's Creek"), WBID 1668A, in March 2008. Pinellas County submitted a TMDL prioritization report to the Florida Department of Environmental Protection (FDEP) in May 2013, as required in the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit No. FLS000005-003 issued January 1, 2013. Pinellas County selected Joe's Creek as the top priority for TMDL monitoring and implementation. A Monitoring and Assessment Plan was submitted in December 2013, followed by commencement of monitoring in the watershed. The next step in the TMDL process is to develop an Implementation Plan for the TMDL, also referred to as a Supplemental Stormwater Management Program (SWMP), which will describe load reduction activities to be undertaken in the watershed.

This TMDL Implementation Plan fulfills the requirements in Part VIII.B.3.d of the NPDES MS4 permit for Pinellas County, the City of St. Petersburg, and Kenneth City, and describes both ongoing and planned efforts to address dissolved oxygen and nutrient impairments in Joe's Creek. Pinellas County, the City of St. Petersburg, and the Town of Kenneth City partnered to develop this plan.

1.2 Description of Joe's Creek

The Joe's Creek watershed has a drainage area of approximately 9,230 acres in south-central Pinellas County (Figure 1). The watershed includes the City of Pinellas Park (1,300 acres), City of St. Petersburg (3,815 acres), Kenneth City (418 acres), and unincorporated Pinellas County (3,700 acres). The watershed is almost completely developed, with over 70% of the land use in the watershed being high density residential, and most of the remainder being commercial, industrial, institutional, and low or medium density residential. Much of upper portion of the creek consists of concrete-lined channels, with numerous inflows for stormwater conveyance. After crossing under 34th Street, Joe's Creek is characterized as an earthen channel with steep side banks that are vegetated or riprapped in places (see ERD 2010 for detailed information and photos).

Figure 1. Location of Joe's Creek watershed in Pinellas County.

The main channel of Joe's Creek is divided into a tidal segment (WBID 1668E) and a freshwater segment (WBID 1668A). The main channel flows from east to west, originating as a discharge from a box culvert, then

entering man-made Silver Lake, then flowing approximately seven miles before discharging into the Cross Bayou Canal and ultimately Boca Ciega Bay. The freshwater segment begins just east of I-275 near the City of St. Petersburg and flows approximately five miles west until it reaches the uppermost portion of the tidal influence. Two tributaries, Bonn Creek (WBID 1668D) and Pinellas Park Ditch #5 (WBID 1668B), flow into the tidal segment of the creek. Miles Creek, the largest tributary, with a drainage area of 2,525 acres, flows into the freshwater segment of the creek from the south and is primarily located within the City of St. Petersburg. The WBID boundaries as described are shown in Figure 2, as are the municipal boundaries in the watershed. **This plan focuses only on the freshwater segment of Joe's Creek (WBID 1668A) which includes Miles Creek,** with a watershed drainage area of approximately 6,000 acres**.**

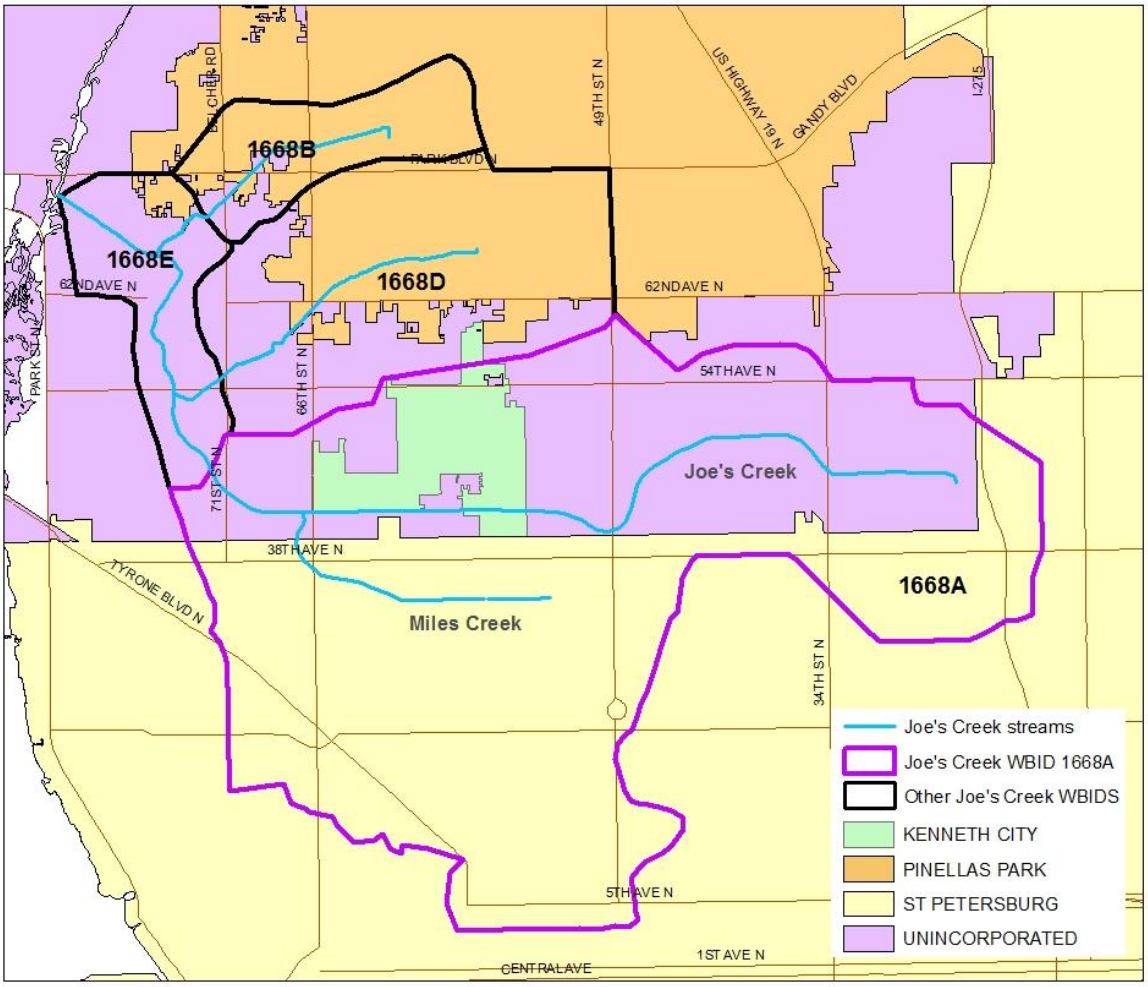

Figure 2. Joe's Creek WBIDs and municipal areas.

1.3 Impairments and the TMDL

When Joe's Creek was assessed in 1998 and again in 2009 for impairment or attainment of water quality standards, the State of Florida did not have numeric nutrient criteria, so any of the following parameters, in combination or alone, were used to determine nutrient impairment: dissolved oxygen (DO), total nitrogen (TN), total phosphorus (TP), chlorophyll, and biochemical oxygen demand (BOD). Values for these parameters were assessed to indicate whether nutrients are present in excessive amounts that would lead to nonattainment of the narrative criterion. The narrative criterion for nutrients stated that "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in

natural populations of aquatic flora and fauna and also not to produce or contribute to conditions that violate the dissolved oxygen criterion, including natural conditions." Excess amounts of nutrients can impair aquatic life by leading to excessive growth of aquatic vegetation and algae, followed by excessive decomposition, and finally, depletion of DO. Human health can be impacted as well if Harmful Algal Blooms (HABs) occur, and these are more likely to occur when there are excessive nutrients.

Joe's Creek (WBID 1668A) was identified as impaired for nutrients and DO by FDEP and was included on the 1998 303(d) List of Impaired Waters. The waterbody was later placed on the 2009 Verified List of Impaired Waters based on data collected during the assessment period of 1999 to 2006. The following water quality criteria, as summarized from the Impaired Waters Rule Chapters 62-303 and 62-302, Florida Administrative Code (F.A.C.) were used to determine impairment:

- DO criterion: "In no case shall the concentration of dissolved oxygen average less than 5.0 in a 24-hour period and…shall not be less than 5 mg/L for fresh waters."
    - Approximately 25% of DO measurements obtained from Joe's Creek from 1999 through June 2006 were below the Class III freshwater criterion of 5 mg/L, more than the 10% allowed by the criterion, indicating DO impairment.
- BOD criterion: BOD "shall not be increased to exceed values which would cause DO to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions."
    - The BOD values in the assessment period had a median of 2.55 mg/L, above the 2.0 mg/L screening level for Florida streams.
- Interpretation of narrative nutrient criteria for streams: "A stream shall be included on the planning list for nutrients if…annual mean chlorophyll-*a* concentrations are greater than 20 µg/L or if data indicate annual mean chlorophyll a values have increased by more than 50% over historical values for at least two consecutive years."
    - The annual mean values of chlorophyll-*a* measured at stations in Joe's Creek in the assessment period from 1999 through June 2006 indicated nutrient impairment, exceeding the historic minimum value by more than 50% (a value of 7.1 µg/L) for all years and exceeding the freshwater threshold criterion of 20 µg/L in two of the years.
    - Analysis of TN and TP collected during the assessment period indicated a median TN/TP water column ratio of 13.0, suggesting that both nitrogen and phosphorus were limiting nutrients.

Table 1, below, shows the current impairments and TMDLs for the freshwater segment of Joe's Creek watershed (1668A). The waterbody also is impaired for fecal coliform and has a TMDL adopted for that impairment. A Bacteria Pollution Control Plan (BPCP) has been developed to specifically address that impairment, so this implementation plan will focus only on the nutrient and DO impairments.

Table 1. Impairments and adopted TMDLs in the Joe's Creek watershed.

WBID -- Name	Impairment (2009 list)	TMDLs
1668A – Joe's Creek (Freshwater Segment) (includes Miles Creek)	Nutrients Dissolved Oxygen Fecal coliform	Nutrients (TN, TP) $CBOD_5$ Fecal coliform

In 2008, the EPA established a TMDL to set loading limits to Joe's Creek that would help restore the impaired waterbody to its Class III designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well balanced population of fish and wildlife as defined by FDEP. The TMDL

and the recommended load reductions for Joe's Creek were based on data collected from 1999 to 2006 and used a regression model to analyze the relationships between low instream DO and nutrients. The adopted TMDL set a MS4 waste load allocation (WLA) of 49% reduction in TN and TP as well as a load allocation (LA) of 49% reduction in TN and TP (EPA 2008).

1.4 Revised Criteria

The Joe's Creek TMDL was determined based on a regression relationship between DO, temperature, and TN and TP concentrations, with a DO target of 5.0 mg/L, using the water quality standards in place at that time. In 2013, FDEP revised some of the State water quality standards and established numeric nutrient criteria for freshwater streams. The applicable revised water quality criteria for the freshwater portion of Joe's Creek, as summarized from the Impaired Waters Rule Chapters 62-303 and 62-302, Florida Administrative Code (F.A.C.), are:

- DO (Peninsula bioregion): "For…Class III…predominantly freshwaters, no more than 10% of the daily average percent DO saturation shall be below 38%."
- Chlorophyll-*a*: "Annual geometric mean threshold concentration of 20 ug/L for freshwater…Threshold geometric mean values are not to be exceeded more than once in any three calendar year period, and geometric mean computation requires a minimum of four samples per year with at least one sample taken between May 1 and September 30."
- Numeric nutrient criteria: "Annual geometric mean TN threshold concentration of 1.54 mg/L; Annual geometric mean TP threshold concentration of 0.12 mg/L; Threshold geometric mean values are not to be exceeded more than once in any three calendar year period; Geometric mean computation requires a minimum of four samples per year with at least one sample taken between May 1 and September 30."
- Biological health assessment: "…the water shall be determined to be biologically impaired if…, given a minimum sample size of two temporally independent bioassessments…the average score of all the temporally independent SCIs is below 40, or either of the two most recent temporally independent SCI scores is less than 35…."

The criteria revisions prompted stakeholders to reevaluate the nutrient and DO impairments for Joe's Creek. Using DO data collected in WBID 1668A from January 2005 through June 2012, only five percent of samples did not attain the new DO criterion, indicating that Joe's Creek is not impaired for DO (ATM 2014). Similarly, assessment of the TN, TP, and chlorophyll-*a* data using the new criteria produced results that Joe's Creek did not exceed the criteria for any of these parameters in any year during the assessment period of 2005-2012 (ATM 2014).

Currently, Joe's Creek remains on the Verified Impaired List, although the next cycle of assessment could result in delisting. Biological monitoring, which began in 2014, is ongoing in the watershed and will also be used to assess attainment of the water quality standards. The most recent biological results indicated passing SCI scores, and long term trend analyses show significantly reduced TN and TSS concentrations and stable TP and chlorophyll-a concentrations. **Based on data collected in 2016, Joe's Creek is attaining the all DO and nutrient criteria; this data has not been formally assessed by the FDEP but will be included in the upcoming reassessment of the Group 1 Basins.** BMPs are in place and planned which will help to further reduce the nutrient loads in the watershed and, hopefully, prevent the waterbodies from becoming impaired in the future under the current standards.

2.0 Water Quality Monitoring

Pinellas County has monitored water quality at various sites in the Joe's Creek watershed since 1991 as part of the Ambient Water Quality Monitoring Program. In fulfillment of permit requirements, the County submitted a TMDL Monitoring and Assessment Plan for Joe's Creek in December, 2013, which includes details on the current monitoring in the watershed. The County's data are regularly uploaded to FDEP STORET system and are also accessible through the Pinellas County Water Atlas website (http://www.pinellas.wateratlas.usf.edu/Default.aspx). Table 2 summarizes the ambient water quality monitored parameters and the sampling methods utilized.

In WBID 1668A, there are currently three active sites (Figure 3), with sample collection typically occurring eight times per year, when flow is present. The continuous period of record extends from 2003 to the present for each of these sites:

- Site 35-10 located on Joe's Creek at 62nd Street North
- Site 35-11 located on Joe's Creek at 46th Street North (at the same location as the USGS gaging station); used for computation of annual pollutant load estimates
- Station 35-12 located on Miles Creek at the 64th Street North crossing in the City of St. Petersburg

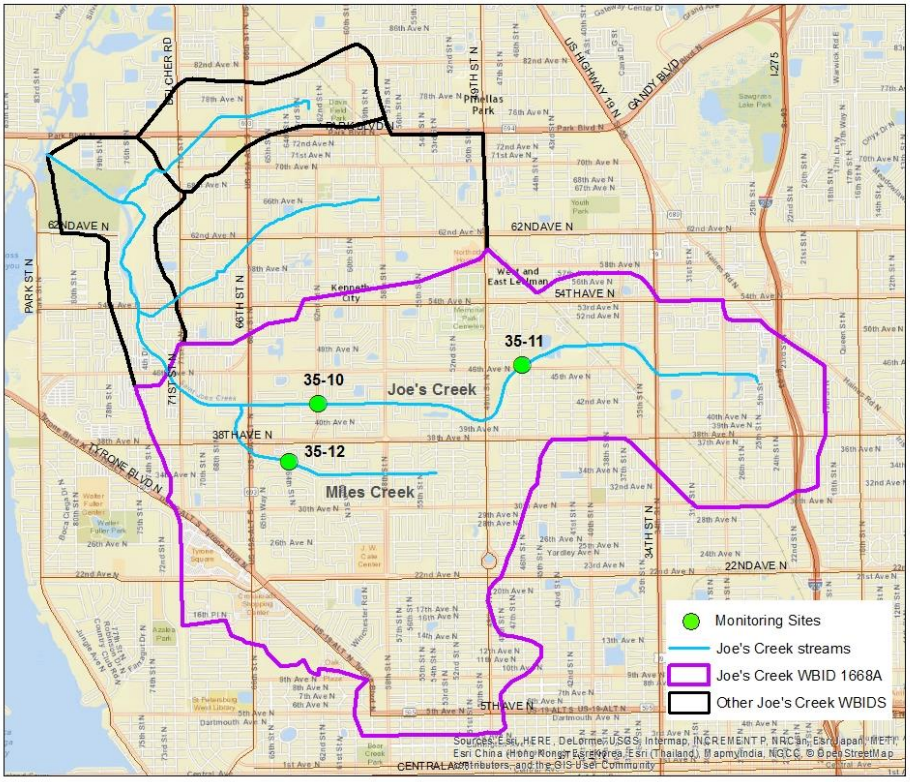

Figure 3. Pinellas County's active ambient water quality monitoring sites in WBID 1668A.

Table 2. Ambient water quality monitoring parameters and sampling methods.

Parameter	Method
Total depth	FDEP-SOP-001/01 FT 1000
Flow (Q)	PCSOP
Temperature (T)	FDEP-SOP-001/01 FT 1400
pH	FDEP-SOP-001/01 FT 1100
Dissolved Oxygen (DO)	FDEP-SOP-001/01 FT 1500
Specific Conductivity	FDEP-SOP-001/01 FT 1200
Salinity	FDEP-SOP-001/01 FT 1300
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Ammonia (NH_4)	SM 4500 NH3-H
Nitrate-Nitrite (NO_x)	SM 4500 NO3-F
Total Phosphorus (TP)	SM 4500-P E
Ortho-phosphorus (OP or PO_4)	SM 4500-P E
Chlorophyll *a*, corrected (Chl-a)	SM 10200-H
Chlorophyll *b* (Chl-b)	SM 10200-H
Chlorophyll *c* (Chl-c)	SM 10200-H
Total Suspended Solids (TSS)	SM 2540-D
Turbidity	SM 2130-B
Biochemical Oxygen Demand (BOD_5)	SM 5210-B
Enterococci (Ecoccus)	Enterolert
Fecal coliform (Fcoli)	SM 9222 D
Escherichia coli (Ecoli) *since 07/2015	SM 9213 D

Pinellas County also performs biological assessments of Joe's Creek and its tributaries at each of the active sites as part of its freshwater biological monitoring program. The program was established in 2014 to determine the biological health of the county's streams and creeks in support of assessment of the nutrient criteria. The stream sampling employs FDEP methods, all of which are cited in Chapter 62-160, F.A.C. The program includes:

1. Stream Condition Index (SCI) -- a composite macroinvertebrate index designed for use in flowing streams. Data generated from the taxonomy and relative abundance of these organisms is used to calculate ten biological metrics, each of which has been shown to respond predictably to human disturbance. Scores are assigned for each metric based on criteria which have been regionally calibrated.
2. Habitat Assessment (HA) – performed concurrent with each SCI collection to evaluate the amount of human disturbance.
3. Rapid Periphyton Survey (RPS) – measures the relative abundance of algae growing on stream substrate in a 100 meter stream segment.
4. Linear Vegetation Survey (LVS) – documents the plant community in a 100 meter stream reach. The average sensitivity of the plant community is calculated based upon each species' ecological tolerance to environmental changes and the percentage of invasive exotics.

Pinellas County will continue monitoring at the three existing sites on Joe's Creek and Miles Creek eight times per year. Annual estimates of water quality data and trends will be used to track the success of this plan and are included in the NPDES annual report. Investigations will be conducted to determine potential causes for results elevated above the typical range, and corrective actions will be implemented as

appropriate. If a high number of annual exceedances occur over consecutive years, options for additional monitoring may be evaluated.

3.0 Pollutant Load Determinations

The EPA TMDL assigned pollutant load allocations for waters in the Joe's Creek watershed and estimated the loading amounts contributed by each general source. The TMDL provided a wasteload allocation (WLA) for point sources, including MS4 stormwater discharges, and a load allocation (LA) for nonpoint sources. Equal WLA and LA reductions for TN and TP of 49% were required in the Joe's Creek freshwater (1668A) TMDL. In the Joe's Creek freshwater portion of the watershed (WBID 1668A), there are no point sources; therefore, all the WLA was attributed to stormwater and is expected to be addressed through the MS4 permit. Based on landuse in the watershed, the LA suggested reductions in potential sources such as animal waste, septic tank leakage, and commercial and residential fertilizer application (EPA 2008). The County and its partners have identified more specifically the most likely primary sources of pollutants in the watershed through a number of studies which are discussed in this section.

First, the physical composition and shape of the creek and its tributaries may increase the likelihood of low dissolved oxygen levels. Many of the Joe's Creek tributaries were constructed for stormwater conveyance and, as such, are concrete-lined. Portions of Miles Creek and Joe's Creek have been altered and are concrete-lined as well. The concrete channels and low gradients in the watershed result in little or no flow much of the time, which leads to higher water temperatures and lower dissolved oxygen than in a more natural streams system. During storm events, a large quantity of water enters the system quickly, bringing stormwater pollutants which then may be trapped in the low gradient channels. Although some fine sediments have settled over some of the concrete channels and some vegetation is growing, this substrate severely reduces the potential for a healthy, natural plant community which could filter out nutrients (Janicki 2005).

Additionally, irrigation runoff from urban sources such as private residential parcels and commercial landscape areas has the potential to carry measurable pollutant loads to receiving waters. Irrigation using reuse, potable water, or groundwater can contribute nutrient loads if the irrigation system's application rate exceeds the soil infiltration capacity or is directed over impervious surfaces. Water quality within the creek has higher nutrient concentrations in reuse areas, especially in Miles Creek (Figure 3.2 in URS 2017a), possibly due to the elevated nutrient concentrations in the irrigation water.

Septic systems, also known as on-site treatment and disposal systems (OSTDS), are less likely to be a significant nutrient source in the Joe's Creek watershed since almost the entire area is service by municipal wastewater collection, treatment, and distribution systems. However, approximately 4.6% of residential parcels in the unincorporated Pinellas County and Kenneth City area are served by OSTDS (URS 2017a). Effluent from poorly maintained and failing septic systems can be a significant nutrient source both to groundwaters and surface waters, so the county will evaluate these areas for connection to municipal wastewater systems in the future.

Sanitary sewer overflows (SSO) are a potential source of nutrients to Joe's Creek and Miles Creek. SSO incidents that have occurred within Pinellas County and the City of St. Petersburg for various reasons (grease blockage, pipe system/manhole seal failures, heavy rains, etc.) have been documented and were assessed. Between 2004 and 2014, 28 SSOs were noted within the Joe's Creek watershed, with 61% releasing less than 1,000 gallons and only five incidents discharging directly into a waterbody (URS 2017a).

A County-wide Wastewater-Stormwater Task Force is working towards collaborative solutions to addressing SSOs (http://www.pinellascounty.org/taskforce/default.htm).

Pinellas County and the City of St. Petersburg have been very proactive in researching possible sources and "hotspots" of water quality impairments in the watershed. Fixed station ambient monitoring continues, and several specific water quality investigations have been completed to refine the description of potential pollutant load sources, as described below.

3.1 Joe's Creek Nutrient Source Evaluation

Pinellas County conducted a targeted monitoring study in Joe's Creek in 2008 to attempt to identify sources of elevated nutrients (ERD 2010). Six surface water sites along Joe's Creek were monitored from July through September 2008 to characterize the quantity and quality of discharges through each area. The sites were monitored on a biweekly basis, which included measurement of field parameters, discharge rates (if applicable), and sample collection for laboratory analyses. The monitoring sites were located strategically along the flow path of Joe's Creek and were intended to identify areas of significant nutrient loading into the creek (Figure 4).

Figure 4. Nutrient source evaluation project monitoring sites (from ERD 2010).

The results of this study (Table 4) indicated that ambient concentrations of TN and TP measured within Joe's Creek were relatively low compared with concentrations commonly observed in urban drainage systems; however, much of Joe's Creek appeared to be a net source of TN and TP rather than a net sink due to inputs from the watershed exceeding removal processes within the creek.

Silver Lake, a nine-acre manmade lake at the headwaters of Joe's Creek, was identified as a significant source of nutrients, particularly phosphorus. The results of monitoring conducted upstream (Site 0) and

downstream (Site 1) of Silver Lake confirmed that the sediments within Silver Lake were a potential source of phosphorus to the water discharging through Joe's Creek. This is the only portion of the watershed where phosphorus concentrations increased despite a substantial decrease in measured concentrations of NOx, suggesting denitrification in an anaerobic environment within this lake (Table 3). Increases in both nitrogen (59%) and phosphorus (63%) loadings were observed between Sites 4 and 5, suggesting that the nutrient inputs within this section exceed the available uptake capacity. This is the largest relative increase in nutrient loadings observed within Joe's Creek after leaving Silver Lake.

Table 3. Mean TN and TP loads as estimated from five sampling events at sites along Joe's Creek (see Figure 4; adapted from ERD 2010).

Site	Mean TN Load (kg/day; lbs/day)	Mean TP Load (kg/day; lbs/day)
Site 0	2.06; 4.54	0.082; 0.18
Site 1	1.72; 3.79	0.191; 0.42
Site 2	2.77; 6.11	0.222; 0.49
Site 3	3.47; 7.65	0.283; 0.62
Site 4	2.99; 6.59	0.229; 0.50
Site 5	4.76; 10.49	0.374; 0.82

Nitrogen and oxygen isotopic signatures within the Joe's Creek system were consistent with nitrate derived from atmospheric deposition, fertilizers, and native soil organic matter, not associated with animal wastes or wastewater.

Shallow groundwater sampling was also conducted at two locations in the upper reaches of Joe's Creek as part of this study. Unlike the FDEP 2008 findings, groundwater samples collected at the two monitoring sites exhibited relatively low concentrations of both TN and TP, so groundwater was not considered a significant source of nutrient loading in this watershed. The study concluded with a recommendation that nonstructural source control programs such as street sweeping and public education could reduce the pollutant loads nearly as effectively as stormwater regulations.

3.2 Joe's Creek Annual Load Estimates From Ambient Program

The USGS maintains a continuous flow gage at the Pinellas County water quality station 35-11 (Figure 3). Pinellas County uses this data along with the ambient monitoring water quality results to estimate annual loads for TN and TP at this site. For the other sites, *in situ* flows are measured eight times a year when samples are collected and are used to estimate loads. Water quality metrics are assumed to be the same throughout a sample period (40.5 days for wet season periods and 50.75 days for dry season periods). Daily loads are estimated using the water quality data from the sample period and daily mean stream flow data calculated by the USGS at site 11 or by using the instantaneous flow recorded *in situ* at sites 10 and 12. Then, daily loads are summed to estimate annual loads at each site (Table 4). In general, higher loads are seen in years with more precipitation. Janicki Environmental has developed a process to hydrologically normalize County data to account for variation in rainfall from year to year which will allow for more precise determination of changes in loads. This analysis will be included in the annual NPDES report once complete.

Table 4. Annual loads for Joe's Creek at ambient monitoring sites 35-11, 35-10, and 35-12.

	Site 35-11		Site 35-10		Site 35-12	
Year	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
2003	16,580	1,560	15,575	1,327	10,945	811
2004	11,800	820	11,941	919	3,288	190
2005	5,880	500	4,169	296	2,786	159
2006	8,020	560	8,451	716	4,739	358
2007	4,540	460	1,656	159	807	94
2008	5,620	440	2,676	196	4,826	583
2009	7,520	580	6,189	656	4,597	465
2010	4,920	520	2,677	210	1,656	78
2011	7,080	920	3,033	359	2,587	218
2012	7,240	680	1,123	79	2,013	133
2013	8,040	820	11,452	1,495	9,676	1,176
2014	7,460	700	3,724	416	3,881	266
2015	11,980	1,280	9,450	922	8,672	858
2016	14,840	1,240	6,840	500	4,480	280

3.3 Joe's Creek Surface Water Resource Assessment

Most recently, Pinellas County, in cooperation with the City of St. Petersburg and the Southwest Florida Water Management District (SWFWMD), contracted with URS/AECOM to conduct a surface water resource assessment (SWRA) for Joe's Creek as part of the development of the Joe's Creek Watershed Management Plan. The purpose of this study was to evaluate the water quality of the watershed and examine the nonpoint source pollutant loads in subbasins in the watershed in support of effective BMP planning. The study area included all of Joe's Creek and its major tributaries.

A local, subbasin-scale pollutant loading model (PLM) was developed for the Joe's Creek watershed to estimate loading from stormwater runoff to the municipal separate storm sewer system (MS4) discharging to Joe's Creek and its tributaries. This runoff-driven model used a combination of GIS database analysis tools and Excel spreadsheet tools to compute average annual loads for TN, TP, and BOD_5. The model adjusted for existing structural BMPs throughout the watershed in order to display areas that are currently contributing the highest loads.

Figures 5 and 6 show the annual constituent loads by subbasin, with the highest loading areas represented in red. In general, the highest nonpoint source pollutant loadings for nutrients and BOD are coming from the eastern lobe of the watershed at the headwaters of Joe's Creek, where dominant landuses are industrial, commercial, and high density residential and few stormwater treatment BMPs are currently in place. Similar landuses west of the railroad divide are producing only moderately high annual loads due to the existing BMP service areas. The water quality sampling results from Station 35-11 are consistent with these PLM results, showing higher concentrations of pollutants than the downstream Station 35-10 results.

The other moderately high pollutant loading area is in the City of St. Petersburg at the southern extent of the watershed. Loads are coming from high density residential and low intensity commercial or institutional land uses south of 22nd Avenue North, areas with few existing BMPs in place and high runoff potential. West of 49th Street North, annual subbasin loads are lower (in a relative sense), with the exception of two regions contributing moderate loads comprising commercial corridors with few existing BMPs to reduce pollutants: the first region is located in Pinellas Park along Park Boulevard, and the other in the City of St. Petersburg in the vicinity of 66th Street North and 30th Avenue North. Table 5 shows the estimated average annual pollutant loads for the freshwater portion of Joe's Creek and Miles Creek.

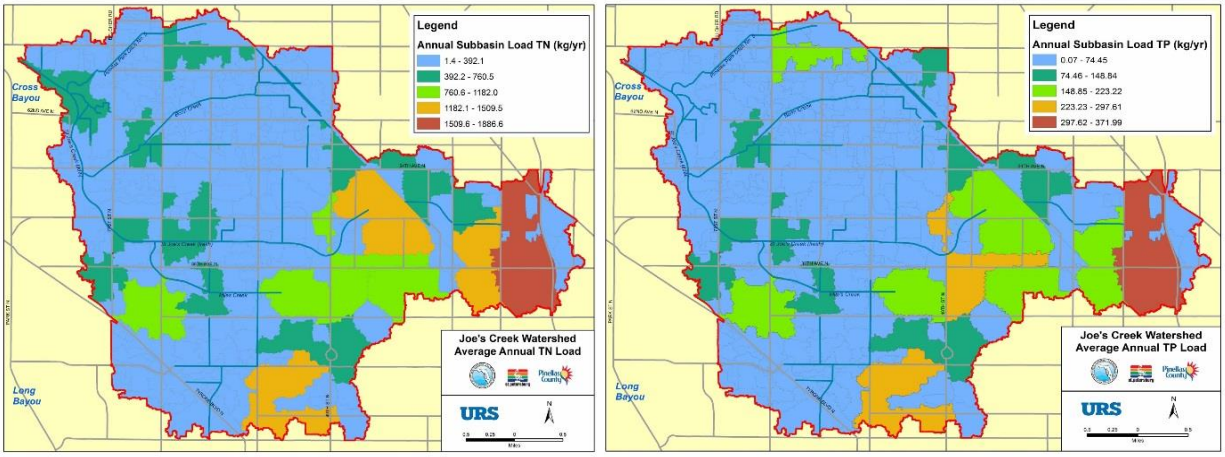

Figure 5. TN and TP loads in subbasins (from URS 2017a).

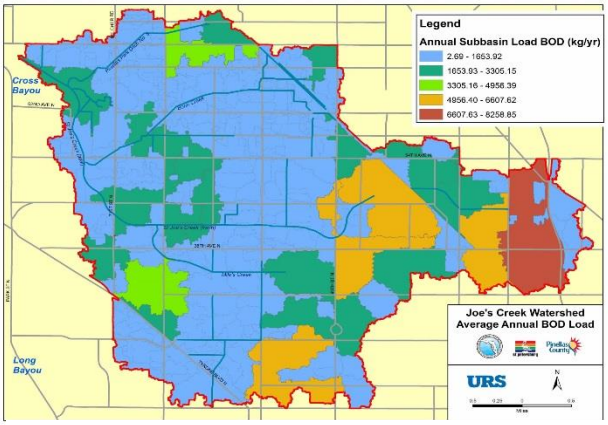

Figure 6. BOD_5 loads in subbasins (from URS 2017a).

Table 5. Average annual pollutant loads for WBID 1668A tributaries, Joe's Creek and Miles Creek (adapted from URS 2017a).

Major Tributary	TN (lbs/yr)	TP (lbs/yr)	BOD_5 (lbs/yr)
Miles Creek	24,791	4,971	120,476
Joe's Creek Freshwater	31,661	5,798	148,395

4.0 BMP Implementation

The TMDL assigned equal load reductions to nonpoint sources and stormwater sources in the Joe's Creek watershed. Pinellas County is actively implementing projects and programs addressing both of these types of pollution to improve the water quality in the Joe's Creek watershed. Both structural and non-structural BMPs are being used to prevent or mitigate the discharge of pollutant loadings in the watershed. A comprehensive Watershed Management Plan for Joe's Creek has just been completed, and it includes recommendations on flood control and water quality improvement projects in the BMP Alternatives Analysis Report (URS 2017b). As stated in Section VIII of the MS4 Permit Resource Manual (FDEP 2013), implementation of the supplemental TMDL Implementation Plan (a.k.a. Supplemental SWMP) will occur over more than one permit cycle in most cases, and nonstructural BMPs are the most cost effective method for reducing stormwater pollution.

4.1 Completed and Ongoing BMPs

Extensive research and monitoring have resulted in a good understanding of the pollutant sources in the Joe's Creek watershed. The following is a list of the **pollutant sources** and a summary of the BMPs that have either been completed or are ongoing to reduce nutrient loads from each source:

- **Silver Lake Sediments**
  Four alum treatments for the purpose of sediment phosphorus inactivation were performed from December 2013 through June 2014. The post-project monitoring report (ERD 2015) stated that "the sediment application reduced saloid-bound phosphorus concentrations in the sediments by approximately 56%, with a 57% reduction in iron-bound phosphorus and a 56% reduction in total available phosphorus within the sediments." Consequently, water column concentrations of soluble reactive phosphorus, particulate phosphorus, and total phosphorus were reduced under post-treatment conditions as a result of alum sediment inactivation. Total phosphorus concentrations were reduced by 15-20% within Silver Lake under post-treatment conditions compared with the assumed pre-treatment characteristics.
- **Stormwater**
  - Structural--Pinellas County and its partners have been implementing structural stormwater treatment controls associated with development since the late 1970's. Within the watershed, a total of 231 installed stormwater quality treatment systems were identified by URS (2017a) based on environmental resource permits and City of St. Petersburg records, including:
    - Dry retention (76)--captures water with controlled release of higher flows
    - Detention with filtration (118)—wet or dry detention with underdrain filtration
    - Wet detention/Wetlands (37)

    These structures are regularly inspected and maintained for optimum performance. Table 6 gives expected pollutant removal efficiencies for each type based on a review of literature values (URS 2017a).

Table 6. Pollutant removal efficiencies for typical structural BMPs (URS 2017a).

BMP Type	TN	TP	BOD_5
Online/Dry Retention	58%	63%	80%
Detention with Filtration	30%	60%	50%
Wet Detention (littoral zones)	30%	60%	50%

Figure 7, below, indicates the locations of the existing permitted retention and detention stormwater BMPs.

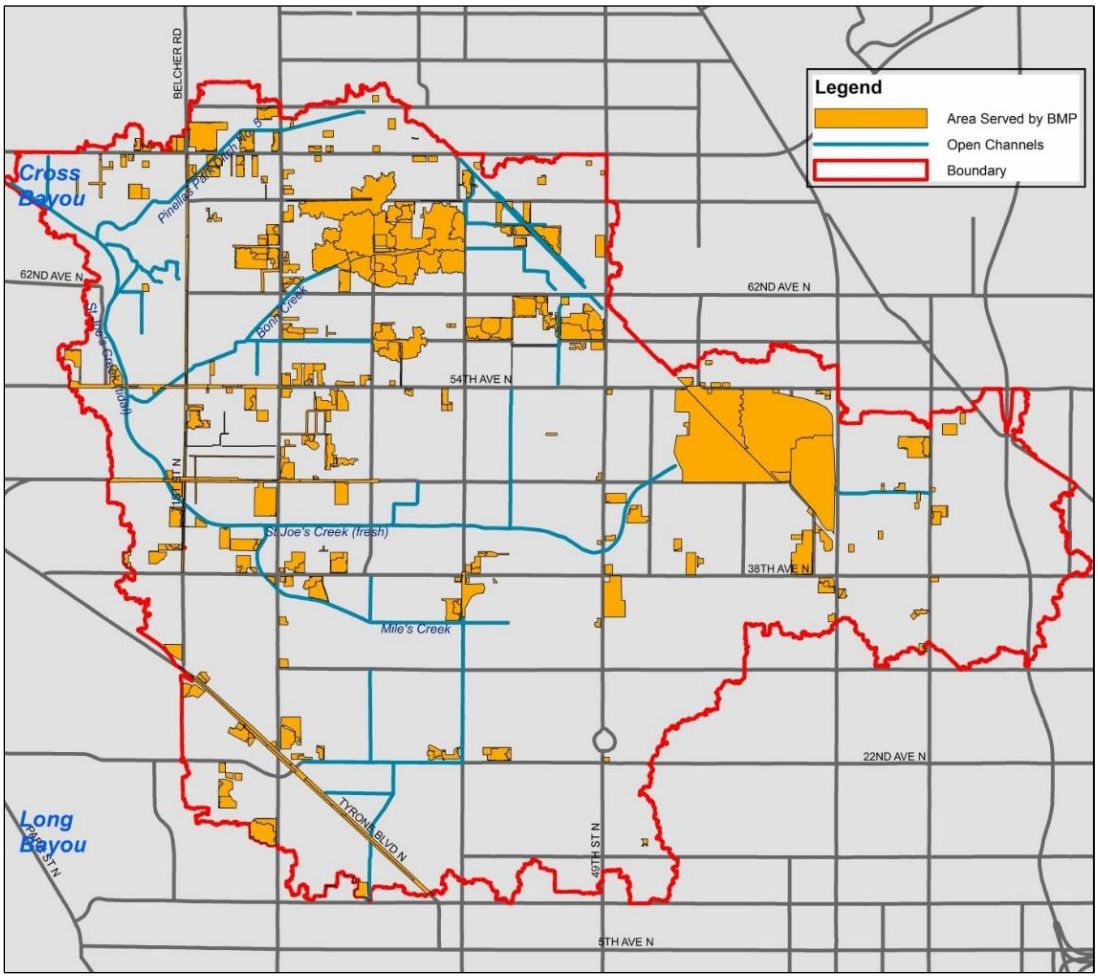

Figure 7. Existing permitted stormwater BMPs in the Joe's Creek watershed (from URS 2017a).

- The Town of Kenneth City added debris baskets at 35 locations (denoted by red boxes in Figure 8, below), a baffle box, and a vortex separator (Figure 8). The debris baskets are cleaned approximately quarterly and yield between 0.5 and 1.0 cubic yards of material, equating to an estimated removal of up to 16 lbs of TP and 24 lbs of TN.

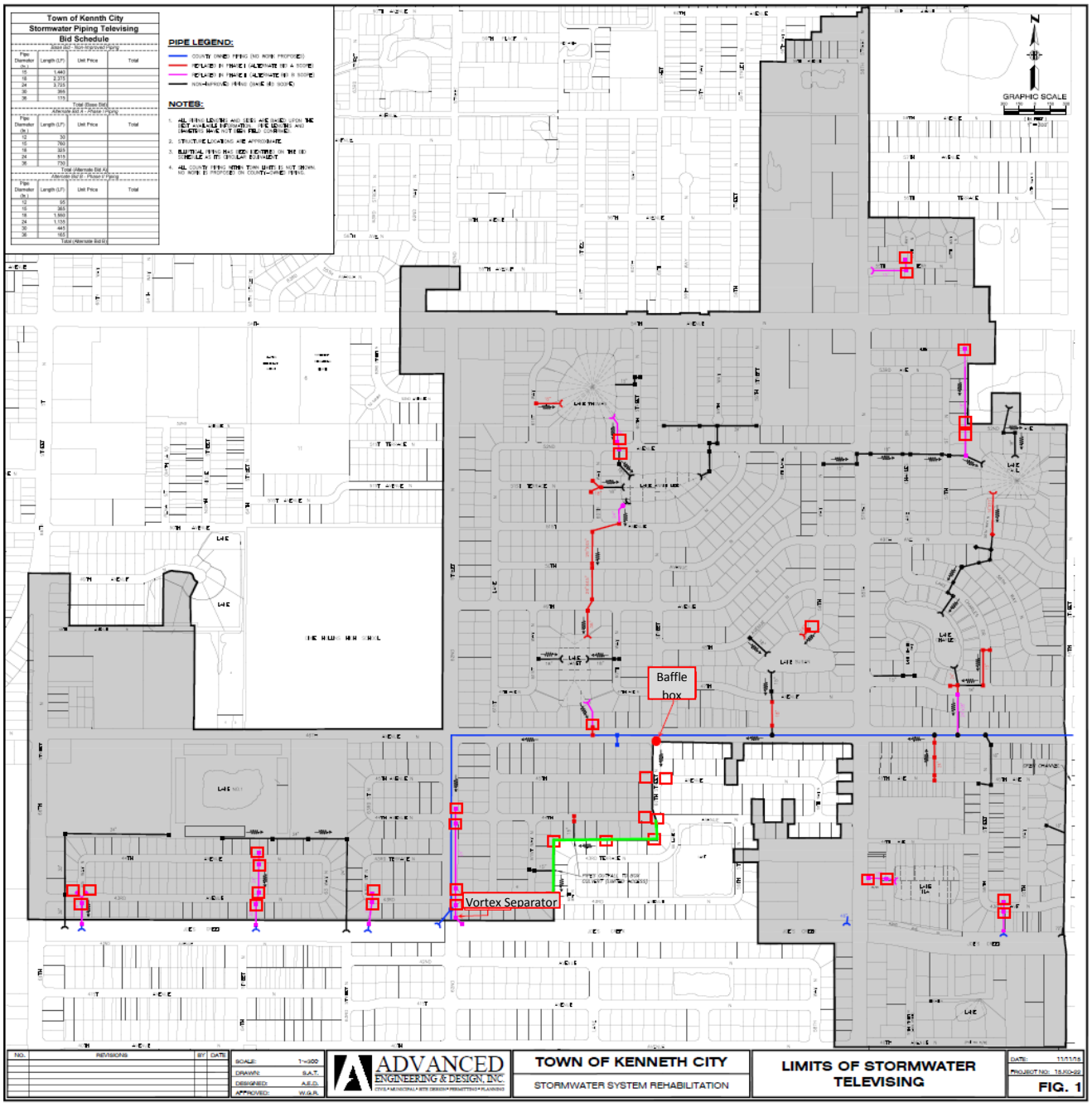

Figure 8. Town of Kenneth City stormwater BMP locations. Red boxes indicate debris baskets.

- Lealman Pond—the most recent wet detention facility was completed in 2016 and will remove approximately 341 lbs of TN per year and 77 pounds of TP per year from a 77 acre area in the watershed (Figure 9, below).

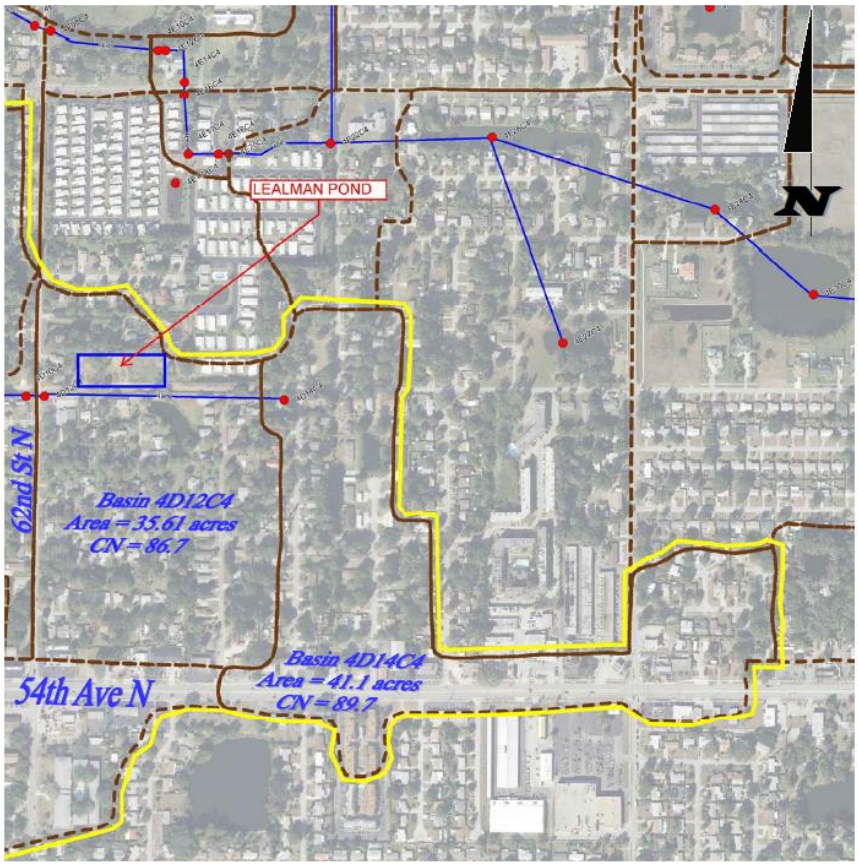

Figure 9. Lealman Pond location and drainage area.

- Ditch maintenance--removal of accumulated sediment and nuisance vegetation from more than six miles of target areas in Joe's Creek since 2012, followed by grading and sodding.
- Stormwater pipe cleanouts—more than 12 miles of County pipes and structures have been cleared of debris and sediment since 2012. About 12,500 cubic yards of material were removed from the stormwater system (ditches, pipes, and permitted facilities) during this time, equating to removal estimates of 11,951 lbs of TP and 19,460 lbs of TN. The City of St. Petersburg is currently implementing a sanitary sewer rehabilitation and pipe lining project throughout the city and within the watershed.
- Stormwater pond compliance and enhancement--Pinellas County began a Stormwater Pond Compliance and Enforcement Program and reestablished the Adopt-a-Pond program in 2014. Both programs are aimed towards improving privately owned stormwater ponds. Currently, there are two Adopt-a-Pond groups in the watershed.
- Street sweeping--reduces total suspended solids and associated pollutant wash-off from urban streets. Pinellas County, the City of St. Petersburg, and Kenneth City have street sweeping programs in place. The County and St. Petersburg are targeting areas in the Joe's Creek watershed for a more frequent sweeping schedule. Pinellas County estimates 72 pounds per year TP removed and 112 pounds per year TN removed from the

watershed. Kenneth City estimates removal of 75 tons of debris annually, which is estimated to result in 54 lbs of TP and 84 lbs of TN removed from the watershed.

- New Pinellas County Stormwater Manual and Code adopted in March 2017—employs the use of BMP trains in addition to standard stormwater treatment designs for nutrient reduction. Redevelopment of properties requires new or expanded stormwater management areas to reduce the pollutant contribution from stormwater runoff. This increases the water quality treatment required for projects that create new impervious surface. The City of St. Petersburg now requires stormwater management areas for redevelopment sites even if there is no increase in impervious area.

- **Fertilizer and Landscape Management**
  - Enacted in 2010, the County-wide fertilizer ordinance, which regulates the types of fertilizers that can be sold and used, as well as how and when fertilizers may be applied, is expected to minimize the nutrient loading from residential and commercial areas. Given the large percentage of residential and commercial landuse, this ordinance could have a significant impact on nutrient reductions in Pinellas County. Additionally, the landscape management program requires all "mow and blow" type personnel to attend BMP training which includes extensive education on managing debris.
- **Sanitary Sewer**
  - Targeted inspection of manholes along Joe's Creek for signs of unreported SSOs.
  - Recent infrastructure upgrades--cleaning of more than 71 miles of the 110 miles of sanitary sewer pipe in the watershed, lining 16 miles of sewer mains, lining 302 manholes, improvement of three pump stations, and smoke testing of 43 miles of pipe. Lining of the remaining portions of unlined gravity sewer main along Joe's Creek is scheduled to be complete by 2018.

In addition to implementing BMPs, Pinellas County and its partner municipalities have been initiated extensive **Public Outreach and Education campaigns**, including:

- Door-to-door distribution of educational materials on pet waste and water quality impacts
- Signs, trash receptacles, and pet waste stations strategically placed along the creek and in Greenway Park
- Displays at events
- Water quality education campaign focusing on the connection between trash/debris and water quality in the Joe's Creek/Lealman neighborhood
- Bi-annual cleanup events in the Joe's Creek watershed
- Stormdrain markers, all partners. Kenneth City is currently updating.
- Pinellas County Environmental Management website with environmental brochures, videos, and links
- Pinellas County Watershed Education Campaign which includes billboards, PSAs at local movie theaters, social media, digital media, vehicle wraps, and other outreach efforts
- Annual Lakes & Ponds Education Seminar related to the function and maintenance of stormwater ponds in Pinellas County
- The City of St. Petersburg holds various events throughout the city in which stormwater education materials are displayed.
- The Town of Kenneth City provides information on watering restrictions, fertilizer use, herbicide use, pesticide use, and illicit discharges through brochures and its website. Kenneth City has also held public events to promote stormwater quality to residents and business owners and has

applied for a grant to fund vehicle wraps to inform about proper disposal of pet waste and lawn clippings.

4.2 Planned BMPs

With the progression of the NPDES programs and current stormwater management research, goals and objectives for stormwater treatment now include:

- Increased requirements for nutrient removal,
- Established requirements for discharges to impaired waters,
- Updated BMP design criteria and allowance for BMP treatment train credits,
- Encouragement of low impact or green infrastructure design, and
- Encouragement to seek retrofitting opportunities.

The Surface Water Resource Assessment referenced in previous sections identified areas in which to target BMP implementation to achieve the greatest load reductions. In conjunction with this assessment, URS examined a number of BMPs and recommended options to achieve water quality improvements. Determination of potential target areas for water quality BMPs was accomplished by:

1. Reviewing the Pinellas County ambient water quality database and evaluating average annual conditions by parameters along the various stream or ditch segments;
2. Assessing the relative average annual subbasin loads (kg/year) of total suspended solids (TSS), biochemical oxygen demand (BOD), TN, and TP from the Joe's Creek Pollutant Loading Model (PLM) and identifying the top ten contributor basins for each parameter;
3. Assessing the relative average annual unit loads (kg/acre-year) for TSS, BOD, TN, and TP and identifying the top 10 contributor basins by intensity for each parameter; and
4. Identifying municipally-owned or potentially acquirable green spaces serving areas of similar land use/loading potential as the top contributing subbasins.

The results of this effort are shown in Figure 9, below.

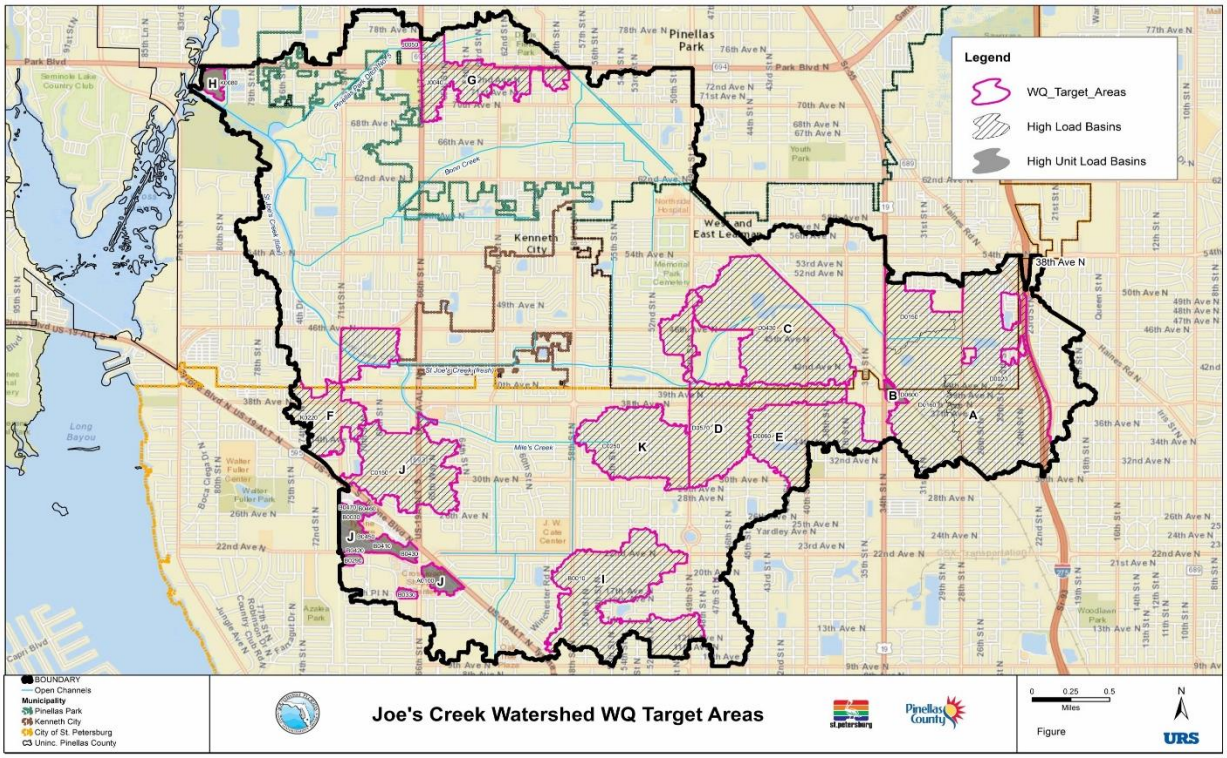

Figure 9. Joe's Creek watershed target areas for water quality BMP implementation (from URS 2017b).

A variety of flood control (FC) and water quality (WQ) BMPs were considered and prioritized, including:

- Detention ponds (Structural FC)
- Add conveyance structures (Structural FC)
- Re-route flow from overtaxed systems (Structural FC)
- Raise structures/roadways (Structural FC)
- Purchase flood affected areas (Non-Structural FC)
- Improve capacity of channels (Structural FC)
- Dry retention areas (Structural WQ)
- Pretreatment retention or terraced detention with biofiltration (Structural WQ)
- Green streets right-of-way infiltration trench (Structural WQ)
- Street sweeping program frequency or extent modifications (Non-Structural WQ)
- Ordinance controls (Non-Structural WQ)
- Rainwater harvesting and low-impact development (LID)/redevelopment incentives (Non-Structural WQ)

A summary of the WQ BMP recommendations from this analysis is in Table 7, and estimated load reductions and project costs are given in Table 8. Specifics of the model used and concept sketches of each BMP considered are located in the Alternative BMP Analysis Report (URS 2017b). Based in part on the URS analysis, the County will be proposing BMP projects for the Joe's Creek watershed to be funded through the 2020 Penny for Pinellas Fund. Projects will be implemented starting in 2020, to be completed by 2030 at the latest. BMPs may also be implemented with cooperative funding through SWFWMD programs focused on natural systems and water quality improvements and flood protection. Currently, a new project to assess water quality BMPs in priority areas of the watershed through a County partnership with the Florida Department of Transportation (FDOT) is expected to begin in 2018.

Table 7. Description of Joe's Creek priority BMP projects for water quality improvement (adapted from Table 4-2, URS 2017b).

BMP #	Problem Area ID (from Fig. 8)	Problem Area Description	Location	Jurisdiction	BMP	Proposed Structure Size	Length (ft.)	Estimated Construction Cost	Comments
WQ-1	A	Industrial, commercial and high density residential areas east of 34th Street N (US Hwy 19) draining to Silver Lake and thence to Joe's Creek	Silver Lake stormwater detention pond	Unincorporated Pinellas County	Pretreatment BAM-enhanced infiltration swale. ½ inch capture capacity over 29.2 acres	Swale area at TOB=32,284 SF 3H:1V bank slopes; 2-foot retention depth	Trench Length = 1,600	$390,000	BMP site is on County-owned lands. Project also provides water quality benefit for City of St. Petersburg contributing areas.
WQ-3	E	Older high density residential areas in the City of St. Petersburg between 30th Ave and 38th Ave N and between 35th and 45th Streets N draining to Joe's Creek	Existing flood detention pond located between 33rd Ave and 34th Ave N	City of St. Petersburg	Pretreatment BAM-enhanced infiltration swale. ½ inch capture capacity over 38 acres	Swale area at TOB=51,470 SF 3H:1V bank slopes; 2-foot retention depth	Trench Length = 1,250	$372,000	BMP site is on City-owned lands.
WQ-4	J	Older high density residential areas in the City of St. Petersburg between 64th and 70th Streets N draining to Joe's Creek	30th Ave N green median.	City of St. Petersburg	Pretreatment BAM-enhanced bio-filtration swale. ½ inch capture capacity over 9.8 acres	Swale area at TOB=20,414 SF 3H:1V bank slopes; 1-foot retention depth	Trench Length = 857	$277,000	BMP site is on City-owned right-of-way.
WQ-5	F	High density residential areas located between Tyrone Boulevard and 38th Ave N in St. Petersburg and similar areas in unincorporated Pinellas County east of 71st Street N between 40th Ave and 46th Ave N, draining to Joe's Creek	County-owned open parcel on south bank of Joe's Creek (east of 71st Street N and north of 41st Terrace N)	Unincorporated Pinellas County	Pretreatment dry retention facility. ½ inch capture capacity over 45.7 acres	Area at TOB=55,108 SF 3H:1V bank slopes; 2-foot retention depth	---	$250,000	BMP site is on County-owned lands. Project also provides water quality benefit for City of St. Petersburg contributing areas.

Table 8. Pollutant load reduction and cost estimates for Joe's Creek priority water quality BMP projects (adapted from Table 4-3, URS 2017b).

BMP	Description	Cost Estimate	Outfall	TN Load Reduction (lb/year)	TP Load Reduction (lb/year)	TSS Load Reduction (lb/year)	BMP Drainage Area (acres)	Estimate of Cost/lb of TN Removal	Estimate of Cost/lb of TP Removal	Estimate of Cost/lb of TSS Removal	Estimate of Cost/Acre of Drainage Area
WQ-1a	Silver Lake pre-treatment with BAM-enhanced infiltration	$390,000	Upper Joe's Creek	80.4	23.8	3,524	29.2	$2,205	$7,448	$50	$13,356
WQ-1b	Silver Lake pre-treatment with in-situ soils infiltration	$135,000	Upper Joe's Creek	77.7	16.6	3,407	29.2	$790	$3,697	$18	$4,623
WQ-3a	St. Petersburg 33rd-34th Ave pond BAM pretreatment	$372,000	Joe's Creek	94.5	28	3,736	38	$1,789	$6,039	$45	$95
WQ-3b	St. Petersburg 33rd-34th Ave pond pretreatment (no BAM)	$183,000	Joe's Creek	91.4	19.6	3,611	38	$910	$4,244	$23	$91
WQ-4a	St Petersburg 30th Ave N biofiltration	$277,000	Joe's Creek	26.9	8.3	1,231	9.8	$4,681	$15,170	$102	$28,265
WQ-4b	St Petersburg 30th Ave N exfiltration	$111,000	Joe's Creek	13.5	5.5	1,163	9.8	$3,737	$9,174	$43	$11,327
WQ-5	Joe's Creek dry retention	$250,000	Joe's Creek	106.6	22.3	4,579	45.7	$1,066	$5,096	$25	$5,470

Many projects have been implemented, are ongoing, and are planned to reduce the nutrient loads and improve/maintain the dissolved oxygen levels in the Joe's Creek watershed to the maximum extent practicable. BMPs in this watershed have expected average nutrient load reductions ranging from 30% to more than 70%. Water quality trends in the County have been stable or improving, due at least in part to the management activities. Pinellas County and its partner municipalities are actively refining methods to more accurately measure loads and load reductions and updating ordinances to accomplish continued water quality improvements.

5.0 References

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