Focus Assessment Report: West Caloosahatchee Basin

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INTRODUCTION

BACKGROUND

The Northern Everglades and Estuaries Protection Program (NEEPP; Section 373.4595, Florida Statutes) directs the South Florida Water Management District (SFWMD or District) in cooperation with the Florida Department of Environmental Protection (FDEP) and Florida Department of Agriculture and Consumer Services (FDACS), collectively referred to as the Coordinating Agencies, and local entities, to complete a watershed protection plan (WPP) for the Caloosahatchee River Watershed (CRW). In 2020, SFWMD began the process of reviewing all the Northern Everglades WPPs annually and committed at the February 11, 2021, SFWMD Governing Board meeting to complete basin-specific assessments in areas identified to be the highest priority for action as part of the watershed protection planning process. The purpose of the assessments is to gather information to pinpoint the most significant nutrient sources contributing to the water quality problems, determine what remains to be done to improve water quality

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and recommend strategic actions for future planning. Information from the assessments will be used to update the WPPs and to inform future FDEP Caloosahatchee River and Estuary (CRE) Basin Management Action Plan (BMAP) updates. This report documents the assessment completed for the West Caloosahatchee Basin (known as West Basin herein) Focus Area in the CRW.

LOCATION OF BASIN

The West Basin is centrally located within the CRW between the Tidal Basin and the East Caloosahatchee Basin (**Figure 1)**. The West Basin covers 350,116 acres (**Figure 1**) in the CRW. It is primarily located in Glades and Hendry counties but also includes portions of Charlotte, Collier, and Lee counties. The West Basin has historically had the largest contributions of total nitrogen (TN) loads, TN unit area loads (UALs), total phosphorus (TP) loads, TP UALs, and flow compared to the other CRW basins, which is why it was selected as a focus area basin at a public workshop in 2020 (**Figure 2)**.

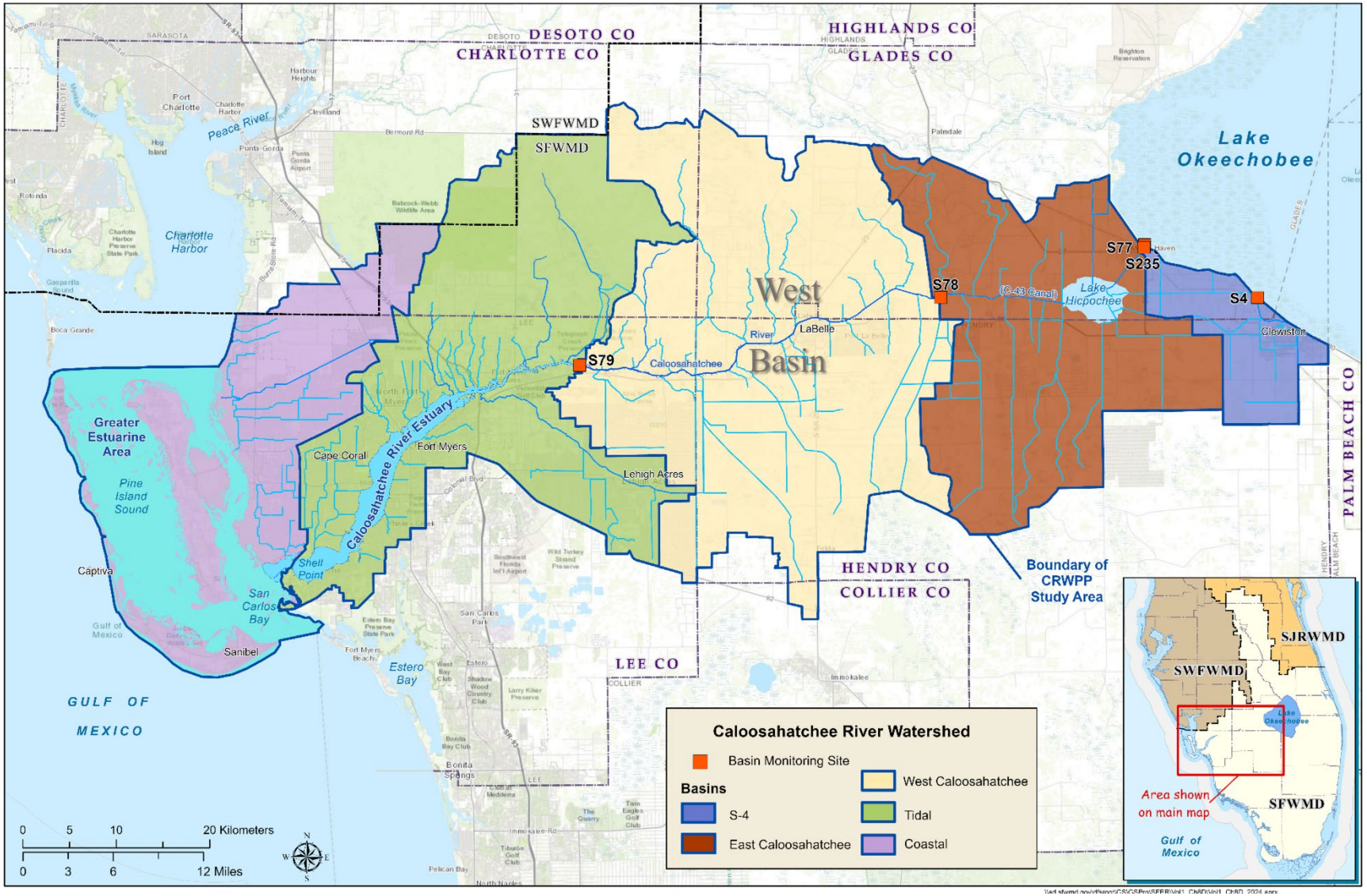


Figure 1. The CRW with its basins and major water control structures. Modeled basin areas (including the Coastal Basin which is not part of the CRW) are also depicted (Figure Source: Taylor et al. 2024 Draft South Florida Environmental Report(SFER), Figure 8D-1).

5-Year Average (WY2016 - 2020)

	TN (mt)	TN FWM (mg/L)	TN UAL (lbs/ac)	TP (mt)	TP FWM (mg/L)	TP UAL (lbs/ac)	Flow (ac-ft x 10^3)	Area (acres)
West	1128.6	1.22	7.1	136.06	0.147	0.856	751.14	350,115
East	513.5	1.88	5.642	63.82	0.233	0.689	221.77	204,093
Tidal Basins	510.56	0.92	4.529	54.33	0.097	0.482	451.98	248,298
S-4	80.13	2.29	4.187	9.49	0.271	0.496	28.36	42,155

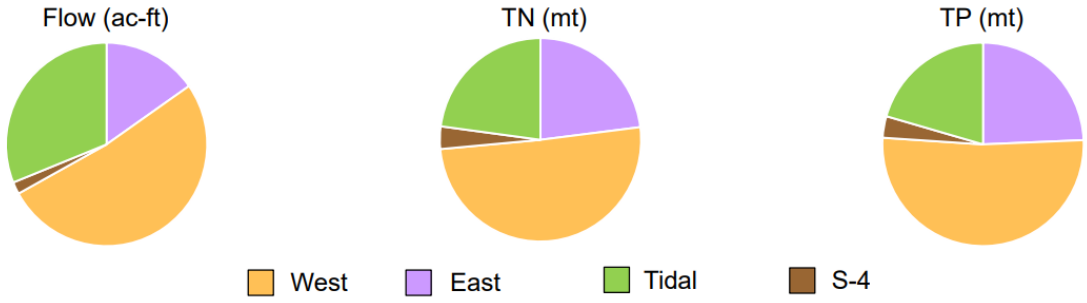


Figure 2. CRW Basin Pie Charts presented at the September 2, 2020 Public Workshop.

NUTRIENT AND STORAGE TARGETS

The TN planning targets for the West Basin were developed in consultation with FDEP via the Coordinating Agencies Technical Team meetings (March 2022). FDEP provided the starting loads and TN reductions needed for each basin in the CRW (M. Frick, personal communication, September 20, 2021). The starting loads were based on the Hydrological Simulation Program Fortran (HSPF) model that was used to develop the TMDL for the CRE. The TN required reduction was based 23% reduction required by the Total Maximum Daily Load (TMDL). The TN planning target load for the West Basin is 611 metric tons (t)[9] based on a 5-year moving average (Olson, 2023). The 5-year moving average is proposed to align with the compliance requirements laid out by FDEP in the 2022 5-Year Review of the Caloosahatchee River and Estuary Basin Management Action Plan (FDEP, 2022a). The purpose of the planning target is to allow an assessment of existing and proposed programs and projects against the planning targets to determine where adjustments are needed.

The West Basin is subject to the CRE TMDL and a portion of the basin is subject to the tributary TMDLs developed for Townsend Canal (Water Body Identification number (WBID) 3235L). The sections below explain how the TMDLs and the planning targets relate to one another.

TN Estuary TMDL and Respective Basin Planning Targets

Table 1 depicts a brief history of the TMDL development. In 2009, FDEP established the TMDL (Bailey et al., 2009) by modeling the effect of flow and TN on seagrass health. FDEP developed the HSPF model that was used to estimate start input loads and reduced these loads to achieve desirable conditions in the estuary, as predicted by the Environmental Fluids Dynamics Code (EFDC) model (Bailey et al., 2009). Based on the prediction, a 23% reduction in the TN load would be required to achieve desirable conditions (Bailey et al. 2009).

In 2020, FDEP revised the HSPF model, then used the results to develop starting TN loads for CRW. Then FDEP applied the 23% TMDL load reduction percentage to the starting TN loads in the 2020 CRE BMAP (FDEP, 2020) to obtain needed TN reductions. The results show CRW starting loads of 1,796 t/yr

[9] The conversion factor used was 1 metric ton = 2,204.62 lbs

of TN with a required reduction of 413 t/yr (**Table 2**). The SFWMD's CRW planning target of 1,383 t/yr of TN (**Table 2**) is equivalent to the FDEP compliance load target for the CRE and is based on subtracting the required TN reduction from the starting load (FDEP, 2022a; Olson, 2023). Of that total watershed planning target load, 44% comes from the West Basin (611 t/yr, Olson, 2023). **Table 2** also presents the TN start loads, required reductions and basin planning targets for each of the CRW Basins. If these long-term planning targets can be achieved, the CRW should achieve the TMDL.

CRE BMAP Targeted Restoration Areas

The 2020 CRE BMAP (FDEP, 2020) also evaluated the TN concentrations against the benchmark of the numeric nutrient criteria (1.54 mg/L for TN) to determine the Targeted Restoration Area (TRA) priority for the CRW subbasins. The TRA priorities were updated as part of the 2022 5-Year Review of the CRE BMAP (FDEP, 2022a). The Cypress Creek Subbasin was given a priority of 1 which is the highest priority (**Figure 3, Table 3)**.

The CRE TMDL does not address phosphorus. However, the 2020 CRE BMAP (FDEP, 2020) identified where phosphorus could be reduced through projects and programs and evaluated the TP concentrations against the benchmark of the numeric nutrient criteria (120 µg/L for TP) to determine the TRA priority. All the subbasins with sufficient data to evaluate were ranked as a Priority 3 for TP, or the lowest priority [i.e., to be addressed as resources allow (**Table 3)]**.

Table 1. Brief history of TMDL and compliance target for CRE.

Date	Event
2009	FDEP establishes 23% TN load reduction needed
2020	FDEP revised model used to develop original numbers and adjusted the starting loads in BMAP update
2022	FDEP published 5-year BMAP review stating that 3,048,783 lbs (1,383 t) TN is the compliance target for CRE

Table 2. BMAP Modeled TN Start and Reduction Loads and Basin Planning Targets (Data Source : BMAP start loads (M. Frick personal communication, Sept. 20, 2021); Basin Planning Targets from Olson, 2023).

Basin	BMAP TN Start Load (lbs/yr)	BMAP TN Start Load (t/yr)	TN Required 23% Reduction (lbs/yr)	TN Required 23% Reduction (t/yr)	Basin Target Load (lbs/yr)	Basin Planning Target Load (t/yr)
East Caloosahatchee[a]	1,008,818	458	232,028	105	776,790	352
Tidal Caloosahatchee	1,200,195	544	276,045	125	924,150	419
West Caloosahatchee	1,750,448	794	402,603	183	1,347,845	611
CRW Total	**3,959,461**	**1,796**	**910,676**	**413**	**3,048,783**	**1,383**

[a]FDEP includes the S-4 Basin with East Caloosahatchee.

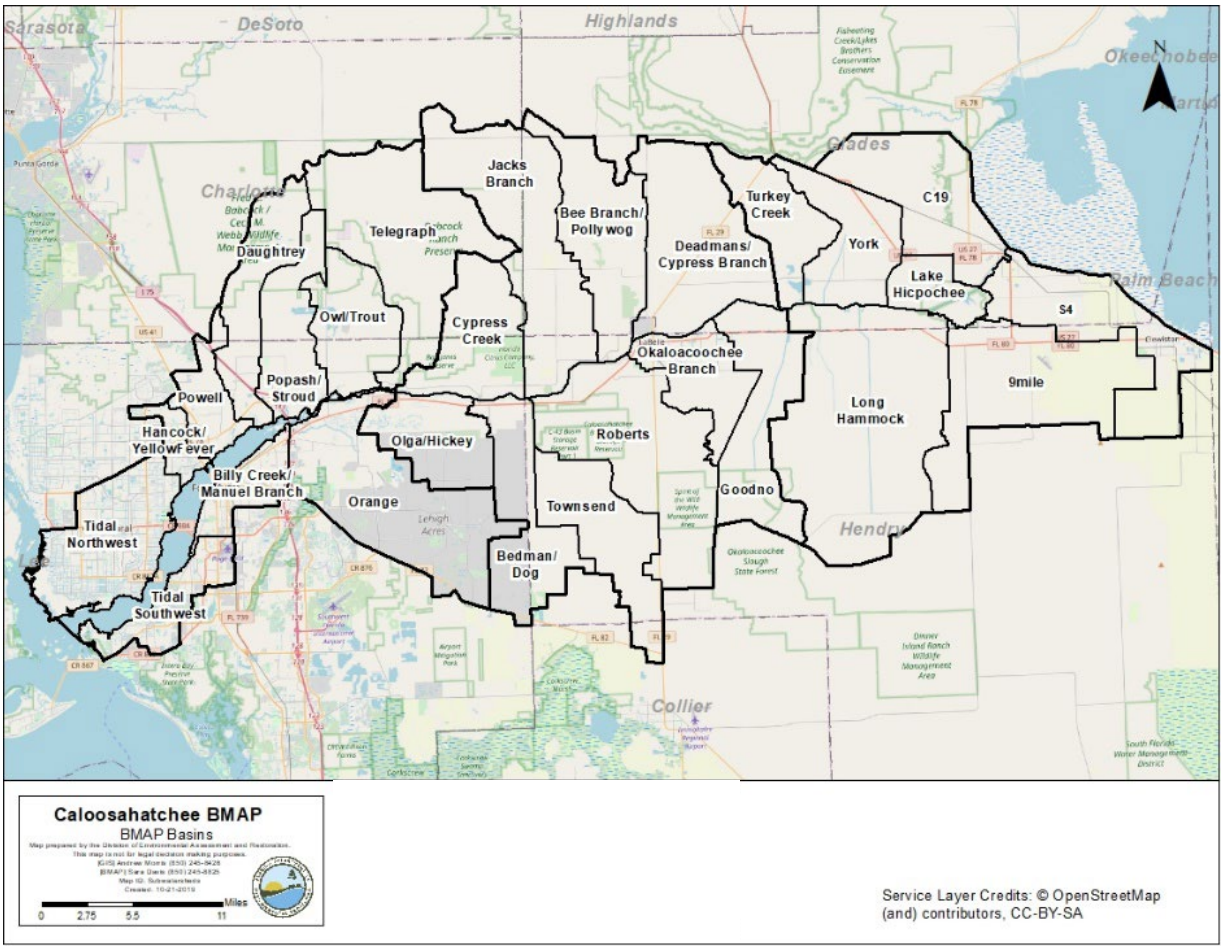


Figure 3. FDEP's Caloosahatchee River subbasins (Figure Source: 2020 CRE BMAP, Figure 3).

Table 3. TRA Evaluation Results for the subbasins of the West Basin (Data Source: FDEP, 2022a 5-Year Review of the Caloosahatchee River and Estuary BMAP, Table 13).

Subbasin	Station	TN Priority	TP Priority
Bedman/Dog	37-4GR	2[1]	3
Bee Branch/Pollywog	G3SD0085	Insufficient Data [2]	Insufficient Data [2]
Cypress Creek	CYPRESSGR/ FICHTERSGR/ SPANISHGR	1	3
Deadmans/Cypress Branch	N/A	Insufficient Data	Insufficient Data
Goodno	N/A	Insufficient Data	Insufficient Data
Jacks Branch	N/A	Insufficient Data	Insufficient Data
Okalocoochee Branch	N/A	Insufficient Data	Insufficient Data
Olga/Hickey	38-3GR	2	3
Roberts	G3SD0146	Insufficient Data	Insufficient Data
Townsend	WQ SITE 15	2	Insufficient Data[3]

[1]This was an increase in priority from the 2020 BMAP TRA for this subbasin.
[2]In the 2020 BMAP, TN and TP were both ranked as 3.
[3]This subbasin was ranked as priority 3 in the 2020 BMAP.

TP and TN Tributary TMDLs and Planning Targets for Townsend Canal

The Caloosahatchee Tributaries TMDLs were adopted in 2019 and established TN, TP, and biochemical oxygen demand (BOD) reduction targets for five freshwater tributaries, including the (1) S-4 Basin, (2) C-19 Canal, (3) Lake Hicpochee, (4) Long Hammock Creek, and (5) Townsend Canal (FDEP, 2019). Out of these tributaries, only the Townsend Canal is in the West Basin (**Figure 4**). FDEP set a 37% reduction for TN and a 38% reduction for TP loads in the Townsend Canal for the TMDL (FDEP, 2019). Similar to the CRE TMDL, the 2020 CRE BMAP (FDEP, 2020) presented starting loads for the five freshwater tributaries and the planning targets for the tributaries are based upon subtracting the TMDL required percent reductions from the revised starting loads (Olson, 2023), which are equivalent to the compliance loads laid out in the 2022 5-Year Review of the CRE BMAP (FDEP, 2022a). The Townsend Canal Subbasin planning targets of 73 t/yr of TN and 6 t/yr of TP (**Table 4**) are based on a 5-year moving average and are consistent with the compliance requirements presented in the 2022 5-Year Review of the CRE BMAP (FDEP, 2022a).

Storage Targets

Previously, there have been no storage targets specifically set for the West Basin. As part of the CRW Protection Plan, the Northern Everglades Regional Simulation Model (NERSM) was used to estimate a storage target of 400,000 ac-ft for the CRW (SFWMD et. al, 2009) but no specific targets were provided at the basin level. The 2020 CRE BMAP (FDEP, 2020) did not include a TRA assessment of water quantity as they had not yet completed the flow evaluation. FDEP indicated that when that evaluation is completed, it will be included in future BMAP annual updates. Through this assessment it was determined that the annual average storage needed to assist with meeting the West Basin planning target of 611 mt/yr TN would be between 190,000 and 335,000 ac-ft. Information on how that storage planning target range was developed is provided in the Additional Nutrient Reductions and Storage Needed Section below.

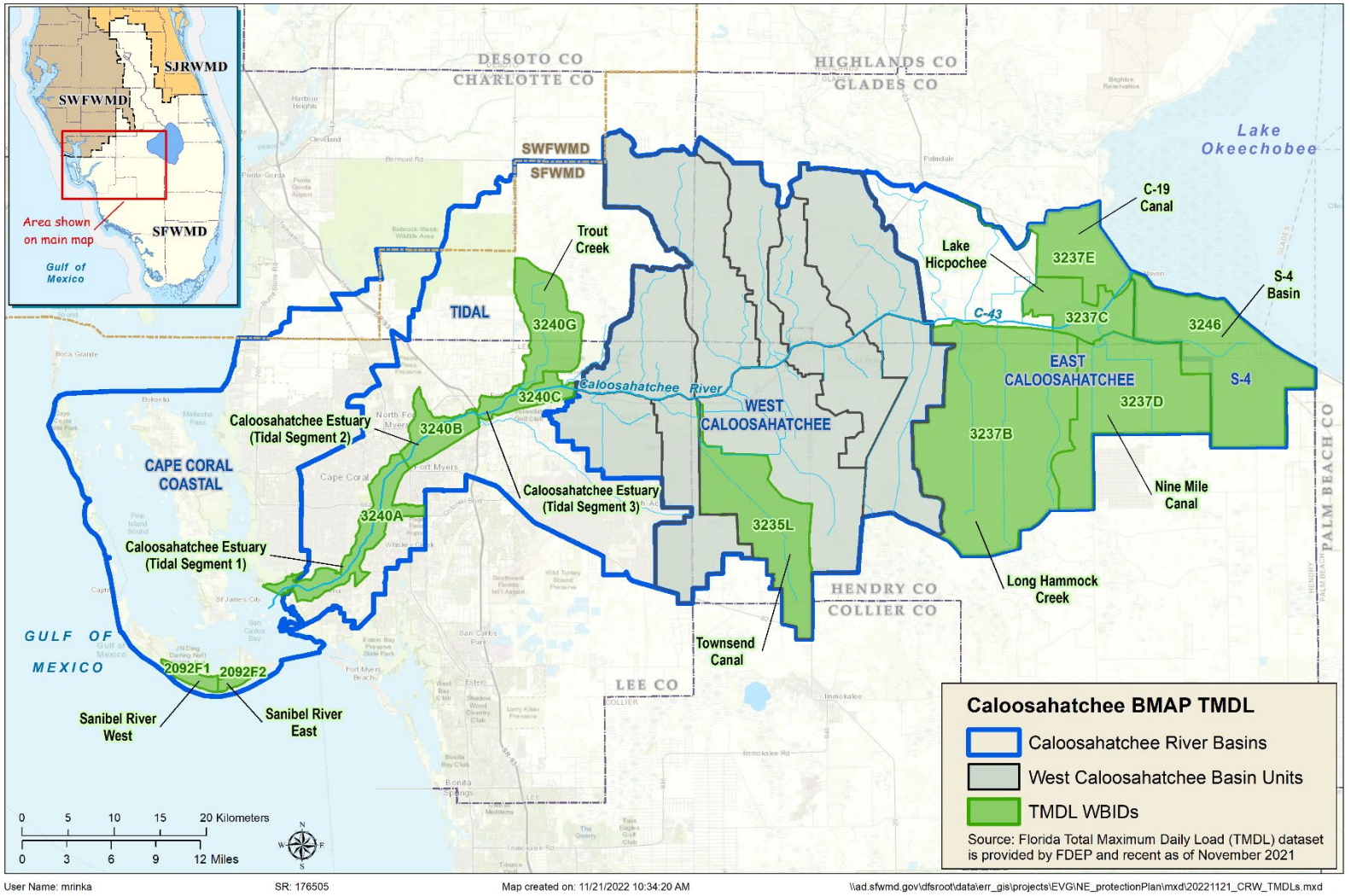


Figure 4. Caloosahatchee River and Estuary TMDL WBIDs.

Table 4. Townsend Canal modeled start and reduction loads, and planning targets (Data Source: BMAP start loads FDEP 2020 CRE BMAP; WBID Planning Target equals compliance target in 2022 5-Year Review of CRE BMAP; Planning Targets in t/yr from Olson, 2023).

WBID	Parameter	BMAP Start Load (lbs/yr)	BMAP TN Start Load (t/yr)	TMDL Required % Reduction	TN Required 23% Reduction (lbs/yr)	TN Required 23% Reduction (t/yr)	WBID Planning Target Load (lbs/yr)	WBID Planning Target Load (t/yr)
Townsend Canal (3235L)	TN	254,468	115	37	94,153	43	160,314[1]	73
	TP	23,065	10	38	8,765	4	14,300	6

[1]This is the value that was published in the 2022 5-Year Review of the Caloosahatchee River and Estuary BMAP (FDEP, 2022a) and is slightly different from the calculated target load of 160,315 lbs/yr. Note that the differences in these values do not change the WBID planning target load.

BASIN OVERVIEW

HYDROLOGY

The West Basin is located in the central portion of the CRW. The Caloosahatchee River (C-43 Canal) is the primary conveyance for local basin runoff. The West Basin is delimited by the S-78 structure on the eastern end of the C-43 canal, and the S-79 structure (also known as the W.P. Franklin Lock and Dam) on the western end (**Figure 1**). Both structures are gated spillways. S-78 aids in control of water levels on adjacent lands upstream. The S-79 is the most downstream structure and marks the beginning of the CRE. The S-79 helps maintain specific water levels upstream, regulates freshwater discharges into the estuary, and serves as an impediment to saltwater intrusion upstream (SFWMD et al. 2009).

The West Basin has been divided by the SFWMD into 10 hydrologic subbasins (**Figure 5, Table 5)**. Five are tributaries to C-43 from the north (from east to west: Deadman's Branch, Pollywog Creek, Bee Branch, Jacks Branch, and Cypress Creek), and five are from the south (from east to west: Goodno, Labelle East, LaBelle West, Bedman Branch, and Hickey Creek). Note that these subbasins do not align with the FDEP hydrologic subbasins depicted in **Figure 3**.

Table 5. West Caloosahatchee Subbasins.

Tributary	Subbasin	Acreage
From the north	Bee Branch	22,664
	Cypress Creek	29,040
	Deadman's Branch	37,766
	Jacks Branch	52,885
	Pollywog Creek	19,620
From the south	Bedman Branch	29,035
	Goodno	32,349
	Hickey Creek	21,346
	LaBelle East	20,872
	LaBelle West	84,538

Figure 5. Hydrology of the West Basin.

WATER AVAILABILITY

Water availability refers to both the quantity and timing of flows relative to watershed objectives and project operations. To conduct the water availability analysis for the West Basin, the following monitoring stations (**Figure 5**) and their relationship to the Caloosahatchee River (C-43) were considered: the S-79 structure (basin outflow), Townsend Canal (tributary inflow), Jack's Branch (tributary inflow), Goodno Canal (tributary inflow), and the S-78 structure (basin inflow). Since the S-78 flow monitoring station located on C-43 is the upstream boundary of the West Basin (**Figure 5**), its hydrograph is used as the basin inflow hydrograph for the West Basin. Similarly, since the S-79 is the downstream boundary of the West Basin (**Figure 5**), its hydrograph is used as the basin outflow hydrograph for the West Basin. This analysis

of water availability was performed for water years (WY) 2020 – 2022 from 5/1/2019-4/30/2022. **Table 6** provides a summary of available data for the stations in DBHYDRO, SFWMD's corporate database (https://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu).

Table 6 West Basin Flow Monitoring Stations in DBHYDRO.

Site	Station	Station Name	DBKEY	Available Data Period
Townsend	Townsend	Townsend Canal	94695, 00860*	12/01/1975-9/30/1992, 12/18/2018-Present
02292740	02292740	Jacks Branch	94694	11/16/2018-Present
02292490	02292490	Goodno Canal	94693	12/04/2018-Present
S78	S78_S	S-78 Spillway	DJ236	5/1/1996-Present
S79	S79_TOT	S-79 Spillway	15045, DJ237, 00865, AN851	1/1/1963-Present

*DBKEY 06522 also contains flow data for the Townsend Canal but only at irregular intervals and is not recommended for use in this analysis.

The following sections summarize the water availability analysis for each of the five stations. Specifically, two metrics (flow exceedance and available flow) are introduced here. The flow hydrographs presented show the daily flow data at each station over the POR, and the exceedance graph shows the frequency that the observed flow exceeded a given rate and can be used as a general assessment regarding how "available" water may be to existing and planned projects (for example: flow exceeds 500 cfs only 2% of the time).

Available flow is defined for this purpose as the 90th percentile flow observed during the evaluation period, or the flows that were available 90% of the time. This criterion was selected to omit rare and extreme flow events and better define "normal" conditions under which water might be available to existing and planned projects. Flows exceeding the 90th percentile are not readily captured by project inflow pumps, because extreme events in these systems occurred over a wide range of flows and for short durations. Instead, volumes exceeding the available flow might be addressed through stormwater detention, wetland restoration, and other passive methods.

S-78 STRUCTURE

The S-78 structure is located on the Caloosahatchee River (C-43) about 16 miles downstream from Lake Okeechobee (**Figure 5**). It is a gated spillway that controls the discharge into the river and maintains the upstream stage. This structure is operated and maintained by the U.S. Army Corps of Engineers (USACE) to maintain an optimum headwater elevation of 11.1 feet (NGVD29), and to pass the design flood at 8,660 cfs. **Figures 6 and 7** show the flow hydrograph and exceedance curve for this structure, respectively.

The flow hydrograph (**Figure 6**) reveals regular fluctuations that result from the operational management of the structure. For WY2020-2022, the discharge from S-78 had a maximum and average flow of 6,466 and 1,047 cfs, respectively. The peak discharge of 6,466 cfs occurred on 11/10/2020 and was a result of Tropical Storm Eta. Available flow (90th percentile) was 1,853 cfs (**Figure 7**). Zero-flow conditions occurred approximately 3% of the time for this POR.

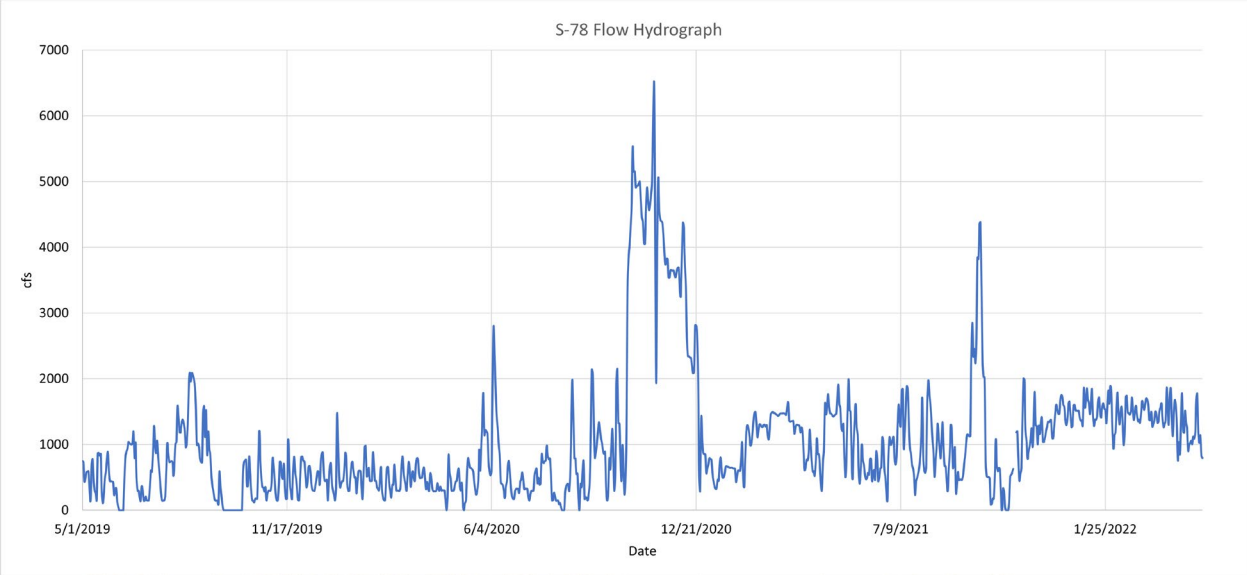


Figure 6. S-78 Flow Hydrograph for WY2020-2022 (Data source: DBHYDRO).

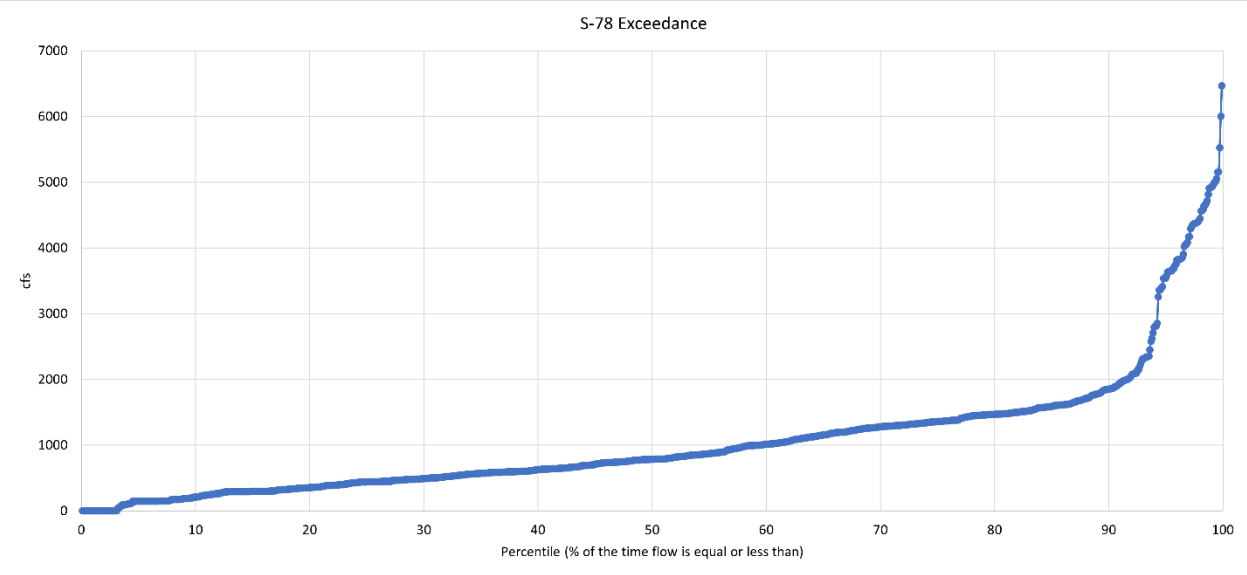


Figure 7. Flow exceedance curve at structure S-78 for WY2020-2022 (Data source: DBHYDRO).

S-79 STRUCTURE

The S-79 structure (W.P. Franklin Lock and Dam) is located on the Caloosahatchee River (C-43) near Olga, about 27 miles west of S-78 (**Figure 5**). S-79 is a coastal structure and therefore experiences tidewater on its western side. This structure is operated and maintained by the USACE and is set to pass the base flow passively. Larger flows are controlled by operatable gates.

In 2001, SFWMD adopted a Minimum Flows and Levels (MFL) rule as one of the mechanisms to protect the minimum necessary water supplies for natural systems to prevent significant harm (SFWMD, 2021). The original Caloosahatchee River MFL rule required a minimum mean monthly flow of 300 cfs at the S-79 water control structure to protect the downstream estuary. The MFL rule is reevaluated periodically to maintain its effectiveness. After an extensive review and incorporation of new science about the effects of flow and salinity on the downstream estuary, the MFL value for S-79 was increased to 457 cfs in June 2021 to prevent significant harm to the ecology of the estuary (SFWMD, 2021). This increase in the MFL has affected the operational procedures and planning for this structure and influenced the water availability through the structure. Additionally, an in-depth study was conducted to develop biologically and ecologically driven metrics for evaluation and assessment of salinity regimes that sustain healthy ecosystems (optimum flows versus minimum flows) in several estuaries in the Northern Everglades (RECOVER). That report determined that optimum flows at S-79 between 750-2100 cfs would produce maximum potential habitat area in the optimal salinity ranges for the Caloosahatchee estuary.

Figures 8 and **9** illustrate the S-79 flow hydrograph and exceedance curve, respectively, for the period of WY 2021 – 2022 when the new MFL was implemented. **Table 7** shows the results of average flow for this structure for the pre MFL period of WY2001 – 2020 and post MFL change for WY2021 and WY2022. From WY2001- WY2022, the discharge from S-79 has maximum and average flow of 13,136 and 2,330 cfs, respectively. The maximum discharge occurred on November 10, 2020, as a result of Tropical Storm Eta. Zero-flow conditions occurred less than 1% of the time for WY21-22.

Available flow (90th percentile) was 4,948 cfs (**Figure 9**). Discharges less than the MFL (457 cfs) occurred approximately 2% of the time, and discharges less than the minimum optimum flow (750 cfs) occurred about 7% of the time.

Table 7. S-79 annual flows, pre- and post-MFL change.

WY Period	Average Flow (cfs)
2001 – 2020 (MFL = 300 cfs)	2,188
2021 – 2022 (MFL = 457 cfs)	2,329

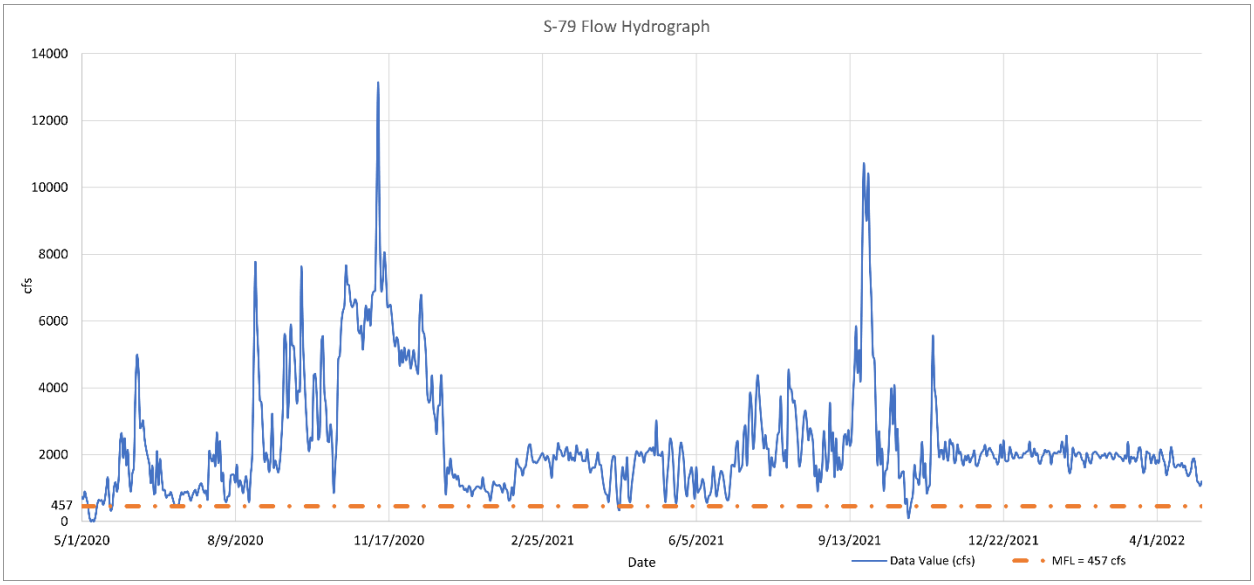


Figure 8. S-79 Flow Hydrograph (Data source: DBHYDRO).

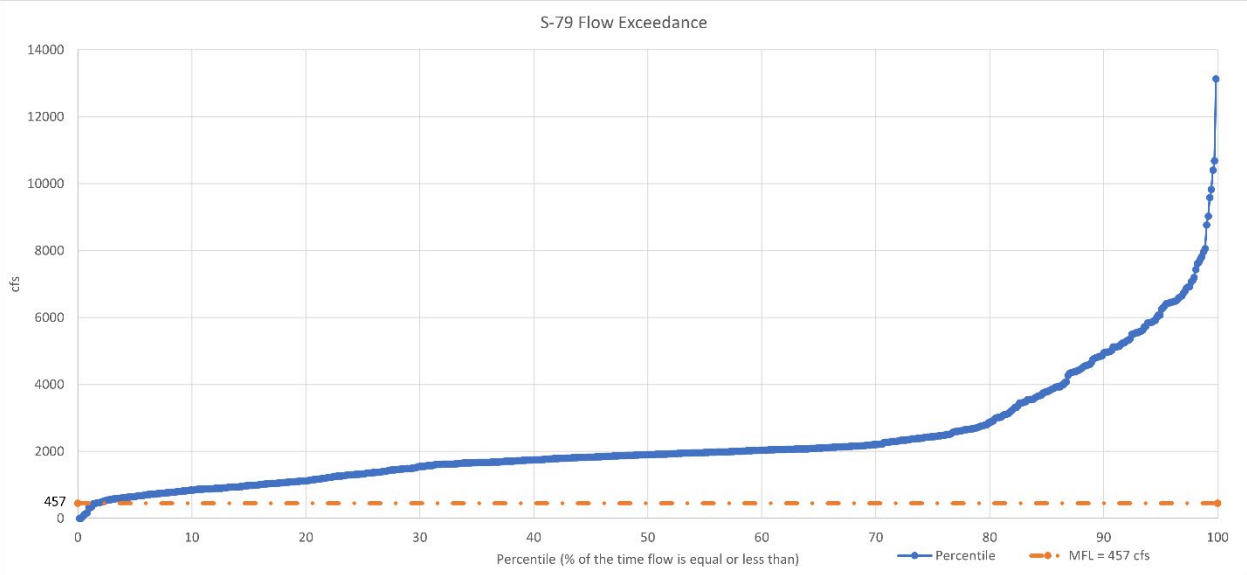


Figure 9. Flow exceedance curve at structure S-78 for WY2021-2022 (Data source: DBHYDRO).

GOODNO CANAL

Goodno Canal is a 13.4-mile drainage canal located south of the S-78 structure near LaBelle within the West Basin. It starts at County Road 832 as Canal 2 and continues to the north and connects to the Caloosahatchee River below the S-78 structure (**Figure 5**). USGS station 02292490 collects flow data measurements for this canal before discharging to the river. For WY2020-WY2022, the canal had a maximum flow of 327 cfs, and an average flow of 26 cfs. **Figure 10** shows the flow hydrograph for this canal for the period WY2020-2022. The hydrograph indicates "flashy" discharge characterized as short duration and high-volume flows which may limit water availability for future projects. Available flow (90th percentile) was 72 cfs (**Figure 11**). For the POR considered here, there were no zero-flow conditions.

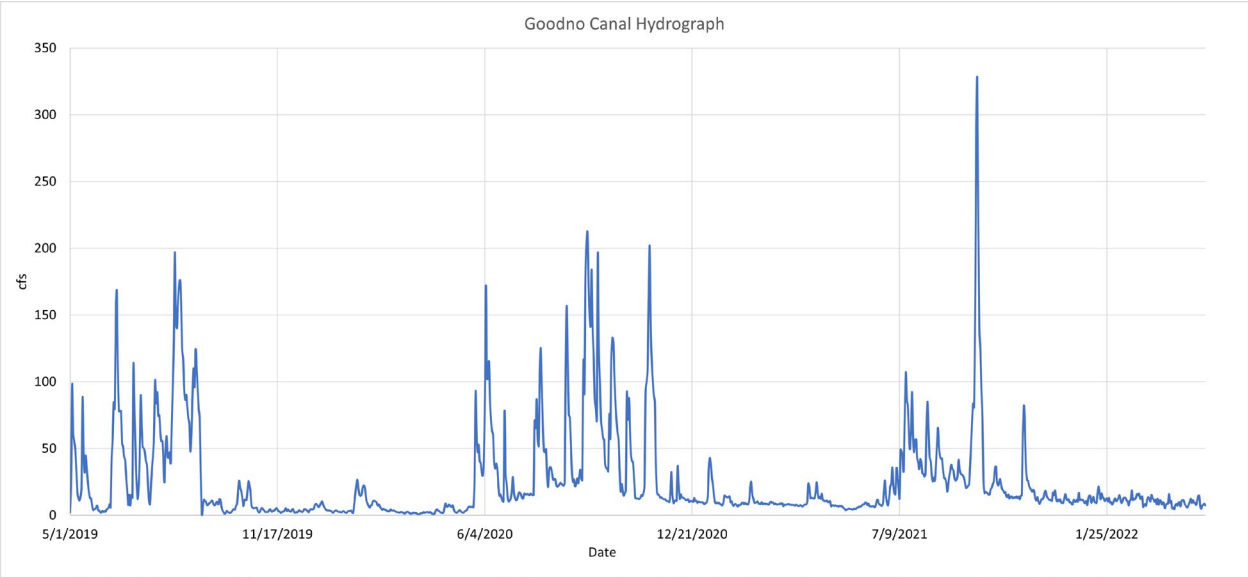


Figure 10. Goodno Canal Flow Hydrograph (Data source: DBHYDRO).

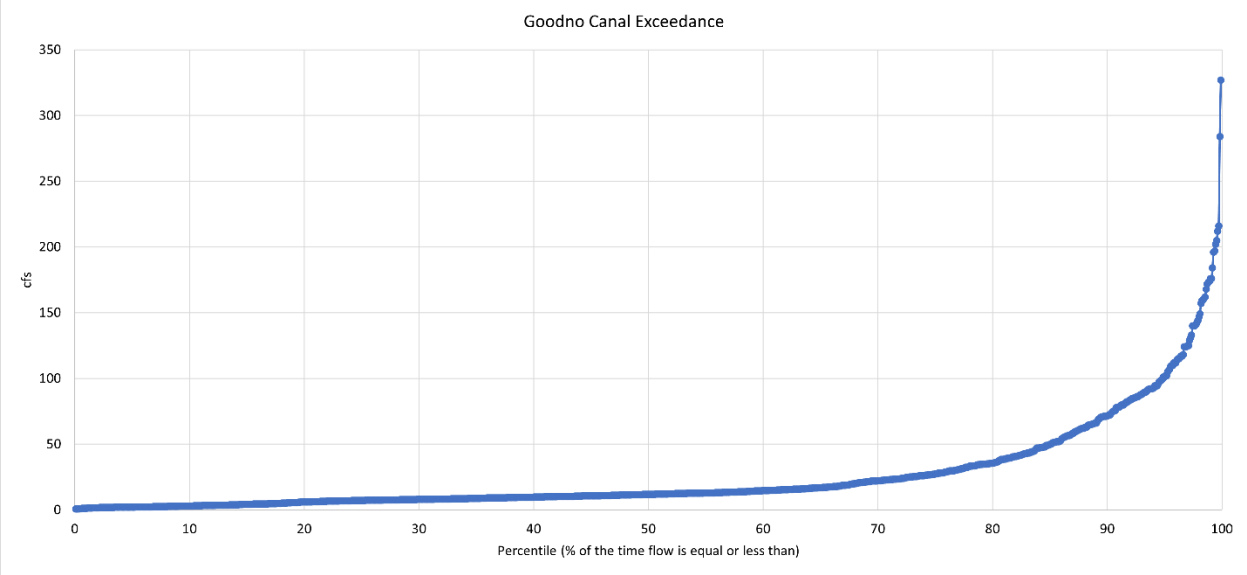


Figure 11. Flow exceedance curve at the Goodno Canal WY2020-2022 (Data source: DBHYDRO).

TOWNSEND CANAL

Townsend Canal is a 16.5-mile canal located near Alva, within the West Basin (**Figure 5**). It is a dual-purpose canal that serves as a drainage canal for basin runoff as well as water supply for upstream irrigation needs and for the upcoming C-43 Storage Reservoir and Water Quality Component. Under normal conditions it flows downstream (to the North) into the C-43 Canal. However, periods of negative flow are observed and reflect pumping upstream for water supply needs. For the WY2020-WY2022, the exceedance graph (**Figures 12** and **13**) of Townsend Canal indicates negative flow approximately 50% of the time. Available flow (90th percentile) was 340 cfs. While many of the pumps are privately owned and operated, the S-476-P structure was built approximately 2.8 miles south of the C-43 Canal as part of the reservoir complex to provide irrigation water to lands on the east side of the reservoir. Additionally, once the reservoir is complete, the S-470 pump structure, located approximately 1.0 miles south of the C-43 Canal, will serve as the main inflow to pull water from the Townsend Canal to hydrate the C-43 Reservoir. When planning for future projects, considerations must be made for the reverse-flow conditions that occur regularly in the Townsend canal because of pumping at S476-P, the other irrigation pumps, and eventual operation of the C-43 reservoir.

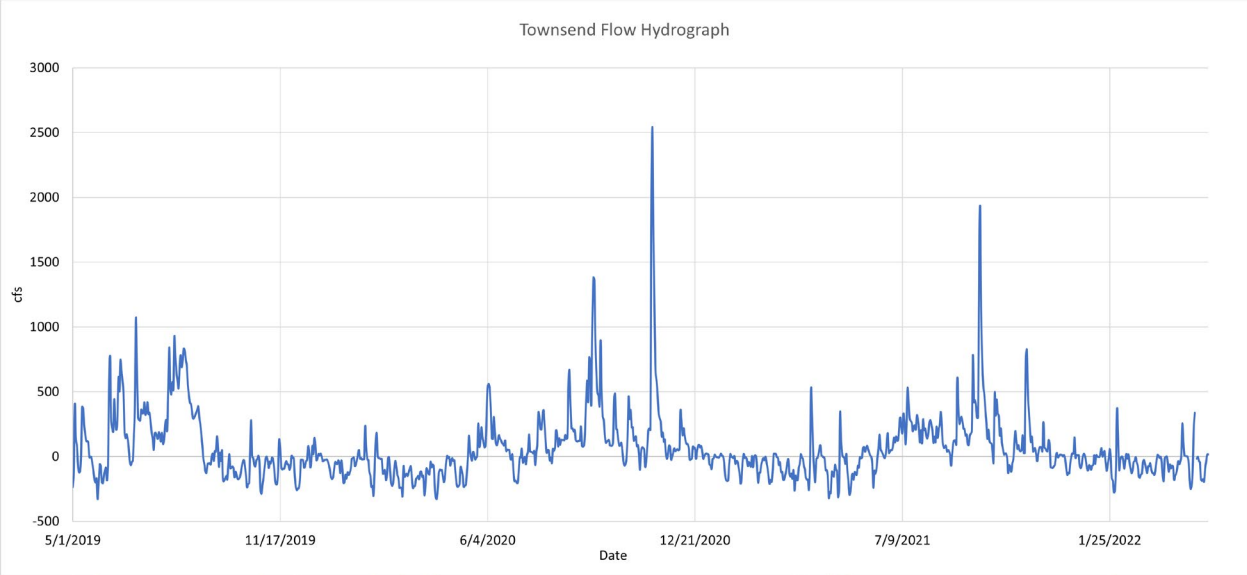


Figure 12. Townsend Canal Hydrograph (Data source: DBHYDRO).

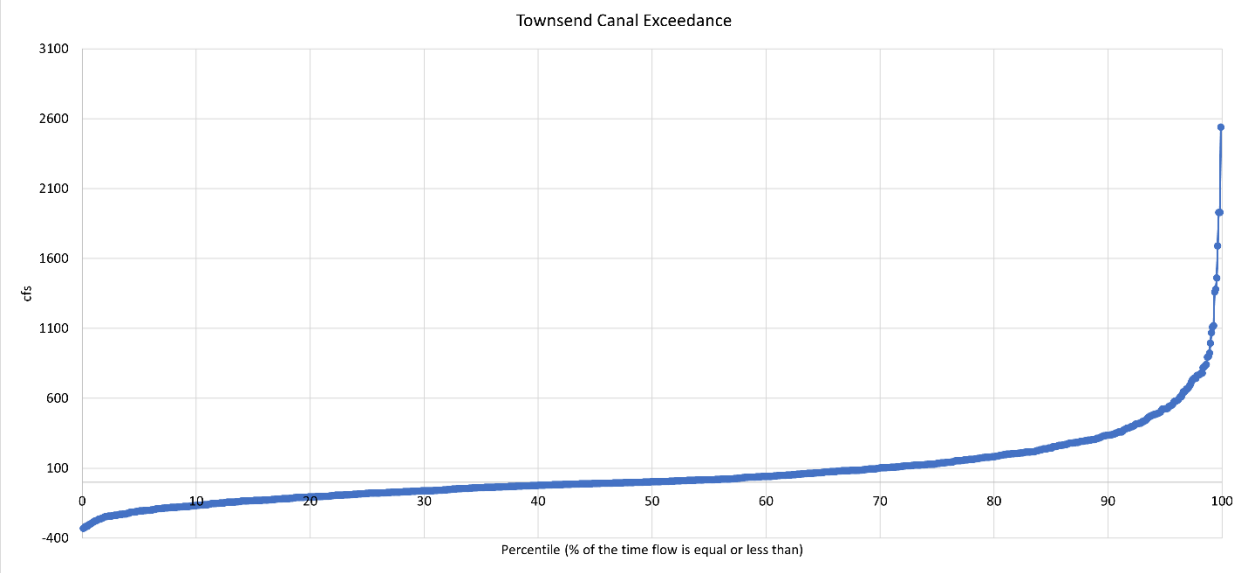


Figure 13. Flow exceedance curve for Townsend Canal from WY2020-2022 (Data source: DBHYDRO).

JACK'S BRANCH

Jack's Branch is a 16.8-mile stream located within the West Basin on the north side of the Caloosahatchee River near Ft. Denaud (**Figure 5**). It is bound by wetlands upstream and downstream. For WY2020-WY2022, the canal had a maximum flow of 568 cfs and average flow of 42 cfs. The hydrograph (**Figure 14**) illustrates "flashy" discharge with short duration and high flow volume. Available flow (90th percentile) was 124 cfs (**Figure 15**). Zero-flow conditions occurred approximately 8% of the time for this POR.

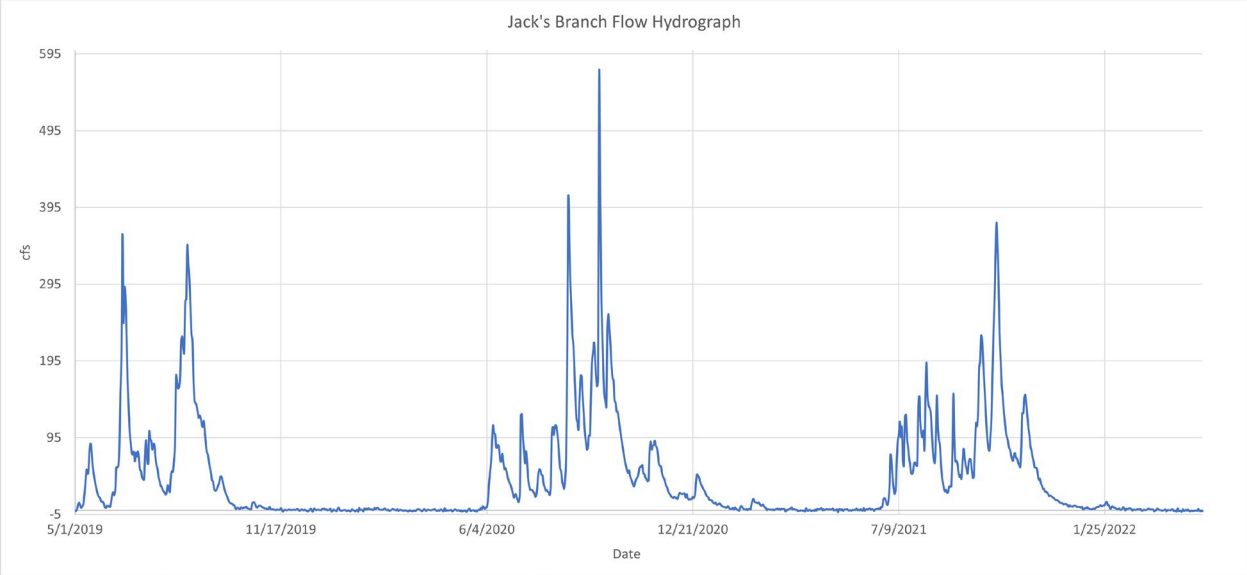


Figure 14. Jack's Branch Flow Hydrograph (Data source: DBHYDRO).

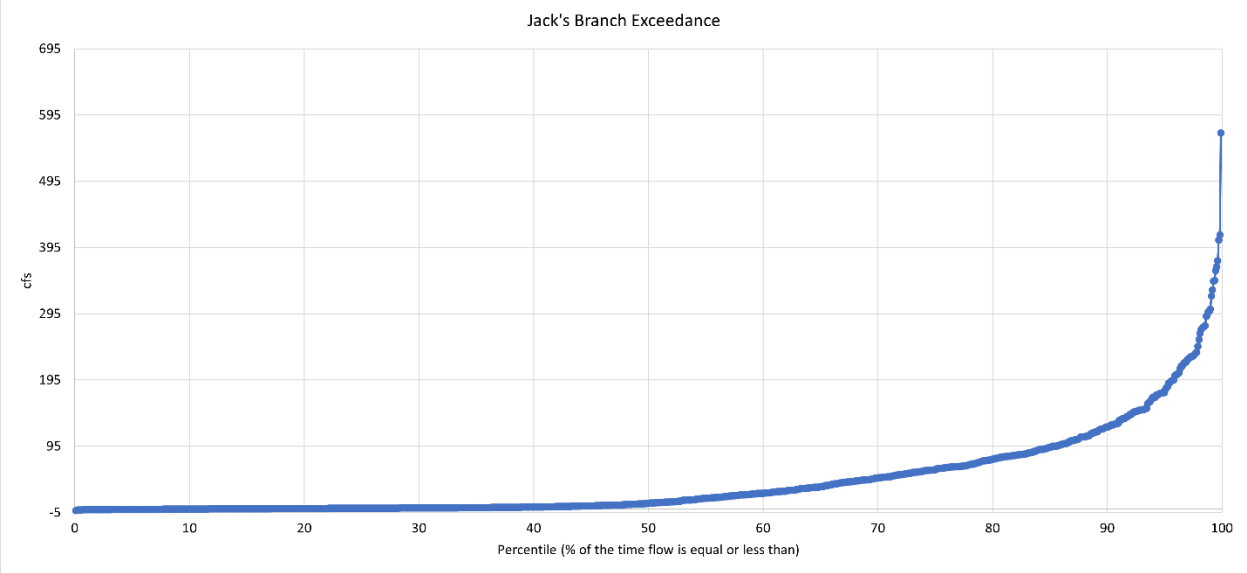


Figure 15. Flow exceedance curve for Jack's Branch from WY2020-2022 (Data source: DBHYDRO).

WATER AVAILABILITY CONCLUSION

The results in **Table 8** show that the portion of the C-43 canal within the West Basin, bounded upstream and downstream by S-78 and S-79, respectively, have water availability (90% value) that could support a water storage or treatment project. Such projects would have to be located in the vicinity of the C-43 Canal to be most cost effective and must consider other water supply demands as well, including the MFL, optimal flows for the ecological health of the estuary, and other permitted uses. For the three upstream tributaries, the hydrographs reveal flashy discharge characteristics, but the 90% values reveal potential for additional projects with careful design considerations. Since the Townsend Canal regularly experiences bi-directional flow, extra consideration should be made for potential projects in that basin.

Based on this water availability review, it is recommended that additional passive stormwater detention and wetland restoration projects be considered throughout the basin to increase the storage capacity.

Table 8. Summary of water availability at monitoring stations.

Canal/Structure	Max. (cfs)	Mean (cfs)	90% (cfs)
S-78	6,466	1,047	1,853
S-79	13,136	2,330	4,948
Goodno Canal	327	26	72
Townsend Canal	2,540	63	340
Jack's Branch	568	42	124

BASIN LEVEL MONITORING ANALYSIS

SFWMD currently monitors at two hydrologic levels within the CRW: subwatershed and basin level (basin monitoring sites) and subbasin level (upstream monitoring sites) (**Figure 16**). Other entities also monitor at the subbasin level. The basin level sites have measurements of flow and nutrient concentrations so loads can be determined. The upstream level sites are used to identify areas of interest further upstream within the basin and most only have measurements of nutrient concentrations. To identify factors contributing to water quality issues, data from both levels were reviewed. This section covers the basin level analysis, and the Upstream Level Analysis Section discusses the upstream level data and highlights areas of interest.

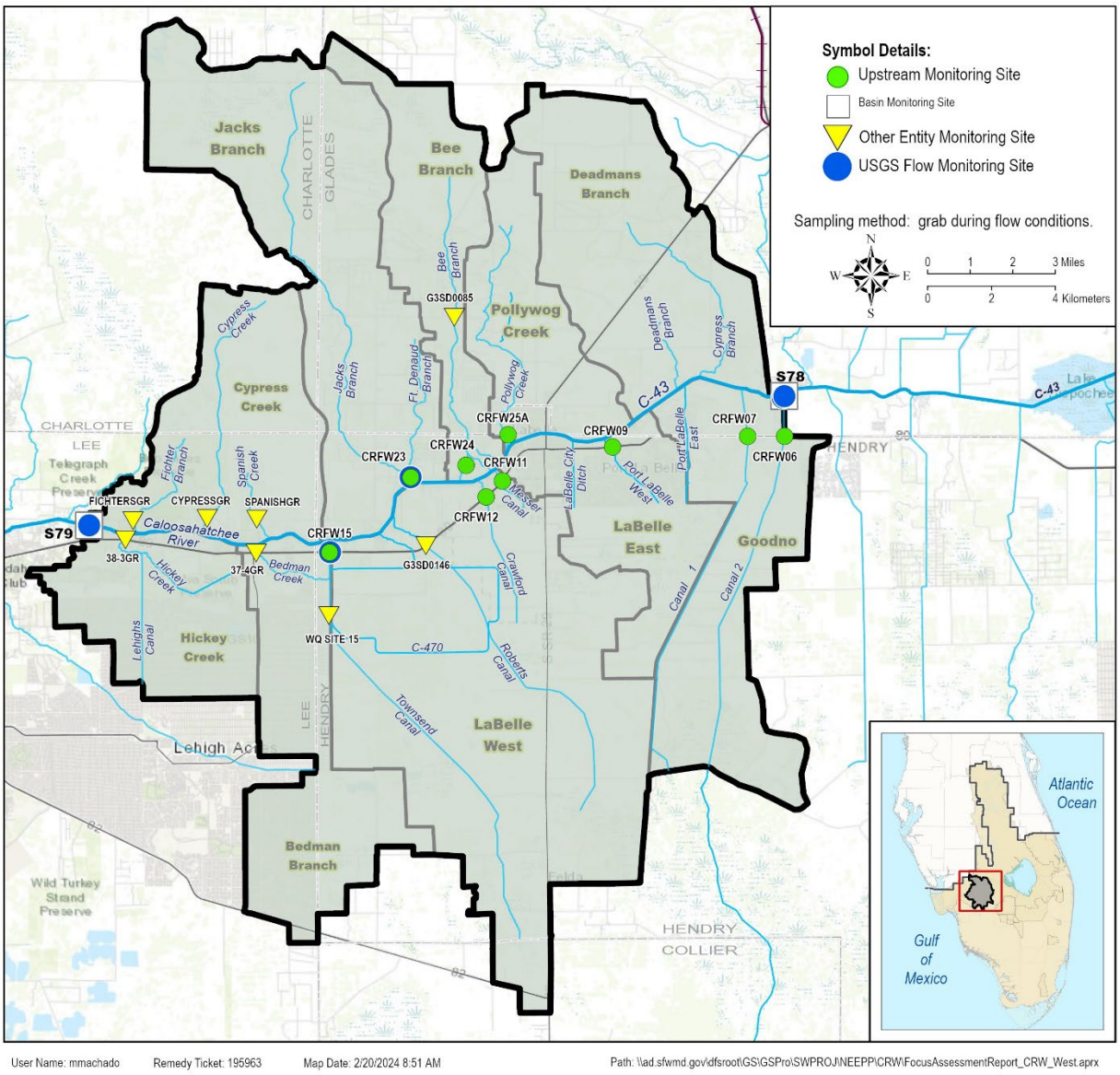


Figure 16. SFWMD basin and upstream level monitoring sites and other entity monitoring sites in West Caloosahatchee subbasins.

To characterize nutrient contributions of the West Basin, basin-level monitoring is conducted at major water control structures along the Caloosahatchee River; S-78 (inflow from the east) and S-79 (discharge point) (**Figure 16**). To determine the nutrient loads that the West Basin contributes to the estuary, the inflow nutrient loads passing through from Lake Okeechobee, East Caloosahatchee, and the S-4 basins must be accounted for. The minimum value of the loads registered at S-78 and S-79 is considered the pass-through nutrient load from those upstream areas. The contribution of the West Basin to the CRE is estimated as the difference between loads at S-79 and the pass-through nutrient loads. The published 5-year TN and TP data from the SFER (Taylor et al., 2023) including flow weighted mean concentrations (FWMC) for the West Basin are presented in **Table 9**. The West Basin had a 5-year (WY2018-WY2022) average TN load of 1,239.5 t which is 628.5 t above the long-term planning target of 611 t TN for this basin.

Table 9. Annual TP loads, TN loads, and total flow for WY2018–WY2022 and 5-year averages[a] for the West Basin (Data source: Taylor et al. 2023 SFER , Table 8D-11).

West Caloosahatchee Basin							
Water Year	TP			TN			Flow (ac-ft x 10^3)
	Load (t)	UAL (lbs/ac)	FWMC (µg/L)	Load (t)	UAL (lbs/ac)	FWMC (mg/L)	
WY2018	218.4	1.38	173	1673.4	10.54	1.32	1024.8
WY2019	148.0	0.93	164	1222.3	7.7	1.36	730.0
WY2020	107.7	0.68	166	901.7	5.68	1.39	524.8
WY2021	129.3	0.81	130	1357.6	8.55	1.36	808.5
WY2022	118.8	0.75	141	1042.5	6.56	1.24	681.2
5-Year Avg.[a]	**144.4**	**0.91**	**155**	**1239.5**	**7.80**	**1.33**	**753.8**

a. Taylor et al., 2023 presents the 5-year averages as the arithmetic mean of the annual data.

Figures 17 and **18** depict the annual loads, annual FWMC, and the 5-year rolling average loads for TN and TP, respectively, in the West Basin from WY1982-2022. Source control activities in the West Basin began in 1997 (**Table 10**) and since that time the annual TN FWMC appears to have visually decreased. Annual TN FWMC were often higher than 1.5 mg/L (See purple line as breakpoint in **Figure 17**) and after 1997 annual TN FWMC were often below that value. This suggests these activities may have assisted in lowering the TN FWMC. The annual TP FWMC are above the numeric nutrient criteria of 120 µg/L but did not exceed 175 µg/L. The 5-year TP FWMC (WY2018 -WY2022) average was 155 µg/L.

The 5-year rolling average TN load has ranged from 752 t (WY2007-WY2011) to 1,522 t (WY1992 - WY1996) over the period of record. The annual rainfall for the West Basin is presented in **Figure 19** and the annual flow in acre-feet x 1000 (ac-ft x 10^3) is presented in **Figure 20**. The data seem to indicate that flows may be influenced by factors other than annual rainfall. Further investigation is needed to determine the variation in flows. The annual flows have ranged between 80,524 ac-ft and 1,058,478 ac-ft over the period of record, while the annual TN FWMC appears to have decreased since the late 1980's and have been below the FDEP numeric nutrient criteria benchmark of 1.54 mg/L since WY2010 (**Figure 17**). This indicates that reducing TN loads further in this basin may require increasing storage (reducing flows). Projects and programs should be aimed at reducing the amount of runoff from the watershed. However, future projects and programs must consider both the MFLs criteria for the S-79 structure as identified in 40E-8.221(2) of the Florida Administrative Code (F.A.C.) and the Optimum Flow Envelopes for the CRE (RECOVER, 2020).

The current MFL target for S-79 is 457 cfs and the minimum optimum flow is 750 cfs. **Table 11** depicts the West Basin and Lake Okeechobee flows in cfs for WY2018 – WY2022. Note that the West Basin values do not include the pass-through flows from the East Basin, S-4 Basin and Lake Okeechobee. Meeting the MFL and optimum flows to the estuary are achieved through a combination of managing watershed and lake flows. Average flows from the West Basin alone often appear to be greater than what is needed to meet the minimum optimum flow and appear to be greater than the MFL which also suggests that further reductions in flows are possible for this basin based on a mathematical analysis (**Table 11**). Timing and distribution of the flows should be considered and the projects must be designed to be able to discharge to the estuary when flows are lower.

A challenge for meeting the target load for this basin is that the FWMCs are often below the numeric nutrient criteria of 1.54 mg/L (**Table 9**). To illustrate this point, using the current 5-year (WY2018-WY2022) TN FWMC of 1.33 mg/L the basin would only need to contribute 372,441 ac-ft (514 cfs) annually to achieve the planning target. This represents about a 50% reduction from the current 5-year flows. Given the large volume of storage needed to achieve the planning target, pursuing a strategy based on storage may require considerable acreage and careful design to be compatible with optimal flows and the MFL. Thus, a

combination of additional storage and reductions in nutrient concentrations may be the best way to reduce TN loads in the West Basin. The impact of nutrient reduction and storage projects on optimal flows and the MFL are discussed in greater detail in the Additional Nutrient Reductions and Storage Needed Section of this report.

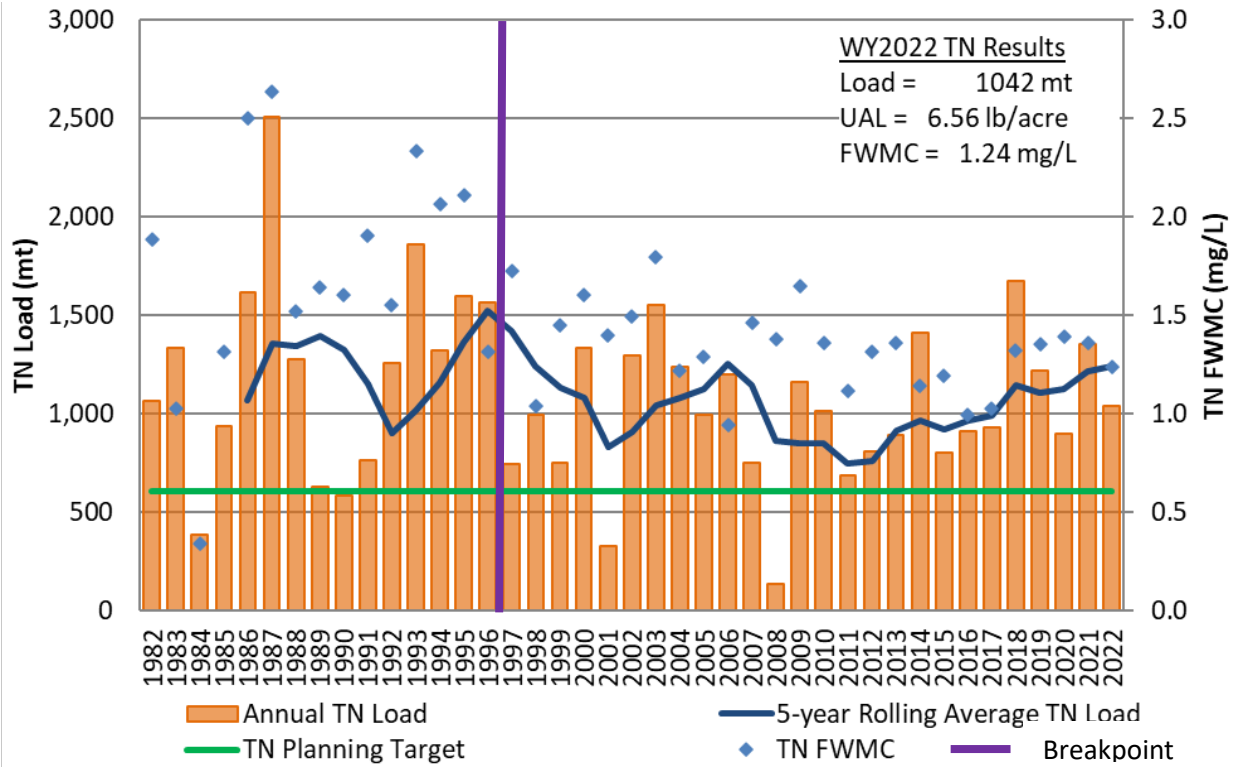


Figure 17. TN load and FWMC data for WY1982-WY2022 with the 5-year rolling average for the West Basin.

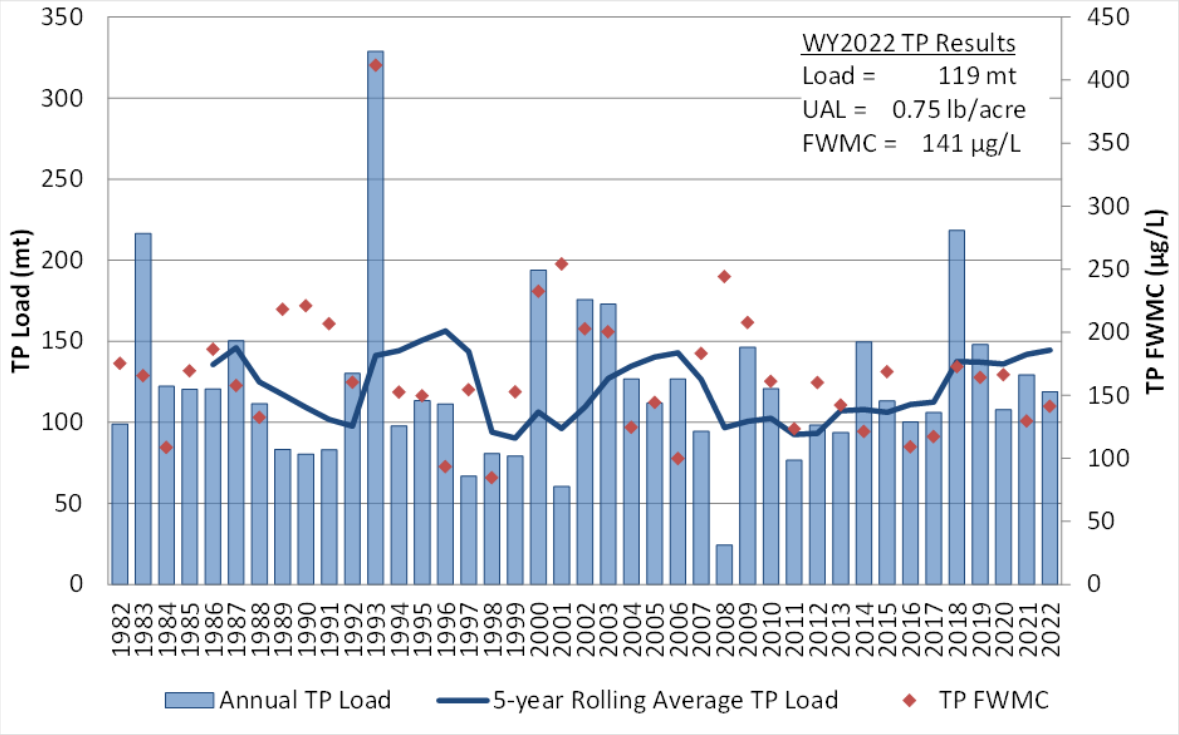


Figure 18. TP load and FWMC data for WY1982-WY2022 with the 5-year rolling average for the West Basin.

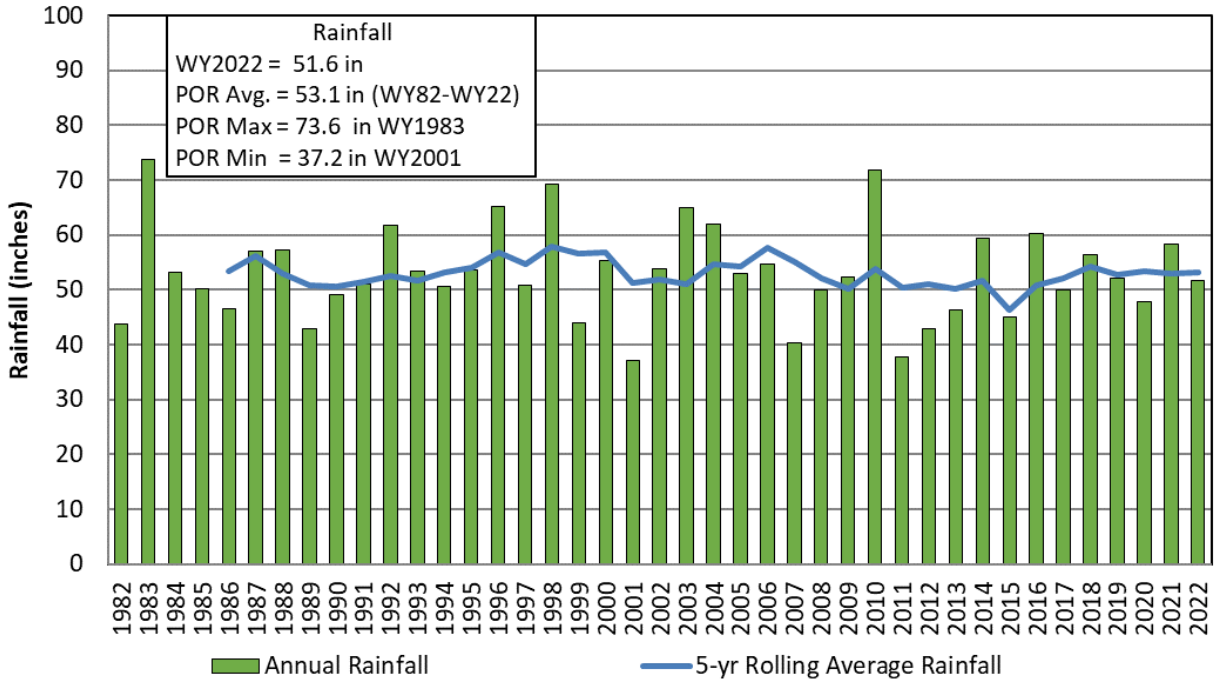


Figure 19. Annual Rainfall (inches) for WY1982-WY2022 for the West Basin and the 5-year rolling average rainfall.

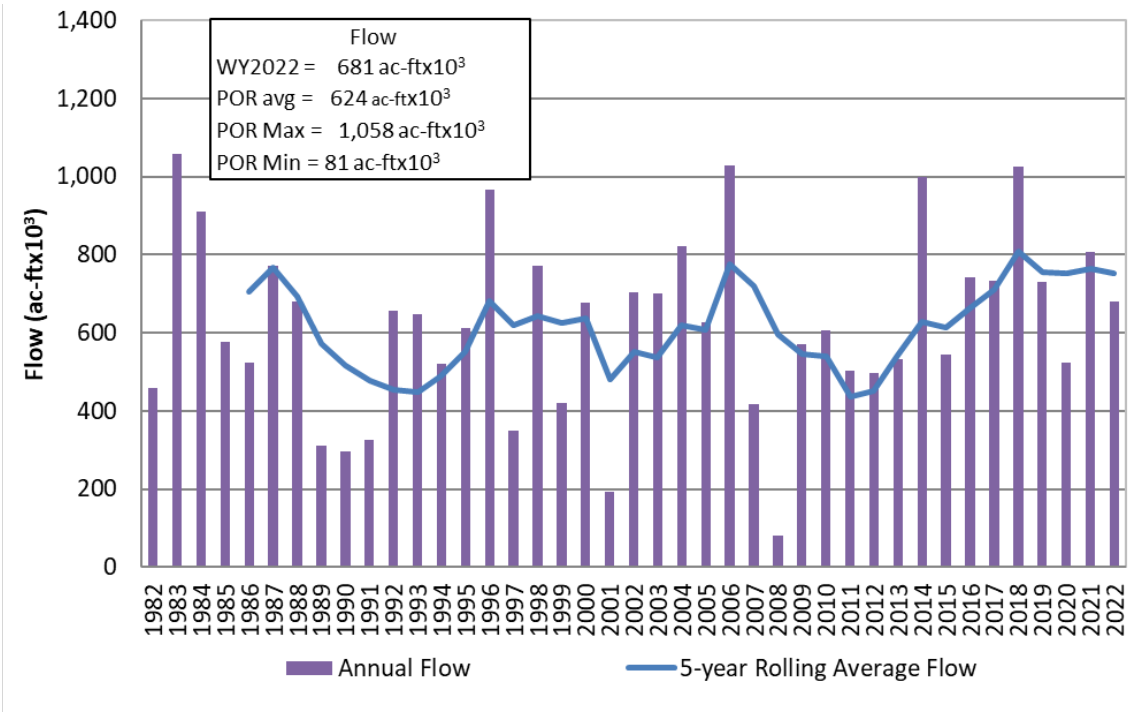


Figure 20. Annual Flow (ac-ft x 10^3) for WY1982-WY2022 for the West Basin and the 5-year rolling average flow.

Table 10. Timeline of major source control activities with the West Basin.

Date	Major Source Control Activities
1997	Phase I MS4 Issued for Lee County
2003	Phase II MS4 Issued for Charlotte County
2008	Fertilizer Ordinance Passed for Charlotte County
2008	Fertilizer Ordinance Passed for Lee County
2010	Phase II MS4 Issued for Hendry County
2010	Phase II MS4 Issued for Glades County
2011	Phase I MS4 Renewed for Lee County
2011	Fertilizer Ordinance Passed for Hendry County
2011	FDACS BMP Rule adopted for the Northern Everglades which includes the Caloosahatchee River Watershed
2014	Mudge Ranch DWM project becomes operational
2023	Four Corners Rapid Infiltration Project

Table 11. Annual flows from West Basin and Lake Okeechobee in ac-ft/yr and cfs for WY2018–WY2022, and 5-year averages[a] (Data Source: Taylor et al., 2023 SFER for Annual flows in ac-ft, Table 8D-11).

	West Basin		Lake Okeechobee	
Water Year	**Annual flow volume Ac-ft x 1000**	**Average flow rate cfs**	**Annual flow volume Ac- ft x 1000**	**Average flow rate cfs**
WY2018	1,024	1,414	1,201	1,659
WY2019	730	1,008	761	1,050
WY2020	524	724	170	235
WY2021	808	1,116	753	1,040
WY2022	681	941	568	784
5-Year Avg.	753	1,040	690	954

[a]Note that the flows in cfs in this table differ from those presented in Table 6 which includes the flows from Lake Okeechobee plus the S-4, East, and West Basins.

Additional information on runoff from the basin comes when comparing the relative runoff quantities (unit area flows) from the West Basin with other District basins of similar size, as shown in **Table 12**. The West Basin has greater flows than areas of similar size, and even has flows close to the Upper Kissimmee Basin that is almost three times larger. It is not known why the runoff from West Basin is so large but there is a sizable elevation drop (80 ft) within the basin (**Figure 21**). Additionally, the C-43 Canal or river is in a valley and there is a large difference in elevation on both sides. Potential considerations for additional storage projects are discussed in the Potential Projects and Funding Opportunities Section of this document.

While it appears that the focus should be on reducing flows, as mentioned above, nitrogen concentrations may also need to be reduced to ensure minimum optimum flows for CRE health. Thus, a comparison was made between the various forms of nitrogen collected at the S-79 Basin structure (**Table 13**) to determine if the nitrogen levels at the S-79 structure were related to a certain forms of nitrogen (speciation). Data used for this analysis were from grab samples when flow was detected on dates when

Table 12. 5-year average flows and runoff in inches for WY2018-WY2022 (Data Source for acreage and flow: Jones et al. 2023 SFER Chapter 8B and Taylor et al. 2023 SFER Chapters 8D).

Subwatershed or Basin	**Acreage**	**WY2018-WY2022**	
		Flow ac-ft/yr	**Runoff Inches/yr**
West Caloosahatchee	350,116	753,800	25.84
East Caloosahatchee	204,095	243,800	14.33
Lake Istokpoga	394,203	326,000	9.92
Lower Kissimmee	429,188	337,000	9.42
Upper Kissimmee	1,028,421	826,000	9.64

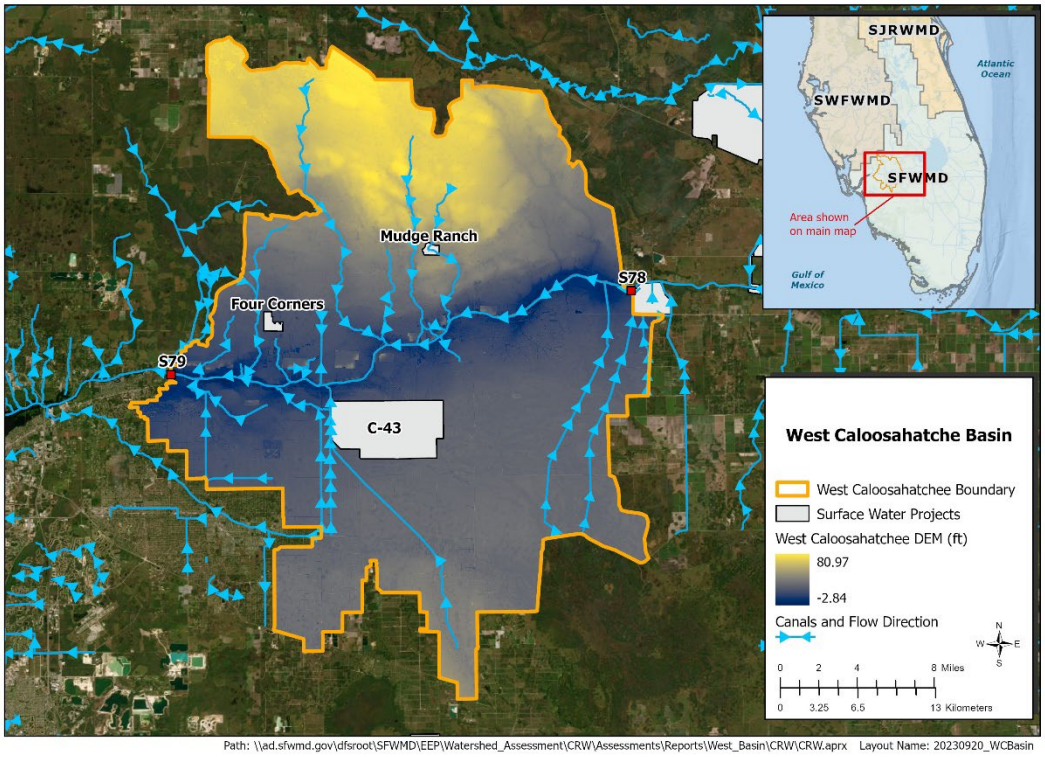


Figure 21. Elevations for the West Basin using a Digital Elevation Model (DEM).

there was information for all three parameters: TN, ammonia-nitrogen (NH_3-N), and nitrate+nitrite (NOx). **Table 13** lists the average annual concentrations, number of samples, and percent of NH_3-N and NOx relative to TN. Based on the data presented in the table, a relatively small amount of the TN data is NH_3-N (average 3.74% over the period of record) and the amount of NOx is only slightly higher (average 17.70% over the period of record). Considering only the period (WY2011 – WY2022) with more samples, the average percentages of NH_3-N and NOx were even lower. Thus, it does not appear that NH_3-N and NOx are the primary contributors to TN in this basin. Therefore, the dominant forms of nitrogen in these samples may have been particulate or dissolved organic forms. As part of routine sampling, total suspended solids (TSS) are also collected at S-79. A review of recent data indicates that TSS has been below the method detection limit or the lab practical quantitation limit for the last 10 water years, with only one exception in WY2022. That would indicate TSS is low at the structure, or that the major form of nitrogen is likely dissolved organic (DON). This is in agreement with the findings of Pisani et al. (2017) which measured all the forms of nitrogen at various locations along the C-43 and found that DON composes 62-99% of total dissolved nitrogen. Thus, additional efforts for BMPs and projects should address DON. SFWMD has previously conducted research projects and continues to investigate the best methods to reduce DON. Those efforts are discussed in the Additional Nutrient Reductions and Storage Needed section of the report.

Table 13. Nitrogen speciation information at the S-79 structure for WY1982-WY2022.

S-79 Speciation Information per Water Year (WY)[a]						
Water Year	Average of TN (mg/L)	Average of NH3-N (mg/L)	Average of NOx (mg/L)	Percentage of NH3-N to TN	Percentage of NOx to TN	Number of Samples
1982	2.07	0.04	0.22	1.69%	10.78%	2
1983	1.58	0.11	0.23	6.94%	14.80%	2
1984	1.25	0.06	0.18	4.40%	14.05%	4
1985	1.39	0.07	0.19	5.04%	13.64%	2
1986[b]	2.67	0.04	0.37	1.50%	13.99%	1
1987	2.32	0.06	0.42	2.76%	17.94%	5
1988[b]	1.03	0.06	0.33	5.85%	31.77%	1
1989	1.69	0.04	0.39	2.07%	23.26%	2
1990	1.69	0.03	0.44	1.48%	25.95%	2
1991	1.58	0.05	0.43	2.85%	27.19%	2
1992[b]	1.97	0.06	0.57	3.05%	28.79%	1
1994[b]	1.95	0.01	0.75	0.51%	38.30%	1
1995	1.46	0.09	0.16	6.17%	10.87%	2
1996	1.09	0.07	0.13	6.71%	11.56%	3
1997[b]	1.45	0.14	0.15	9.66%	10.34%	1
1998	1.44	0.07	0.19	4.67%	13.52%	7
1999	1.48	0.06	0.28	3.88%	18.97%	4
2000	1.51	0.03	0.41	2.13%	27.21%	5
2001	1.40	0.13	0.25	9.52%	18.00%	2
2002	1.65	0.07	0.35	4.25%	21.04%	2
2003	1.72	0.08	0.22	4.42%	13.03%	5
2004	1.26	0.07	0.15	5.68%	11.98%	5
2005	1.38	0.03	0.29	2.46%	20.72%	4
2006	1.51	0.04	0.38	2.39%	25.24%	5
2007	1.31	0.03	0.36	2.51%	27.62%	2
2009	1.53	0.03	0.34	2.10%	21.99%	2
2010	1.46	0.06	0.17	3.79%	11.97%	6
2011	1.29	0.05	0.16	3.54%	12.06%	22
2012	1.35	0.04	0.20	3.20%	14.90%	25
2013	1.38	0.05	0.13	3.67%	9.67%	40
2014	1.28	0.05	0.16	3.83%	12.59%	43
2015	1.23	0.04	0.19	3.33%	15.73%	45
2016	1.32	0.04	0.22	3.31%	16.48%	37
2017	1.14	0.03	0.17	2.92%	14.98%	24
2018	1.37	0.05	0.20	3.58%	14.82%	43
2019	1.39	0.03	0.23	2.03%	16.56%	46
2020	1.39	0.03	0.19	2.08%	13.67%	47
2021	1.34	0.05	0.18	3.52%	13.35%	45
2022	1.33	0.03	0.14	2.56%	10.81%	45
Minimum	**1.03**	**0.01**	**0.13**	**0.51%**	**9.67%**	**1**
Maximum	**2.67**	**0.14**	**0.75**	**9.66%**	**38.30%**	**47**
Average	**1.50**	**0.05**	**0.27**	**3.74%**	**17.70%**	**14**

[a]Only used sample collection dates that represented TN, NH3-N, and NOx.

[b]Only 1 sample was available that represented all 3 parameters in these years.

PROJECT EVALUATION

Evaluation of the projects and practices currently implemented in the basin is important to see if any adjustments are needed. Source control activities have been implemented in the West Basin since the late 1990's (**Table 9**). Details on past projects and programs can be found in previous Caloosahatchee watershed protection plans and SFERs. Additional information on completed projects by other entities, such as local counties and the Florida Department of Transportation, can be found in the BMAP update (FDEP, 2020).

SFWMD PROJECTS

Currently, there are two projects operating and two under construction to help reduce nutrient loading and increase storage within the West Basin (**Figure 22**, **Table 14**).

Mudge Ranch

The Mudge Ranch is a 304-acre passive Dispersed Water Management (DWM) project on privately owned lands in the Pollywog Creek Subbasin. The purpose of the project is to provide on-site water retention to facilitate stormwater runoff attenuation and extending hydroperiods of on-site wetlands. The site is predominately ranch lands with hardwood hammocks and wetlands at the south end of the property. A modified weir was added to the existing Natural Resources and Conservation Services (NRCS) designed culverts as part of construction. The project stored 620 ac-ft in WY2021 and 450 ac-ft in WY2022, which is 224 ac-ft per year and 54 ac-ft greater per year, respectively, than the long-term project estimated annual storage of 396-ac-ft. There is not a water quality monitoring component in the Mudge Ranch cooperative agreement and a long-term nutrient removal estimate was not calculated. **Table 14** presents the nutrient reduction estimated reductions from WY2022. Due to the lack of water quality data for passive projects, such as Mudge, nutrient load retention estimates are determined by using FWMCs from each basin where projects are located. FWMCs provide the best metric to gauge potential water quality influences on the receiving waters. Therefore, the annual FWMC data reported in WY2022 from the West Basin were used to estimate the potential nutrient load reduction associated with the water retained for the Mudge Project. Since this project has been operating since 2014, it is expected that any nutrient benefits from this project have already been realized. The contract with the landowner is funded through May of 2024 and is expected to be renewed.

Four Corners Rapid Infiltration Project

In November of 2022, SFWMD entered an agreement with ALJO Groves for the Four Corners Rapid Infiltration Project. The project is situated on the north side of the C-43 Canal in the West Basin. The purpose of the project is to increase water and nutrient retention via a 366-acre above ground impoundment (AGI) and includes a 97-acre seepage area. The project stores direct rainfall and excess regional run-off from surrounding drainage basins and recharges local groundwater. It receives water from Cypress Creek and Babcock Ranch. The long-term average annual benefits include 20,000 ac-ft of storage, 39.3 t TN removal and 1.2 t TP removal (**Table 14**). Additional project benefits include wetland and hydrologic restoration and connectivity with the state-owned Babcock Ranch Preserve. Construction of the AGI was completed in May of 2023 and operations began in the summer of 2023.

C-43 West Basin Storage Reservoir

The C-43 West Basin Storage Reservoir is a 10,700-acre CERP hydrologic restoration project located on former farmland in Hendry County in the LaBelle West Subbasin. It is currently under construction and when finished will hold approximately 170,000 acre-feet of water, or 43% of the storage needed for the CRW (based on the 400,000 ac-ft storage target). However, it should be noted that the reservoir will also capture Lake Okeechobee water. By capturing local basin runoff and Lake Okeechobee regulatory releases, the project will reduce discharges reaching the estuary and provide fresh water during the dry season to

help balance salinity levels. The project is currently under construction and is estimated to be completed in 2025.

C-43 West Basin Storage Reservoir Water Quality Component

The construction of the C-43 West Basin Storage Reservoir also included a water quality component feasibility study. This study was intended to evaluate siting, design, construction, and operation of a water quality treatment technology at the C-43 West Basin Storage Reservoir project. The goal was to understand what type of project would be best to reduce discharge of nutrients from the reservoir which may contribute to subsequent blue-green algal blooms in the Caloosahatchee River. Phases 1 and 2 of the study are complete (Feasibility Study & Siting Evaluation – J-Tech 2020 and J-Tech 2021, respectively). The cost-benefit and trade-off analysis suggested reducing nutrients at the inflow with an in-line injection of alum (aluminum sulfate) during reservoir filling would be the most cost-effective method to suppress potential nuisance algal growth within the reservoir while optimizing water quality discharges to the Caloosahatchee River. Design of this Reservoir Water Quality Component is currently underway and was completed in December of 2023 and is under construction. The project is expected to be completed in 2025. The intake for the C-43 Reservoir will be located along the Townsend canal. The planned alum treatment system will be located at the S-470 intake pump for the planned C-43 reservoir. For this assessment, the assumed TN reduction from the treatment component is 33.7 t (M. Frick, personal communication October 6, 2021). After prorating for the West Basin and accounting for water received from Lake Okeechobee, the S-4 Basin, and the East Basin, the estimate comes out to be a 14.7 t/yr long-term reduction. It should be noted that this proration was based on the amount of flow at S-79 from the period of WY2018-WY2022.

BMAP PROJECTS

The projects listed in **Table 15** and **Figure 22** are planned or BMAP projects completed since 2019 in the West Basin where long-term TN reduction estimates were available. Entities responsible for these projects include agricultural producers, the City of LaBelle, Lehigh Acres Municipal Services Improvement District (LA-MSID), and Lee County. Note that there are additional BMAP projects which either were completed prior to 2019 or had no estimated nutrient reduction that are not included in the table. For more information on those projects see the 2020 CRE BMAP (FDEP, 2020). Together these projects are expected to bring an additional long-term 26.9 t TN reduction annually.

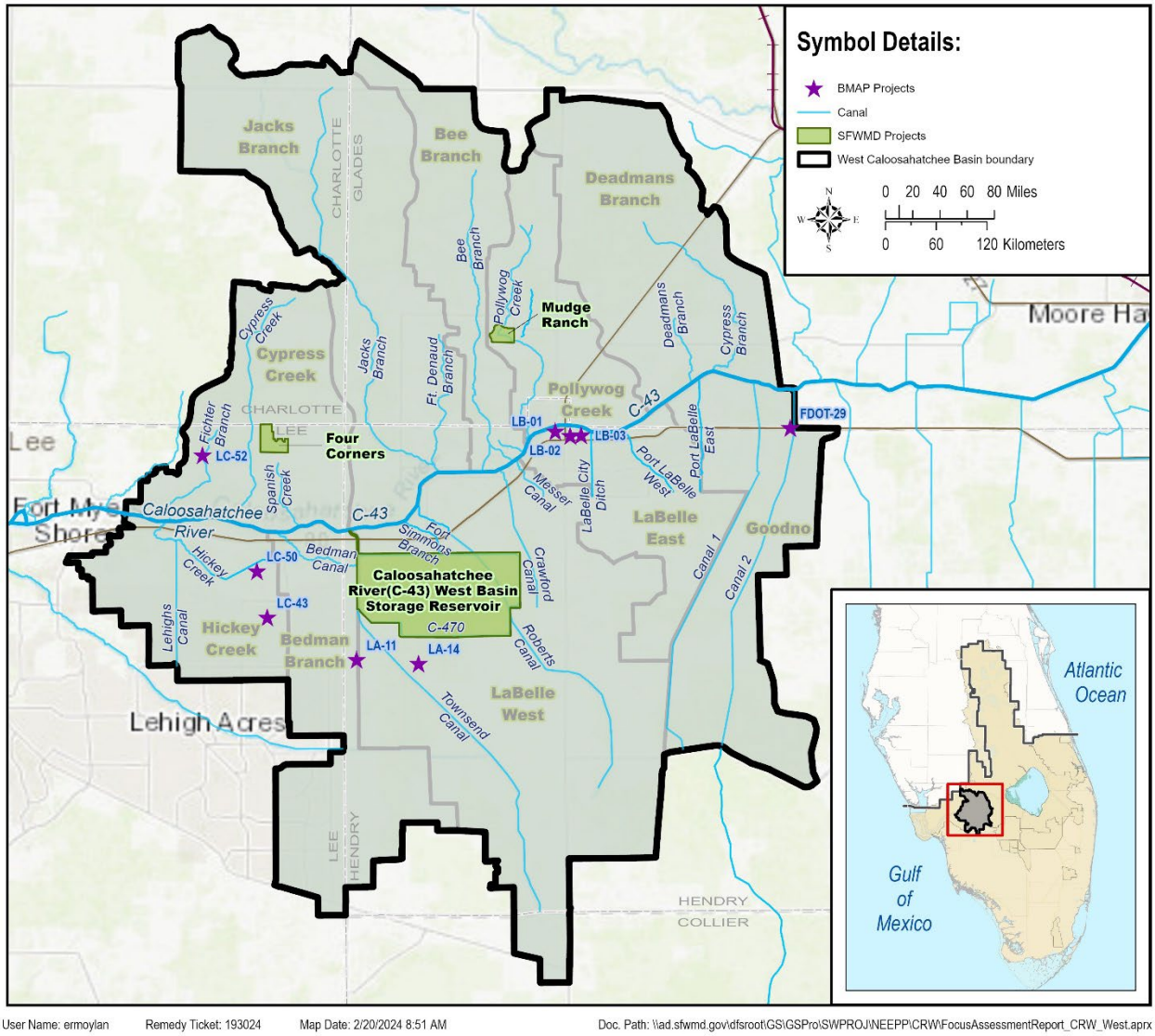


Figure 22. Current and future projects in the West Basin.

Table 14. Current SFWMD and select Coordinating Agency projects in the West Basin, including long-term project estimates and WY2022 storage and nutrient retention (Data Source: Taylor et al. 2023 and 2024).

Project Name	Project Type	Project Area (ac)	Project Status (FY2022) [a]	Description	Estimated Storage (ac-ft)	WY2022 Storage (ac-ft)	Estimated TN Removed (t/yr.)	WY2022 TN Removed (t/yr.)	Estimated TP Removed (t/yr.)	WY2022 TP Removed (t/yr.)
Mudge Ranch (NE-PES) [b]	DWM	304	O&M	Dispersed Water Management public-private partnership. This passive storage project on 304 ac retains excess stormwater.	396	450	N/A [d]	1.0	N/A [d]	0.1
C-43 West Basin Storage Reservoir	Hydrologic Restoration	10,700	Construction	Storage of 170,000 acre-feet of local stormwater runoff and Lake Okeechobee regulatory releases. The project will reduce the volume of lake discharges in the wet season and provide freshwater flow to the estuary in the dry season to promote desirable salinities. Construction completion expected in 2024.	170,000 [c]	N/A [e]	N/A [d]	N/A [d]	N/A [d]	N/A [d]
C-43 West Basin Storage Reservoir: Water Quality Component Selection	Nutrient Removal	TBD	Design	Construct an inline alum injection system at the C-43 Reservoir project to reduce the discharge of nutrients.	N/A [d]	N/A [d]	14.7 [f]	N/A [e]	TBD [g]	N/A [e]
Four Corners Rapid Infiltration	Storage	463	Project Agreement	Project objective is to capture direct precipitation and stormwater runoff for water retention and nutrient load reducing such that harmful discharges to the CRE are reduced.	20,000	N/A [e]	39.3	N/A [e]	1.2	N/A [e]
				West Caloosahatchee Total	**190,396**	**450**	**54.0**	**1.0**	**1.2**	**0.1**

a. Reflects the project status at the end of FY2022.

b. NE-PES – Northern Everglades Payment for Environmental Services.

c. Value shown reflects static storage (i.e., project capacity).

d. N/A – not applicable; benefit is not associated with the project's primary objective; however, project performance will be calculated where data are available.

e. Measured project performance is not available for WY2022; however, future water year performance may be determined once project begins operations.

f. Estimated reduction based on proration as described in the text above under the C-43 West Basin Storage Reservoir Water Quality Component

g. TBD – to be determined; estimated benefits have not been established.

Table 15. Planned and BMAP projects completed since 2019 with estimated long term load reductions (Data Source: FDEP 2022b Statewide Annual Report and J. Thera, personal Communication February 7, 2022).

Lead Entity	BMAP Project Number	Project Name	Subbasin	Project Description[a]	Long Term Estimated TN Reduction (t)	Status
Ag Producers	FDACS-02	BMP Implementatoin and Verification	All	Enrollment and verification of BMPs by agricultural producers. Attenuated reductions based on HSPF model. Acres treated based on FDACS OAWP December 2020 Enrollment and FSAID VII.	14.3	Underway
City of LaBelle	LB-01	City of LaBelle Zone J Septic Tank to Central Sewer	LaBelle East	Septic tank conversion project that will consist of a pump station, force main and gravity sewer to provide an estimated 55 customers (area buildout) with sanitary sewer.	0.1	Underway
City of LaBelle	LB-02	City of LaBelle Zone A Septic Tank to Central Sewer	LaBelle East	Septic tank conversion project that will consist of a pump station, force main and gravity sewer to provide an estimated 496 customers (area buildout) with sanitary sewer.	1.0	Underway
City of LaBelle	LB-03	City of LaBelle Zone B Septic Tank to Central Sewer	LaBelle East	Septic tank conversion project that will consist of a pump station, force main and gravity sewer to provide an estimated 315 customers (area buildout) with sanitary sewer.	0.6	Planned
LA-MSID	LA-11	S-H-2 Weir Replacement	LaBelle West	Replace failed fabriform weir.	0.03	Completed 2019
LA-MSID	LA-14	CREST	LaBelle West	Lehigh Acres Municipal Services Improvement District (LA-MSID) is designing a 105- acre, multi-ecosystem storage and water quality stormwater facility that will provide protection. The project will provide a water quality marsh, deep water storage and a passive park. This project will create 300-500 acre-feet of storage.	6.5	Underway
Lee County	LC-50	Alva Scrub Preserve	Hickey Creek	Land Use purchase and change to conservation land	0.9	Completed 2019
Lee County	LC-43	GS-10[b]	Hickey Creek	Land purchase and conversion to conservation land use.	3.4	Completed 2019
FDOT	FDOT-29	SR-80 from Dalton Lane to CR833	Goodno	Widening project provided extra nutrient removal in treatment ponds.	0.04	Completed 2020
Lee County	LC-52	Bob Janes Restoration	Cypress Creek	Two hydrologic modification projects to provide attenuation of peak flows and nutrient reduction in water discharging from the Bob Janes Preserve.	0.5	Planned
Total					**27.4**	

a. Note that there are additional future projects in the BMAP that do not have load reductions estimates that were not included in this table (see 2020 CRE BMAP and FDEP 2022b Statewide Annual Report for additional details).

b. Reductions were split into two to reflect some reductions for the Tidal Basins.

ADDITIONAL NUTRIENT REDUCTIONS AND STORAGE NEEDED

A review of the 5-year average (WY2018-WY2022) TN loading data compared to the basin TN planning target (**Table 16)** indicates that an additional 628.5 t TN average annual load reduction is needed for the West Basin, assuming all existing projects operating for at least five years have achieved their TN reduction benefits. The expected long-term average annual TN reductions from the upcoming C-43 Reservoir Water Quality Component is expected to be 14.7 t/yr for the West Basin (prorated to account for other basins – see C-43 West Basin Storage Reservoir Treatment Project above). The Four Corners Rapid Infiltration Project is expected to have a long-term average annual TN reduction of 39.3 t/yr and upcoming BMAP projects are expected to have a long-term average annual TN reduction of 27.4 t/yr. Thus, if the known reductions from the upcoming and recently completed projects are considered (81.4 t/yr), an additional 547.1 t/yr average annual reduction of TN is still needed. Achieving that reduction will require additional projects and optimization of existing projects when possible.

Table 16. Planning targets for the West Basin and the 5-year average (WY2018-WY2022) 5-year average TN loads and the long-term average annual TN reductions needed to achieve the planning target.

	TN Planning Target (t)	WY2018 - WY2022 avg (t)	Reduction Range Needed without Planned Projects Benefits (t)	Recently Completed and Planned Project Estimated Reductions (t)[a]	Reduction Range Needed assuming Planned Project Benefits (t)
West Basin	611	1,239.5	628.5	81.4	547.1

[a]Assumes that all projects operating for 5 years have realized their TN reductions. Includes reductions from recently completed and planned projects where load estimates were available.

As discussed above, since TN concentrations are close to the numeric criteria for TN, storage projects might be best way to reduce TN loads from this basin. The long-term expected storage from Mudge Ranch is 396 ac-ft (**Table 14**), while upcoming storage for the C-43 Reservoir and the Four Corners projects are expected to be 170,000 ac-ft and 20,000 ac-ft, respectively. Assuming the Mudge Ranch Project continues (it is currently only funded through May of 2024) that means the storage in the West Basin is expected to be 190,396 ac-ft annually, which is 48% of the 2009 CRW Protection Plan NERSM target for the Caloosahatchee River Watershed of 400,000 ac-ft.

An important factor to consider when determining the amount of storage to plan for West Basin is the optimum flows needed at S-79 to sustain a healthy ecosystem in the CRE. The RECOVER Northern Estuaries Program identified the optimum flow range for S-79 as 750 to 2100 cfs (RECOVER, 2020). That means that the lowest annual flows at S-79 need to be 542,972 ac-ft (750 cfs) to keep CRE healthy. To determine the flow discharging from the West Basin, the inflows passing through from Lake Okeechobee, East Caloosahatchee, and S-4 basins must be accounted for. The minimum value of the flow at S-78 and S-79 is considered the pass-through flow from those upstream areas. The flows from the West Basin to the CRE is estimated as the difference between the flows at the S-79 structure and the pass-through flows. A review of the 10-year average outflow from WY2013-WY2022 for the West Basin indicates that the flow is 732,080 ac-ft annually.

To develop the storage targets two scenarios were reviewed (**Table 17**). The first assumed the West Basin receives no flow from East Caloosahatchee, S-4 and Lake Okeechobee, and the minimum flow target for optimum estuary health (542,972 ac-ft) is subtracted out from the West Basin flows, the storage target would be 189,108 ac-ft which is very close to the current amount of storage projects operating and planned

(190,396 ac-ft). However, in the last 10 years, the average annual flows at the inflow to the West Basin (at S-78 from Lake Okeechobee, East Caloosahatchee and S-4 basins) have been about 1 million ac-ft which means scenario 1 is unlikely to occur.

Therefore, the second scenario considered the portion of the minimum optimum flow that West Basin has historically provided. To determine this the minimum optimum flow proportioned by the West basin contribution of historic flow. Historically, the West Basin has contributed 73% of the combined West, East and S-4 basin flows (Lake Okeechobee flows were excluded). To determine the amount of minimum optimum flow West Basin should contribute 73% of 542,972 was calculated, which is 396,370 ac-ft per year. When that portion of the minimum optimum flow is subtracted from the flows as West Basin that results in a storage target for West Basin of 335,710 ac-ft of which 190,396 ac-ft is planned. Thus, an additional 145,314 ac-ft of storage would still be needed. It is important to note that second scenario method assumes the remaining portion of the minimum optimum flow (146,602 ac-ft) is provided by East and S-4 Basins which contribute 23% and 4% of the total flow, respectively. It is critical that any storage projects in the West Basin be able to release water back into the basin when needed to ensure that minimum optimum flow to the estuary are met.

If the storage target range of 190,000 ac-ft to 335,000 ac-ft is achieved, that may reduce the TN loads by approximately 300 t to 500 t annually from West Basin based on the reduction of flows and the 5-year average annual concentration of 1.33 mg/L TN. It should be noted that these storage targets are based on historical operational data and as future operational changes occur, they may need to be revised.

Table 17. West Basin storage target range based on the 10-year average flows and meeting the optimum flow at S-79.

Scenario 1 **Storage if the only flows at S-79 were from West Basin with minimum optimum flow**		**Scenario 2** **Storage considering flows from East, West, and S-4 Basins with minimum optimum flow**	
10-yr average flow from West Basin ac-ft	732,080	10-yr average flow from West Basin ac-ft	732,080
Minimum optimum flow ac-ft	542,972	West Basin portion of minimum optimum flow ac-ft (73%)[a]	396,370
Storage target ac-ft	189,108	Storage target ac-ft	335,710
Existing/planned storage projects ac-ft	190,000	Existing/planned storage projects ac-ft	190,000
Additional storage needed ac-ft	0	Additional storage needed ac-ft	145,710

[a]Assumes that the remaining portion of the optimum flow (146,602 ac-ft) is provided by East Caloosahatchee and S-4, basin flows.

With the amount of potential storage and minimum flows identified, the next step was to review the basin target load (611 mt) and the minimum optimum flow (542,972 ac-ft/yr) to determine the TN planning target concentration for the basin. It is estimated that to meet the planning target TN load the long-term average concentration at S-79 needs to be 0.913 mg/L. The WY2018-WY2022 average TN concentration was 1.33 mg/L indicating that additional water quality as well as storage projects are needed. It is important to note that if only the West Basin portion of optimum flows are considered, the target concentration is 1.25 mg/L, but it is recommended that additional water quality projects be planned to try to achieve the nutrient reduction target concentration of 0.913 mg/L.

However, as stated in the Basin Monitoring Analysis section most of the TN is DON and most of that is not biologically available for uptake (Pisani et al., 2017). That means that it may not be possible to achieve 0.913 mg/L using biologically based water quality projects such as wetlands or traditional

stormwater treatment areas. Jorgensen et al. (2014) suggested that biological availability of nitrogen be considered during TMDL development. SFWMD continues to investigate alternative technologies and has projects such as the upcoming C-43 Water Quality Component which uses alum and an ultraviolet radiation experiment at the Boma property. Results from these projects could provide valuable insight into the type of alternative nutrient reduction projects needed to further reduce TN concentrations in the West Basin but they are not expected for another 3 to 5 years. In the meantime, it is recommended that the projects in the West Basin focus on storage and flow attenuation.

TIMELINE TO ACHIEVE RECENTLY COMPLETED AND PLANNED PROJECT REDUCTIONS

To provide an estimate of the time it will take to achieve the long-term average TN reductions from the recently operating and planned projects, the dates when operations would begin for each project were estimated (**Table 18**). It should be noted that the exact timeline for achieving reductions is not known. The TN load reductions are long-term average annual estimates and individual water years will vary due to changes in rainfall, runoff, and biological removal processes. Also, assumptions were made as to when projects would be completed and begin operations which presumed that funding would be available. The timeline for all of the planned projects to be in the operations phase is 2025 (when the CREST project begins operation). Allowing 5 years for the projects long-term average reductions to take effect, the West Basin should begin seeing the 81.4 t/yr long-term average annual TN reduction around 2030; assuming that there are no project delays and that the long-term estimated reductions are realized over a 5-year period.

Table 18. Operational dates and expected TN reductions for recently completed and planned projects in the West Basin.

Project Name	Long-term Average Annual TN Reduction (t/yr)	Operation Start Date	Long-Term TN Reduction may be Realized[a]
S-H-2 Weir Replacement	0.03	2019	2024
GS-10	3.4	2019	2024
Alva Scrub Preserve	0.9	2019	2024
FDACS BMP Enrollment and Verification	14.3	2019	2024
SR 80 from Dalton Lane to CR 833	0.04	2020	2025
LaBelle Septic to Sewer Zone J	0.1	2023	2028
LaBelle Septic to Sewer Zone A	1.0	2023	2028
LaBelle Septic to Sewer Zone B	0.6	2023	2028
Four Corners	39.3	2023	2028
Bob Janes Restoration	0.5	2024	2029
C-43 West Basin Storage Reservoir: Water Quality Component	14.7	2025	2030
CREST	6.5	2025	2030
Total	81.4		

[a] Assuming no project delays and estimates for long-term reductions are realized over a 5-year period.

UPSTREAM LEVEL MONITORING ANALYSIS

To better understand the source of nutrients within the watershed and to better define where additional projects or program adjustments are needed, data from the upstream monitoring sites were reviewed. Currently, there are nine SFWMD upstream monitoring locations in the West Basin where TP, TN, OPO_4, NH_3-N, and NO_x are collected (**Figure 23, Tables 19-21)**. Monitoring at the upstream sites is conducted bi-weekly when flowing, though at most upstream monitoring locations there is no measurement of flow. Sampling at these locations began in January of 2020 (WY2020) as part of the expanded monitoring effort approved by the SFMWD Governing Board in August of 2019. There were data collected at some of these sites as part of previous efforts but the most recent sampling prior to the expanded monitoring was in September of 2015 (WY2016). Note that only data for WY2021 and WY2022 are presented as those were complete water years.

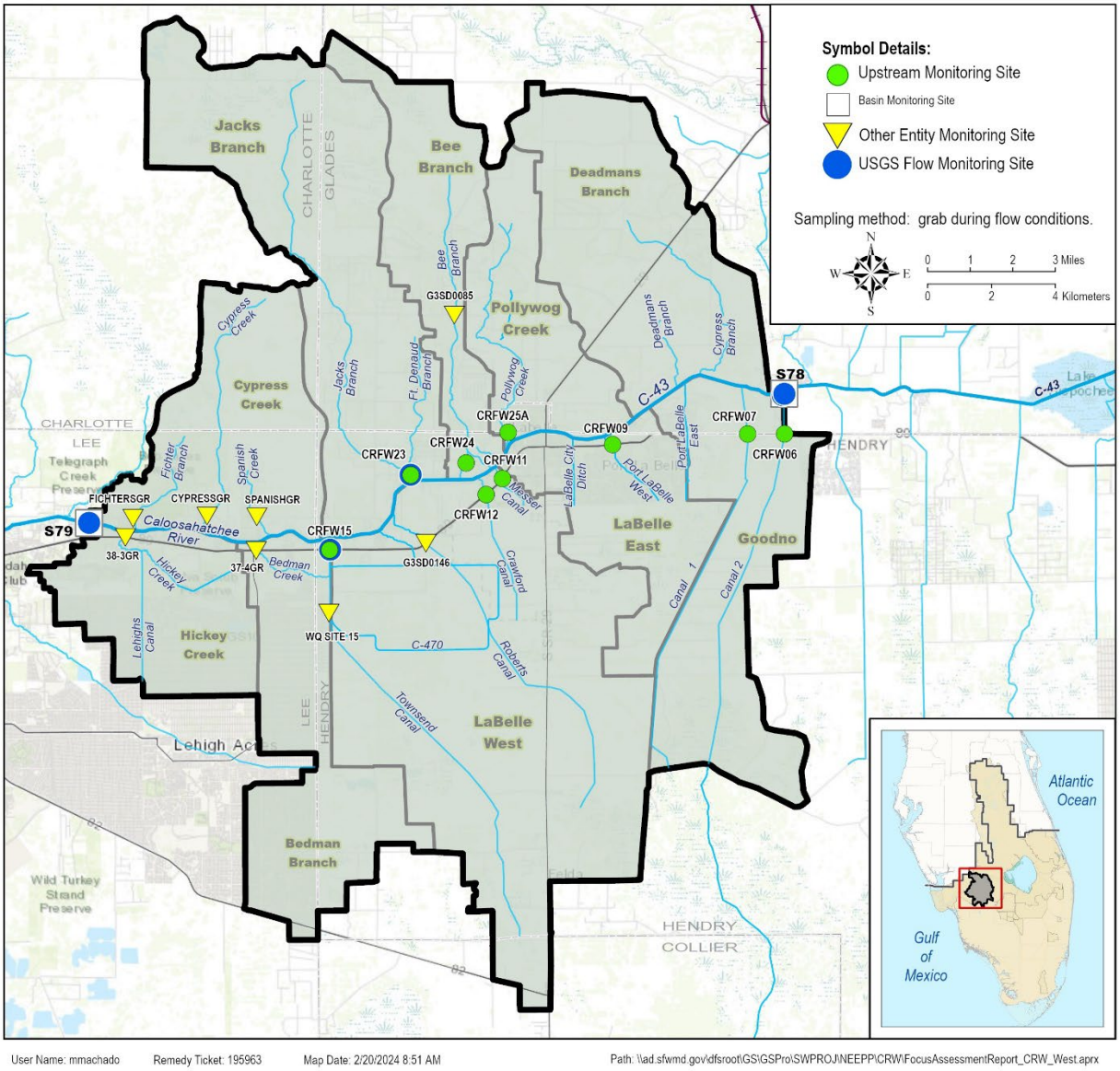


Figure 23. SFWMD basin and upstream level monitoring sites and other entity monitoring sites in West Caloosahatchee subbasins.

In addition to SFWMD monitoring, there are eight sites collected by other entities: Lee County (five), the city of Cape Coral (one), and FDEP (**Figure 23**, **Tables 22 - 25**). The frequency of sample collection for the other entities is depicted in **Table 22**. Note that only WY2021 and WY2022 are reported here for comparison with SFWMD data but there may be additional data at those stations prior to WY2021. Also, note that these other entities estimate total Kjeldahl nitrogen (TKN) instead of TN, so TN data in **Table 23** were estimated by combining the TKN and NOx data.

Table 19. Most recent 2-year TN concentration data (WY2021–WY2022) for the SFWMD upstream monitoring sites within the West Basin (Data Source: Frye and Carvatta 2023 SFER Appendix 8D-1, Table 5). (Note: Avg. – Average, Conc. – Concentration, Max. – Maximum, Min. – Minimum, and No. – Number of Samples.)

West Caloosahatchee	WY2021				WY2022				2-Year Avg. TN Conc. (mg/L)	2-Year Median TN Conc. (mg/L)
Site	No.	TN Conc. (mg/L)			No.	TN Conc. (mg/L)				
		Avg.	Min.	Max.		Avg.	Min.	Max.		
CRFW06[a]	18	1.28	0.95	2.06	21	1.16	1	1.54	1.21	1.12
CRFW07	26	1.38	1.00	2.24	20	1.44	1.12	1.86	1.4	1.36
CRFW09	25	1.15	0.77	1.51	20	1.11	0.7	1.44	1.13	1.12
CRFW11	24	1.27	0.87	1.80	3	1.52	0.94	1.81	1.3	1.18
CRFW12	24	1.03	0.79	1.34	13	1.01	0.8	1.26	1.02	1.03
CRFW15[a]	14	1.44	0.92	1.96	11	1.3	1.07	1.58	1.38	1.34
CRFW23[a]	14	1.22	0.80	1.88	10	1.16	0.86	1.52	1.197	1.185
CRFW24	19	1.28	0.66	2.16	7	1.51	1.28	1.74	1.35	1.36
CRFW25A	18	1.35	0.66	2.22	18	1.03	0.39	1.83	1.19	1.28

a. Flow data were collected by the United States Geological Survey and funded by the FDEP at associated flow stations. The flow data are available in SFWMD's DBHYDRO database accessible at https://www.sfwmd.gov/science-data/dbhydro.

Table 20. Most recent 2-year TP concentration data (WY2021–WY2022) for the SFWMD upstream monitoring sites within the West Basin (Data Source: Frye and Carvatta 2023 SFER Appendix 8D-1, Table 4). (Note: Avg. – Average, Conc. – Concentration, Max. – Maximum, Min. – Minimum, and No. – Number of Samples.)

West Caloosahatchee	WY2021				WY2022				2-Year Avg. TP Conc. (µg/L)	2-Year Median TP Conc. (µg/L)
Site	No.	TP Conc. (µg/L)			No.	TP Conc. (µg/L)				
		Avg.	Min.	Max.		Avg.	Min.	Max.		
CRFW06[a]	18	92	37	293	21	84	38	189	88	60
CRFW07	26	131	33	344	20	180	38	438	152	107
CRFW09	25	80	39	264	20	77	47	171	79	63
CRFW11	24	159	50	394	3	206	43	359	164	130
CRFW12	24	191	55	489	13	213	52	532	189	107
CRFW15[a]	14	213	58	561	11	142	62	251	182	151
CRFW23[a]	14	141	35	238	10	116	35	270	131	126
CRFW24	19	178	60	294	7	234	166	301	193	204
CRFW25A	18	396	113	870	18	413	143	1337	404	321

a. Flow data were collected by the United States Geological Survey and funded by the FDEP at associated flow stations. The flow data are available in SFWMD's DBHYDRO database accessible at https://www.sfwmd.gov/science-data/dbhydro.

The 2-year average annual TN concentrations were all less than the 1.54 mg/L benchmark (FDEP, 2020) but greater than the 0.913 mg/L planning target concentration at the SFWMD monitoring stations (**Table 19**). At the stations collected by other entities, the 2-year average concentrations were all less than 1.54 mg/L except CYPRESSGR (3.30 mg/L 2- year average TN concentration; **Table 23**). Three of the eight stations had 2-year average TN concentrations lower than the 0.913 mg/L planning target concentration.

Seven of the nine SFWMD sites had 2-year average TP concentrations greater than the FDEP numeric nutrient criteria of 120 µg/L (**Table 20**) but only one of the other entity sites had TP concentrations above

that benchmark (G3SD0085 at 145 µg/L; **Table 24**). The SFWMD site with the highest 2-year average TP concentration (404 µg/L) was CRFW25A. The remaining SFWMD stations all had TP concentrations less than 200 µg/L.

Regarding the other parameters collected, there were a couple noteworthy items: The NOx average concentration for CYPRESSGR WY2022 was 2.375 mg/L (78% of the WY2022 TN) indicating that perhaps fertilizer practices within the Cypress subbasin should be reviewed (**Table 25**). Otherwise, the NH_3-N and NOx values were relatively low compared to the TN values, again indicating that the issue may be DON. The OPO_4 for CRFW25A was 277 µg/L (67% of the WY2022 TP) indicating that dissolved P may play a bigger role in the high concentrations of the Polywog Creek Subbasin (**Table 21**).

The 2022 5-Year Review of the Caloosahatchee River and Estuary BMAP (FDEP, 2022a) used a Seasonal Kendall Tau test (SKT), which is a non-parametric test frequently used to detect trends for water quality time series data. It is a rank-order statistic that can be applied to time series data exhibiting seasonal cycles, missing and censored data, and indications of non-normality (Yu and Zou 1993). Non-parametric tests perform analyses based on the ranks of the data and therefore, are not influenced by outliers or skewed data that may have been present during the study period due to extremely wet or dry conditions. The SKT analysis found a statistically significant increasing trend in TN concentrations in the Bedman/Dog (based on data from 37-4GR) and Cypress Creek subbasins (based on data from CYPRESSGR, FICHTERGR, and SPANISHGR; see **Figure 3** for FDEP subbasins) for the period of WY2009 – WY2022. No significant trends were found in TP concentrations. Note that FDEP only conducted the analysis on sites with a minimum of 5-years of data, which excluded seven of the 17 upstream sites (SFWMD expanded monitoring was not fully implemented until WY2021) in the West Basin so this analysis will need to be revisited in the future to determine the Water Quality characteristics for the remaining areas of the basin. The seven excluded stations were CRFW06, CRFW07, CRFW11, CRFW12, CRFW15, CRFW24, and CRFW25A.

Based on FDEP's TRA analysis in the 2022 5-Year Review of the Caloosahatchee River and Estuary BMAP (FDEP, 2022a) the priority for the Bedman Dog subbasin was increased from 3 to 2 for TN. The Cypress Creek basin was ranked priority 1 for TN in the 2020 BMAP and the 5-Year review. **Table 3** provides a list of the TRA rankings and the changes from the 2020 BMAP.

The FDEP TRA ranking plus WQ data indicate the Cypress Subbasin may be one in which nutrient projects are needed. The recently completed Four Corners Project is expected to remove an estimated long-term average 39.3 t TN /yr and should assist with TN nutrient reductions from Cypress Subbasin. Since the TN concentrations are increasing in Cypress Creek and Bedman Dog subbasins, the Coordinating Agencies should focus source control efforts and consider water quality treatment projects in both basins. The eastern stations had higher TP concentrations, so any efforts in TP removal should be done near those locations.

UPSTREAM MONITORING FLOW ANALYSIS

Flow measurements are collected for three upstream monitoring sites at the following tributaries, the Townsend Canal near CRFW15, Jacks Branch at CRFW23, and Canal 2 near CRFW06 (**Table 26**, **Figure 23**). CRFW15, on the Townsend Canal, is downstream of the future C-43 Reservoir and currently represents discharges from upstream areas.

Loads for WY2021 and WY2022 were calculated at the three upstream sites to determine individual contributions from the tributaries to the West Basin (**Table 27**). In WY2021, Canal 2 contributed 3.5 t TP and 41.6 t TN, Jack's Branch contributed 7.3 t TP and 53.6 t TN, and the Townsend Canal contributed 28.5.1 t TP and 138.9 t TN. In WY2022, Canal 2 contributed 2.2 t TP and 25 t TN, Jack's Branch contributed 4.6 t TP and 44.6 t TN, and the Townsend Canal contributed 11.1 t TP and 68.5 t TN. Irrigation during the dry season can cause backflows into the Townsend Canal (J. Bobsein, personal communication March 29, 2022). Until recently, water quality samples were only collected during positive flows at the Townsend Canal site (CRFW15) but beginning in June of 2022 this site is now collected during reverse flows as well to capture backflow concentrations. Since those data were not yet available for this analysis, and the

Townsend Canal is approximately halfway between the S78 and S79 basin monitoring stations, average monthly backflow concentrations from the C-43 at the monitoring site were estimated by combining concentrations at S78 and S79 from WY2017-2021 and WY2018-WY2022, averaging, and then interpolating monthly concentrations based on those values. These monthly concentrations were used to estimate the total WY2021 and WY2022 loads that backflowed from the river up the tributary, using actual flow measurements. The net total was calculated based on measured outflow loads (to river) and calculated inflow loads (from river).

Table 21. Number of samples and averages for additional water quality parameters collected in WY2022 (Data Source: Frye and Carvatta 2023 SFER Appendix 8D-1, Table 6) for the upstream monitoring sites within the West Basin (Note: Avg. – Average and No. – Number of Samples.)

WY2022								
West Caloosahatchee	OPO_4 (µg/L)		NH_3-N (mg/L)		NOx (mg/L)		Specific Conductance (µS/cm)	
Site	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
CRFW06	21	37	21	0.072	21	0.057	21	487
CRFW07	20	130	20	0.099	20	0.079	20	537
CRFW09	18	12	20	0.041	20	0.01	20	693
CRFW11	3	130	3	0.088	3	0.065	3	430
CRFW12	10	218	10	0.035	10	0.05	12	555
CRFW15	11	92	11	0.084	11	0.158	11	530
CRFW23	10	86	10	0.031	10	0.071	10	337
CRFW24	7	169	7	0.05	7	0.058	7	179
CRFW25A	18	277	18	0.055	18	0.047	18	399

Table 22. Frequency of sample collection for other sampling entities

Sampling Entity	Sampling Frequency
The City of Cape Coral	Monthly regardless of flow
FDEP	Monthly when flowing for the BMAP project and also collecting for the Strategic Monitoring Plan a minimum of 2 sample events in dry season and 2 sample events during the wet season when flowing.
Lee County	Monthly when flowing

Of the three monitored tributaries, the Townsend Canal has the most flow, thus it is logical that the C-43 Reservoir project is located on that tributary. Jack's Branch and Canal 2 should also be evaluated for storage projects in those areas to assist with reducing flows in the West Basin. Flows from the other tributaries are not known. Additional flow monitoring may be warranted to further evaluate tributaries within the West Basin.

The Townsend Canal is also subject to tributary TMDLs for TP and TN (**Table 4**) which must be met on a 5-year rolling average (FDEP, 2022a). Based on the data from WY2021 and WY2022, Townsend canal does not yet appear to be achieving the planning target load of 6 t TP or 73 t TN based on a 2-year average TP load of 19.8 t TP and 103.7 t TN. However, it should be noted that the TMDL is measured against a 5-year average (FDEP, 2022a).

Table 23. Most recent 2-year TN concentration data (WY2021–WY2022) for the Other Entity upstream monitoring sites within the West Basin (Note: Avg. – Average, Conc. – Concentration, Max. – Maximum, Min. – Minimum, and No. – Number of Samples.)

West Caloosahatchee	Sampling Entity	WY2021				WY2022				2-Year Avg.	2-Year Median
		No.	TN Conc. (mg/L)[a]			No.	TN Conc. (mg/L)			TN Conc. (mg/L)	TN Conc. (mg/L)
Site			Avg.	Min.	Max.		Avg.	Min.	Max.		
37-4GR	Lee County	12	0.85	0.28	1.76	10	0.77	0.45	1.03	0.81	0.76
G3SD0085	FDEP South	9	1.28	0.80	2.15	14	1.34	0.69	2.16	1.32	1.35
CYPRESSGR	Lee County	12	3.52	2.00	6.45	10	3.04	1.05	6.96	3.30	2.76
FICHTERSGR	Lee County	12	1.08	0.61	2.42	10	0.88	0.62	1.53	0.99	0.87
SPANISHGR	Lee County	11	1.13	0.52	1.72	7	1.14	0.45	1.61	1.14	1.11
38-3GR	Lee County	12	0.65	0.39	1.11	10	0.67	0.37	1.06	0.66	0.60
G3SD0146	FDEP South	4	1.44	1.20	1.57	12	1.23	1.00	1.57	1.28	1.25
WQ SITE 15[b]	Cape Coral	4	0.67	0.40	0.93	2	0.85	0.80	0.90	0.73	0.77

[a] TN calculated by adding TKN and NOx.
[b] NOx calculated by adding average Nitrate and Nitrite values.

Table 24. Most recent 2-year TP concentration data (WY2021–WY2022) for the Other Entity upstream monitoring sites within the West Basin. (Note: Avg. – Average, Conc. – Concentration, Max. – Maximum, Min. – Minimum, and No. – Number of Samples.)

West Caloosahatchee	Sampling Entity	WY2021				WY2022				2-Year Avg.	2-Year Median
		No.	TP Conc. (µg/L)			No.	TP Conc. (µg/L)			TP Conc. (µg/L) [a]	TP Conc. (µg/L)
Site			Avg.	Min.	Max.		Avg.	Min.	Max.		
37-4GR	Lee County	12	17	6	39	10	34	11	87	25	19
G3SD0085	FDEP	9	117	76	160	14	163	55	380	145	130
CYPRESSGR	Lee County	12	55	20	180	10	44	11	100	50	36
FICHTERSGR	Lee County	12	117	46	300	10	77	58	95	99	80
SPANISHGR	Lee County	11	44	19	100	7	47	22	65	45	45
38-3GR	Lee County	12	47	12	97	10	38	11	71	43	37
G3SD0146	FDEP	4	110	68	150	12	86	46	150	92	75
WQ SITE 15	Cape Coral	5	80	50	100	2	100	100	100	86	100

Table 25. Number of samples and averages for additional water quality parameters collected by Other Entities in WY2022 for the upstream monitoring sites within the West Basin (Note: Avg. – Average and No. – Number of Samples.)

WY2022									
West Caloosahatchee Site	Sampling Entity	OPO_4 (µg/L)		NH_3-N (mg/L)		NOx (mg/L)		Specific Conductance (µS/cm)	
		No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
37-4GR	Lee County	10	7	10	0.023	10	0.243	10	970
G3SD0085	FDEP	13	88	14	0.044	14	0.045	14	245
CYPRESSGR	Lee County	10	19	10	0.025	10	2.375	10	668
FICHTERSGR	Lee County	10	27	10	0.031	10	0.042	10	729
SPANISHGR	Lee County	7	22	7	0.043	7	0.383	7	513
38-3GR	Lee County	10	14	10	0.020	12	0.036	10	583
G3SD0146	FDEP	12	28	12	0.065	12	0.052	12	554
WQ SITE 15	Cape Coral	2	75	2	0.150	2	0.200	12	721

Table 26. Upstream flow monitoring stations in West Basin.

Tributary	Subbasin	Measurement Type	Associated Water Quality Site	Flow Direction
Canal 2	Goodno	Calculated via Stilling Well	CRFW06	North (to C-43)
Jack's Branch	Jack's Branch	Index Velocity Meter	CRFW23	South (to C-43)
Townsend Canal	LaBelle West	Index Velocity Meter	CRFW15	North (to C-43) South (from C-43)

Table 27. West Basin upstream load calculations for WY2021 and WY2022.

Tributary	WY2021					WY2022				
	Flow (cfs)	Total Phosphorus		Total Nitrogen		Flow (cfs)	Total Phosphorus		Total Nitrogen	
		Load (t)	FWMC (µg/L)	Load (t)	FWMC (mg/L)		Load (t)	FWMC (µg/L)	Load (t)	FWMC (mg/L)
Canal 2	**11,942**	**3.5**	**120**	**41.6**	**1.43**	**8,153**	**2.2**	**112**	**25**	**1.25**
Jack's Branch	**17,966**	**7.3**	**167**	**53.6**	**1.22**	**15,309**	**4.6**	**122**	**44.6**	**1.19**
Townsend Canal										
Outflow (to river)	**46,501**	**32.1**	**282**	**180.6**	**1.59**	**36,417**	**15.1**	**170**	**118.4**	**1.33**
Inflow (from river)	**-13,117**	**-3.6[a]**	**-**	**-41.7[a]**	**-**	**-15,512**	**-4[b]**	**-**	**-49.9[b]**	**-**
Townsend Net[c] Total (Outflow-Inflow)	**33,384**	**28.5**	**-**	**138.9**	**-**	**20,905**	**11.1**	**-**	**68.5**	**-**

[a]Concentrations estimated by combining monthly concentrations at S78 and S79 from WY2017-2021, averaging and then interpolating based on those values.
[b]Concentrations estimated by combining monthly concentrations at S78 and S79 from WY2018-2022, averaging and then interpolating based on those values.
[c]Net is the outflow to the river minus the inflow to determine the amount of flow and loads coming from the Townsend Canal Tributary

PROJECT OPPORTUNITIES

The issue for the West Basin appears to be primarily related to flows, not nutrient concentrations. This basin discharges a large volume of water relative to its size, with flows similar to the Upper Kissimmee subwatershed (in the Lake Okeechobee Watershed) that is nearly three times the size of the West Basin. However, to maintain enough flow to keep the CRE healthy, flows can only be reduced to a certain extent. The annual planning target load for this basin is 611 t TN, which would require achieving a TN concentration of 0.913 mg/L with the minimum optimum flows necessary for estuary health. The TN FWMC at the basin outlet for the past five water years have been below the FDEP TN benchmark numeric nutrient criteria of 1.54 mg/L, but above the planning target concentration of 0.913 mg/L. This concentration may be difficult to achieve without alternative technologies which are currently being tested. Thus, at this present time projects within this basin should primarily focus on storage.

Storage projects could be located anywhere sufficient water and land are available. Currently, there are three SFWMD storage projects in the basin, Mudge Ranch, C-43 Reservoir, and Four Corners, which collectively store 190,396 ac-ft annually. Of the three monitored tributaries with flow, Townsend Canal contributes the most so the location of the C-43 Reservoir along this canal is ideal. As mentioned above, the addition of 145,000 ac-ft of storage would assist with achieving the basin planning target of 611 t/yr TN but these storage projects must be able to release water when needed to ensure the minimum optimum flows are met at S-79.

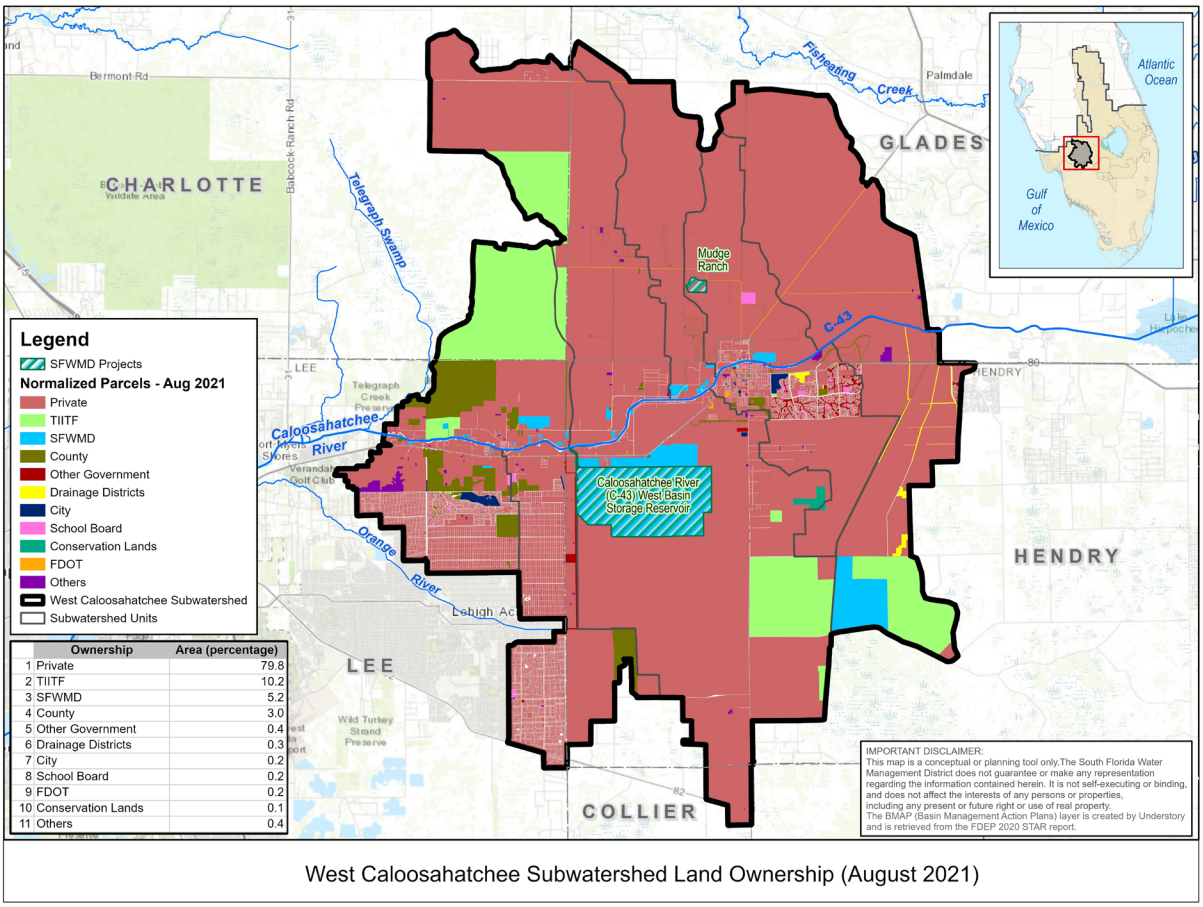
Regarding nutrients, source control activities appear to be working in the West Basin as TN FWMC at the basin outlet are below the numeric nutrient criteria and TP FWMC at the basin outlet are close to the numeric nutrient criteria. However, the TN concentrations at 14 of the 17 upstream stations are above the planning target concentration of 0.913 mg/L, so these areas may need to be addressed by alternative technologies in the future. Additionally, TN concentrations at the upstream monitoring sites are increasing in Cypress Creek and Bedman Dog (Bedman Branch) subbasins (FDEP, 2022a), so the Coordinating Agencies should focus source control efforts there. CYPRESSGR is the only upstream monitoring site with TN concentrations above the numeric nutrient criteria (3.30 mg/L based on a 2-year average). The NOx average concentration at that site was 2.375 mg/L indicating that perhaps fertilizer practices within the Cypress Creek Subbasin should be reviewed. The eastern upstream monitoring sites had higher TP concentrations, so any efforts in TP removal should be done upstream of those locations. Water quality treatment projects work best when placed as close to the downstream receiving waterbody as possible and should be considered during planning. Also, when considering nutrient projects in this basin, it is important to remember that the primary source of TN is this basin appears to be DON based on the data at S-79.

There are currently one active (Four Corners) and one planned (C-43 West Basin Storage Reservoir Water Quality Component) SFWMD water quality treatment projects in the West Basin. The Four Corners project treats water from Cypress Creek Subbasin. The C-43 West Basin Storage Reservoir Treatment Project will treat water flowing into the reservoir from Townsend and C-43 canals. Townsend Canal has TMDL requirements for both TN and TP. Both projects are appropriately located in subbasins with nutrient issues. Additional projects are recommended in the Potential Projects and Funding Opportunities section below along with some information on additional potential projects that were considered.

PUBLIC LAND OWNERSHIP

One step in formulating project opportunities is to review land ownership to determine the availability of public land. The majority of land within the West Basin is privately owned but there also are areas of state-owned land (**Figure 24).** The Board of Trustees of the Internal Improvement Fund of the State of Florida (TIITF) own 34,413 acres. These properties are mainly located in the northwest and southeast portion of the basin along the boundary. SFWMD owns approximately 17,580 acres in the West basin. The majority of these lands (10,700 acres) are incorporated into the C-43 West Basin Storage Reservoir. There

are approximately 1,900 acres of District-owned lands north of the C-43 reservoir that may be used for additional water quality treatment (K. Fikoski, personal communication September 29, 2023). There are some SFWMD parcels (5 to 400 acres) adjacent to vacant or lower intensive use lands, on the downstream side of the subbasin where they are located and near the Caloosahatchee River (C-43 Canal). An initial review of these SFWMD lands completed in 2021 indicated that many had challenges which did not lend themselves to affordable simple projects (J. Bobsein, personal communication October 2, 2023). It is recommended that if these properties are not suitable for storage or water quality treatment, that they be exchanged with parcels that are.



West Caloosahatchee Subwatershed Land Ownership (August 2021)

Figure 24. Land ownership highlighting state-owned lands in the West Basin as of August 2021.

POTENTIAL PROJECTS AND FUNDING OPPORTUNITIES

Of the three monitored tributaries, the Townsend Canal has the most flow, thus it is logical that the C-43 Reservoir project is located on that tributary. The other two tributaries, Jack's Branch and Canal 2 have the potential for additional projects pending careful design considerations based on the Water Availability Analysis. Flows from the other tributaries are not known.

The following actions are recommended:

- Determine if any of the Mudge Ranch storage project can be expanded as part of the renewal of the dispersed water management agreement.

- Consider developing storage projects on all available SFWMD properties within the West Basin since additional acreage will likely be necessary for storage. If the properties are not suitable for storage or water quality treatment, perhaps they can be traded for more suitable parcels.
- To minimize costs and maximize benefits, any new water quality treatment or large storage projects should be located at the lowest elevations (typically close to the C-43 Canal).
- Consider a request for proposals (RFP) for additional storage projects in the West Basin. The RFP response must include a water availability analysis along with the proposed storage and TN reductions that the project can achieve.
- Consider additional passive stormwater detention and wetland restoration projects throughout the basin to increase the storage capacity.
- Consider additional tributary flow monitoring to determine where high flows are coming from and assist in siting additional storage and water quality treatment projects. At a minimum, the following SFWMD upstream water quality stations should be reviewed for consideration for additional storage (CRFW7, CRFW9 (note there appears to be a large storage pond immediately upstream of this location), CRFW12, and CRFW25A). These stations have a high number of samples (average of 15 samples or more for last two water years) and are located on conveyances that are greater than 10 ft in width. Sampling two times during the wet season and two times during the dry season is recommended to provide an estimate of water availability from those stations. Other entity sites CYPRESSGR and 37-4GR should also be reviewed as they appear to also have a high number of monthly samples and are located along larger conveyances (approximately 60 ft wide). Any potential impacts to or from the Four Corners Rapid Infiltration Project should be considered for any proposed projects along Cypress Creek.
- Continue funding for Boma research into alternative technologies since the water quality issue is primarily DON (62-99% of total dissolved nitrogen) which does not respond to traditional wetland treatment and since the amount of storage in the basin is constrained by the flows needed to maintain optimum estuary health. Storage alone will not enable us to achieve the water quality goals.
- Add particulate nitrogen as a parameter to all SFWMD water quality stations to be able to calculate DON directly. This would allow the propriate resources to be directed to the right locations to make the biggest impact.

Spanish Creek Preserve Spoil Restoration

The proposed Spanish Creek Preserve Spoil Restoration Project (**Figure 25**) would have been located on a 410-acre District-owned parcel historically used for spoil disposal in the Cypress Creek Basin. The project was to restore the spoil site providing a restored rainfall driven system, recreate historic wetland function and storage, improve water quality, promote groundwater recharge, and provide opportunities for passive recreation with a public education component. The restored site would have also improved connectivity with the Lee County Spanish Preserve. A removal of 0.3 mt/yr. of TP and 2.8 mt/yr. of TN and an average annual storage of 1.845 ac-ft was estimated for the project. Project design was conditioned to the ability to dispose of or regrade/contour historically disposed spoils. This project was proposed to FDEP in August 2020 but ultimately was not funded. Later it was determined that storage may be difficult at this location due to the elevations at the site and the earthwork needed might make the project costs high relative to the benefits provided. Based on that information, SFWMD should see if the land could be swapped for a more suitable project location.

Frank Mann Preserve (formerly GS-10) Stormwater Treatment Area (STA)

LA-15, The Frank Mann Preserve (**Figure 26**), is a joint agency water quality and water storage initiative between Lee County and the LA-MSID. The Frank Mann Preserve Project is comprised of the

parcel formerly known as Section 10 purchased by the Lee County Conservation 20/20 Program and both LA-MSID's existing Greenbriar Swamp and Canal Network and is in the Bedman Branch (FDEP's Bedman Dog) subbasin. This project will provide flood protection, aquifer recharge, and water quality benefits for the Caloosahatchee River and Lehigh Acres in the Hickey Creek Subbasin. Phase 1 proposes to remove 2.30 mt/yr TN and 0.68 mt/yr TP, and Phase 2 proposes to remove 0.23 mt/yr TN and 0.03 mt/yr TP. Phase 1 provides 1,100 ac-ft storage and Phase 2 will provide an additional 300 ac-ft in Greenbriar Preserve (after modifying the Greenbriar discharge structure) plus additional storage in 3,800-acre catchment basins. Lee County and LA-MSID are seeking funding support for the construction of Phase 1, as well as the design, permitting, and construction of Phase 2. This project is recommended as it would provide water quality treatment and additional storage, and is located in a subbasin with increasing TN trends.

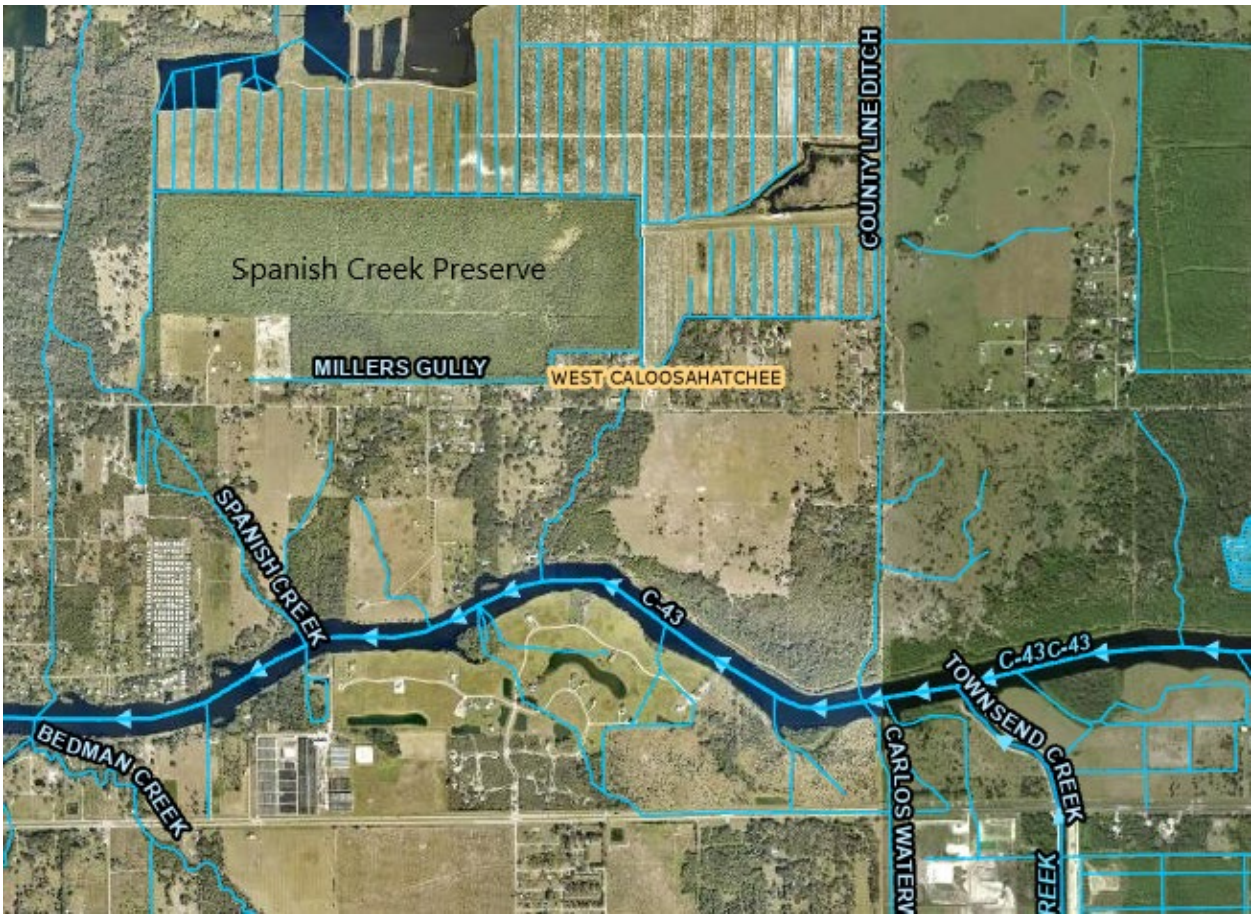


Figure 25. Spanish Creek Preserve.

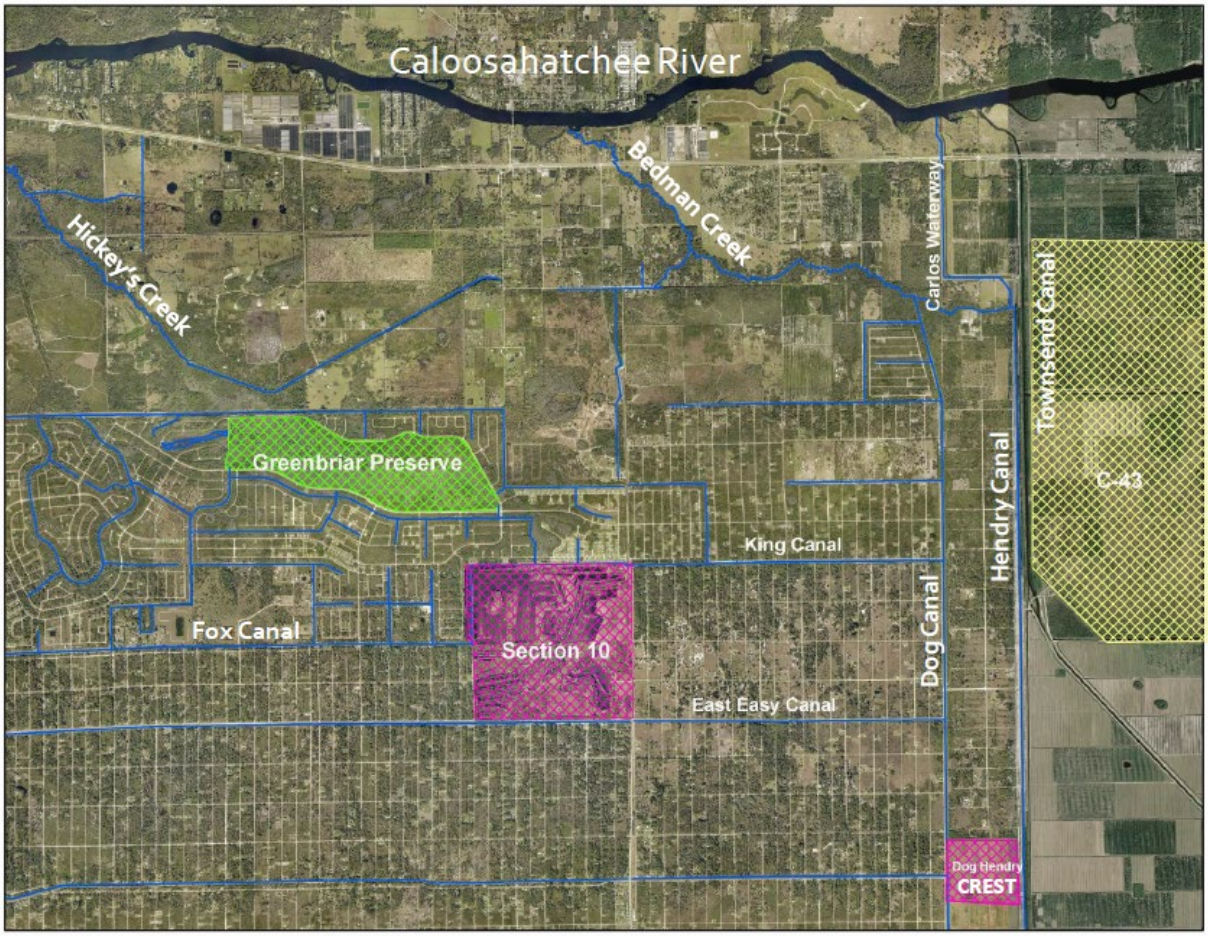


Figure 26. Frank Mann Preserve (Section 10) (Data Source: LA-MSID Dec. 7, 2022 meeting presentation).

AFTERWORD

Data through WY2022 were the latest data available when this assessment was originally drafted in January of 2023. This afterword provides a brief review of the WY2023 data and potential impacts, if any, on the recommendations from this report.

- The West Basin 5-year average TN loads and flows for the period of WY2019-WY2023 are 1,166.4 t and 714,700 ac-ft, respectively (Taylor et al., 2024 Chapter 8D SFER). The five-year average TN FWMC from the basin outlet was 1.32 mg/L
- The 5-year average TN load of 1,166.4 t is 555.4 t above the West Basin TN planning target load of 611 t. This is closer to the target than the WY2018-WY2022 TN load most likely due to the lower flows during the WY2019-WY2023 period.
- In the time it took to complete the report, the Frank Mann project became fully funded, so the expected TN reductions from recently completed and planned projects is now 83.93 t annually and the expected storage is now 194,196 ac-ft annually. Note that the high-level summary document reflects this change.
- Regarding the SFWMD upstream monitoring all the sites in the West Basin had 3-year average annual concentrations below the numeric nutrient criteria for TN but greater than the 0.913

mg/L TN planning target (Landfield and Olson, 2024 SFER Appendix 8D-1). The same seven SFWMD sites that had TP 2-year average annual concentrations above the numeric nutrient criteria for TP had 3-year average annual concentrations above the numeric nutrient criteria.

- Based on this information, all recommendations in the report remain the same after a review of the WY2023 data.

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