Water Resource Values Analysis of Outstanding Florida Springs and Assessment of Recreation, Aesthetic, and Scenic Attributes of Florida Springs
Task 6 – Final Report

Prepared for

Suwannee River Water Management District

TWA: 19/20-064.003

June 28, 2021

Prepared by

Wetland Solutions Inc

Table of Contents

Table of Exhibits

Figures

Tables

Executive Summary

Each of the Florida's five Water Management Districts (WMDs) are tasked with establishing minimum flows and minimum water levels (MFLs) for specific waterbodies within their boundaries under Section 373.042 of the Florida Statutes. Criteria used to define a MFL are further defined in the Florida Administrative Code (FAC) 62-40.473 and include seasonal fluctuations in flows and levels, non-consumptive uses, and ten specifically identified water resource values (WRVs). Evaluation of these ten WRVs has received variable treatment in adopted MFLs with more intense focus on some WRVs than others. Specifically, human use WRVs 1, *Recreation In and On the Water*, and 6, *Aesthetic and Scenic Attributes*, have generally received limited analysis or quantification except in limited cases on a small percentage of evaluated systems.

The SRWMD contains 14 outstanding Florida springs (OFSs) and a large number of additional springs. SRWMD stakeholders have requested specific metrics be developed to evaluate recreation, aesthetic, and scenic (RAS) attributes in future springs MFLs. This study was comprised of six tasks described below.

1. Summarizing existing MFLs and WRV methods, with a specific discussion of RAS metrics and methods.
2. Data compilation and database development for 19 springs (14 OFSs and 5 priority MFL springs) within the SRWMD.
3. Assessment of the applicability of each of the ten WRVs for the 19 evaluated springs, discussing the sufficiency of data for evaluation, and identification of potential data collection efforts to support WRV evaluation.
4. Development metrics to evaluate RAS metrics, identification of sampling frequency, and development of standard operating procedures (SOPs) for data collection.
5. Evaluation of RAS attributes for a selected spring based on available data with identification of data gaps.
6. Preparation of a final report that summarizes all findings.

This study found that MFLs had been developed for a total of 26 waterbodies that included one or more springs. Development of specific springs' MFLs were treated variably with some spring-specific MFLs developed (e.g. Volusia Blue Spring, Manatee Springs, and Fanning Springs) while others were evaluated in the context of the river to which they contribute flow (e.g. Lower Santa Fe River, Middle Suwannee River, and Lower Alafia River). Of the systems with MFLs developed, the limiting WRV varied by system as shown below:

WRV	MFLs with WRV as Limiting
1 – Recreation In and On the Water	1
2 – Fish and Wildlife Habitats and the Passage of Fish	17
3 – Estuarine Resources	1
5 – Maintenance of Freshwater Storage and Supply	1

WRV	**MFLs with WRV as Limiting**
6 – Aesthetic and Scenic Attributes	1
Limiting WRV Not Presented	7

Evaluation of completed MFLs found that RAS attributes were explicitly considered and evaluated under WRV 1 in 11 MFLs for 14 uses including: motorboats (4), paddle craft (4), tour boats (1), human use (1), in-water activities (1), tubing (1), and swimming (2). Six MFLs evaluated the applicability of WRV 6 for nine uses including: water clarity (4), nature viewing (1), wildlife viewing (2), sandboil springs (1), and cultural resources (1).

For the 19 evaluated springs data were identified, compiled, and organized into a database from a variety of sources. Major data types included hydrological, water quality, biological, and recreational. Following data compilation, 17 of the 19 springs (excluding Poe Springs and Devil's Ear Spring) were visited to evaluate the applicability of each WRV to the spring. This effort included a focus on the RAS attributes that were available at each spring. The applicability of each WRV was considered in the context of data availability and adequacy for analysis. Following site visits, data recommendations were developed for springs to collect data in a consistent and comprehensive manner for each spring with recommended data collection frequencies. Recommended data collection included: physical data (bathymetry, water levels, flows); water quality (field parameters, nutrients, and other); human use data (attendance, human use, and surveys); biological data (vegetation, fish, manatees, turtles, macroinvertebrates, and bioassessments); and other (water clarity, metabolism, and light attenuation).

Evaluation of existing and new MFL RAS metrics was based on available data and recommended supplemental data collection. RAS metrics were divided into RAS attributes, direct measures of RAS use including attendance and human use, and RAS drivers, characteristics that impact RAS attributes (e.g. physical, water quality, or other characteristics). Recommended measures included standard operating procedures (SOPs) provided for data collection.

Based on data availability and the proposed RAS metrics, a single spring system was chosen for more detailed analysis with the recommended methods. Manatee Springs was selected based on the availability of a long-term data record, that included park attendance, human use activities, water quality, manatee counts, water clarity, bathymetry, water levels, and flows.

This analysis identified the following observations and relationships for RAS metrics at Manatee Springs:

- Based on the available period with high-frequency flow data (the past 12 years), flows showed an increasing trend at Manatee Springs. Not unexpectedly, the flows at the spring were correlated with the differential head between an adjacent well and the spring pool level.
- Residence time, which has been considered as a metric, was evaluated for Manatee Springs. Residence time in the spring pool is too short (~30 minutes at the one percentile flow) to provide a meaningful MFL metric for evaluation. Residence time

and the relationship to water quality and/or water clarity may provide some value in systems with a longer spring run and residence time.

- Bathing capacity, which has been used as a metric in MFL development, was assessed for Manatee Springs. Based on Department of Health guidelines (500 gallons/person/day), flow through the spring pool is sufficient to accommodate more than 86,000 swimmers per day, even at the one percentile flow. This is significantly more than the park can accommodate from the standpoint of area within the spring pool and all other facilities (parking, bathrooms, etc.). This metric is not sensitive enough to be valuable for MFL development.
- Manatee presence is correlated with higher park attendance in winter, providing a useful metric for MFL development. Furthermore, persistent manatee presence was correlated with increases in park attendance.
- Decreases in water clarity at Manatee Springs are due to flooding events on the Suwannee River with dark water conditions (Clarity Level C-E) being related to lower flows than clear water conditions (Clarity Level A). The highest observed flows were associated with Clarity Level B (green tinted water). Both temperature and specific conductance data in the spring pool showed the occurrence of dark water events indicating the potential value of these parameters for supplemental monitoring. Higher park attendance was correlated with better water clarity (Clarity Level A).

The finding of increased attendance during periods with better water clarity and the relationship of water clarity and spring flow indicates the importance of protecting clear water days to maintain the user experience. This RAS metric can be applied to MFL development by using a hydrodynamic model to evaluate the change in dark water frequency, the length of dark water events, and the recovery time from flow reversal events. The data required for this evaluation and calibration of a model can likely be collected relatively easily during a typical annual flood event and does not necessarily require a long-term dataset since changes in flow are driven by differential head. The relationship observed between manatee presence and attendance further supports protection of manatees under WRV 6 in addition to consideration under WRV 2.

Based on review of existing MFLs the typical recreational depth protected was no more than 2-2.5 feet for boat passage. This depth appears to be insufficient to protect swimming in spring pools or runs. This study recommended the use of bathymetric data to determine the allowable change in levels that can be accommodated while not causing significant harm to recreational opportunities. This method was applied at Manatee Springs for three classes of recreational use with varying depth requirements (wading 0-2 feet, bathing 2-4 feet, and swimming >4 feet) to determine the area available for each form of recreation. This analysis showed that as levels decreased, the area available for each use type changed and the loss of recreational area could be assessed to establish a maximum allowable decrease in levels by use.

This study found that additional metrics are available to assess RAS attributes in springs as part of MFL development. The application of these metrics can be accomplished based on a variety of existing data and supplemental data collection. One important limitation in development of MFLs based on WRV 6 is that public perception has not been well quantified to determine user preference and tolerance for changes in aesthetic and scenic attributes. This study identified several recommendations to collect data on public perception for application across springs' MFLs. Through continued data collection and application of new and novel analyses, MFL development based on all applicable WRVs can be improved to protect Florida's springs.

Section 1.0 Springs MFL WRVs Summary Assessment

1.1 Introduction

Each of the Florida's five Water Management Districts (WMDs) are tasked with establishing minimum flows and minimum water levels (MFLs) for specific waterbodies within their boundaries under Section 373.042 of the Florida Statutes. Specifically, all Outstanding Florida Springs (OFSs) were required to have MFLs adopted by July 1, 2017, except for OFSs within the Northwest Florida Water Management District (NWFWMD) which had until July 1, 2026 for adoption. Within Section 373.042, a minimum flow is defined as, "…the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area."; and a minimum water level is defined as, "…the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources or ecology of the area."

Criteria used to define a MFL are further defined in the Florida Administrative Code (FAC) 62-40.473 and include seasonal fluctuations in flows and levels, non-consumptive uses, and ten specifically identified water resource values (WRVs). After adoption or revision of an MFL, if the waterbody is below, or projected to fall below the MFL within 20 years, the WMD shall approve a recovery or prevention strategy for the waterbody. MFLs developed to be protective of the identified WRVs may be set at multiple levels defining a minimum hydrologic regime that is protective. The WMDs are further required to submit a priority list and schedule annually that identifies systems that are planned for MFLs for the subsequent three-year period. This priority list also identifies whether the WMD will complete a voluntary scientific peer review.

1.1.1 Springs MFLs

As of March 2021, 26 MFLs[1] have been developed for springs, springs groups, or river reaches that contain springs. Included in these MFLs are hundreds of springs and spring vents, as many of the evaluated systems are spring groups, rather than a single spring vent. A vast majority of these springs and spring vents have not been individually evaluated and instead exist as part of a spring system (e.g. the Silver Springs Group includes at least 30 springs and 69 vents in the upper river). This distinction is important in the context of understanding the scope of MFL development since the WMDs were tasked with MFL development. Developed MFLs are shown in Table 1 by WMD with their adoption year. Figure 1 shows the locations of the springs and associated rivers that have adopted MFLs (the Wakulla and Sally Ward Springs MFL has not yet been adopted).

---

[1] The 26 MFLs do not include those systems that have been re-evaluated.

Table 1. Adopted Minimum Flows and Minimum Levels for Springs

District	MFL Name	Year
NWFWMD	St. Marks River Rise	2019
	Wakulla and Sally Ward Springs	Draft
SJRWMD	Alexander Springs	2017
	De Leon Springs	2017
	Gemini Springs	2017
	Silver Glen Springs	2017
	Silver Springs	2017
	Volusia Blue Springs	2006
	Wekiva Springs	1992
SRWMD	Aucilla River, Wacissa River and Priority Springs	2016
	Falmouth Spring, Lafayette Blue Spring, Peacock Springs, and Troy Spring	2017
	Madison Blue Spring	2005
	Lower Santa Fe and Ichetucknee Rivers and Priority Springs	2015[2]
	Upper Santa Fe River	2007
	Steinhatchee River	2019
	Lower Suwanee River and Estuary, Little Fanning, Fanning and Manatee Springs	2006
	Waccasassa River, Estuary and Levy (Bronson) Blue Spring	2007
SWFWMD	Lower Alafia River	2010
	Chassahowitzka River System	2013/2019[3]
	Crystal River / Kings Bay Spring Group	2018
	Gum Slough Spring Run	2016
	Upper Segment of the Hillsborough River	2008
	Homosassa River System	2013/2019[3]
	Rainbow River System	2017
	Sulphur Springs	2007
	Weeki Wachee River System	2009

---

[2] the 2019 re-evaluated MFL was not adopted at the time of this report.

[3] MFL summary based on 2019

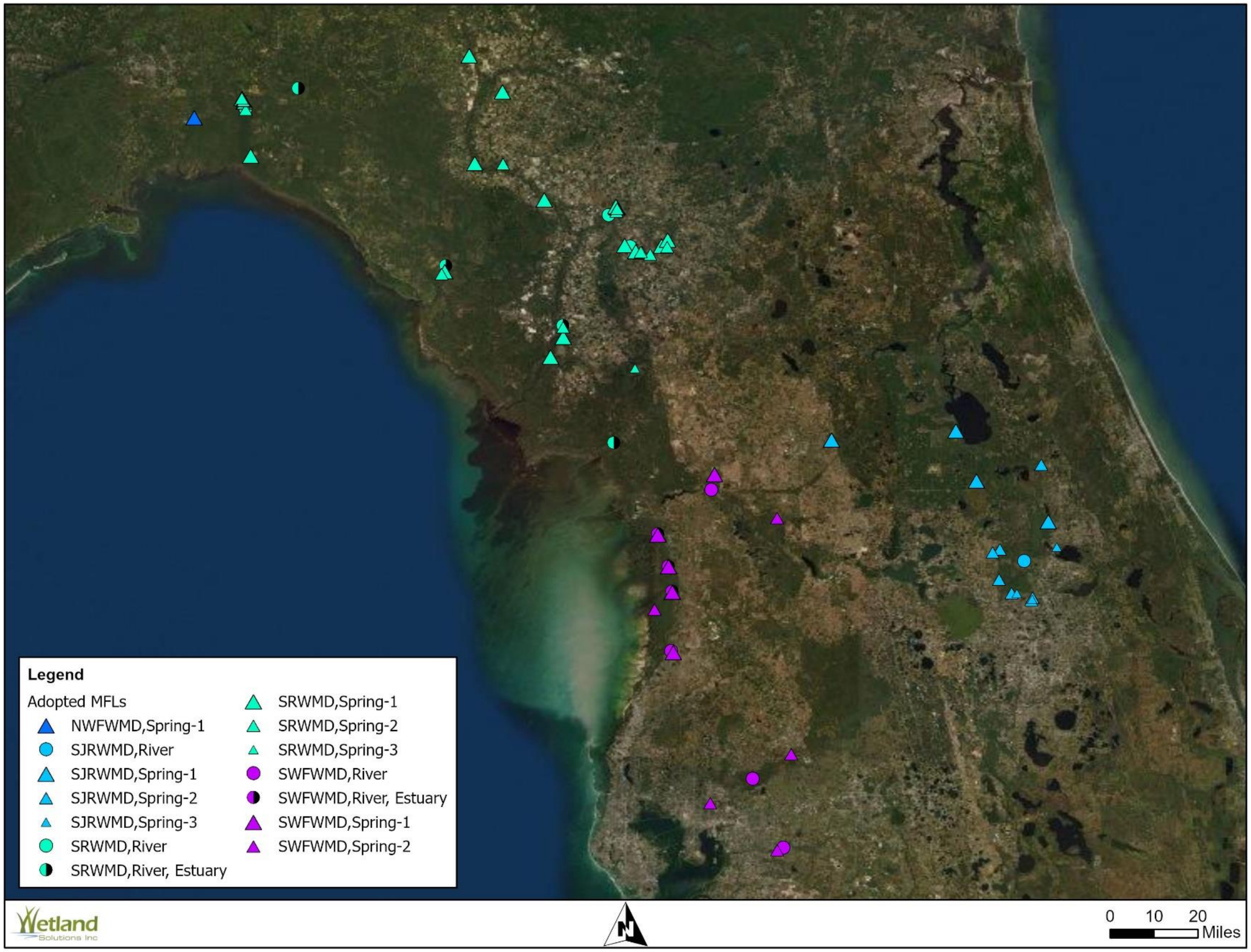


Figure 1. Locations of Spring Minimum Flows and Minimum Levels

1.1.2 Water Resource Values

Chapter 62-40.473 Minimum Flows and Levels of the F.A.C. provides: "In establishing minimum flows and levels pursuant to Sections 373.042 and 373.0421, F.S., consideration shall be given to natural seasonal fluctuations in water flows or levels, non-consumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetlands ecology." The setting of MFLs is based on defining a threshold at which a further reduction would cause a "significant harm" to one or more of ten enumerated WRVs. The identified WRVs that are included as part of the MFL process are shown in Table 2.

Table 2. Water Resource Values

Water Resource Value
1 – Recreation in and on the water
2 – Fish and wildlife habitats and the passage of fish
3 – Estuarine resources
4 – Transfer of detrital material
5 – Maintenance of freshwater storage and supply
6 – Aesthetic and scenic attributes
7 – Filtration and absorption of nutrients and other pollutants
8 – Sediment loads
9 – Water quality
10 – Navigation

1.2 MFL Summary by System

Each of the 26 MFLs for springs, spring groups, or river reaches with springs were reviewed to determine which WRVs were considered in their development. This review considered each WRV and classified their inclusion based on one of three treatments: *not quantified or not evaluated*, the WRV was not discussed or discussed but not quantified; *quantified*, the WRV was evaluated based on data or using modeling; and *limiting*, the WRV was determined to be the most sensitive criteria and used to develop the MFL. A summary of the WRVs by MFL is provided in Table 8. These WRVs are only those that were evaluated for the spring specifically and not for WRVs that were assessed within the rivers, but not the springs. The following sections briefly summarize each of the MFLs with a focus on the springs that are a part of the system. A more complete discussion of each of the MFLs and the WRVs applied is provided in Appendix A.

1.2.1 Northwest Florida Water Management District

1.2.1.1 St. Marks River Rise

The St. Marks River Rise is located in the Northwest Florida Water Management District (NWFWMD) and had an MFL developed and adopted in 2019 (NWFWMD, 2019). The rise is characterized as a first magnitude spring, with a long-term average flow of 452 cfs, calculated as the difference between the flow into the swallets and the flow leaving the rise. The St. Marks River flows to the Gulf of Mexico.

The MFL developed for St. Marks River Rise allows a 7.4% flow reduction (33 cfs), for the average baseline flow of 452 cfs. The MFL was developed based on the inundation of hardwood hammock habitats.

1.2.1.2 Wakulla and Sally Ward Springs

Wakulla and Sally Ward Springs is located in the NWFWMD and had an MFL developed in 2014 with a new draft MFL developed in 2020 (Atkins, 2014; NWFWMD, 2020). This MFL has not yet been adopted, but is anticipated to be adopted in 2021. Wakulla and Sally Ward Springs System is a first magnitude spring system with a long-term average flow of 575 cfs. The Wakulla River discharges into the St. Marks River before flowing to the Gulf of Mexico.

The MFL developed for the Wakulla and Sally Ward Springs System allows a 9.9% flow reduction (59.21 cfs), for the average baseline flow of 598 cfs. The MFL was developed based on safe manatee passage up the spring run.

1.2.2 St. Johns River Water Management District

1.2.2.1 Alexander Springs

Alexander Springs is located in the St. Johns River Water Management District (SJRWMD) and had an MFL developed and adopted in 2017 (Freese & Sutherland, 2017). Alexander Springs is a first magnitude spring system with an average baseline flow of 102.7 cfs. Alexander Springs is a largely unimpacted spring system that is surrounded by natural land uses. Alexander Springs flows down Spring Creek to the St. Johns River.

The MFL developed for Alexander Springs allows for a flow reduction of 6.8% (7 cfs) from the baseline flow of 102.7 cfs. The MFL was developed based on the average flow reduction percentages of other approved MFLs.

1.2.2.2 DeLeon Springs

De Leon Springs is located in the SJRWMD and had an MFL developed in 2016 (Harris et al., 2016). The MFL was adopted in 2017. De Leon Springs is a second magnitude spring with a long-term average flow of 25.6 cfs. De Leon Springs is a highly altered spring with a concrete-sided spring pool and an associated spring run. De Leon Springs flows into Spring Garden Lake which then flows into Lake Woodruff and the Lake Dexter on the St. Johns River.

The MFL for De Leon Springs is a 0% flow reduction based on the baseline flow of 25.6 cfs. The baseline flow includes an estimated 9.3% (2.6 cfs) flow reduction due to groundwater pumping. The MFL was developed based on no further reduction to warm water habitat for the Florida manatee.

1.2.2.3 Gemini Springs

Gemini Springs is located in the SJRWMD and had an MFL developed and adopted in 2017 (Mace, 2017). Gemini Springs is a second magnitude spring with an average flow of 9.8 cfs (1995-2015). Gemini Springs includes the spring vents and an associated spring impoundment and a spring run below the impoundment that is highly influenced by levels in the St. Johns River. Gemini Springs flows into Lake Monroe.

The MFL for Gemini Springs is a 15% flow reduction (1.6 cfs), for a pre-pumping baseline flow of 10.9 cfs. The baseline flow includes an estimated 1.0 cfs of flow reduction due to groundwater pumping through 2010. The MFL was developed based on a 15% increase in the spring residence time in the impoundment that was expected to cause a decrease in the aesthetic and scenic attributes and habitat value.

1.2.2.4 Silver Glen Springs

Silver Glen Springs is located in the SJRWMD and had an MFL developed and adopted in 2017 (Harris et al., 2017). Silver Glen Springs is a first magnitude spring with an average flow of 102.2 cfs. Silver Glen Springs is surrounded by generally natural land uses and discharges to Lake George and the St. Johns River.

The MFL for Silver Glen Springs is a 2.5% flow reduction (2.6 cfs), for the baseline flow of 102.2 cfs. The baseline flow includes an estimated 2.1 cfs of existing flow reduction from groundwater withdrawals. The MFL was developed based on maintaining the designated critical thermal refuge for the Florida manatee.

1.2.2.5 Silver Springs Group

The Silver Springs Group is located in the SJRWMD and had an MFL developed and adopted in 2017 (Sutherland et al., 2017). Silver Springs is a first magnitude springs group with an approximate average flow of 700 cfs from more than 30 springs. Silver Springs is surrounded by urban areas near the head springs and generally undeveloped areas along the spring run. The Silver River flows into the Ocklawaha River upstream of Rodman Reservoir.

The MFL for Silver Springs was developed as a series of three flow conditions (Frequent High, Minimum Average, and Frequent Low) with associated durations and return intervals to protect floodplain habitats. The Frequent High was defined as a flow of 828 cfs with a 30-day duration and a return interval of 5 years. The Minimum Average was defined as a flow of 638 cfs with a 180-day duration and a return interval of 1.7 years. The Frequent Low was defined as a flow of 572 cfs with a 120-day duration and a return interval of 3 years. The Frequent Low was found to be the most constrained with an allowable flow reduction of 6%. Current withdrawals were estimated to have caused a flow reduction of 3.5%.

1.2.2.6 Volusia Blue Spring

Volusia Blue Spring is located in the SJRWMD and had an MFL developed and adopted in 2006, with an update issued in 2013 (Rouhani et al., 2007; SJRWMD, 2013; Wetland Solutions, Inc., 2006b). Volusia Blue Spring is a first magnitude spring located in Volusia County that discharges into the St. Johns River downstream of the Wekiva River and Lake Monroe.

The MFL for Volusia Blue Spring is a phased restoration to the full historic long-term average flow of 157 cfs. The MFL was developed to be phased in over a little more than 18 years as shown in Table 3. The MFL was developed based on providing critical warm-water refuge for the Florida manatee in the spring and spring run.

Table 3. Minimum Flows and Minimum Levels for Volusia Blue Spring

Spring	Baseline Flow	Time Period	Minimum Flow (cfs)	Reduction
Volusia Blue Spring	157 cfs	Effective Date-3/31/2009	133	15%
		4/1/2009-3/31/2014	137	13%
		4/1/2014-3/31/2019	142	10%
		4/1/2019-3/31/2024	148	6%
		After 4/1/2024	157	0%

1.2.2.7 Wekiva River System

The Wekiva River System is located in the SJRWMD and had an MFL developed and adopted in 1992 with additional evaluation in 2008 and 2019 (Hupalo et al., 1994; Rao, 2008; Seong & Wester, 2019; Wetland Solutions, Inc., 2007). Springs within the MFL include: Messant Springs, Miami Springs, Palm Springs, Rock Springs, Sanlando Springs, Seminole Springs, Starbuck Spring, and Wekiwa Springs, each of which had an MFL developed. The combined flow of the Wekiva River System classifies it as a first magnitude spring system. The Wekiva River discharges into the St. Johns River, downstream of Lake Monroe.

The MFL developed for the Wekiva River System includes five flow rates that span the range of low, medium, and high flows with additional phased water restrictions flows (Table 4). The MFL also included flows and water elevations for the main springs in the Wekiva River System (Table 5). The MFLs were developed to protect a range of values including: wildlife habitat, human use, floodplain function, and fish passage.

Table 4. Minimum Flows and Minimum Levels for the Wekiva River at the State Road 46 Bridge

MFL Category	Level (ft NGVD29)	Flow (cfs)	Duration (days)	Return Period (years)
Minimum Infrequent High	9.0	880	≥7	≤5
Minimum Frequent High	8.0	410	≥30	≤2
Minimum Average	7.6	240	≤180	≥1.7
Minimum Frequent Low	7.2	200	≤90	≥3
Phase 1 Restriction	7.0	190	N/A	N/A
Phase 2 Restriction	6.9	180	N/A	N/A
Phase 3 Restriction	6.7	160	N/A	N/A
Phase 4 Restriction	6.5	150	N/A	N/A
Minimum Infrequent Low	6.1	120	≤7	≥100

Table 5. Minimum Flows and Minimum Levels for the Wekiva River System Springs

Spring Name	County	Head (ft NGVD29)	Discharge (cfs)
Messant Spring	Lake	32	12
Miami Springs	Seminole	27	4
Palm Springs	Seminole	27	7
Rock Springs	Orange	31	53
Sanlando Springs	Seminole	28	15
Seminole Springs	Lake	34	34
Starbuck Springs	Seminole	31	13
Wekiwa Springs	Orange	24	62

1.2.3 Suwannee River Water Management District

1.2.3.1 Aucilla River, Wacissa River, and Priority Springs

The Aucilla River, Wacissa River, and associated "priority" springs (2nd magnitude or greater on public lands) are located in the Suwannee River Water Management District (SRWMD) and had an MFL developed and adopted in 2016 (HSW Engineering, Inc., 2016). Springs within the MFL include: Big Blue Spring, Buzzard Log Spring, Cassidy Spring, Garner Spring, JEF63991, JEF63992, JEF63993, Jefferson Blue Spring, Little Blue Spring, Log Spring, Minnow Spring, Nutall Rise, Thomas Spring, and the Wacissa Headspring although separate MFLs were not developed for each spring. The Aucilla River System is a river that flows underground and re-emerges at Nutall Rise, a first magnitude spring. The Wacissa River originates from a collection of large first and second magnitude springs before merging with the Aucilla River and flowing to the Gulf of Mexico.

The MFL for the Aucilla River was developed as a series of tiered flows with larger reductions available at higher flows (Table 6). In the Aucilla, lower flows were developed to protect salinity zones in the lower river, medium flows were to protect bank habitat, and high flows were developed to protect floodplain habitat. For the Wacissa River low flows were developed to protect recreational boating and higher flows were developed to protect instream habitat.

Table 6. Minimum Flows and Minimum Levels for the Aucilla and Wacissa Springs

System (Assessment Location)	Gage Flow	Reduction
Aucilla River and Nutall Rise (Lamont Gage)	≤355 cfs	6.5%
	>355-558 cfs	13%
	>558 cfs	17%
Wacissa River and Springs Group (Wacissa Gage)	≤376 cfs	5.1%
	>376 cfs	7.3%

1.2.3.2 Falmouth Spring, Lafayette Blue Spring, Peacock Springs, and Troy Spring

Falmouth Spring, Lafayette Blue Spring, Peacock Springs, and Troy Spring are located in the SRWMD and had an MFL developed and adopted in 2017 (SRWMD, 2017). Falmouth, Lafayette Blue, and Troy Springs are first magnitude springs, while Peacock Springs is a second magnitude spring with all discharging into the Middle Suwannee River Reach. Lafayette Blue, Troy, and Peacock Springs all connect to the Suwannee River, but Falmouth is comprised of a rise and sink with no surface water discharge.

The MFLs developed for the springs included a 9.9% reduction for each of the springs from the baseline flows. Falmouth Spring initially incorporated a 15% flow reduction, but was modified to 9.9% reduction to match the other springs. This MFL was adopted under emergency rule development to protect the water resource and ecology until a non-emergency MFL could be developed.

1.2.3.3 Madison Blue Spring

Madison Blue Spring is located in the SRWMD and had an MFL developed in 2004 and adopted in 2005 (Water Resource Associates, Inc., 2004). Madison Blue Spring is a first magnitude spring located in Madison County. The spring discharges down a short spring run to the Withlacoochee River (North).

The MFL for Madison Blue Spring is a flow of 70 cfs when the Withlacoochee Pinetta Gage is at 55 feet (NGVD29) or less. This MFL is expected to provide a median flow of 100 cfs at the spring. This MFL was developed based on fish passage in shoal areas within the Withlacoochee River.

1.2.3.4 Lower Santa Fe River, Ichetucknee River, and Priority Springs

The Lower Santa Fe River, Ichetucknee River, and associated "priority" springs are located in the SRWMD and had an MFL developed in 2013, adopted in 2015, with a re-evaluation completed in 2021 (HSW Engineering, Inc., 2021a; Suwannee River Water Management District, 2013). Priority springs within the MFL include: Blue Hole Spring, COL101974, Columbia Spring, Devil's Ear Spring, Devil's Eye Spring, Grassy Hole Spring, Hornsby Spring, Ichetucknee Headspring, July Spring, Mill Pond Spring, Mission Spring, Poe Spring, Rum Island Spring, Santa Fe River Rise, Siphon Creek Rise, and Treehouse Spring although separate MFLs were not developed for each spring. The Ichetucknee Springs Group constitutes a first magnitude spring, while the Lower Santa Fe Rivers includes a variety of first and second magnitude springs.

The MFL for the Ichetucknee River was a 2.8% flow reduction (10 cfs) for a baseline flow 356 cfs. This flow was developed to protect woody habitat and hydric soils. The MFL for the Lower Santa Fe River includes an allowable 9.1% flow reduction at the US441 Gage (50 cfs), for a baseline flow of 552 cfs to protect fish passage based on a proportional shift to the MFL determined for the Fort White Gage (an allowable 8.1% flow reduction [103 cfs], for a baseline flow of 1,270 cfs).

1.2.3.5 Upper Santa Fe River

The Upper Santa Fe River is located in the SRWMD and had an MFL developed and adopted in 2007 (Water Resource Associates, Inc., 2007). Santa Fe Spring is the only large spring located in the Upper Santa Fe River and did not have an MFL developed. The spring functions as an estavelle receiving water at high river stages and discharging under lower river conditions.

1.2.3.6 Steinhatchee River

The Steinhatchee River is located in the SRWMD and had an MFL developed in 2018 and adopted in 2019 (Applied Technology and Management, Inc., 2018). This MFL includes Steinhatchee River Rise and Beaver Creek Spring. The Steinhatchee River Rise is where flows re-emerge after the river goes into a sink upstream. The rise is a first magnitude spring and Beaver Creek Spring is a second magnitude spring. The baseline flow for the Steinhatchee River was 102 cfs.

The MFL for the Steinhatchee River and applied to the Steinhatchee River Rise and Beaver Creek Spring was an 11.5% flow reduction. This MFL was developed based on protecting salinity habitats in the estuary.

1.2.3.7 Lower Suwannee River and Estuary, Little Fanning Springs, Fanning Springs, and Manatee Springs

The Lower Suwannee River and Estuary, Little Fanning Springs, Fanning Springs, and Manatee Springs are located in the SRWMD and had MFLs developed in 2005 (Water Resource Associates, Inc., 2005), with adoption in 2006. Manatee and Fanning Springs are first magnitude springs and Little Fanning Spring is a second magnitude spring, all of which discharge to the Lower Suwannee River. The baseline flow for Manatee Springs was 106 cfs and for Fanning Springs was 73 cfs. Fanning Springs experiences reverse flows when stages in the Lower Suwannee River exceeds approximately 9 feet (above mean sea level [msl]).

The MFLs for Manatee Springs and Fanning Springs were developed based on providing thermal refuge to manatees from November 1-April 30 with a 10% allowable reduction during the remainder of the year (May 1-October 31). The MFL for Manatee Springs is 130 cfs during the winter period and for Fanning Springs is a level of 2.71 feet (above msl).

1.2.3.8 Waccasassa River, Waccasassa Estuary, and Levy Blue Spring

The Waccasassa River, Waccasassa Estuary, and Levy Blue Spring are located in the SRWMD and had an MFL developed in 2006 (Water Resource Associates, Inc., 2006), with adoption in 2007. Levy Blue Spring is a second magnitude spring that flows into the Waccasassa River. Mean spring flows were 6.9 cfs based on a limited number of manual readings.

The MFL for Levy Blue Spring is a 10% flow reduction (0.7 cfs), based on an average flow of 6.9 cfs. The allowable flow reduction was set based on maintaining recreation and aesthetic water resources while supporting the river during median and low-flow periods.

1.2.4 Southwest Florida Water Management District

1.2.4.1 Lower Alafia River

The Lower Alafia River is located in the Southwest Florida Water Management District (SWFWMD) and had an MFL developed in 2005 (Kelly et al., 2005), with adoption in 2010. This MFL includes the Lithia and Buckhorn Springs Group, which discharge to the river. No MFL was developed for either spring system. During the evaluation of the Upper Alafia River MFL the springs were evaluated, but a recommendation was made to evaluate the springs as part of the Lower Alafia River MFL. However, no specific spring MFLs were developed as a part of that process.

1.2.4.2 Chassahowitzka River System

The Chassahowitzka River System is located in the SWFWMD and had an MFL developed in 2012, with adoption in 2013, and an updated MFL developed in 2019 (Herrick et al., 2019a; Heyl et al., 2012). The springs in this system include Blind Springs and the springs that make up the Chassahowitzka Springs Group. The Chassahowitzka Springs Group is a first magnitude springs system with an unimpacted flow rate of 59.7 cfs[4]. The Chassahowitzka River discharges to the Gulf of Mexico.

The updated MFL for the Chassahowitzka River System is an 8% flow reduction (4.7 cfs), for the unimpacted flow of 59.7 cfs. The MFL was developed based on a 15% reduction in salinity-based and temperature-based habitats. This MFL was a re-evaluation of the 2013 MFL that had an allowable flow reduction of 9% modeled with a 3% allowable reduction adopted based on public comments and Governing Board approval.

1.2.4.3 Crystal River and Kings Bay Spring Group

The Crystal River and Kings Bay Springs Group are located in the SWFWMD and had an MFL developed in 2017 (Herrick et al., 2017), with adoption in 2018. The Kings Bay Springs Group is a first magnitude spring system that discharges into the Gulf of Mexico. The system is highly tidally-influenced and had a long-term, tidally-filtered average flow of 456 cfs.

The MFL for the Kings Bay Spring Group is an 11% flow reduction (50 cfs), for a baseline flow of 456 cfs. The MFL was set based on peer review comments and the availability of low salinity, natural and vegetated shoreline.

---

[4] does not include Crab Creek and other downstream springs that increase total flow to greater than 100 cfs

1.2.4.4 Gum Slough Spring Run

The Gum Slough Spring Run is located in the SWFWMD and had an MFL developed in 2011 (Basso et al., 2011), with adoption in 2016. Gum Slough Springs Run is a second magnitude springs group that discharges into the Withlacoochee River. The median spring flow from 2003-2010 was 84 cfs.

The MFL for the Gum Slough Springs Run was a 9% annual reduction in flows. Additionally, surface water withdrawals are not allowed to decrease minimum flows below 35 cfs. The MFL was set based on a 15% loss of habitat for specific species life stages for the 9% flow reduction, and for fish passage at shoals for the 35 cfs flow based on surface water withdrawals.

1.2.4.5 Hillsborough River – Upper Segment

The Hillsborough River Upper Segment is located in the SWFWMD and had an MFL developed in 2007 (Munson et al., 2007a), with adoption in 2008. This MFL includes Crystal Springs, a second magnitude spring system located in Pasco County that discharges to the river. Crystal Springs provides a substantial portion of the flow of the Upper Hillsborough River during low-flow periods.

The MFL for Crystal Springs was a 16% flow reduction, and a minimum flow of 46 cfs. This MFL was developed to provide no more than a 15% decrease in the 52 cfs MFL for the Hillsborough River at the Morris Gage being violated under Block 1 (April 20-June 4).

1.2.4.6 Homosassa River System

The Homosassa River System is located in the SWFWMD and had an MFL developed in 2012, adopted in 2013, with an updated MFL developed in 2019 (Herrick et al., 2019b; Leeper et al., 2012). The Homosassa River System includes a large number of springs that make up the Homosassa River, as well as spring flow in tributaries that flow into the Homosassa River before it reaches the Gulf of Mexico. The Homosassa Springs Group is a first magnitude springs group with a long-term average flow of 146 cfs. Existing groundwater withdrawals were estimated at 3 cfs for the spring system.

The MFL for the Homosassa Springs Group was a 5% flow reduction (8 cfs), for an unimpacted spring flow of 149 cfs. Current withdrawals are estimated to cause a 3 cfs impact with a remaining allowable withdrawal of 5 cfs. The MFL was developed based on temperature-based habitat for the common snook.

1.2.4.7 Rainbow River System

The Rainbow River System is located in the SWFWMD and had an MFL developed and adopted in 2017 (Holzwart et al., 2017). The Rainbow River flows into the Withlacoochee River above Lake Rousseau. The Rainbow River System is a first magnitude spring system with average annual flows of 690 cfs.

The MFL for the Rainbow River System was a 5% flow reduction (34 cfs), for an unimpacted baseline flow of 683 cfs. Groundwater withdrawals were modeled as causing a 1.7% flow reduction for the system. The MFL was developed based on a 15% reduction in floodplain habitat occurring at a 5% flow reduction.

1.2.4.8 Sulphur Springs

Sulphur Springs is located in the SWFWMD and had an MFL developed in 2004 (SWFWMD, 2004), with adoption in 2007. Sulphur Springs is a second magnitude spring with an average flow of 34 cfs. The spring is located in Tampa in a highly urbanized area with a concrete-lined spring pool. This spring discharges to the Lower Hillsborough River and is used as a water supply by the City of Tampa during drought periods.

The MFL for Sulphur Springs was developed as a multi-part MFL based on levels in the Hillsborough River Reservoir, tide stage, and water temperatures (Table 7). The MFL was developed based on providing water supply during dry periods while avoiding salinity incursions in the upper spring run. Additionally, the temperature-based limits provide warm-water habitat to manatees during periods with cold-water temperatures.

Table 7. Minimum Flows and Minimum Levels for Sulphur Springs

Condition	Flow (cfs)
MFL when Hillsborough River Reservoir >19 feet	18
MFL when Hillsborough River Reservoir <19 feet	13
MFL when Hillsborough River Reservoir <19 feet, and low tide	10
MFL when Lower Hillsborough River <15°C	18

1.2.4.9 Weeki Wachee River System

The Weeki Wachee River System is located in the SWFWMD and had an MFL developed in 2008 (Heyl, 2008), with adoption in 2009. The Weeki Wachee Springs Group is a first magnitude spring system with an average flow of 162 cfs. The Weeki Wachee River discharges to the Gulf of Mexico.

The MFL for the Weeki Wachee River was a 10% flow reduction, for the baseline flow of 162 cfs. Current groundwater withdrawals were modeled to cause a 17 cfs decrease in spring flows. The MFL was developed based on averaging the limiting parameters (excluding manatee thermal refuge and fish habitat based on non-representative conditions during sampling). This MFL was the only MFL, of those reviewed, that averaged the limiting conditions, allowing some of the limiting criteria to be significantly harmed before falling below the MFL.

Table 8. Water Resource Value Assessment for Springs, by MFL System

✓ - limiting; ○ - quantified; Δ - not quantified or not evaluated, N/A-WRVs were not developed at the time of the study

System	Year Adopted	WRV 1	WRV 2	WRV 3	WRV 4	WRV 5	WRV 6	WRV 7	WRV 8	WRV 9	WRV 10
Northwest Florida Water Management District											
St. Marks River Rise	2019	○	✓	○	Δ	Δ	Δ	Δ	Δ	○	Δ
Wakulla and Sally Ward Springs	N/A	○	✓	○	Δ	Δ	Δ	Δ	Δ	○	Δ
St. Johns River Water Management District											
Alexander Springs	2017	○	○	○	○	Δ	○	○	○	○	Δ
De Leon Springs	2017	Δ	✓	○	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Gemini Springs[5]	2017	Δ	Δ	Δ	Δ	Δ	✓	Δ	Δ	Δ	Δ
Silver Glen Springs	2017	○	✓	Δ	Δ	Δ	○	Δ	○	Δ	Δ
Silver Springs	2017	○	✓	Δ	○	Δ	○	○	○	○	○
Volusia Blue Spring	2006	Δ	✓	○	Δ	Δ	Δ	Δ	○	○	Δ
Wekiva River System[6]	1992	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

---

[5] MFL set based on assumption of impacts to aesthetics from increased water residence time in the reservoir downstream of spring boil

[6] Messant Springs, Miami Springs, Palm Springs, Rock Springs, Sanlando Springs, Seminole Springs, Starbuck Spring, Wekiwa Springs

Table 8. Water Resource Value Assessment for Springs, by MFL System

✓ - limiting; ○ - quantified; Δ - not quantified or not evaluated, N/A-WRVs were not developed at the time of the study

System	Year Adopted	WRV 1	WRV 2	WRV 3	WRV 4	WRV 5	WRV 6	WRV 7	WRV 8	WRV 9	WRV 10
Suwannee River Water Management District											
Aucilla River, Wacissa River and Priority Springs[7]	2016	✓	✓	✓	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Falmouth, Lafayette Blue, Peacock, and Troy Springs	2017	Δ	○	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Madison Blue Spring	2005	Δ	✓	Δ	Δ	Δ	○	Δ	Δ	Δ	Δ
Lower Santa Fe and Ichetucknee Rivers and Priority Springs[8]	2015	○	✓	Δ	Δ	Δ	Δ	Δ	○	Δ	Δ
Upper Santa Fe River	2007	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Steinhatchee River[9]	2019	Δ	Δ	○	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Lower Suwanee River and Estuary, Little Fanning, Fanning and Manatee Springs	2006	Δ	✓	Δ	Δ	Δ	Δ	Δ	Δ	○	Δ
Waccasassa River, Estuary and Levy (Bronson) Blue Spring	2007	○	Δ	Δ	Δ	✓	Δ	Δ	Δ	Δ	Δ

---

[7] Big Blue Spring, Buzzard Log Spring, Cassidy Spring, Garner Spring, JEF63991, JEF63992, JEF63993, Jefferson Blue Spring, Little Blue Spring, Log Spring, Minnow Spring, Nutall Rise, Thomas Spring, Wacissa Headspring

[8] Blue Hole Spring, COL101974, Columbia Spring, Devil's Ear Spring, Devil's Eye Spring, Grassy Hole Spring, Hornsby Spring, Ichetucknee Headspring, July Spring, Mill Pond Spring, Mission Spring, Poe Spring, Rum Island Spring, Santa Fe River Rise, Siphon Creek Rise, Treehouse Spring

[9] Steinhatchee River Rise, TAY76992

Table 8. Water Resource Value Assessment for Springs, by MFL System

✓ - limiting; ○ - quantified; Δ - not quantified or not evaluated, N/A-WRVs were not developed at the time of the study

System	Year Adopted	WRV 1	WRV 2	WRV 3	WRV 4	WRV 5	WRV 6	WRV 7	WRV 8	WRV 9	WRV 10
Southwest Florida Water Management District											
Lower Alafia River (Lithia/Buckhorn Spring Group)	2010	○	○	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Chassahowitzka River System[10]	2013	Δ	✓	○	Δ	Δ	Δ	Δ	Δ	○	Δ
Crystal River / Kings Bay Spring Group	2018	Δ	✓	○	Δ	Δ	Δ	Δ	Δ	○	Δ
Gum Slough Spring Run	2016	Δ	✓	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Upper Segment of the Hillsborough River (Crystal Springs)	2008	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Homosassa River System	2013	Δ	✓	○	Δ	Δ	Δ	Δ	Δ	○	Δ
Rainbow River System	2017	Δ	✓	Δ	○	Δ	Δ	○	Δ	○	Δ
Sulphur Springs	2007	Δ	✓	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Weeki Wachee River System	2009	Δ	✓	○	Δ	Δ	Δ	Δ	Δ	Δ	Δ

WRV 1	Recreation In and On the Water	WRV 5	Maintenance of Freshwater Storage and Supply	WRV 8	Sediment Loads
WRV 2	Fish and Wildlife Habitats and the Passage of Fish	WRV 6	Aesthetic and Scenic Attributes	WRV 9	Water Quality
WRV 3	Estuarine Resources	WRV 7	Filtration and Absorption of Nutrients and other Pollutants	WRV 10	Navigation
WRV 4	Transfer of Detrital Material				

---

[10] Blind Springs, Chassahowitzka Spring Group

1.3 Summary of RAS Studies

A variety of studies have evaluated the recreational and economic impacts of Florida's springs. These studies fall into five general categories: human use in springs, the economic value of springs, park management plans, human impacts of recreation, and visitor perception.

Table 9. Studies Relating to Recreation, Economics, and Visitation in Florida Springs

Reference	Title
Alenicheva, 2012	Assessing Springshed Residents' Perceptions of North Central Florida Springs
Billington, 1995	Use Levels, Encounters, Satisfaction, and Perceived Crowding Among Recreation Visitors to the Rainbow River
Bonn, 2004	Visitor Profiles, Economic Impacts and Recreational Aesthetic Values Associated with Eight Priority Florida Springs Located in the St. Johns River Water Management District
Bonn & Bell, 2003	Economic Impact of Selected Florida Springs on Surrounding Local Areas. Florida Department of Environmental Protection.
Borisova et al., 2014	Economic Contributions and Ecosystem Services of Springs in the Lower Suwannee and Santa Fe River Basins of North-Central Florida
Borisova et al., 2020	Economic Value of Florida Water Resources: Contributions of Tourism and Recreation to the Economy
Borisova, Wade, Bi, Oehlbeck, et al., 2019a	Economic Value of Florida Water Resources: Value of Freshwater-Based Recreational Experiences
Borisova, Wade, Bi, Oehlbeck, et al., 2019b	Valuing Florida's Water Resources: Ecosystem Services Approach
DuToit, 1979	The Carrying Capacity of the Ichetucknee Springs and River
Evans, 2007	Algae, Exotics, and Management Response in Two Florida Springs: Competing Conceptions of Ecological Change in a Time of Nutrient Enrichment
Faraji, 2017	Ichetucknee Springs: Measuring the Effects of Visitors on Water Quality Parameters Through Continuous Monitoring
Florida Department of Environmental Protection, 2000	Ichetucknee Springs State Park Unit Management Plan
Florida Department of Environmental Protection, 2003	Fanning Springs State Park Unit Management Plan
Florida Department of Environmental Protection, 2005	Lafayette Blue Springs State Park Unit Management Plan
Florida Department of Environmental Protection, 2007	Florida State Park System Economic Impact System
Florida Department of Environmental Protection, 2011	Florida State Park System Economic Impact Assessment
Florida Department of Environmental Protection, 2013	Wes Skiles Peacock Springs State Park Unit Management Plan
Florida Department of Environmental Protection, 2016	Madison Blue Spring State Park Unit Management Plan
Florida Department of Environmental Protection, 2017a	Gilchrist Blue Springs Survey Results - Online Survey Preliminary Public Workshop

Table 9. Studies Relating to Recreation, Economics, and Visitation in Florida Springs

Reference	Title
Florida Department of Environmental Protection, 2017a	Gilchrist Blue Springs Survey Results
Florida Department of Environmental Protection, 2018a	Stephen Foster Folk Culture Center State Park Approved Unit Management Plan
Florida Department of Environmental Protection, 2017b	Troy Spring State Park Unit Management Plan
Florida Department of Environmental Protection, 2018b	Manatee Springs State Park Unit Management Plan
Florida Department of Environmental Protection, 2020	Ruth B. Kirby Gilchrist Blue Springs State Park Unit Management Plan
The Florida Springs Task Force, 2006	Florida’s Springs Strategies for Protection & Restoration
Holland & Cichra, 1994	Human and Environmental Dimensions of the Recreational Use of Blue Run and Rainbow Springs State Park, Dunnellon, Florida
Howard T. Odum Florida Springs Institute, 2012	Ichetucknee Springs Restoration Plan
Howard T. Odum Florida Springs Institute, 2015	Lower Suwannee River Springs Restoration Plan
Howard T. Odum Florida Springs Institute, 2016a	Kings Bay / Crystal River Springs Restoration Plan
Howard T. Odum Florida Springs Institute, 2016b	Lower Ichetucknee Baseline Assessment
Howard T. Odum Florida Springs Institute, 2016c	Wakulla Springs Baseline Ecosystem Assessment
Howard T. Odum Florida Springs Institute, 2016d	Wekiva River and Springs Restoration Plan
Howard T. Odum Florida Springs Institute, 2017	Middle Suwannee River Springs Restoration Plan
Howard T. Odum Florida Springs Institute, 2018a	Florida Springs Conservation Plan
Howard T. Odum Florida Springs Institute, 2018b	Volusia Blue Spring Restoration Plan
Howard T. Odum Florida Springs Institute, 2020	Santa Fe River and Springs Environmental Analysis - Phase 3
Howard T. Odum Florida Springs Institute, 2021	Blueprint for Restoring Springs on the Santa Fe River
Huth & Morgan, 2011	Measuring the Willingness to Pay for Cave Diving
Kil & Confer, 2005	A Classification of Major Springs in Florida Using the Water Recreation Opportunity Spectrum Framework
Knight & Gutzwiller, 1995	Wildlife and recreationists: coexistence through management and research
Morgan & Huth, 2011	Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving
Mumma et al., 1996	Effects of Recreation on the Submersed Aquatic Plant Community of Rainbow River, Florida
Pandion Systems, 2003	Carrying Capacity Study of Silver Glen Spring and Run

Table 9. Studies Relating to Recreation, Economics, and Visitation in Florida Springs

Reference	**Title**
Paulauskas, 2001	Factors Associated with Satisfaction of Recreational Users of the Ichetucknee River
Shrestha et al., 2002	Visitor Preferences and Values for Water-Based Recreation: A Case Study of the Ocala National Forest
Sorice et al., 2006	Managing Endangered Species Within the Use–Preservation Paradox: The Florida Manatee (*Trichechus manatus latirostris*) as a Tourism Attraction
Solomon et al., 2004	The Florida Manatee and Eco-Tourism: Toward a Safe Minimum Standard
Wetland Solutions, Inc., 2006	Human Use and Ecological Evaluation of the Recommended Minimum Flow Regime for Blue Spring and Blue Spring Run, Volusia County, Florida
Wetland Solutions, Inc., 2007	Human Use and Ecological Water Resource Values Assessments of Rock and Wekiwa Springs
Wetland Solutions, Inc., 2010	An Ecosystem-Level Study of Florida's Springs
Wetland Solutions, Inc., 2011	Ichetucknee River, Florida Assessment of the Effects of Human Use on Turbidity
Wu et al., 2018	Valuing the Recreation Benefits of Natural Springs in Florida
Wu & Bi, 2018	Valuing the Recreation Visits to Florida Springs: Benefits Estimates from TCM and CVM

1.4 Recreation, Aesthetic, and Scenic Attributes in MFL Development

The MFLs developed for springs, and rivers that include springs, have incorporated recreation, aesthetic, and scenic (RAS) metrics to varying extents under WRV 1 – *Recreation In and On the Water* and WRV 6 – *Aesthetic and Scenic Attributes*. RAS metrics that have been evaluated in MFLs are shown in Table 10 along with the systems where they were included and the criteria that were applied. Of these two WRVs, WRV 1 has received more attention in the MFLs than WRV 6.

WRV 1 recreational uses have been evaluated in the context of motorboats, paddle craft, tubers, tour boats, swimming, and other in-water activities. These activities have for many of the MFLs been evaluated quantitatively based on specific criteria that are measurable and modellable (e.g. 2′ depth across a contiguous 30′ width for boat passage). Despite the semi-frequent use of these metrics for MFL development, there has been some variation in the specific criteria applied in each system. This is most clearly observed in the variation of depths considered for motorboats 2-2.5 feet, widths considered for motorboats 30-50 feet, and depths considered for paddle craft 0.5-1.5 feet.

WRV 6 aesthetic and scenic attributes have been considered in the context of filamentous algae, nuisance and exotic vegetation, water clarity, spring run residence time, cultural resources, whitewater rapids, and dark water intrusions. Despite the apparent range of criteria for WRV 6, only three springs have had quantifiable metrics evaluated. As an illustration of the variability of assessment the three springs that had quantifiable assessment of WRV 6 were:

- Wakulla and Sally Ward Springs: Water clarity and flows were inversely correlated so could not be used to establish an MFL.
- Alexander Springs: 30-day and 90-day high water levels continuously exceeded for expanded wildlife habitat and viewing opportunities.
- Silver Springs: 30-day and 90-day low water levels continuously not exceeded for optimal scenic and wildlife viewing.

These examples demonstrate the apparent inconsistency and limited metrics that have been applied to WRV 6. Other metrics that show promise, but that have been described as lacking information for quantification include: spring run residence time, water clarity, filamentous algae, and dark water intrusions.

Table 10. RAS Metrics by MFL

WRV	Use	Spring	Criteria
1	Motorboats	St. Marks River Rise	2’ depth across contiguous 30’ width
1	Paddle Craft	St. Marks River Rise	1.5’ depth
1	Motorboats	Wakulla and Sally Ward	2’ depth across contiguous 30’ width
1	Paddle Craft	Wakulla and Sally Ward	1.5’ depth
1	Tour Boat*	Wakulla and Sally Ward	3’ depth across two, 20’ widths
1	Paddle Craft	Alexander Springs	0.5’ depth, 1- and 7-day restrictions

Table 10. RAS Metrics by MFL

WRV	Use	Spring	Criteria
1	Human Use	De Leon Springs	Increased residence time in the spring run
1	In-Water Activities	Silver Glen Springs	Decreased velocities in the spring run
1	Motorboats	Silver River	2.5’ depth across contiguous 50’ width
1	Paddle Craft	Aucilla River	Days with stage greater than 48 feet
1	Motorboats	Wacissa River	2’ depth across contiguous 30’ width
1	Tubing	Ichetucknee River	1.05’ depth above threshold SAV elevation
1	Swimming	Levy Blue Spring	Dept of Health, 500gal/person/day bathing criteria
1	Swimming	Lithia Spring	Dept of Health, 500gal/person/day bathing criteria
6	Water Clarity	Wakulla and Sally Ward	Clarity inversely correlated to flow
6	Water Clarity	Alexander Springs	Water level used as a corollary, 30-day and 90-day high stages
6	Wildlife Viewing**	De Leon Springs	Increased residence time in the spring run
6	Viewing	Gemini Springs	15% increase in residence time
6	Wildlife Viewing**	Silver Glen Springs	Decreased velocities in the spring run
6	Water Clarity	Silver Glen Springs	Dark water intrusion into spring run
6	Sandboil Springs	Silver Glen Springs	Consistency of sand boils
6	Cultural Resources	Silver Glen Springs	High water levels to protect cultural resources
6	Water Clarity	Silver Springs	30- and 90-day low levels for better clarity

*This metric should probably be a part of WRV 10 as it is commercial in nature

**This metric was listed as a part of WRV 1, but is probably more accurately a part of WRV 6

Section 2.0 Data Compilation

2.1 Purpose and Background

The Suwannee River Water Management District (SRWMD) contains 14 Outstanding Florida Springs (OFSs, Figure 2). SRWMD stakeholders have requested that specific metrics and methods be developed for future spring MFL evaluations. As part of this effort, Wetland Solutions, Inc. (WSI) identified and compiled electronic data relevant to springs' WRV metrics (e.g., hydrologic, water quality, and biological data) for all 14 OFSs plus 5 additional priority MFL springs in the SRWMD (Table 11).

This data compilation section describes the methods used in development of the SRWMD OFS database, including data sources, screening procedures, database structure, and inventory of assembled data for each spring system. Relevant data to springs WRV analyses not included in the database (e.g. continuous in situ water quality data, hard-copy data, bathymetric data) are also identified. The compiled information will be used in future tasks to characterize the sufficiency of data availability to evaluate WRVs and to make recommendations for additional data collection.

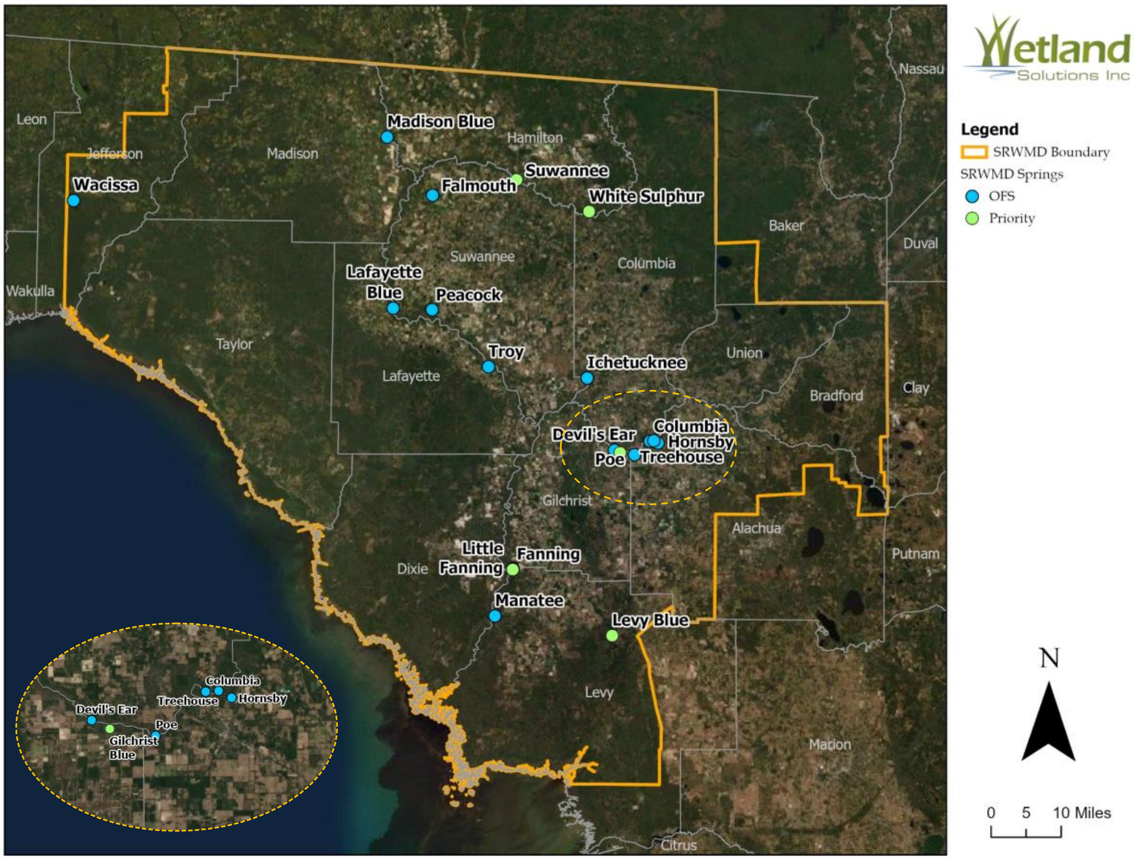


Figure 2. SRWMD Outstanding Florida Springs (OFSs) and Priority MFL Springs Locations

Table 11. SRWMD OFSs and Priority MFL Springs

Spring	River System	Magnitude	Run Length (mi)	County	Latitude (dd)	Longitude (dd)
Columbia (OFS)	Lower Santa Fe	1	0.1	Columbia	29.8541	-82.6120
Devil's Ear (OFS)	Lower Santa Fe	1	<0.1	Gilchrist	29.8353	-82.6966
Falmouth (OFS)	Middle Suwannee	1	<0.1	Suwannee	30.3611	-83.1350
Fanning (OFS)	Lower Suwannee	2	0.1	Levy	29.5876	-82.9353
Gilchrist Blue	Lower Santa Fe	2	0.2	Gilchrist	29.8299	-82.6829
Hornsby (OFS)	Lower Santa Fe	2	0.9	Alachua	29.8504	-82.5932
Ichetucknee (OFS)	Ichetucknee	2	7.0	Suwannee	29.9842	-82.7619
Lafayette Blue (OFS)	Middle Suwannee	1	<0.1	Lafayette	30.1258	-83.2261
Levy Blue	Wacasassa River	3	0.4	Levy	29.4507	-82.6990
Little Fanning	Lower Suwannee	2	0.2	Levy	29.5864	-82.9355

Table 11. SRWMD OFSs and Priority MFL Springs

Spring	River System	Magnitude	Run Length (mi)	County	Latitude (dd)	Longitude (dd)
Madison Blue (OFS)	Withlacoochee	1	<0.1	Madison	30.4804	-83.2444
Manatee (OFS)	Lower Suwannee	1	0.5	Levy	29.4895	-82.9769
Peacock (OFS)	Middle Suwannee	2	2.0	Suwannee	30.1233	-83.1331
Poe (OFS)	Lower Santa Fe	2	<0.1	Alachua	29.8257	-82.6490
Suwannee	Middle Suwannee	2	<0.1	Suwannee	30.3945	-82.9345
Treehouse (OFS)	Lower Santa Fe	1	<0.1	Alachua	29.8549	-82.6029
Troy (OFS)	Middle Suwannee	1	<0.1	Lafayette	30.0061	-82.9972
Wacissa (OFS)	Wacissa	1	14.0	Jefferson	30.3399	-83.9915
White Sulphur	Upper Suwannee	2	<0.1	Hamilton	30.3295	-82.7604

2.2 Database Development

2.2.1 Data Sources

Detailed water quality, hydrologic, biological, and recreational data were identified and obtained from the various sources listed below. Additional source details are discussed within the data inventory section for each spring system.

Water Quality / Hydrologic Data

- Florida Department of Environmental Protection (FDEP) Watershed Information Network (WIN) (https://prodenv.dep.state.fl.us/DearWin/)
- FDEP Florida STORET (https://prodenv.dep.state.fl.us/DearSpa/)
- USGS National Water Information System (NWIS) (https://waterdata.usgs.gov/nwis)
- SRWMD Water Data Portal (https://www.mysuwanneeriver.com/507/Water-Data-Portal)
- FDEP Florida Park Service (FPS)
- Howard T. Odum Florida Springs Institute (FSI)
- Alachua County Environmental Protection Department (ACEPD)
- Wetland Solutions, Inc. (WSI)
- University of Florida (UF)

Biological Data

- FDEP Aquatic Ecology and Quality Assurance Section
- FPS
- USGS
- FSI

- Karst Environmental Services, Inc. (KES)
- Stetson University
- WSI
- Cardno
- Amec Foster Wheeler

Park Attendance / Human Use Data

- ACEPD
- FDEP, Division of Recreation and Parks
- WSI
- FSI

2.2.2 Database Design

All historical data collected for this study were electronically stored and organized within Microsoft Excel. Microsoft Excel was selected because of its flexibility in being able to organize, review, and analyze data efficiently. The SRWMD OFS database contains the following primary tables titled:

- SRWMD OFS WQ Table (Water Quality/ Hydrologic Data)
- SRWMD OFS Vegetation Table (Vegetation Data)
- SRWMD OFS Faunal Table (Wildlife Data)
- SRWMD OFS ParkAtt Table (Park Attendance Data)
- SRWMD OFS HumanUse Table (Human Use Data)

A brief description of each of the database tables created for this project, including field names and descriptions, is provided below.

2.2.2.1 Water Quality / Hydrologic Database Table

Historic water quality and hydrological data for this project were retrieved from a variety of sources. Data were selected based on monitoring station location, with a focus on collecting representative spring pool water quality, stage, and flow data from each study area.

Table 12 provides a summary of water quality and hydrologic database table fields and descriptions developed for this project. Merging data from multiple data sources is a common data management challenge due to differences in database structure, sampling location identification, parameter codes, parameter naming, reporting units, and other inconsistencies. This database was designed to preserve much of the original structure from each source, while allowing consistency in data naming convention for data query and analyses associated with future project tasks. A cross-reference table is provided in Appendix A and includes database fields for the SRWMD OFS and source databases. This cross-reference information is also important for quality assurance and quality control (QA/QC) purposes.

Water quality parameter naming across data sources proved to be the most inconsistent field. The original organization parameter names from source databases are reported in the 'Org Parameter' fields, while consistent parameter nomenclature and units developed for this project are included in the 'Parameter Group', 'Parameter Name', and 'Units' fields. Due to the large number of unique parameter/unit combinations reported (> 1,030) from the source databases, only select parameters of interest were included in this parameter renaming effort. Records with non-selected parameters still remain in the database; however, the 'Parameter Group', 'Parameter Name', and 'Units' fields are not populated.

Table 12. SRWMD OFSs Water Quality and Hydrologic Table Fields and Descriptions

Field	Description
Rec No	Record Number ID
Org ID	Organization ID
Site	SRWMD OFS / Priority Spring Name
Location ID	Location ID (Organization Station ID)
Sampling Type	Activity/Sampling Type (defined by Organization)
Sampling Date	Sample Collection Date
Sampling Time	Sample Collection Time
Sampling Depth (m)	Sample Collection Depth
Matrix	Sample Matrix (defined by Organization)
Result ID	Report Number
Org Parameter Group	Organization Parameter Group
Org Parameter Code	Organization Parameter Code
Org Parameter Name	Organization Parameter Name
Org Result Number	Organization Result (number format)
Org Result Text	Organization Result (text format)
Org Units	Organization Units
Parameter Group	Parameter Group (consistent naming)
Parameter Name	Parameter Name (consistent naming)
Result Number	Reported Value (number format)
Result Text	Reported Value (text format)
Units	Parameter Units (consistent by parameter)
Remark Code	Result Remark Code
Sample Fraction	Laboratory Sample Fraction
Comment	Record Comments
MDL	Laboratory Method Detection Limit
PQL	Laboratory Practical Quantitation Limit
Data Source	Data Source
Record Flag	WSI Record Flag (data not used in analyses)
Entry Date	WSI Database Record Entry Date
Entry Notes	WSI Notes or Comments

Data provided in this database table include the following with a complete parameter list provided in the SRWMD OFS database (under 'WQInventory').

- Water Quality Parameters
    - Nutrients – nitrate+nitrite nitrogen (NOx-N), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH4-N), total phosphorus (TP), and orthophosphorus (Ortho P)
    - Biological - chlorophyll-a (Chl-a), Pheophytin-a (Pheo-a), fecal coliform, and total coliform
    - Physical/ Field parameters - color, secchi depth, dissolved oxygen (DO), pH, water temperature, specific conductance (SpCond), total dissolved solids (TDS), and salinity
    - General inorganic – alkalinity (Alk), chloride (CL-T), fluoride (F-T), and sulfate (SO4-T)
    - General organic – total organic carbon (TOC) and dissolved organic carbon (DOC)
- Hydrologic Parameters – manual and daily average where available
    - Flow
    - Water Elevation / Stage
- Metabolism Parameters - gross primary productivity (GPP), community respiration (CR), net primary productivity (NPP), production/respiration (P/R) ratio, and ecological efficiency
- Bioassessment Parameters - stream condition index (SCI), stream and river habitat assessment (HA), rapid periphyton survey (RPS), and linear vegetation survey (LVS)

Several database fields, including 'Rec No', 'Data Source', 'Record Flag' and 'Entry Notes', are common to each database table and are important in documenting any record QA/QC issues. Initial data screening was conducted for all source data imported into the database; however, additional screening will be conducted under future data analysis tasks. The 'Entry Notes' field is used to document any changes made to the original organization results reported. Examples include parameter unit conversions necessary for consistency within the database or reporting the MDL concentration in place of a "non-detect" for a result. The 'Record Flag' field is used to mark a record suspect and keep it from being used in any analyses. Common flags included: "QD" (questionable data) for records reported as non-detect with both an MDL and Result equal to 0; "QD" for records with a '?' laboratory remark code; "X" for records reported as "missing data" or "data not recorded" in the comment field; and "FB" for records reported as a Field Blank in the sampling type field.

The 'Remark Codes' field includes data qualifier codes assigned by the source databases. A list of data qualifiers codes is provided in with the SRWMD OFS database. No adjustments were made to the water quality results reported as below the laboratory method limit for this data compilation and inventory task.

2.2.2.2 Biological Database Table

Table 13 and Table 14 provide a summary of the vegetation table fields, field descriptions, and parameters developed for this project. This database table includes data associated with macrophyte and algal communities monitored within the SRWMD OFSs and priority springs. A similar database format was also used for faunal data, including vertebrate and macroinvertebrate populations (Table 15 and Table 16). Each database table includes the same QA/QC database fields as described above.

Table 13. SRWMD OFSs Vegetation Table Fields and Descriptions

Field	Description
Rec No	Record Number ID
Site	SRWMD OFS / Priority Spring Name
Location	Location / Station
Date	Field Activity Date
Scientific Name	Scientific Name
Common Name	Common Name
Parameter Name	Parameter Name
Result Number	Reported Value (number format)
Result Text	Reported Value (text format)
Units	Units
Comments	Record Comments
Data Source	Data Source
Record Flag	WSI Record Flag (data not used in analyses)
Entry Date	WSI Database Record Entry Date
Entry Notes	WSI Notes or Comments

Table 14. SRWMD OFSs Vegetation Table Parameters

Parameter Name	Description	Units
Percent Cover	Percent Cover	%
RAS	Relative Abundance Score	%
CAS[11]	Cumulative Abundance Score	
Height	Vegetation Height	m
Dry Wt	Dry Weight	g/m2
AFDW	Ash-Free Dry Weight	g/m2

---

[11] Semi-quantitative method using abundance ratings (1/Low; 2/Medium; 3/High) assigned to sections along a transect

Table 15. SRWMD OFSs Faunal Table Fields and Descriptions

Field	Description
Rec No.	Record Number ID
Site	SRWMD OFS / Priority Spring Name
Location	Location / Station
Location Description	Location Description
Date	Field Activity Date
Taxa	Taxonomic Group
Scientific Name	Scientific Name
Common Name	Common Name
Parameter Name	Parameter Name
Result Number	Reported Value (Number format)
Result Text	Reported Value (Text format)
Units	Units
Comment	Record Comments
Data Source	Data Source
Record Flag	WSI Record Flag (data not used in analyses)
Entry Date	WSI Database Record Entry Date
Entry Notes	WSI Notes or Comments

Table 16. SRWMD OFSs Faunal Table Parameters

Parameter Name	Description	Units
Count	Number of organisms	
Avg Length	Average Length	mm
Avg Weight	Average Weight	g
Biomass	Biomass	kg/ha
Density	Density	#/m^2 or #/ha
Observed	Observed but not quantified	

2.2.2.3 Park Attendance / Human Use Database Tables

Table 17 provides a summary of the park attendance table fields and descriptions. The majority of the records in this database table were developed using state park visitor data obtained from FDEP (Division of Recreation and Parks), therefore only minor modifications were made to the database structure. An additional field was added to identify the monitoring type to allow other forms of visitor data to be included. Examples include monthly visitor totals, monthly daily peak, or vehicle counts available from other parks. The park attendance table also includes the same QA/QC database fields as described above.

Table 17. SRWMD OFSs Park Attendance Table Fields and Descriptions

Field	Description
Rec No	Record Number ID
Site	SRWMD OFS / Priority Spring Park
Type	Monitoring Type (e.g., Daily Total/Monthly Total)
Date	Survey Date
Actual	Actual Visitor Count (Staff observed)
Estimated	Estimated Visitor Count (e.g., trail counter/vehicle counter)
Overnight	Overnight Visitor Count
Total	Total Visitors (Actual, Estimated, and Overnight)
Comments	Record Comments
Data Source	Data Source
Record Flag	WSI Record Flag (data not used in analyses)
Entry Date	WSI Database Record Entry Date
Entry Notes	WSI Notes or Comments

A summary of human use database table fields and descriptions are provided in Table 18. This database table quantifies the number of individuals participating in various activities in and around the SRWMD OFSs and priority springs within specified time intervals. A summary of the in-water and out-of-water activities are defined in Table 19. The database table also includes the same QA/QC database fields as described above.

Table 18. SRWMD OFSs Human Use Table Fields and Descriptions

Field	Description
Rec No	Record Number ID
Site	SRWMD OFS / Priority Spring Name
Location	Survey Location
Date	Survey Date
Time	Survey Time
Count	Visitor Count
Activity	Visitor Activity
Type	Activity Type (In Water / Out of Water)
Comments	Total Visitors (Actual, Estimated, and Overnight)
Source	Data Source
Record Flag	WSI Record Flag (data not used in analyses)
Entry Date	WSI Database Record Entry Date
Entry Notes	WSI Notes or Comments

Table 19. SRWMD OFSs Human Use Activity Types

Activity Type	Activity
In Water	Bathing[12]
	Canoeing/Kayaking/Paddleboarding
	Floating
	Power-boating
	SCUBA
	Snorkeling
	Swimming
	Tubing
	Wading
	Other
Out of Water	Dive Prep
	Fishing
	Nature Study
	Sitting
	Sunbathing
	Viewing
	Walking
	Other

2.3 Database Inventory

Detailed water quality, hydrological, biological, and recreational data from each of the SRWMD OFSs and priority springs were summarized to identify available data for each system (Table 20). This summary is intended to act as a quick reference and identify presence or absence for select parameters included within the database tables, unless otherwise noted. Numbers in the table identify the number of days that observations were recorded, while an 'X' denotes that data are available but not included in the SRWMD OFS database. Relevant data to the springs WRV analyses, not included in the database, are noted in Appendix B.

Historic water quality data for the majority of the select parameters exist for each spring system, although at variable sampling frequencies. The same holds true for hydrologic data collection at each of the springs. Additional exhibits were produced to better understand the distribution of available data for each of the SRWMD OFSs and priority springs. These exhibits are described below and are provided in Appendix B.

- Temporal daily data availability charts - visually identify data-rich periods
- Period of record statistics with distribution charts – includes percent of records reported below the detection limit (BDL)
- Period of record monthly average seasonal distributions – includes seasonal distribution charts

---

[12] greater than waist deep and less than neck deep

Due to the number of data sources, particularly in the water quality and hydrologic database table, record duplication is likely. To reduce any influence from duplicate results, daily averages were used as the source data for these exhibits.

2.4 Relevant Non-electronic Data

A variety of data sources were identified that were not available in an electronic format that could be readily imported into the SRWMD OFS database. These sources are listed in Table 21

Table 20. SRWMD OFSs and Priority Spring Database Inventory (# - *number of days*)

Parameter	Columbia	Devil's Ear	Falmouth	Fannings	Gilchrist Blue	Hornsby	Ichetucknee	Lafayette Blue	Levy Blue	Little Fanning	Madison Blue	Manatee	Peacock	Poe	Suwannee	Treehouse	Troy	Wacissa	White Sulphur
Hydrologic																			
Flow (cfs)	77	19	111	7,114	135	144	3,091	2,190	115	49	6,603	7,350	52	185	134	70	3,228	4,564	109
Wtr Elev (ft)	8		1,893	8,059	5,255	166	3,002	2,142	861	2,547	6,825	9,991	29	1,679	12	12	6,504	208	266
Water Quality - Nutrients																			
NOx-N (mg/L)	81	65	142	300	231	256	182	249	53	2	205	303	77	217	94	85	282	84	31
TKN (mg/L)	77	63	120	263	203	243	134	213	47	2	165	263	44	198	84	82	241	83	23
NH4-N (mg/L)	76	63	120	268	204	246	123	217	48	3	165	270	45	206	89	81	244	82	28
TP (mg/L)	77	63	121	266	203	245	124	213	48	3	166	266	45	200	93	82	243	83	26
OrthoP (mg/L)	77	64	106	247	211	236	164	199	49	3	166	249	78	195	83	82	217	71	29
Water Quality - Biological																			
Chl-a corr (µg/L)			17	25	9	19	23	22	6	2	1	25	1	11	14	6	27	13	1
Water Quality - Physical / Field Parameters																			
Color (PCU)	71	64	117	261	212	243	137	202	46	2	161	258	42	202	89	76	233	84	26
Secchi (m)	76	55	100	238	179	219	123	195	48	2	160	238	46	185	105	81	215	53	18
Turb (NTU)	71	64	116	264	196	234	132	203	43	2	166	260	47	197	81	76	231	84	23
DO (mg/L)	79	66	141	295	246	268	181	246	98	2	209	300	52	249	122	84	267	85	26
pH (SU)	79	66	142	304	248	270	184	250	56	2	212	305	53	252	127	83	275	85	34
Wtr Temp (C)	80	66	142	303	248	271	197	252	131	2	214	310	66	254	127	84	273	85	31
SpCond (umhos/cm)	81	67	143	306	249	272	184	254	124	2	215	312	53	252	130	85	279	85	35
TDS (mg/L)	71	64	125	268	198	238	114	217	46	3	171	264	43	201	92	76	248	83	29
Salinity (ppt)	67	17	77	185	136	161	61	142	44	1	127	194	31	154	102	64	153	15	17
Water Quality - General Inorganic / Organic																			
Alk (mg/L)	70	19	103	235	176	210	58	166	43	2	129	232	43	193	90	70	212	23	29
CL-T (mg/L)	71	65	119	265	199	239	135	213	46	3	163	266	47	202	92	76	240	83	32
F-T (mg/L)	71	49	107	249	183	212	118	195	40	2	145	250	35	192	85	76	217	69	22
SO4-T (mg/L)	71	65	115	255	197	229	130	201	40	2	153	251	41	195	85	76	230	83	22
TOC (mg/L)	71	63	113	257	187	223	122	201	50	2	154	252	35	193	81	75	224	82	23
Water Quality - Continuous *In-Situ*																			
Flow (cfs)				X			X*	X			X	X						X*	
Wtr Elev (ft)			X	X			X*	X			X	X					X	X*	
Wtr Temp (C)			X	X	X		X	X			X	X	X				X	X	
SpCond (umhos/cm)			X	X	X		X	X			X	X	X				X	X	X
DO (mg/L)			X	X	X		X	X			X	X	X				X	X	
pH (SU)			X	X	X		X	X			X	X	X				X	X	
NOx-N (mg/L)			X	X	X		X	X			X	X	X				X	X	
TDS (mg/L)																		X	
Turb (NTU)					X		X						X						
fDOM (QSM)					X		X						X						
Park Attendance																			
Park Attendance				8,707	1,248		14,064	5,663			5,891	14,064	11,777	222			8,674		9,990
Biological																			
Vegetation			1	1	21	5	64	1			2	6	1	16		1	1	2	
Fish			1	1	14	5	24	2			2	2	1	13			1		
Manatees				187			406					470					5		
Turtles				X	X	X	X					1	X	X			X		
Macroinvertebrates							4				23	3					2	2	
Bioassessment				1			2	2	2			1						5	
Other																			
Water Clarity Score				2,846				2,742		2,729	737	2,757	3,467				3,684		
Human Use					11		9				2	4		12					
Metabolism					38	31	56				4	4		78					

Notes: X - data are available but not included in the SRWMD OFS database; * located downstream in spring run

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Adler et al., 2018	An Aggregation of Turtles in a Florida Spring Yields Insights into Effects of Grazing on Vegetation			X			X					
Alenicheva, 2012	Assessing Springshed Residents' Perceptions of North Central Florida Springs									X		
Anderson, 2005	Levy Blue Springs Bathymetry								X			
Beeler & O'Shea, 1988	Distribution and Mortality of the West Indian Manatee (*Trichechus manatus*) in the Southeastern United States: A Compilation and Review of Recent Information. Volume Two: The Gulf of Mexico Coast					X						
Bonn & Bell, 2003	Economic Impact of Selected Florida Springs on Surrounding Local Areas									X		
BRA, 2006	Madison Blue Spring Third Annual Monitoring Report Biological Monitoring Specified by the Environmental Monitoring Plan Associated with Suwannee River Water Management District Water Use Permit No. 2-98-00025M, Madison County, Florida	X	X		X			X				
BRA, 2007	Madison Blue Spring Fourth Annual Monitoring Report Biological Monitoring Specified by the Environmental Monitoring Plan Associated with Suwannee River Water Management District Water Use Permit No. 2-98-00025M, Madison County, Florida	X	X		X			X				
Borisova et al., 2014	Executive Summary of the Economic Contributions and Ecosystem Services of Springs in the Lower Suwannee and Santa Fe River Basins of North-Central Florida									X		
Butt et al., 2007	Swallet/Resurgance Relationships on the Lower Santa Fe River, Florida	X										

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Chapin & Meylan, 2011	Turtle Populations at a Heavily Used Recreational Site: Ichetucknee Springs State Park, Columbia County, Florida						X					
Cardno, 2017	2016 Annual Monitoring Report Madison Blue Spring		X					X				
Cardno, 2018	2017 Annual Monitoring Report Madison Blue Spring		X					X				
Cardno, 2019	2018 Annual Monitoring Report Madison Blue Spring		X					X				
Cardno, 2020	2019 Annual Monitoring Report Madison Blue Spring		X					X				
Canfield Jr. & Hoyer, 1988	Influence of nutrient enrichment and light availability on the abundance of aquatic macrophytes in Florida streams		X									
Dormsjo, 2008	Oxygen Mediated Grazing Impacts in Florida Springs		X	X				X				
DuToit, 1979	The Carrying Capacity of the Ichetucknee Springs and River			X	X		X	X		X		
Edwards & Guillette Jr., 2007	Reproductive characteristics of male mosquitofish (*Gambusia holbrooki*) from nitrate-contaminated springs in Florida		X		X							
Faraji, 2017	Ichetucknee Springs: Measuring the Effects of Visitors on Water Quality Parameters Through Continuous Monitoring		X							X		
Florida Department of Environmental Protection, 1997	Bioassessment: Ichetucknee River							X				
Florida Department of Environmental Protection, 2007a	Fanning Spring EcoSummary (2000 – 2007)		X					X				
Florida Department of Environmental Protection, 2007b	Ichetucknee Spring EcoSummary (2000 – 2007)		X					X				
Florida Department of Environmental Protection, 2000a	Manatee Spring EcoSummary (2000 – 2007)		X					X				
Florida Department of Environmental Protection, 2000b	Ichetucknee Springs State Park Unit Management Plan	X								X		

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Florida Department of Environmental Protection, 2003b	Troy Spring EcoSummary (2001 – 2003)		X					X				
Florida Department of Environmental Protection, 2005a	Peacock Springs EcoSummary (2002 – 2005)		X					X				
Florida Department of Environmental Protection, 2003a	Fanning Springs State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2005b	Lafayette Blue Springs State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2013	Wes Skiles Peacock Springs State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2016	Madison Blue Spring State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2017a	Gilchrist Blue Springs Survey Results - Online Survey Preliminary Public Workshop									X		
Florida Department of Environmental Protection, 2017b	Fanning Springs State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2017c	Troy Spring State Park Unit Management Plan		X			X				X		
Florida Department of Environmental Protection, 2018a	Stephen Foster Folk Culture Center State Park Approved Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2018b	Manatee Springs State Park Unit Management Plan	X	X	X	X					X		
Florida Department of Environmental Protection, 2020	Ruth B. Kirby Gilchrist Blue Springs State Park Unit Management Plan	X	X	X	X					X		

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Florida Department of Environmental Protection & Florida Department of Agriculture and Consumer Services, 2015	Focused Implementation of Best Management Practices in the Santa Fe River Basin 2015 Interim Progress Report for the Santa Fe Restoration Focus Area (Data for January 2013–June 2015).	X	X									
Florida Springs Task Force, 2006	Florida's Springs Strategies for Protection and Restoration		X									
Flowers & Pine III, 2008	Observation of a Juvenile Gulf Sturgeon in the Santa Fe River, Florida				X							
Franz, 2002	Crustacean Surveys in Spring Habitats of Seventeen Florida State Parks							X				
FWC, 2021	Manatee Synoptic Survey Observation Locations					X						
Hale & Streever, 1994	Cave Fauna Distribution within Fully-Flooded Cave Systems in Florida				X			X				
Hallas & Magley, 2008	Nutrient and Dissolved Oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z)	X	X							X		
Herring & Judd, 1995	A Floristic Study of Ichetucknee Springs State Park, Suwannee and Columbia Counties, Florida.			X								
Howard T. Odum Florida Springs Institute, 2012	Ichetucknee Springs & River: A Restoration Action Plan	X	X	X						X		
Howard T. Odum Florida Springs Institute, 2015b	Lower Suwannee River Springs Restoration Plan	X	X	X						X		
Howard T. Odum Florida Springs Institute, 2015	Ichetucknee River Monitoring Summary (March 2014 – January 2015)	X	X	X	X							
Howard T. Odum Florida Springs Institute, 2016	Lower Ichetucknee Baseline Assessment	X	X	X	X			X		X	X	
Howard T. Odum Florida Springs Institute, 2017	Middle Suwannee River Springs Restoration Plan	X	X	X						X		

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Howard T. Odum Florida Springs Institute, 2020	Santa Fe River and Springs Environmental Analysis - Phase 3	X	X	X	X			X		X	X	
Howard T. Odum Florida Springs Institute, 2021	Blueprint for Restoring Springs on the Santa Fe River	X	X	X	X					X		
HSW Engineering, Inc., 2019	Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs	X		X	X	X		X		X		X
Incera Geosciences and Engineering, 2013	Hydrologic Database, Statistical Analysis, and Adjusted Historical Flow Development of Select Surface Water Stations on the Lower Santa Fe and Ichetucknee Rivers	X										
Johnston et al., 2016	The Santa Fe River in Northern Florida: Effects of Habitat Heterogeneity on Turtle Populations	X	X				X					X
Johnston et al., 2018	Origin and Structure of a Large Aggregation of Suwannee Cooters						X					
Johnston et al., 2020	Temporal Variation in a Turtle Assemblage Inhabiting a Florida Spring-Fed River						X					
Katz et al., 1999	Sources and Chronology of Nitrate Contamination in Spring Waters, Suwannee River Basin, Florida		X									
Kurz et al., 2004	Mapping and Monitoring Submerged Aquatic Vegetation in Ichetucknee Springs	X	X	X					X			
Liebowitz & Cohen, 2013	Environmentally Meditated Gastropod Control of Algal Proliferation in Ichetucknee Springs			X				X				
Mattson et al., 2019	Synoptic Biological Survey of 14 Spring-Run Streams in North and Central Florida		X	X								
McClean, 2005	Manatee Springs Bathymetry Study, Levy County, FL	X							X			
Mirti, 2001	Springflow Assessment of White Sulphur Springs	X										
Normandeau Associates, Inc., 2011	Ichetucknee Springs and River Restoration Plan	X	X									

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Odum, Howard T., 1953	Productivity of Florida Springs, NONR 580 (02). The 1st semi-annual report to Biology Division, Office of Naval Research: Progress from June 1 1952 to January 31 1953			X								
Paulauskas, 2001	Factors Associated with Satisfaction of Recreational Users of the Ichetucknee River									X		
Politano, 2008	Factors Affecting Periphyton Abundance on Macrophytes in a Spring-Fed River in Florida			X								
Provancha et al., 2012	Carrying Capacity Assessment of Manatee Forage and Warm-water Associated with Eleven Florida Sites	X		X								
Rosenau et al., 1977	Springs of Florida	X	X									
Sickman et al., 2009	A Comparison of Internal and External Supply of Nutrients to Algal Mats in Two First Magnitude Springs in Florida		X	X								
Skiles et al., 1991	Ichetucknee Hydrology Study	X										
Steigerwalt, 2005	Environmental factors affecting aquatic invertebrate community structure on snags in the Ichetucknee River, Florida							X				
Stevenson et al., 2007	Ecological Condition of Algae and Nutrients in Florida Springs: The Synthesis Report.			X								
Streever, 1992	Report of a Cave Fauna Kill at Peacock Springs Cave System, Suwannee County, Florida				X			X				
Walsh & Williams, 2003	Inventory of Fishes and Mussels in Springs and Spring Effluents of North-central Florida State Parks				X			X				
Warren et al., 2008	Habitat Selection by Stream Indicator Biota: Development of Biological Tools for the Implementation of Protective Minimum Flows for Florida Stream Ecosystems	X						X				X

Table 21. Relevant Non-Electronic Data (Not Included in SRWMD OFS Database)

Reference	Title	Hydrology	Water Quality	Vegetation	Fish	Manatee	Turtles	Macroinvertebrates	Bathymetry	Human Use	Metabolism	Habitat
Warren & Bernatis, 2017.	Status of the Ichetucknee Siltsnail (*Floridobia mica*) in Coffee Spring, Ichetucknee Springs State Park, Suwannee County, Florida							X				X
Water Resource Associates, Inc., 2005	MFL Establishment for the Lower Suwannee River & Estuary, Little Fanning, Fanning & Manatee Springs							X	X			
Wetland Solutions, Inc., 2006	Ichetucknee River, Florida Ecosystem Evaluation and Impairment Assessment	X	X	X				X		X	X	
Wetland Solutions, Inc., 2010	An Ecosystem-Level Study of Florida's Springs	X	X	X	X			X	X	X	X	
Wetland Solutions, Inc., 2011	Ichetucknee River, Florida Assessment of the Effects of Human Use on Turbidity	X	X	X				X		X		
Wetland Solutions, Inc., 2013	Ginnie Springs Ecological Analysis	X	X	X	X			X			X	
Wetland Solutions, Inc., 2014	Ichetucknee River Ecosystem Metabolism Study (2012-2013)	X	X	X	X						X	
Whitford, 1956	The Communities of Algae in the Springs and Spring Streams of Florida			X								
Woodruff, 1993	Florida Springs Chemical Classification and Aquatic Biological Communities			X	X			X				

Section 3.0 WRV Applicability and Data Availability

3.1 Purpose and Background

The applicability of each of the ten WRVs was evaluated for 17 of the SRWMD's 19 springs that are a part of this project (Figure 2). Site visits to each spring were conducted between March 22nd and 26th, 2021. Devil's Ear was removed from consideration based on direction from the SRWMD and WSI was denied access to Poe Springs for evaluation of existing WRVs. Poe Springs is currently undergoing construction and WRV applicability was based on previous visits/site knowledge. This task involved field visits to each spring combined with consideration of the values offered by the facilities and the natural setting of each spring. Generally, all of the WRVs have some degree of applicability for the considered springs with the exceptions of WRV 3 – *Estuarine Resources* and WRV 10 – *Navigation*. Both of these WRVs are generally inapplicable for the reasons discussed below.

In the case of WRV 3, any individual spring within the SRWMD does not provide a substantial portion of the flow on an annual basis that is discharged by the Aucilla, Suwannee, or Waccasassa River Systems to the Gulf of Mexico. In MFL development for the SJRWMD this contribution approach was used to describe the relatively minor percent of flow that was provided by any individual spring in the context of flows in the St. Johns River (Casey Harris et al., 2016; Freese & Sutherland, 2017; Sutherland et al., 2017). This WRV was then removed from consideration in these MFLs. It is worth noting that while evaluation of the contribution of a single spring might be minor, the contribution of all of the springs on the Ichetucknee, Santa Fe, and Suwannee Rivers is substantial, particularly during dry periods. This contribution should receive consideration under WRV 3 based on aggregate flows and their impacts on the downstream river and estuaries. This is also important because of the fact that stressors on spring flows and levels are likely to impact springs regionally rather than in an isolated, single spring context.

WRV 10 relates to navigation of commercial watercraft. As such, it generally does not apply for most spring systems, except where there are commercial tours or diving tours. For the evaluated springs in the SRWMD these uses are generally not present within the springs although they are present in some of the waterbodies that rely on the evaluated springs for flows and levels.

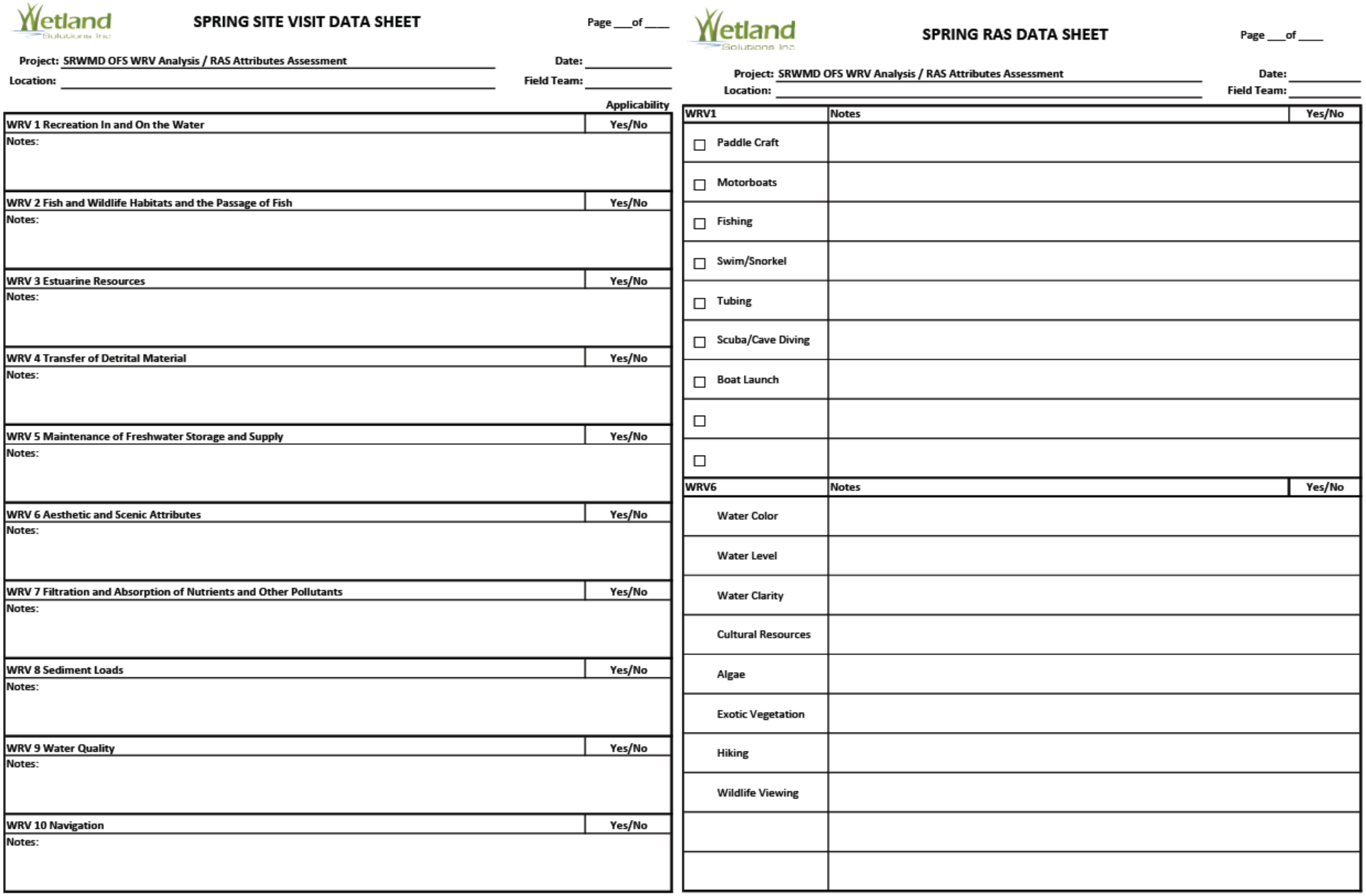
3.2 Spring Site Visits

Each of the 17 springs were visited as part of this task. These reconnaissance efforts included visiting the spring to evaluate the spring boil, spring run, setting, flow characteristics, vegetation, habitat value, degree of development, user-access features, and other spring-specific attributes. During each site visit, notes were taken with regard to each WRV. Specifically, with regard to recreation, aesthetic, and scenic (RAS) metrics a variety of uses and characteristics were documented. The form used for data collection is shown in Figure 3.

The applicability of each WRV to the evaluated springs is shown in Table 22. This table also provides a summary of the data availability and adequacy for evaluating the WRV in the context of an MFL. Detailed summaries for each system are provided in Appendix B and include temporal data availability charts, database inventory and statistics, and seasonal distribution tables. Based on reviews of the available data collected during this study, few of the WRVs in the evaluated systems are expected to have all of the data that is necessary for assessment. This is primarily the result of MFL development requiring substantial model construction, calibration, and verification. Many of the evaluated systems did not appear to have bathymetric data, vegetation data, habitat data, biological data, or human use data. Where models had previously been developed to assess WRVs in the context of MFLs it was assumed that data were adequate for assessment.

Following evaluation of WRV applicability, each spring was also evaluated for specific RAS attributes and uses. Recreational activities available were determined based on observation of facilities, and when possible, discussions with park staff. Results of this data collection effort are presented in Table 23, with the WRV and RAS data forms for each spring in Appendix C.

As previously stated, nearly all WRVs pertain to each of the springs, with the exception of WRV 3 and WRV 10. Each of the individual evaluated springs is discussed in the subsequent sections with a focus on the WRVs for the spring. Within WRV 1 – *Recreation In and On the Water* and WRV 6 – *Aesthetic and Scenic Attributes,* specific focus on the available uses and characteristics are included. RAS attributes for the springs are summarized in Table 23. Each of the following sections provides a short description of the spring, a discussion of the data available for the spring, and the applicability of the ten WRVs to the spring.



SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: ____________

Location: ____________

Field Team: ____________

	Applicability
WRV 1 Recreation In and On the Water	**Yes/No**
Notes:	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	**Yes/No**
Notes:	
WRV 3 Estuarine Resources	**Yes/No**
Notes:	
WRV 4 Transfer of Detrital Material	**Yes/No**
Notes:	
WRV 5 Maintenance of Freshwater Storage and Supply	**Yes/No**
Notes:	
WRV 6 Aesthetic and Scenic Attributes	**Yes/No**
Notes:	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	**Yes/No**
Notes:	
WRV 8 Sediment Loads	**Yes/No**
Notes:	
WRV 9 Water Quality	**Yes/No**
Notes:	
WRV 10 Navigation	**Yes/No**
Notes:	

SPRING RAS DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: ____________

Location: ____________

Field Team: ____________

WRV1	**Notes**	**Yes/No**
☐ Paddle Craft		
☐ Motorboats		
☐ Fishing		
☐ Swim/Snorkel		
☐ Tubing		
☐ Scuba/Cave Diving		
☐ Boat Launch		
☐		
☐		
WRV6	**Notes**	**Yes/No**
Water Color		
Water Level		
Water Clarity		
Cultural Resources		
Algae		
Exotic Vegetation		
Hiking		
Wildlife Viewing		

Figure 3. Spring Visit Data Form

Table 22. WRV Applicability and Data Availability/Adequacy by Spring

WRV Applicability (Top Left): ✓– applicable; ○ – semi-applicable; Δ – inapplicable

Data Availability/Adequacy (Bottom Right): ● – likely sufficient; ⊙ – partially sufficient; ○ – insufficient, – – inapplicable

Spring	WRV1	WRV2	WRV3	WRV4	WRV5	WRV6	WRV7	WRV8	WRV9	WRV10
Columbia	✓ ⊙	✓ ⊙	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	○ ⊙
Devil's Ear	Not Evaluated									
Falmouth	✓ ⊙	✓ ⊙	Δ –	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Fanning	✓ ⊙	✓ ●	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Hornsby	✓ ⊙	✓ ⊙	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Ichetucknee	✓ ●	✓ ●	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Lafayette Blue	✓ ⊙	✓ ⊙	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Madison Blue	✓ ⊙	✓ ⊙	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	○ ⊙
Manatee	✓ ⊙	✓ ●	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	○ ⊙
Peacock	✓ ⊙	✓ ●	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	Δ –
Poe	✓ ⊙	✓ ⊙	○ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	✓ ⊙	○ ⊙

Table 22. WRV Applicability and Data Availability/Adequacy by Spring

WRV Applicability (Top Left): ✓– applicable; ○ – semi-applicable; Δ – inapplicable

Data Availability/Adequacy (Bottom Right): ● – likely sufficient; ⊙ – partially sufficient; ○ – insufficient, – – inapplicable

Spring	WRV1	WRV2	WRV3	WRV4	WRV5	WRV6	WRV7	WRV8	WRV9	WRV10
Treehouse	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	○ / ⊙
Troy	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	○ / ⊙
Wacissa	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	○ / ⊙
Gilchrist Blue	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	Δ / –
White Sulphur	Δ / –	○ / ⊙	○ / ⊙	○ / ⊙	○ / ⊙	✓ / ⊙	○ / ⊙	○ / ⊙	○ / ⊙	Δ / –
Suwannee	✓ / ⊙	✓ / ⊙	○ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	Δ / –
Little Fanning	✓ / ○	✓ / ○	○ / ○	✓ / ○	✓ / ○	✓ / ○	✓ / ○	✓ / ○	✓ / ○	○ / ○
Levy Blue	✓ / ⊙	✓ / ⊙	○ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	✓ / ⊙	Δ / –

WRV 1 – Recreation in and on the water; WRV 2 – Fish and wildlife habitats and the passage of fish; WRV 3 – Estuarine resources; WRV 4 – Transfer of detrital material; WRV 5 – Maintenance of freshwater storage and supply; WRV 6 – Aesthetic and scenic attributes; WRV 7 – Filtration and absorption of nutrients and other pollutants; WRV 8 – Sediment loads; WRV 9 – Water quality; 10 – Navigation

Table 23. Recreational Uses by Spring

Spring	Paddle Craft	Motorboats	Fishing	Swim/ Snorkel	Tubing	Scuba/ Cave Diving	Boat Launch
Columbia	✓	✓	✓	✓	✓	✓	
Devil's Ear	Not Evaluated						
Falmouth	✓		✓	✓	✓	✓	
Fanning				✓	✓	✓	
Hornsby	✓			✓			
Ichetucknee				✓	✓	✓	
Lafayette Blue				✓	✓	✓	
Madison Blue	✓	✓		✓	✓	✓	
Manatee	✓	✓	✓	✓	✓	✓	
Peacock	✓			✓	✓	✓	
Poe	✓		✓	✓	✓		
Treehouse	✓	✓	✓	✓		✓	
Troy	✓	✓	✓	✓	✓	✓	
Wacissa	✓	✓	✓	✓	✓	✓	✓
Gilchrist Blue	✓			✓	✓		
White Sulphur							
Suwannee				✓		✓	
Little Fanning	✓	✓	✓	✓	✓	✓	
Levy Blue				✓	✓		

3.2.1 Columbia Spring

Columbia Spring is a first magnitude spring located along the Lower Santa Fe River approximately 2 miles northwest of High Springs, and downstream of the US 441 Santa Fe Boat Ramp (Figure 4). The spring, located in Columbia County, includes an approximately 400-foot steep, rapid-filled run from the river up to the spring boil. The spring pool is surrounded by natural land uses and state-owned property. The spring flow was characterized by dark water on the day of the site visit (March 22, 2021) and appears to be fed largely by resurgent Santa Fe River water that goes underground in a sink upstream. This spring does not have a separate MFL, but is part of the Lower Santa Fe River MFL (Suwannee River Water Management District, 2013). Representative photos of the spring and conditions during the site visit are shown in Figure 5.

Figure 4. Columbia Spring Location

Figure 5. Columbia Spring: Spring Boil (Top, Looking Upstream) and Spring Run (Bottom, Looking Upstream)

Limited hydrological data were available for Columbia Spring. Manual discharge measurements have been collected since 1998 (generally quarterly) with very few reported water elevations. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were also collected (generally quarterly) since 1998. Samples were collected slightly more frequently (59% on average) during the wet season (June through October) than during the dry season (November through May). No biological or human-use data were available for Columbia Spring.

3.2.1.1 WRV 1 – Recreation In and On the Water

This spring allows a variety of water-based recreational opportunities including paddle craft, fishing, swimming/snorkeling, tubing, and scuba/cave diving. Recreation appears to be limited to in-water activities, although state-owned land surrounds the spring with no land-based facilities or indications of allowed uses. This system is likely to see somewhat limited use because of the challenges associated with access (the strong current in the run) and because of the dark water that limits visibility under dark water conditions in the river.

3.2.1.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

The spring offers a wide variety of habitat including areas with fast currents in the run, woody and snag habitat in the run and boil, submerged aquatic vegetation (SAV) in the run, and adjacent upland/floodplain habitat. Fish passage may be limited in the run during low water periods and due to high velocities. Habitat availability in the spring boil may also be limited for some species of water-dependent wildlife that cannot move up the spring run during periods with high velocities.

3.2.1.3 WRV 3 – Estuarine Resources

This spring system contributes water to the Santa Fe River, which flows into the Suwannee River and into the Gulf of Mexico supporting a large estuary at the mouth of the Suwannee River. As a function of its flow, this spring individually contributes a minor fraction of the water ultimately discharging to the Gulf of Mexico at the mouth of the Suwannee.

3.2.1.4 WRV 4 – Transfer of Detrital Material

Transfer of detrital material in springs is largely a function of floodplain inundation and direct deposition and senescence of plant material (Herrick et al., 2019a; Wetland Solutions, Inc., 2004). Columbia Spring has a heavily treed fringe around the spring and along the spring run that can contribute leaves and twigs to the spring and run. SAV observed in the spring run could also be expected to contribute senescent material.

Floodplain connections to the spring and run could occur under high-water levels driven by levels in the Santa Fe River. These floodplain inundation events would not be expected to be directly related to spring flows.

3.2.1.5 WRV 5 – Maintenance of Freshwater Storage and Supply

Both spring flow and freshwater supply are integrally related to levels in the Floridan Aquifer. As such, a level in the aquifer that is protective of spring flows will be, by definition protective of freshwater supplies. Furthermore, levels that are protective of freshwater supplies may be protected at levels substantially lower than those that are protective of springs given the use of pumps.

MFLs are generally evaluated in the context of current conditions and the estimated impacts of current permitted withdrawals. An MFL that does not find that a system is in recovery is therefore protective of current permitted water users. This does not mean that the MFL is necessarily protected with the addition of future permits.

3.2.1.6 WRV 6 – Aesthetic and Scenic Attributes

Columbia Spring is surrounded by state-owned land although no access appears to be permitted and all public access appears to occur through the spring run from the Santa Fe River. The activities associated with reaching the spring would therefore be considered as WRV 1, recreational uses. However, upon reaching the spring boil and within or below the spring run a variety of aesthetic and scenic uses exist. Aesthetic and scenic attributes and uses include: wildlife viewing, enjoying the natural setting, the sound of water rushing over rocks in the spring run, sounds of wildlife, a historic structure on the private property that adds to the natural setting, an evident boil at the water surface, and a full spring pool.

3.2.1.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

The spring run at Columbia Spring is short, with high velocities that limit residence time and likely treatment before water reaches the Santa Fe River. However, the spring run does contain SAV that could provide some limited nutrient and pollutant removal.

3.2.1.8 WRV 8 – Sediment Loads

The property surrounding the spring pool and run appears to limit uses of the bank, which has allowed vegetation to establish to the water’s edge. This vegetation appears to reduce the likelihood of sediment runoff into the spring. Flows within the spring pool and run are also high with velocities sufficient to transport sediment to the Santa Fe River.

3.2.1.9 WRV 9 – Water Quality

The water quality of Columbia Spring appears to be directly tied to the Santa Fe River with much of the water in the spring contributed by the river through an upstream suck hole. As such, the water quality of Columbia Spring is expected to largely mirror water quality in the Santa Fe River. During the site visit the water in the spring was dark and clear.

3.2.1.10 WRV 10 – Navigation

This spring does not have direct commercial boat traffic. Columbia Spring flows into the Santa Fe River, which flows into the Suwannee River. The Lower Suwannee River supports some minor commercial traffic including fishing guides and boat tours. Columbia Springs individually contributes a minor fraction of the water ultimately discharging to the Gulf of Mexico at the mouth of the Suwannee.

3.2.2 Devil's Ear Spring

Devil's Ear Spring is a first magnitude spring located in Gilchrist County, approximately 6.2 miles west of High Springs. Devil's Ear Spring is part of the Ginnie Springs Complex and surrounded by the privately-owned Ginnie Springs Outdoors, LLC. Devil's Ear Spring is located in the edge of the Santa Fe River with no spring run (Figure 6). This spring does not have a separate MFL, but is part of the Lower Santa Fe River MFL. This spring was not visited as part of this project.

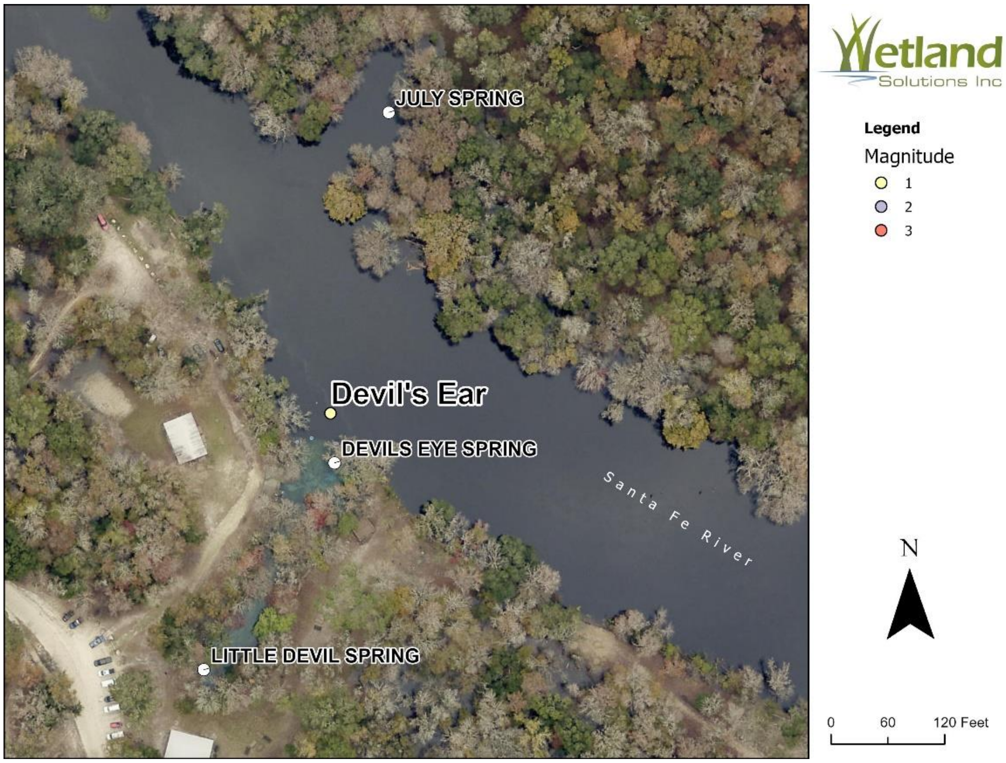


Figure 6. Devil's Ear Spring Location

3.2.3 Falmouth Spring

Falmouth Spring is a first magnitude spring located in Suwannee County, approximately 0.5 miles west of Falmouth and 3.4 miles east of the Suwannee River. Falmouth Spring is a designated OFS with a unique spring to sink configuration and no surface water connection (Figure 7). The spring run is approximately 300 feet between the spring and sink. The property is publicly-owned and managed by the SRWMD. The spring flow was characterized by dark water on the day of the site visit (March 24, 2021) and appears to be closely linked to the Suwannee River with both water color, flow, and flow direction being highly variable. This spring had an MFL developed as part of the evaluation of four OFSs along the Middle Suwannee River (SRWMD, 2017). Representative photos of the spring and conditions during the site visit are shown in Figure 8.

Figure 7. Falmouth Spring Location

Figure 8. Falmouth Springs: Spring/Sink and Surrounding Features

Hydrological data were first collected with some regularity from Falmouth Spring in 1997 with more frequent measurements since 2014 for flows (generally monthly) and 2015 for water elevations (daily). Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1993, with more frequent sampling (generally bimonthly) since 2012. Samples were collected slightly more frequently (59% on average) during the wet season (June through October) than during the dry season (November through May). Additional continuous in-situ water quality data are available from USGS NWIS for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2015. Limited biological data were available for Falmouth Springs with vegetation and fish populations estimates from 2017.

3.2.3.1 WRV 1 – Recreation In and On the Water

Falmouth Spring offers a variety of recreational opportunities including: paddle craft, fishing, swimming/snorkeling, tubing, and scuba/cave diving. This system is unique amongst the evaluated systems in that no direct connection exists between this spring and other surface waters. Recreational opportunities are limited by this inability to access the spring by water from a larger waterbody. During the site visit (March 24, 2021) the water was dark with strong and potentially dangerous currents. These conditions which occur during flooding on the Suwannee River are likely to limit human use.

3.2.3.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring is surrounded by natural areas and offers a variety of habitat to wildlife. The spring is isolated and does not have a surface water connection to other waterbodies, limiting the movement of wildlife into and out of the spring. The system is surrounded by forest which contributes detrital material to support the food chain. Movement of water within the system is from a rise to a sink, which can reverse depending on water levels in the aquifer.

3.2.3.3 WRV 3 – Estuarine Resources

This spring does not have a surface water connection, although it is impacted by levels in the Suwannee River. Any flow contributed from this spring to the Suwannee River is occurring within the aquifer and through another spring. For these reasons this WRV was considered not applicable.

3.2.3.4 WRV 4 – Transfer of Detrital Material

This spring does not have a surface water connection, limiting the applicability of this WRV. The system does receive detrital material during high-water periods when water stages up and washes material into the system. There is also significant tree cover and the potential for direct deadfall of wood and leaves into the system.

3.2.3.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.3.6 WRV 6 – Aesthetic and Scenic Attributes

Falmouth Spring offers a natural setting that features a variety of overlooks that highlight the aesthetic and scenic attributes of the park. This spring is very unique in its configuration as both a spring and sink.

3.2.3.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring has a short run and flows can change direction between the spring and sink. Given the short run and relatively high velocities observed the potential residence time in the system seems short. During the site visit the water was dark and no vegetation was observed within the spring or run. The site also features a relatively dense canopy which reduces the potential for solar energy to support plants that might provide uptake of nutrients.

3.2.3.8 WRV 8 – Sediment Loads

Falmouth Spring is surrounded by natural land uses. The spring has access stairs and boardwalks that minimize human use on the edges of the spring reducing erosion into the spring. Unlike springs that have spring runs that can flood and experience erosion, Falmouth Spring is completely enclosed by high banks. Erosion could occur into the spring from the steep side slopes and from high velocities between the spring and sink, but any eroded material would be deposited within the cave system rather than being exported to a downstream waterbody.

3.2.3.9 WRV 9 – Water Quality

This spring appears to have a close connection to the Suwannee River based on dark water, high stages, and high flows on the day of the site visit. As with other WRVs that can be evaluated in the context of downstream impacts, this WRV has less applicability in Falmouth Springs where no surface water connection exists. As previously described, the spring and sink at Falmouth can reverse flow direction based on conditions in the aquifer that feeds the system.

3.2.3.10 WRV 10 – Navigation

There is no commercial navigation associated with Falmouth Springs.

3.2.4 Fanning Spring

Fanning Spring is a second magnitude spring located in Levy County approximately 0.5 miles southwest of the City of Fanning Springs. The spring is a designated OFS and was historically a first magnitude spring. The spring is part of Fanning Springs State Park, managed by the Florida Park Service. The spring run is approximately 400 feet, discharging into the Suwannee River 0.2 miles downstream of the crossing of US19 (Figure 9). The spring can act as an estavelle during high river stages with dark water entering the spring and intruding into the aquifer. This spring is part of the Lower Suwannee River MFL and had a specific MFL developed for the spring to maintain manatee access to the spring for thermal refuge (Water Resource Associates, Inc., 2005). Representative photos of the spring and conditions during the site visit are shown in Figure 10.

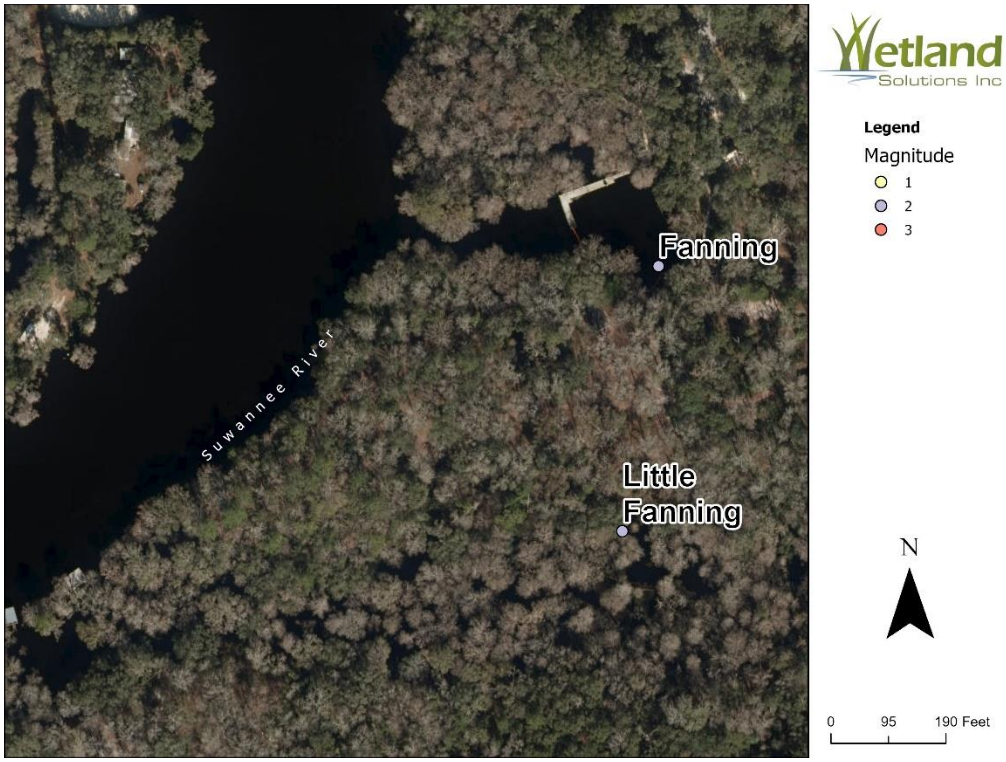


Figure 9. Fanning Springs Location

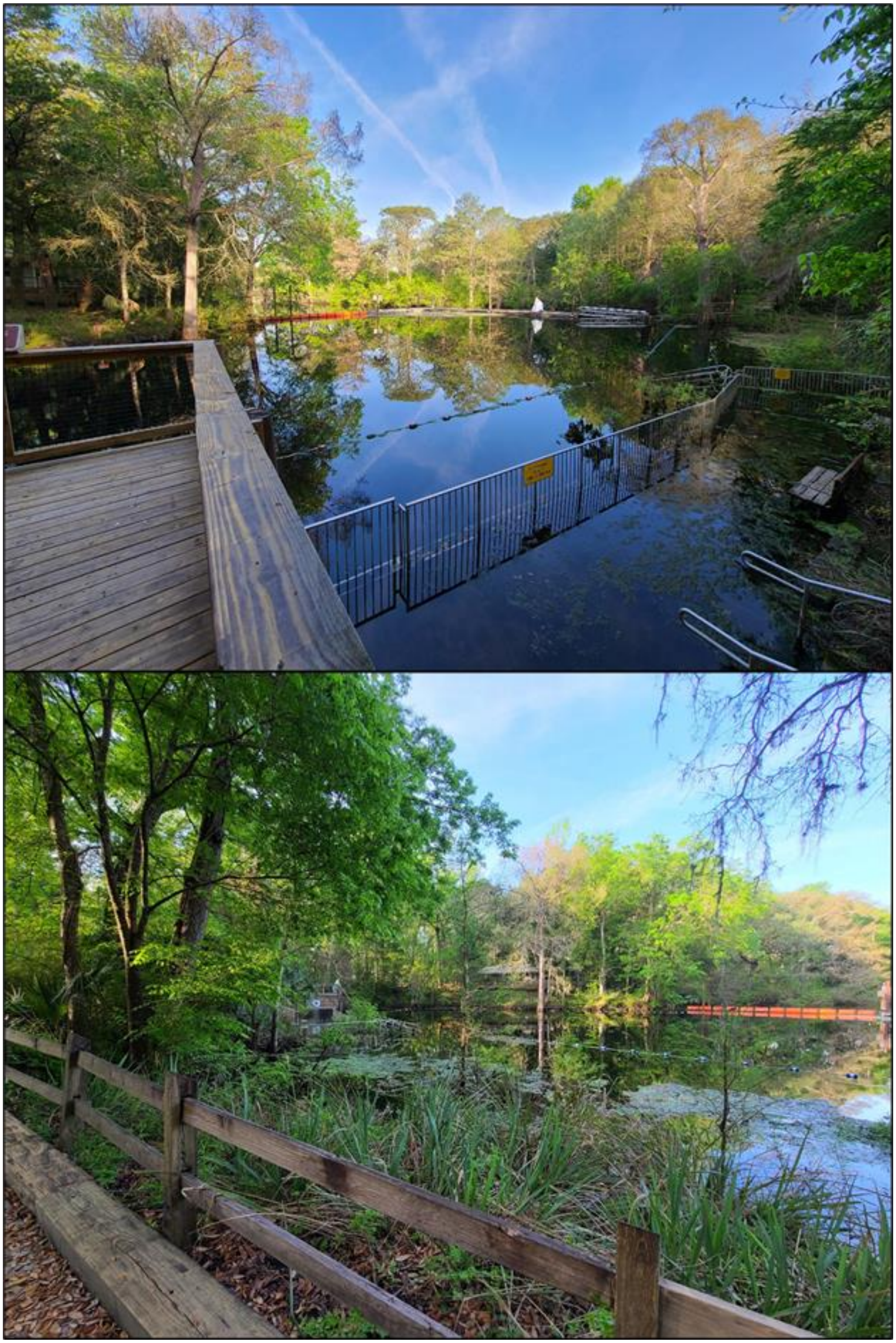


Figure 10. Fanning Springs: Spring Pool and Surroundings

Hydrological data were first collected with some regularity from Fanning Springs in 1997 with more frequent measurements since 2001 for flows (daily) and 1997 for water elevations (daily). Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters, were collected with some regularity since 1995, with more frequent sampling (generally monthly) since 1998. Samples were collected slightly more frequently (53% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from USGS NWIS for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2014. Frequent (generally daily) water clarity observation scoring data were available since 2009, manatee observations since 2017, and daily park attendance data since 1997. Limited biological data were available with vegetation and fish populations estimates from 2017.

3.2.4.1 WRV 1 – Recreation In and On the Water

Fanning Springs is part of a well-developed park with uses that include: swimming/snorkeling, tubing, and scuba/cave diving. The spring has a well-defined swim area near the spring vent that excludes paddle craft and boats although these uses can occur in the spring run from the swim area to the Suwannee River. Access to the spring is available from both a floating dock and stairs with littoral edges of the spring boil roped off. During the site visit the water was generally clear, but somewhat off color associated with high levels on the Suwannee River.

3.2.4.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring is directly connected to the Suwannee River through a short spring run. Although the spring pool does allow human recreation, portions of the spring are roped off from human use. Vegetation observed within the spring was dominated by filamentous algae. A variety of habitat types exist surrounding the spring boil including trees, woody snag habitat, and other littoral vegetation types. This spring also has the potential to provide thermal refuge to manatees based on the proximity to the Suwannee River and Gulf of Mexico.

3.2.4.3 WRV 3 – Estuarine Resources

This spring system contributes water to the Suwannee River which flows into the Gulf of Mexico supporting a large estuary at the mouth of the river. As a function of its flow, this spring only contributes a minor fraction of the water ultimately discharging to the Gulf of Mexico at the mouth of the Suwannee.

3.2.4.4 WRV 4 – Transfer of Detrital Material

Fanning Springs has a spring boil that is partially surrounded by natural land uses with modified shorelines on several sides. This spring, as is true of many of the evaluated systems, has a long history of human use in and around the spring pool. Some of this history is reflected in the trails and hardscapes that exist along the edges of the spring to protect the shoreline from foot traffic. Large portions of this shoreline have been returned to more native vegetation. Trees in the fringe of the spring pool are expected to contribute detrital material. Large amounts of filamentous algae are present in the spring boil which also produces detrital material as growth and senescence occurs.

3.2.4.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.4.6 WRV 6 – Aesthetic and Scenic Attributes

This spring is part of the Florida Park Service and a park with high levels of attendance. These visitors go to the park to enjoy recreational activities and the aesthetic and scenic beauty of the spring. This park features extensive human use facilities that allows visitors to experience the spring including overlooks, trails, and a floating dock. This spring includes a large pool, natural settings in many areas, and a short run to the Suwannee River. The fringe of the spring pool also includes a large number of trees that contribute to the spring's natural setting.

3.2.4.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

A short spring run connects Fanning Springs to the Suwannee River. Under normal conditions on the Suwannee River residence time in the spring run would be relatively short. During the site visit conditions in the spring run were dark so the presence or absence of vegetation could not be observed. Vegetation within the spring boil appeared to be limited to filamentous algae except in the littoral fringe of the spring pool where some emergent plants were observed.

3.2.4.8 WRV 8 – Sediment Loads

Sediment loads in the spring are likely driven by the combination of high-water events that can loosen and erode the spring banks where bare ground exists and stormwater runoff that can carry sediments into the spring pool from the steep spring side slopes. Sediment that enters the spring may then be conveyed into and down the spring run by flows under low river conditions when velocities in the run are higher. Much of the edge and bank of the spring is roped off to limit access by visitors in these areas and to reduce erosion and sedimentation in the spring.

3.2.4.9 WRV 9 – Water Quality

During the site visit the spring was clear, but did not appear to have significant flow to the Suwannee River, given the high river stages. Water quality will be evaluated based on the available data.

3.2.4.10 WRV 10 – Navigation

There is no commercial navigation within the spring pool.

3.2.5 Hornsby Spring

Hornsby Spring is a second magnitude spring located in Alachua County approximately 1.6 miles north of High Springs. The spring was historically a first magnitude spring and is a designated OFS. Hornsby Spring is privately owned and is part of the Camp Kulaqua River Ranch used recreationally for camp, education, and religious activities (Figure 11). The spring has an approximately 0.8 mile run to the Santa Fe River although a portion of the water goes down a sink in the run which discharges, at least partially, to Treehouse Spring. This spring is included in the Lower Santa Fe River MFL although it is not individually assessed (Suwannee River Water Management District, 2013). Representative photos of the spring and conditions during the site visit are shown in Figure 12.

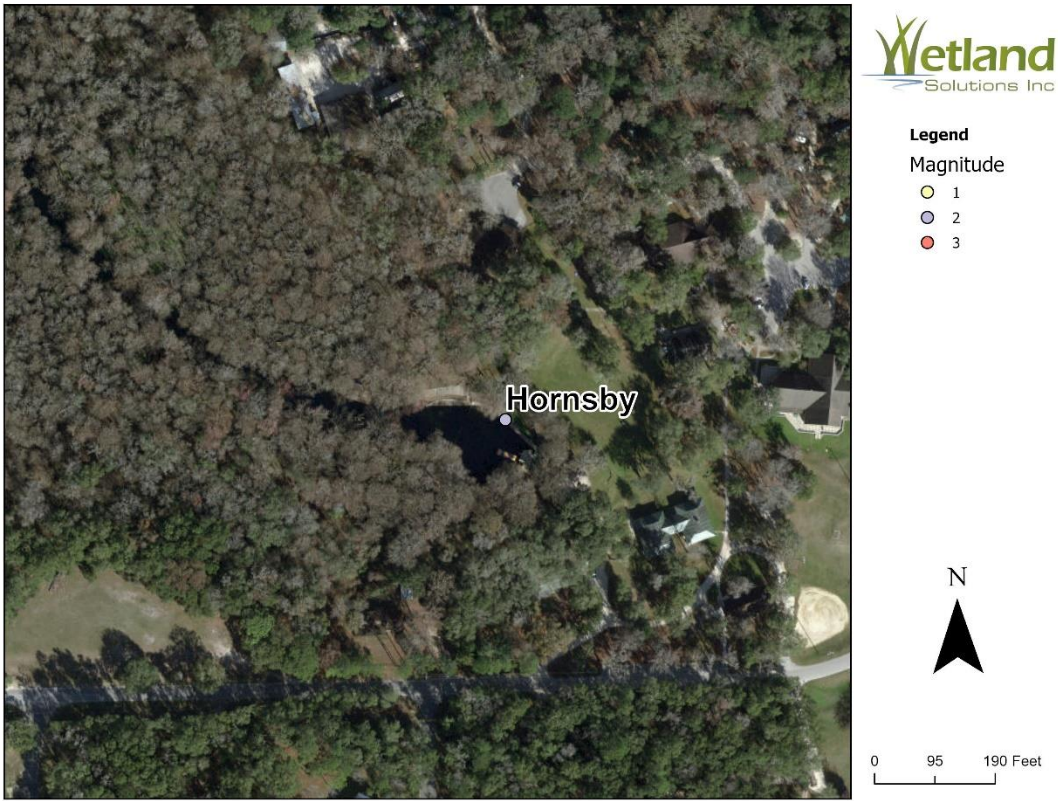


Figure 11. Hornsby Spring Location

Figure 12. Hornsby Spring: Spring Pool (Top Left) and Spring Run (Bottom Left and Right)

Hydrological data were first collected with some regularity from Hornsby Spring in 1998 with periods of generally monthly and bimonthly monitoring. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1992, with more frequent sampling (generally monthly and bimonthly) since 1998. Samples were collected slightly more frequently (53% on average) during the dry season (November through May) than during the wet season (June through October). No park attendance data were available and limited biological data were available with vegetation and fish populations estimates beginning in 2017.

3.2.5.1 WRV 1 – Recreation In and On the Water

This spring features a variety of recreational opportunities and facilities in and around the spring. These include: a designated swim/snorkel area, a rope swing, a diving board and "blob", a boardwalk along the spring run, and paddle craft within the spring run. This spring has a floating dock and swim dock that keep water users from treading on the bank and causing damage in the littoral edge of the pool. This spring does not have a clear, well-defined channel to the downstream Santa Fe River, but rather appears to have a large portion of the flow go underground in a sink before re-emerging in Treehouse and possibly other springs.

3.2.5.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

Hornsby Spring supports a wide variety of habitat in and along the spring run. In the spring pool there is a variety of littoral vegetation and primarily filamentous algae. Within the run there is some limited SAV and filamentous algae. Adjacent to the spring run there is a large connected floodplain that appears to be inundated under normal water level conditions providing substantial habitat. This floodplain includes a diverse array of SAV, trees, and emergent vegetation. Access to the Santa Fe River downstream is highly limited by the spring run which is shallow and highly-braided with a large part of the spring flow being lost to a sink in the spring run. This limits access by water dependent species to the spring boil and spring run.

3.2.5.3 WRV 3 – Estuarine Resources

See Section 3.2.1.3.

3.2.5.4 WRV 4 – Transfer of Detrital Material

This spring has a large and well-connected floodplain that exists near the spring pool and along the spring run. This floodplain appears to be well connected under normal water levels allowing for significant detrital material input. Furthermore, the spring and spring run have extensive tree cover that allows for significant direct detrital input from litter fall. Finally, within the spring pool and run there is the contribution of vegetation and algae that is sloughed off during growth and senescence.

3.2.5.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.5.6 WRV 6 – Aesthetic and Scenic Attributes

This spring has significant aesthetic and scenic attributes given the primarily natural settings and the variety of user infrastructure that exists to connect users to the natural environment. This spring also has a large well-connected floodplain that enhances the natural and scenic value of the spring system. This spring system also includes a substantial, old-growth baldcypress tree within the floodplain along the spring run.

3.2.5.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring includes a moderately long spring run and a closely connected floodplain. These features are expected to provide water quality improvement for pollutants or nutrients discharged at the spring. The spring pool is somewhat open allowing for solar inputs, although the spring run includes a dense, forested canopy that limits solar inputs to vegetation within the spring run. Vegetation within the spring pool is dominated by filamentous algae with some SAV and emergent vegetation in the run and floodplain.

3.2.5.8 WRV 8 – Sediment Loads

Hornsby Spring has a relatively large amount of human use and infrastructure in the vicinity of the spring pool. These uses have the potential to cause erosion or loss of vegetation that supports sediments. The facilities and parking areas in the vicinity of the spring pool also have the potential to contribute sediment in runoff. The floodplain along the spring run reduces the likelihood of sediments flowing into the spring run from adjacent upland areas. Velocities within the spring run do not appear high enough to significantly scour sediments.

3.2.5.9 WRV 9 – Water Quality

The spring was clear during the site visit with clear water along the spring run. Water quality will be evaluated based on the available data.

3.2.5.10 WRV 10 – Navigation

There is no commercial navigation within the spring pool or spring run.

3.2.6 Ichetucknee Spring

The Ichetucknee Head Spring is a second magnitude spring located in Suwannee County approximately 5.8 miles northwest of Fort White. The head spring is one of a large number of springs along the Ichetucknee River which flows about 7 miles to the Santa Fe River (Figure 13). The head spring and many of the other springs in the first three miles of the river are located within Ichetucknee Springs State Park. This spring had a separate MFL developed as part of the Lower Santa Fe River (Suwannee River Water Management District, 2013). Representative photos of the spring pool during the site visit are shown in Figure 14.

Figure 13. Ichetucknee Head Spring Location

Figure 14. Ichetucknee Head Spring: Natural Spring Fringe and Spring Pool Overview

Hydrological data were first collected with some regularity from Ichetucknee Head Spring in 2001. Daily flow data were available through 2010 with periods of monthly and quarterly data available after 2015. Daily water elevation data were also available through 2010 with periods of monthly and quarterly data available through 2017. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters, were collected with some regularity since 2001, with periods of monthly and quarterly sampling. Samples were collected slightly more frequently (58% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for water temperature, conductivity, dissolved oxygen, pH, NOx-N, and fDOM beginning in 2015. Daily park attendance data were available from the FPS since 1982, with limited human-use counts since 2009. The majority of the available biological data were from downstream monitoring within the spring run.

3.2.6.1 WRV 1 – Recreation In and On the Water

The Ichetucknee Head Spring is located within the north entrance of Ichetucknee Springs State Park. Recreation at this spring includes: swimming/snorkeling, tubing, and scuba/cave-diving. Cave-diving is popular downstream at Blue Hole (Jug Hole) with boardwalk access available from the head spring. Access to the head spring is from a hardened shoreline to protect the spring from erosion of the bank. The head spring is separated from the spring run by a swim line.

3.2.6.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a combination of hardened and natural shoreline around the spring pool. Some available habitat exists within the spring pool although little vegetation is evident except in the littoral fringe along the natural shoreline. Substantial habitat occurs downstream of the head spring within the river.

3.2.6.3 WRV 3 – Estuarine Resources

See Section 3.2.1.3.

3.2.6.4 WRV 4 – Transfer of Detrital Material

This spring has a combination of natural and man-made shoreline. There is the potential for detrital inputs from the surrounding natural land uses, although this spring has less overhanging tree cover than some other springs. Little vegetation occurs within the spring limiting detrital inputs from vegetation within the spring.

3.2.6.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.6.6 WRV 6 – Aesthetic and Scenic Attributes

This spring offers aesthetic and scenic opportunities based on the surrounding natural land uses, clear, blue spring boil, and strong flow. The hardened shoreline was developed using local chert and limestone which blends into the setting. This spring also has a large spring pool that is minimally shaded, offering well-lit views of the spring and spring vent.

3.2.6.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

The Ichetucknee Head Spring has limited capacity for nutrient or pollutant removal given a lack of vegetation and an expected short residence time. Some algae exists within the head spring and there is some littoral vegetation in the natural wetland fringe. Substantial SAV exists within the spring run downstream of the head spring.

3.2.6.8 WRV 8 – Sediment Loads

Some sediment loading is likely to occur associated with the human uses of the spring although these inputs are reduced by the hardened shoreline in the area of primary human use. Within the spring boil there is some potential for sediment to be moved or deposited by human use and walking in the shallower areas.

3.2.6.9 WRV 9 – Water Quality

The Head Spring was clear and blue during the site visit. Water quality will be evaluated based on the available data.

3.2.6.10 WRV 10 – Navigation

There is no commercial navigation in the spring.

3.2.7 Lafayette Blue Spring

Lafayette Blue Spring is a first magnitude spring located in Lafayette County, approximately 5.8 miles northwest of Mayo. The spring is a designated OFS with an approximately 200-foot spring run to the Suwannee River. The spring is located within Lafayette Blue Spring State Park and is managed by the Florida Park Service. The spring has an adopted MFL as one of four OFSs evaluated in the Middle Suwannee River Basin (SRWMD, 2017). Representative photos of the spring pool during the site visit are shown in Figure 16.

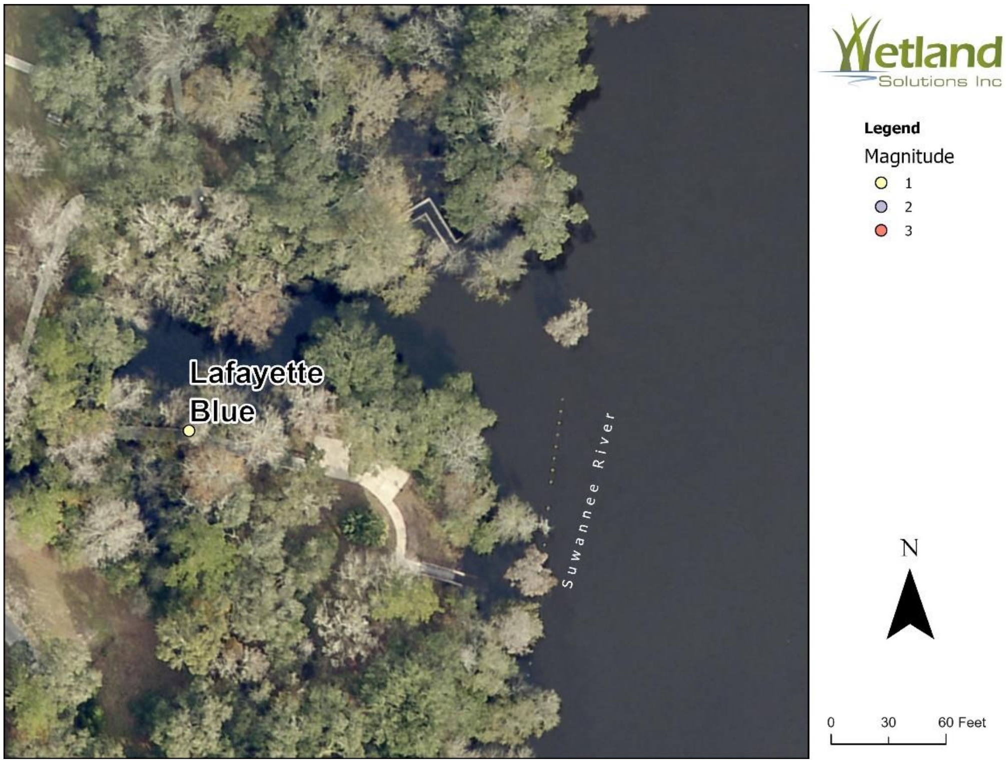


Figure 15. Lafayette Blue Spring Location

Figure 16. Lafayette Blue Spring: Spring Pool (Bottom), Spring Run (Top Left), and No Swimming Sign

Hydrological data were first collected with some regularity from Lafayette Blue Spring in 1998. Periods of monthly and quarterly flow data were available through 2015 with daily flow estimates since. Water elevation data were available through 2013 (generally monthly) with daily data beginning in 2015. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1995, with more frequent sampling (generally monthly) since 1998. Samples were collected nearly equally between the dry season (November through May) and the wet season (June through October). Additional continuous in-situ water quality data are available from USGS NWIS for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2015. Frequent (generally daily) water clarity observation scoring data were available since 2009 and daily park attendance data since 2005. Limited biological data were available with vegetation cover estimates in 2017 and fish populations estimates from 2017 and 2020.

3.2.7.1 WRV 1 – Recreation In and On the Water

During the site visit the Suwannee River was in flood, during these conditions human uses in the spring are restricted due to dark water conditions and reduced visibility. Under normal conditions recreation allowed includes: swimming/snorkeling, tubing, and scuba/cave-diving. This spring includes a swim rope at the mouth to the Suwannee River to restrict access to the spring from the river and to limit uses within the spring. Recreation is available from stairs into the spring from both sides of the spring pool.

3.2.7.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a short run to the Suwannee River. There do not appear to be limitations to access into the spring, although conditions during the site visit were high and dark based on stages in the Suwannee River. Habitat within the spring includes a generally natural shoreline. The spring pool is characterized by generally steep banks at the levels the water was at during the site visit.

3.2.7.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.7.4 WRV 4 – Transfer of Detrital Material

Lafayette Blue Spring is surrounded by generally natural land uses with limited access points to the spring pool. The area surrounding the spring pool includes relatively steep side slopes and a treed fringe that could be expected to contribute detrital material from litterfall. Additionally, there is the potential for some detrital deposition from the Suwannee River during floods when water may back up into the spring carrying debris. Under normal water conditions in the Suwannee River it is expected that deposited detrital material would be conveyed to the river and downstream.

3.2.7.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.7.6 WRV 6 – Aesthetic and Scenic Attributes

This spring had user features developed to provide a variety of scenic and aesthetic opportunities while protecting the spring. Around the top of the spring a boardwalk allows visitors views of the spring pool. Given the short spring run there are also views of the spring, spring run, and Suwannee River. The natural surroundings provide additional scenic and aesthetic attributes. During the site visit the spring was characterized by dark water due to intrusion from the Suwannee River although the water was somewhat clearer in the spring pool than in the river.

3.2.7.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

Lafayette Blue Springs was flooded out during the site visit so the applicability of this WRV could not be thoroughly evaluated. However, based on the configuration of the spring including a short spring run and the typical spring flow residence time in the spring and run is expected to be low. Also given the human use and observations at other springs it is expected that little vegetation is present in the spring pool or spring run reducing the opportunity for water quality improvement.

3.2.7.8 WRV 8 – Sediment Loads

Sediment can enter the spring from erosion of the steep banks, from erosion during human use, and can also be washed in from the Suwannee River during flooding. Some amount of sediment deposition was observed on the boardwalk to the spring that appeared to have been deposited from the Suwannee River. Sediment deposited in the spring pool or run is likely then conveyed to the Suwannee River during normal flows.

3.2.7.9 WRV 9 – Water Quality

The Suwannee River was in flood during the site visit and dark water had intruded within the spring pool. Water within the spring pool was less tannic than in the spring run and river. Water quality will be evaluated based on the available data.

3.2.7.10 WRV 10 – Navigation

There is no commercial navigation associated with this spring. All boat access is restricted by a designated swim area.

3.2.8 Madison Blue Spring

Madison Blue Spring is a first magnitude spring located in Madison County, approximately 5.3 miles northeast of Lee. The spring is a designated OFS and is located within Madison Blue Spring State Park, managed by the Florida Park Service. The spring run is less than 200 feet and discharges to the Withlacoochee River (Figure 17). An MFL has been adopted for Madison Blue Spring (Water Resource Associates, Inc., 2004). Representative photos of the spring pool during the site visit are shown in Figure 18.

Figure 17. Madison Blue Spring Location

Figure 18. Madison Blue Spring: Spring Pool (Top Left), Spring Run (Top Right), Spring Water in River (Bottom Left), Adjacent Karst Window (Bottom Right)

Hydrological data were first collected with some regularity from Madison Blue Spring in 1990 with more frequent measurements since 2002 for flows (daily) and water elevations (daily). Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 2001 (generally monthly). Samples were collected slightly more frequently (54% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2014. Frequent (generally daily) water clarity observation scoring data were available from 2009 to 2016. Daily park attendance data were available since 2004 with limited detailed human-use counts from 2008. Macroinvertebrate populations data have been collected semiannually in the spring pool and run since 2003, with limited vegetation and fish populations estimates from 2008 and 2017.

3.2.8.1 WRV 1 – Recreation In and On the Water

Madison Blue Spring includes a variety of recreational opportunities including: paddle craft, swimming/snorkeling, tubing, and scuba/cave-diving. Cave-diving access is typically from the main spring, however other access locations include Rabbit Hole (near main entrance) and Martz Sink (near main pairing area).[13] This spring has no clear separation from the Withlacoochee River and it appears that boats could enter the spring or spring run, although they were not identified as an allowed use. Fishing was also not an identified use although no clear signs were present that restricted fishing access. The edges of the spring pool are hardened with a retaining wall in some areas and natural limestone. Access to the water is from stairs into the water.

3.2.8.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a short run to the Withlacoochee River. There do not appear to be limitations to wildlife access into the spring. Habitat within the spring includes a generally natural shoreline. The spring pool is surrounded by generally steep banks although a variety of areas exist for wildlife access.

3.2.8.3 WRV 3 – Estuarine Resources

This spring system contributes water to the Withlacoochee River, which flows into the Suwannee River and into the Gulf of Mexico supporting a large estuary at the mouth of the Suwannee River. As a function of its flow, this spring individually contributes a minor fraction of the water ultimately discharging to the Gulf of Mexico at the mouth of the Suwannee.

3.2.8.4 WRV 4 – Transfer of Detrital Material

This spring is surrounded by generally natural land uses with several improved access points to the spring pool. The area surrounding the spring pool includes relatively steep sides that are protected by retaining walls and a treed fringe that could be expected to contribute detrital material from litterfall to the spring. Velocities observed in the spring run to the Withlacoochee River appear to be adequate to transfer detrital material downstream to the river.

---

[13] https://cavediving.com/where/madison/

3.2.8.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.8.6 WRV 6 – Aesthetic and Scenic Attributes

Madison Blue Spring offers a variety of aesthetic and scenic opportunities. These include spring and river viewing and wildlife viewing. During the site visit the flow in the spring was clear and the flow in the spring run was strong. This spring also has a karst window located adjacent to the spring pool that is connected to the spring boil and offers additional viewing opportunities.

3.2.8.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring has a relatively short run to the Withlacoochee River and high flows and velocities in the spring run that are likely to lead to short residence times in the spring and run. The only vegetation that was observed in the spring and run was some algae.

3.2.8.8 WRV 8 – Sediment Loads

This spring has a largely hardened and protected shoreline that helps reduce sedimentation in the spring. There are still some portions of the shoreline that have some sand that could be introduced into the spring. Additionally, this system is likely to experience some inundation from the Withlacoochee River during flooding conditions and these flows could wash sediment into the spring.

3.2.8.9 WRV 9 – Water Quality

During the site visit the water in the spring was observed to be clear with a green tinge. This greenish color may be the result of recent flooding that might have caused some intrusion of tannic water into the spring vent that had not been fully flushed out. Water quality will be evaluated based on the available data.

3.2.8.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.9 Manatee Spring

Manatee Spring is a first magnitude spring located in Levy County, approximately 7.1 miles west of Chiefland. The spring is a designated OFS and has an approximately 0.25-mile spring run to the Suwannee River (Figure 19). During high river stages the spring can act as an estavelle with dark water intrusion into the spring pool. The spring has an adopted MFL based on providing thermal refuge for manatees as part of the Lower Suwannee River Basin (Water Resource Associates, Inc., 2005). Representative photos of the spring pool during the site visit are shown in Figure 20.

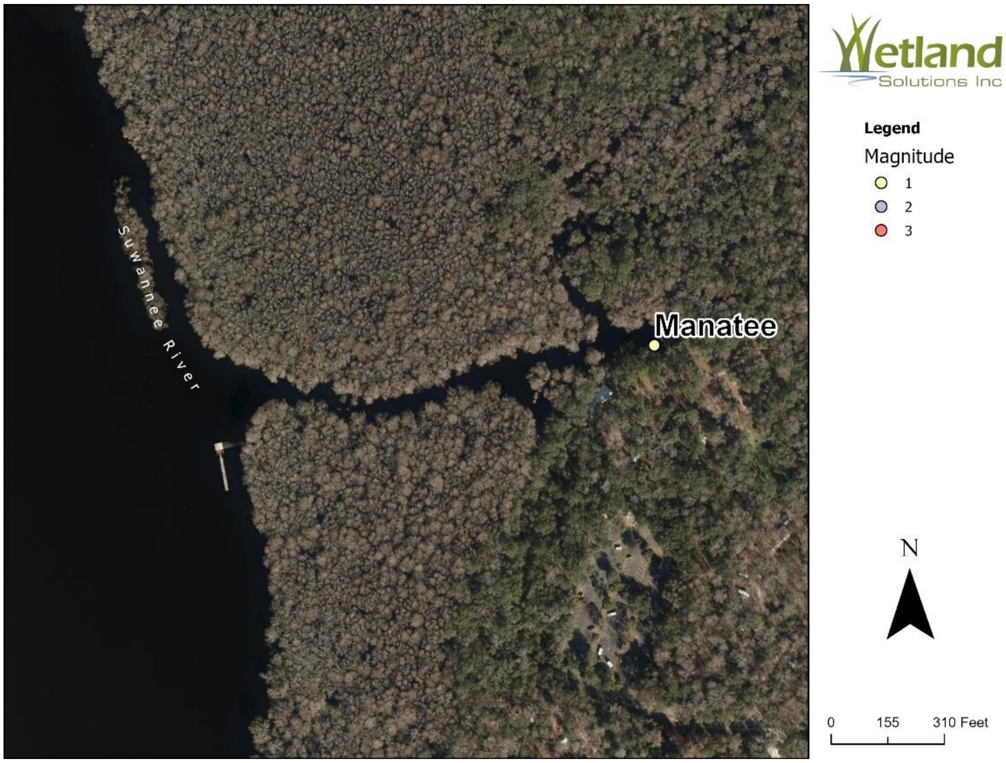


Figure 19. Manatee Springs Location

Figure 20. Manatee Springs: Spring Pool (Top Left), Spring Run, (Right), and Manatee in Run (Bottom Left)

Hydrological data were first collected with some regularity from Manatee Springs in 1982 with more frequent measurements since 2001 for flows (daily) and from 1987 to 1991 and after 1997 for water elevations (daily). Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1995, with more frequent sampling (mostly monthly) since 1998. Samples were collected slightly more frequently (54% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2014. Frequent (generally daily) water clarity observation scoring data were available since 2009, manatee observations since 2009, and daily park attendance data since 1982. Limited biological data were available with vegetation cover (2009, 2015, and 2017), fish populations (2001, 2009, and 2017), and macroinvertebrate populations (2002 and 2015). Detailed human use counts were conducted during four events in 2009.

3.2.9.1 WRV 1 – Recreation In and On the Water

Manatee Springs includes a large spring pool and associated spring run to the Suwannee River. Recreational opportunities at Manatee Springs include: swimming/snorkeling, tubing, and scuba/cave-diving in the spring pool. Cave-diving access is via Catfish Hotel, a sinkhole adjacent to the main spring. Additional recreational opportunities exist in the spring run including paddle craft and motorboats. A fence separates the run from the spring pool. This spring experiences dark water conditions associated with flooding in the Suwannee River and swimming is not allowed during dark water intrusion periods.

3.2.9.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring includes a variety of wildlife habitat within the spring pool, spring run, and associated floodplain. This includes warm water refuge for manatees during cold weather. The spring run and a portion of the spring pool offer natural conditions that allow use of the littoral fringe and floodplain during high water periods. During the site visit on March 26, 2021 a manatee was observed eating SAV in the spring run within the floodplain fringe. This spring may also provide important habitat and warm-water refuge for the common snook which has had its range expand further north, while still requiring warmer water during cold periods.

3.2.9.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.9.4 WRV 4 – Transfer of Detrital Material

This spring has a relatively long, highly-connected spring run and floodplain. This connection during high water periods on the Suwannee River is expected to provide a significant source of detrital material. The spring pool and spring run are also heavily treed with the fringes expected to contribute litterfall to the spring system. During lower flow periods on the Suwannee River velocities in the spring run are still expected to provide velocities that can transport detrital material downstream.

3.2.9.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.9.6 WRV 6 – Aesthetic and Scenic Attributes

Manatee Springs is part of a state park and offers a wide variety of aesthetic and scenic opportunities. This includes viewing areas around the spring pool and a boardwalk along the spring run and out to the Suwannee River. During the site visit the spring pool was clear and extended some distance down the spring run although the run was tannic at the river. A single manatee was observed in the spring run. Wildlife viewing in and adjacent to the spring pool appears to be an important scenic value.

3.2.9.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring includes a relatively large spring pool, natural shoreline, and a relatively long spring run all of which offer the opportunity for nutrient treatment. Within the spring pool relatively large stands of filamentous algae occur although the spring run did not have clarity to indicate the presence of vegetation within the run. The spring also includes substantial littoral and floodplain vegetation providing additional opportunity for treatment to occur.

3.2.9.8 WRV 8 – Sediment Loads

This spring appears to have a largely stabilized spring pool with natural conditions around a portion of the spring pool and access through limited access points with stairs. These improvements are expected to provide reduced sediment loading within the spring pool and spring run. Some sediment input may occur during periods when the floodplain is inundated and water levels recede. During normal water levels it is expected that flow velocities would be adequate to move sediments downstream to the Suwannee River. Near the mouth of the spring run there is the potential for greater sediment deposition from the Suwannee River during flooding.

3.2.9.9 WRV 9 – Water Quality

During the site visit the water in the spring was observed to be clear. Water quality will be evaluated based on the available data.

3.2.9.10 WRV 10 – Navigation

There is no commercial navigation allowed in the spring pool although there is some potential for small river tour boats to access the spring run from the Suwannee.

3.2.10 Peacock Spring

Peacock Spring is a second magnitude spring located in Suwannee County, approximately 5.4 miles northeast of Mayo. The spring is a designated OFS and flows down an approximately two-mile spring run to the Suwannee River. Peacock Springs is located in the Wes Skiles Peacock Springs State Park (Figure 21). The spring has an approved MFL as one of four evaluated OFSs in the Middle Suwannee River Basin (SRWMD, 2017). Representative photos of the spring pool during the site visit are shown in Figure 22.

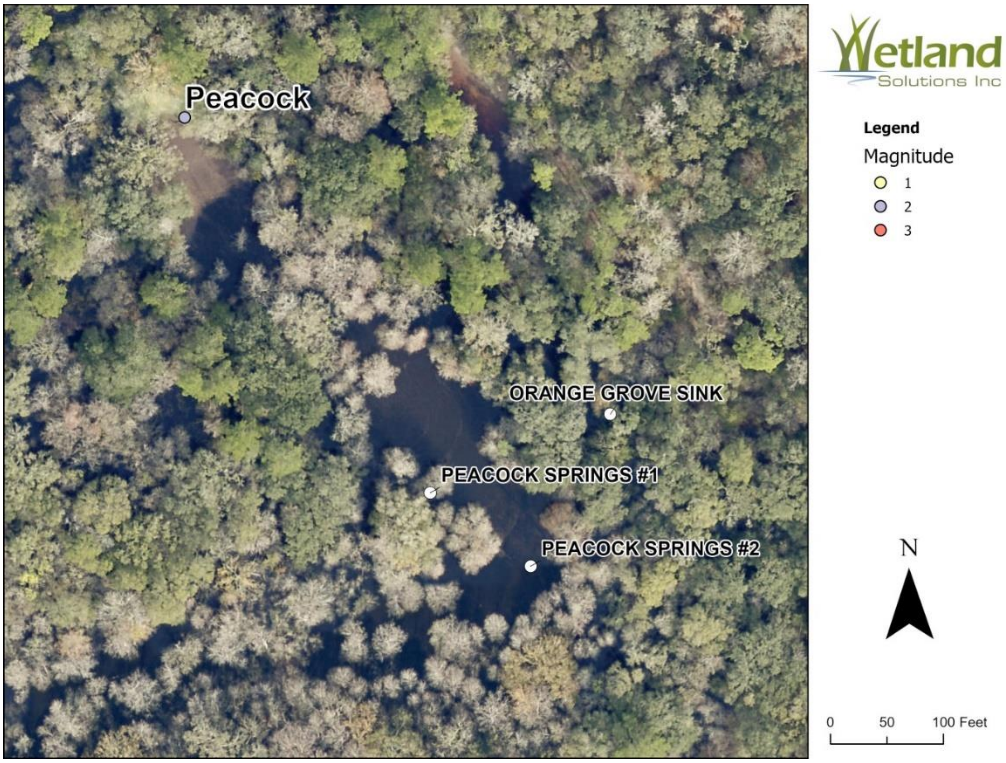


Figure 21. Peacock Springs Location

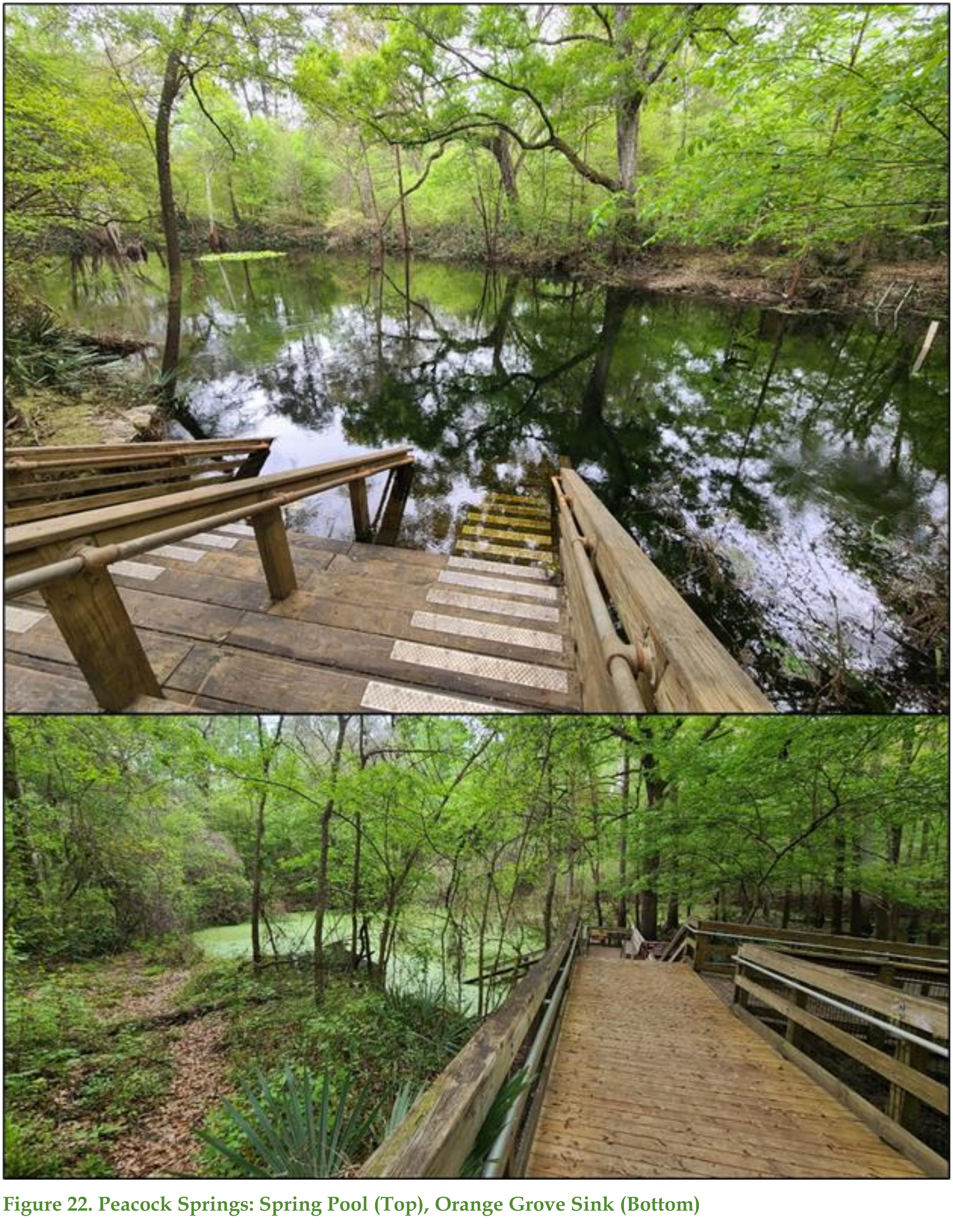


Figure 22. Peacock Springs: Spring Pool (Top), Orange Grove Sink (Bottom)

Hydrological data were first collected with some regularity (generally quarterly) from Peacock Springs in 2014. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were also collected with some regularity (generally quarterly) since 2014. Samples were collected slightly more frequently (58% on average) during the wet season (June through October) than during the dry season (November through May). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for conductivity beginning in 2013 and water temperature, dissolved oxygen, pH, turbidity, NOx-N, and fDOM beginning in 2015. Frequent (generally daily) water clarity observation scoring data were available since 2009 and daily park attendance data were available beginning in 1988. Limited biological data were available with vegetation cover from 2017 and fish counts from 2002 and 2017.

3.2.10.1 WRV 1 – Recreation In and On the Water

Peacock Springs offers a variety of recreational opportunities, but caters to cave divers more than most of the other evaluated springs. This spring system is internationally recognized as a premier cave diving location and has been extensively mapped for more than 60 years.[14] During the site visit, water conditions were high and dark with the facility closed to swimming and diving. Recreational opportunities include: swimming/snorkeling, tubing, and scuba/cave diving. Within the spring run it appears that paddle craft can be used although access by motorboat appears to be limited.

3.2.10.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring is largely natural with limited access points for recreation and generally natural shorelines. This spring has a heavily forested floodplain and spring run. Passage for fish and/or manatees may be limited in the spring run from the Suwannee River although this could not be evaluated during the site visit. This spring system includes a larger number of sink/karst window features in addition to the main spring. The spring pool and run appear to be highly connected to the floodplain at high Suwannee River stages.

3.2.10.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.10.4 WRV 4 – Transfer of Detrital Material

Peacock Springs is in a largely natural condition and has a forested fringe and forested spring run. These components are expected to contribute litterfall to the spring pool and spring run on an annual cycle. During the site visit the spring was experiencing brown out conditions due to stages on the Suwannee River and the presence of vegetation in the spring pool and spring run could not be evaluated. During normal flow conditions it is expected that some portion of detrital material would be transported downstream. This system also experiences inundation of a large floodplain that can transport detrital material from the floodplain into the spring pool and run.

---

[14] https://www.floridastateparks.org/learn/cave-diving-peacock-springs

3.2.10.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.10.6 WRV 6 – Aesthetic and Scenic Attributes

This spring is located in a state park and offers a largely natural setting with minimal infrastructure other than stairs for entering the springs without damaging the shoreline. This natural setting offers significant opportunities for aesthetic and scenic activities. The system is heavily forested and offers a variety of viewing opportunities between the main spring and the other karst windows that exist in the park.

3.2.10.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring and spring run are largely natural with human use occurring primarily in the spring pool and karst windows. Given the dark water conditions during the site visit it was not possible to assess the presence or extent of SAV, but it appears likely to be present under normal clear conditions. During flood conditions nutrient and pollutant removal may also occur in the floodplain.

3.2.10.8 WRV 8 – Sediment Loads

Sediment loads at Peacock Springs are expected to be less than at some other springs because of the stair entry points that keep users off the spring banks and the largely natural condition of the spring which includes greater vegetation to stabilize the spring pool and spring run. This spring also appears to receive substantially less visitation than some other more accessible springs. This spring has a longer spring run and it is likely that sediment that do enter the spring may deposit in areas of lower velocity along the spring run before reaching the Suwannee River.

3.2.10.9 WRV 9 – Water Quality

During the site visit the water in the spring was observed to be dark from flooding on the Suwannee River, but clear. Water quality will be evaluated based on the available data.

3.2.10.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.11 Poe Spring

Poe Spring is a second magnitude spring located in Alachua County, approximately 3.1 miles west of High Springs. Poe Spring is an OFS and flows to the Lower Santa Fe River down a 225-foot spring run (Figure 23). Poe Spring is located in a county park, Poe Spring County Park, owned by Alachua County. This spring does not have a separate MFL, but is part of the Lower Santa Fe River MFL (Suwannee River Water Management District, 2013). This spring could not be visited due to ongoing construction in the park. WRV applicability described was based on previous visits/site knowledge, although current construction is anticipated to cause some user access modifications.

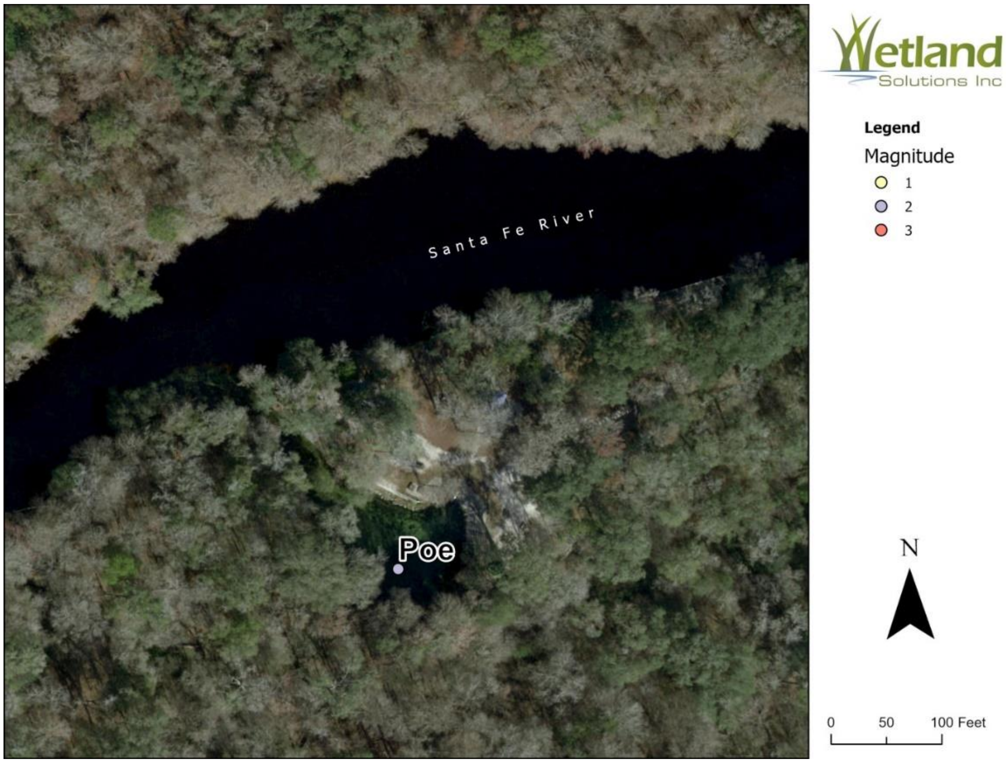


Figure 23. Poe Spring Location

Hydrological data were first collected with some regularity from Poe Spring in 1997, with generally bimonthly flow data and daily for water elevations until 2001, mostly biweekly data for both through 2013, and mostly quarterly after 2013. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were also collected with some regularity (generally monthly with periods of quarterly sampling) since 1998. Samples were collected slightly more frequently (57% on average) during the dry season (November through May) than during the wet season (June through October). Available park attendance data includes peak visitation by month (1992 through 2008), monthly totals (2009 through 2010), and monthly vehicle totals (2017 through 2020). Detailed human-use counts were available for 12 events since 2019. Available biological data included vegetation and fish data since 2017.

3.2.11.1 WRV 1 – Recreation In and On the Water

During normal operations Poe Spring allows recreation including: swimming/snorkeling, paddle craft, and tubing. Recreation is available from stairs into the spring from the side of the spring pool and into the spring run.

3.2.11.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a relatively short run to the Santa Fe River. Habitat within the spring includes a partially natural shoreline with a portion of the pool surrounded by concrete-lined access. Within the spring run there is a combination of substrate and bare limestone.

3.2.11.3 WRV 3 – Estuarine Resources

See Section 3.2.1.3.

3.2.11.4 WRV 4 – Transfer of Detrital Material

Poe Spring is surrounded by generally natural land uses with limited access points to the spring pool and run. Much of the area surrounding the spring pool includes moderate side slopes and a treed fringe that could be expected to contribute detrital material from litterfall. Additionally, there is the potential for some detrital deposition from the Santa Fe River during floods when water backs up into the spring carrying debris. Under normal water conditions in the Santa Fe River it is expected that deposited detrital material would be conveyed to the river and downstream.

3.2.11.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.11.6 WRV 6 – Aesthetic and Scenic Attributes

This spring is laid out to provide a variety of scenic and aesthetic opportunities. Around a portion of the spring a boardwalk allows visitors views of the spring pool. Given the short spring run there are also views of the spring, spring run, and Santa Fe River. The natural surroundings provide additional scenic and aesthetic attributes.

3.2.11.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

Based on the configuration of the spring including a short spring run and the typical spring flow residence time in the spring and run is expected to be low. Also given the human use and observations at other springs it is expected that little vegetation is present in the spring pool or spring run reducing the opportunity for water quality improvement.

3.2.11.8 WRV 8 – Sediment Loads

Sediment can enter the spring from erosion of the surrounding banks, from erosion during human use, and can also be washed in from the Santa Fe River during flooding. Sediment deposited in the spring pool may then be conveyed to the Santa Fe River during normal flows.

3.2.11.9 WRV 9 – Water Quality

Poe Springs experiences flow reversals during high water periods on the Santa Fe River. During these events dark water may intrude all the way to the spring pool and cause river flows to enter the aquifer. These dark water periods are then often followed by discharge of green-tinged water following flow reversals(Howard T. Odum Florida Springs Institute, 2020). Water quality will be evaluated based on the available data.

3.2.11.10 WRV 10 – Navigation

There is no commercial navigation associated with this spring.

3.2.12 Treehouse Spring

Treehouse Spring is a first magnitude spring located along the Lower Santa Fe River approximately 1.9 miles north of High Springs, and upstream of the US 441 Santa Fe Boat Ramp (Figure 24). The spring is located in Alachua County and flows down an approximately 130-foot spring run to the Santa Fe River. The spring pool is surrounded by private land that is a part of the Camp Kulaqua River Ranch Water Park. The spring flow was characterized by dark water on the day of the site visit (March 22, 2021) and appears to be fed largely by resurgent Santa Fe River water. This spring does not have a separate MFL, but is part of the Lower Santa Fe River MFL (Suwannee River Water Management District, 2013). Representative photos of the spring and conditions during the site visit are shown in Figure 25.

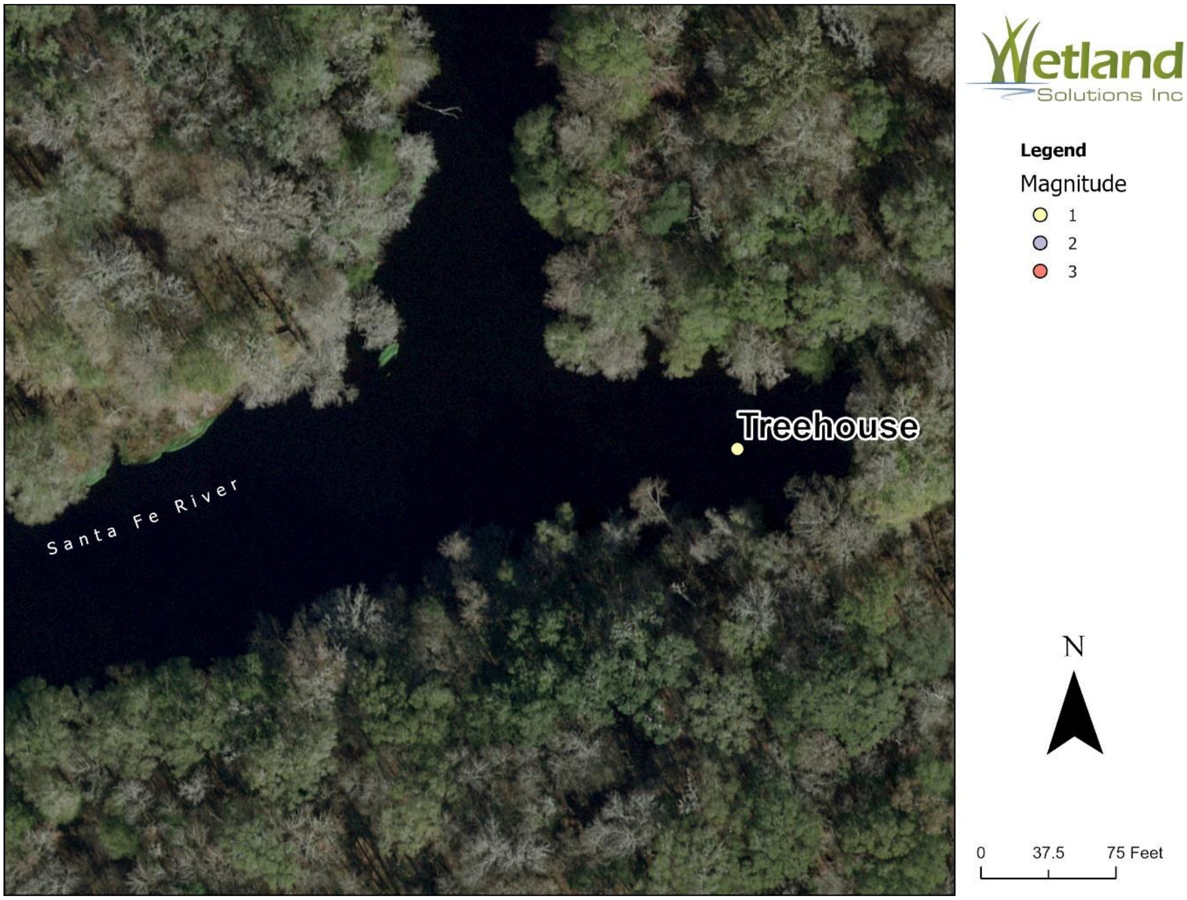


Figure 24. Treehouse Spring Location

Figure 25. Treehouse Spring: Spring Pool (Top Left), Spring Run (Top Right), Santa Fe River Confluence (Bottom)

Hydrological data were first collected with some regularity from Treehouse Spring beginning in 1998 for flows (generally quarterly) with limited water elevation data. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were also collected with some regularity (generally quarterly) since 1998. Samples were collected slightly more frequently (57% on average) during the wet season (June through October) than during the dry season (November through May). Limited biological data were available with vegetation cover estimates from 2017.

3.2.12.1 WRV 1 – Recreation In and On the Water

This spring allows a variety of water-based recreational opportunities including paddle craft, fishing, swimming/snorkeling, tubing, and scuba/cave diving. Recreation appears to be limited to in-water activities because of private land ownership for areas surrounding the spring pool. Recreation at this site is expected to be somewhat limited by the private ownership and limited visibility during dark water periods.

3.2.12.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a variety of habitat available both in and around the spring pool. During the site visit levels in the Santa Fe River were elevated, with dark water reducing the ability to assess in-water habitat. Habitat adjacent to the spring pool and run includes a variety of forested wetland and upland habitat. Spring banks were low and gently sloping in many areas improving access for wildlife. The spring run appeared to be deep based on the observed flow and lack of surface turbulence.

3.2.12.3 WRV 3 – Estuarine Resources

See Section 3.2.1.3.

3.2.12.4 WRV 4 – Transfer of Detrital Material

Treehouse Spring has a heavily treed fringe and relatively low spring banks with some connected floodplain areas. These areas are expected to contribute detrital material during floods on the Santa Fe River when elevated water levels move material out of the floodplain into the spring pool and run. There is also expected to be direct litterfall from the vegetation surrounding the spring pool and run. No SAV could be observed given the dark water conditions in the spring on the day of the visit.

3.2.12.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.12.6 WRV 6 – Aesthetic and Scenic Attributes

This spring is surrounded by private land which limits access to the spring except by water. Within the spring and spring run aesthetic and scenic attributes include: wildlife viewing, enjoying the natural settings, wildlife sounds, and a full spring pool. A major draw of the spring is the natural setting.

3.2.12.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring appears to have limited residence time based on the high flows and short spring run. Dark water conditions during the site visit made assessing instream vegetation infeasible. Some potential treatment exists in the spring fringe and adjacent floodplain under high water levels.

3.2.12.8 WRV 8 – Sediment Loads

The property surrounding the spring pool and run is private limiting uses of the bank, which has allowed vegetation to establish to the water's edge. This vegetation appears to reduce the likelihood of sediment runoff into the spring. Given high flows in the spring and the short spring run any sediment entering the spring is likely to be moved downstream to the Santa Fe River. Under high flow conditions on the Santa Fe River sediment could be deposited from the river into the spring run.

3.2.12.9 WRV 9 – Water Quality

During the site visit the water in the spring was dark and clear. Water quality in the spring appears to be closely tied to the Santa Fe River. There is also some potential for water to be contributed from Hornsby Spring to this spring. Water quality will be evaluated based on the available data.

3.2.12.10 WRV 10 – Navigation

This spring does not have commercial navigation.

3.2.13 Troy Spring

Troy Spring is a first magnitude spring located in Lafayette County, approximately 5.2 miles northwest of Branford. Troy Spring is a designated OFS and flows down an approximately 230-foot spring run to the Suwannee River (Figure 26). An MFL has been developed for the spring as part of four OFSs evaluated in the Middle Suwannee River Basin (SRWMD, 2017). Representative photos of the spring and conditions during the site visit are shown in Figure 27

Figure 26. Troy Spring Location

Figure 27. Troy Spring: Spring Pool (Top) and Extent of Spring Pool Flooding (Bottom)

Hydrological data were first collected with some regularity from Troy Spring in 1998. Periods of mostly monthly flow data were available through 2001, with daily data through 2015 (with the exception of no data from August 2010 through February 2014), and mostly quarterly after 2015. Water elevation data were available through 2020 (generally monthly) with daily data beginning in 2021. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1992, with more frequent sampling (generally monthly) since 1998. Samples were collected nearly equally between the dry season (November through May) and wet season (June through October). Additional continuous in-situ water quality data are available from USGS NWIS for water temperature, conductivity, dissolved oxygen, pH, and NOx-N beginning in 2014. Frequent (generally daily) water clarity observation scoring data were available since 2009, manatee observations since 2019, and daily park attendance data since 1997. Limited biological data were available with vegetation and fish population estimates from 2017.

3.2.13.1 WRV 1 – Recreation In and On the Water

Troy Spring includes a variety of recreational opportunities including: paddle craft, swimming/snorkeling, tubing, and scuba/cave-diving. Only open-water scuba diving is permitted. This spring is separated from the Suwannee River by a swim rope that appears to restrict boat entry to the spring and run. Access to the water is from a ramp although the facilities around the spring pool were submerged during the site visit.

3.2.13.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

The spring was flooded during the site visit. These conditions appear to provide access by wildlife to higher areas and the floodplain that could provide valuable habitat services and nutrients. Conditions during the site visit were characterized by dark water and in spring habitat could not be directly assessed although it is expected to be similar to other evaluated systems that allow access to the Suwannee River down a well-defined and consistently inundated spring run.

3.2.13.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.13.4 WRV 4 – Transfer of Detrital Material

Troy Spring was flooded outside of the spring pool during this site visit. This flooding is expected to allow for the transfer of detrital material from the floodplain into the spring pool and run. Based on review of aerials some canopy exists around portions of the spring boil which could contribute litterfall although the canopy is not as closed along the spring run. Material entering the spring run is expected to be conveyed to the Suwannee River under normal conditions.

3.2.13.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.13.6 WRV 6 – Aesthetic and Scenic Attributes

During the site visit most of the user facilities were flooded not allowing for complete assessment of the features. However, based on an aerial review this system appears to have a spring overlook in a similar manner to other springs. These overlooks allow for visitors to take in the natural beauty of the site. It also appears that upland trails exist to allow users to walk along the spring run and view the spring run mouth at the Suwannee River. This spring also features a Civil War Era wreck that offers unique viewing opportunities.

3.2.13.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring appears to have limited residence time based on the high flows and the short spring run. Dark water conditions during the site visit made assessing instream vegetation infeasible. Some potential treatment exists in the spring fringe and adjacent floodplain under high water levels.

3.2.13.8 WRV 8 – Sediment Loads

This spring offers access to the water through a limited number of locations with stairs. These improvements are expected to provide reduced sediment loading within the spring pool and spring run from bank erosion. Some sediment input may occur during periods when the floodplain is inundated and water levels recede carrying sediment. During normal water levels it is expected that flow velocities would be adequate to move sediments down the short spring run to the Suwannee River. Near the mouth of the spring run there is the potential for sediment deposition from the Suwannee River during flood flows.

3.2.13.9 WRV 9 – Water Quality

The spring was completely flooded during the site visit with dark tannic water. Water quality will be evaluated based on the available data.

3.2.13.10 WRV 10 – Navigation

This spring does not support commercial navigation.

3.2.14 Wacissa Spring

The Wacissa River is fed by multiple springs although this assessment focused on the Wacissa Head Spring which is a first magnitude spring located in Jefferson County, approximately 1.3 miles southeast of Wacissa. The spring is accessed from property owned by Jefferson County that supports a county park (Figure 28). The Wacissa River flows approximately 12 miles before joining with the Aucilla River and flowing to the Gulf of Mexico. An MFL has been developed for the Aucilla and Wacissa Rivers (HSW Engineering, Inc., 2016). Representative photos of the spring and conditions during the site visit are shown in Figure 29.

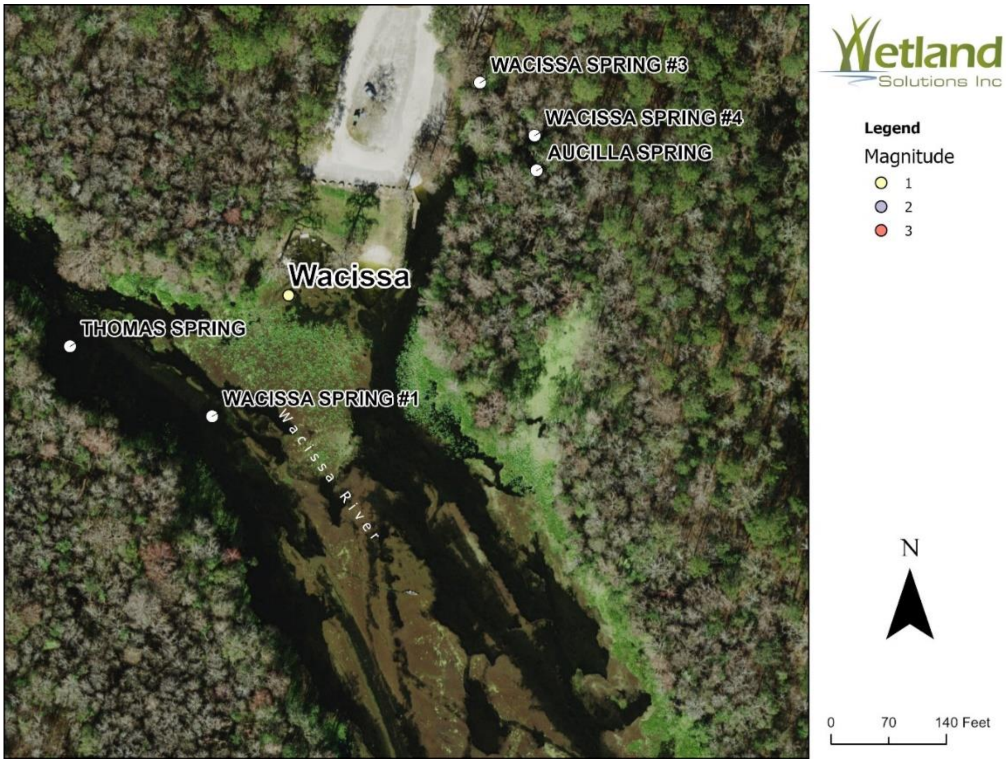


Figure 28. Wacissa Springs Location

Figure 29. Wacissa Head Spring: Park Facility (Top Left), Spring Pool (Top Right), Wacissa River Connection (Bottom)

Hydrological data were first collected with some regularity from Wacissa Headspring in 1998. Periods of flow data generally every two months were available through 2007, with daily data after 2007. The flow station is located approximately 2.8 miles downstream of the headspring within the spring run. Water elevation data were available (generally monthly) from 1999 through 2016. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity (generally quarterly) since 2002. Samples were generally collected equally between the dry season (November through May) and wet season (June through October). Additional continuous in-situ water quality data are available from USGS NWIS at the downstream flow station for water temperature, conductivity, dissolved oxygen, and pH beginning in 2016, and NOx-N beginning in 2018. Limited biological data were available from downstream monitoring within the spring run with vegetation and fish populations estimates from 2017.

3.2.14.1 WRV 1 – Recreation In and On the Water

The Wacissa Headspring supports a large variety of in and on water recreation. Available activities include: paddle craft, swimming/snorkeling, tubing, motorboating, and scuba/cave-diving. This spring also provides a boat ramp for small boats to be launched, a kayak launch, a dock that can be used for paddle craft launching and fishing, a rope swing, and a sandy beach that can be used for swimming. Boats launching at this location can be used to access the spring or the remainder of the river and other vents. Portions of the spring pool and run near the vent are heavily vegetated with hydrilla and floating aquatics. The shoreline in the vicinity of the spring pool is partially protected with a swim ladder although access is also available from a sand beach.

3.2.14.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

The Wacissa Headspring is surrounded by generally natural land uses and adjacent low-lying floodplains that offer a variety of in and out of water habitat for wetland dependent species. The spring pool is located in the edge of the spring run and access between the two is available across a wide cross-section. Significant vegetation occurs around and in the vicinity of the spring pool offering additional habitat although some portion of this is dense, invasive hydrilla and filamentous algae.

3.2.14.3 WRV 3 – Estuarine Resources

The Wacissa Headspring contributes flow to the Wacissa River which flows to the Aucilla River and to the Gulf of Mexico. The Wacissa Headspring contributes a significant portion of the flow of the Wacissa River; however, the headspring flow contributes a relatively minor fraction of the water ultimately discharging to the Gulf of Mexico at the mouth Aucilla River. During dry conditions, the importance of this spring is expected to make up a much higher percentage of the total flow to the Gulf.

3.2.14.4 WRV 4 – Transfer of Detrital Material

This spring is located in the edge of the Wacissa River and does not have a significant spring run. A large portion of the spring edge is in grass, sandy beach, or retaining walls that are not expected to contribute a significant detrital load from litterfall. A large floodplain swamp is adjacent to the spring pool that can contribute additional detrital material during elevated water conditions. Significant vegetation occurs in and adjacent to the spring pool including SAV, algae, and floating aquatic plants. This vegetative material can be expected to contribute detrital material to the spring and river system.

3.2.14.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.14.6 WRV 6 – Aesthetic and Scenic Attributes

The Wacissa Head Spring is a large, open spring system surrounded by generally natural land uses. The system also features several large baldcypress trees that contribute to the natural setting. Water clarity was excellent and contributes to the scenic attributes. This system is more open with a treed fringe, and substantial area that is outside of the forest canopy.

3.2.14.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring includes a large amount of SAV, floating aquatic plants, and filamentous algae that is likely to provide treatment for nutrients and pollutants. Additionally, the system has a connected floodplain that can provide treatment at higher stages.

3.2.14.8 WRV 8 – Sediment Loads

This spring has relatively low slopes into the spring and low surrounding elevations that are not expected to contribute a significant sediment load. This spring does include a relatively large beach on the spring fringe and sand within the vicinity of the spring boil. Wading and swimming in this area is likely to cause sediment loading into the spring pool and run.

3.2.14.9 WRV 9 – Water Quality

The water appeared to have excellent clarity during the site visit. Water quality will be evaluated based on the available data.

3.2.14.10 WRV 10 – Navigation

There is no commercial navigation in this spring although some commercial fishing charters may occur on the river.

3.2.15 Gilchrist Blue Spring

Gilchrist Blue Spring is a second magnitude spring located in Gilchrist County, approximately 5.4 miles west of High Springs. The spring is located in Ruth B. Kirby Gilchrist Blue Springs State Park and has an approximately 0.2-mile spring run to the Lower Santa Fe River (Figure 30). The spring does not have a separate MFL, but is part of the Lower Santa Fe River which has an adopted MFL (Suwannee River Water Management District, 2013). Representative photos of the spring and conditions during the site visit are shown in Figure 31.

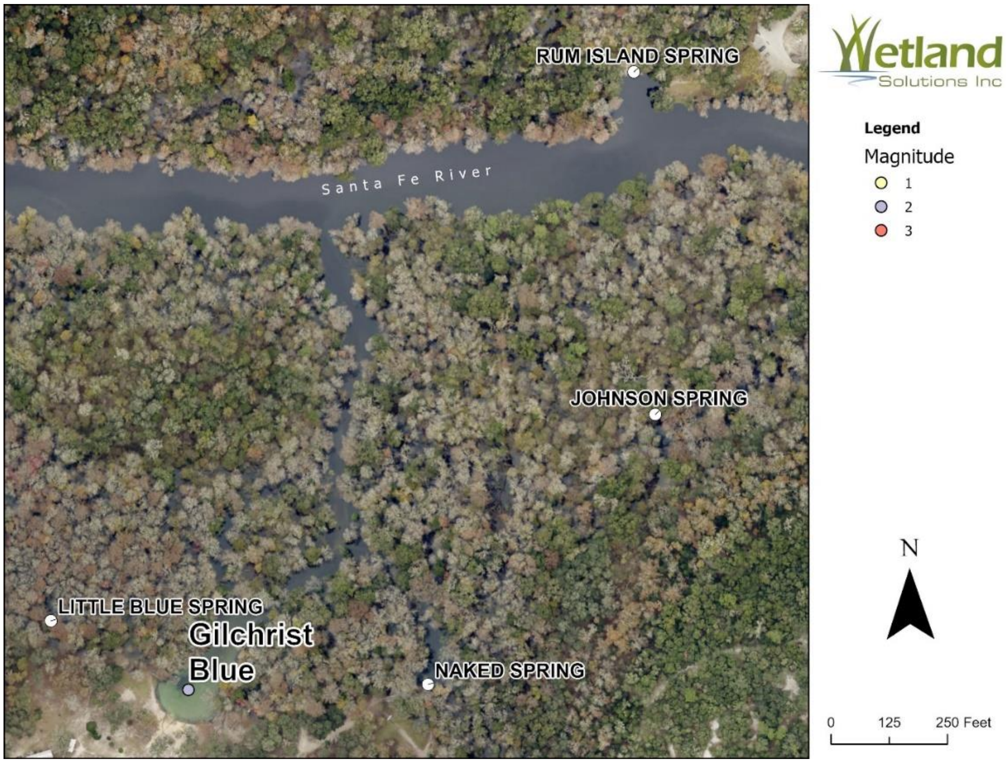


Figure 30. Gilchrist Blue Spring Location

Figure 31. Gilchrist Blue Spring: Spring Pool (Top) and Upland Facilities (Bottom)

Hydrological data were first collected with some regularity from Gilchrist Blue Springs in 1997 for flows (generally every other month) and water elevations with periods of daily, weekly, and monthly monitoring. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1992, with periods of monthly and quarterly sampling. Samples were collected slightly more frequently (53% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for water temperature, conductivity, dissolved oxygen, pH, NOx-N, and fDOM beginning in 2019. Daily park attendance data were available since 2017. Limited biological data were available with vegetation and fish populations estimates beginning in 2017, and detailed human use counts since 2018.

3.2.15.1 WRV 1 – Recreation In and On the Water

Gilchrist Blue Spring includes a variety of recreational opportunities including: paddle craft, swimming/snorkeling, and tubing. The park also includes significant upland facilities although changes are anticipated associated with park renovations. The spring is largely enclosed by a retaining wall that is supporting a substantial amount of sand that appears to have moved toward the spring pool. Access to the spring pool is from a sand beach and from the shoreline on the side bank. Access to the spring run is limited and users are not allowed to walk in the spring run.

3.2.15.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring is connected to the Santa Fe River down a spring run that includes a large amount of SAV. Within the spring pool, natural habitat exists along approximately half of the shoreline that is in a largely undisturbed condition. The remainder of the shoreline is dominated by sand beaches. Vegetation within the spring pool is limited except in the littoral edges, although there have been periods when robust SAV communities have occupied the spring pool. Access to upland and floodplain areas are available to wildlife from both the spring pool and spring run, with an extensive floodplain during periods with high water levels on the Santa Fe River.

3.2.15.3 WRV 3 – Estuarine Resources

See Section 3.2.1.3.

3.2.15.4 WRV 4 – Transfer of Detrital Material

This spring has a relatively large pool with a forested natural fringe around approximately half of the spring pool. Within the natural fringe trees overhang the pool and could contribute litterfall to the spring. Some littoral vegetation occurs in the spring pool which could also contribute detrital material. Detrital transfer is expected to be more significant in the spring run where the run is heavily treed and there is high SAV coverage in the channel. These communities are expected to contribute significant detrital material in the run. Floodplain connection could also contribute detrital material during high water periods.

3.2.15.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.15.6 WRV 6 – Aesthetic and Scenic Attributes

Gilchrist Blue Spring has a large spring pool with clear blue water (during the site visit) and a prominent spring vent which offers aesthetic and scenic attributes. The spring is surrounded by elevated areas around portions of the spring pool that offer excellent overlooks of the spring pool. As a new state park, this spring is expected to undergo changes in operations and facilities that are likely to change the aesthetic and scenic attributes of the spring. The boardwalk that extended along the spring run historically is currently in the process of being removed with no other access to the spring run except by paddle craft.

3.2.15.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring has a small amount of vegetation in the fringe of the spring pool that could provide some treatment. The spring run includes a significant quantity of SAV that would be expected to provide treatment. Additional treatment may also be provided during high water periods in the floodplain swamps near the spring pool and spring run.

3.2.15.8 WRV 8 – Sediment Loads

Gilchrist Blue Spring has a less stable shoreline than many of the other considered springs and there is significant potential for sediment to be carried into the spring by visitors, or erosion. This spring also has large and relatively high retaining walls that are holding back 4-5 feet sand that could move into the spring during major rainfall events or in the event of a structural failure. Sediment reaching the spring has some potential to be moved downstream in the run and to the river, but velocities in the spring pool are likely insufficient to move sand downstream.

3.2.15.9 WRV 9 – Water Quality

On the day of the visit the spring had a full spring pool with clear, blue water. Water quality will be evaluated based on the available data.

3.2.15.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.16 White Sulphur Spring

White Sulphur Spring is a historic second magnitude spring located in Hamilton County, in the Town of White Springs. This spring is located on the bank of the Suwannee River and the spring pool is surrounded by a historic spring bathhouse with vertical concrete walls and an upper wooden walkway (Figure 32). This spring was backflowing at the time of the visit and rarely has consistent spring flow. The spring lies within the Stephen Foster Folk Culture Center State Park. There is no MFL for this spring. Representative photos of the spring and conditions during the site visit are shown in Figure 33.

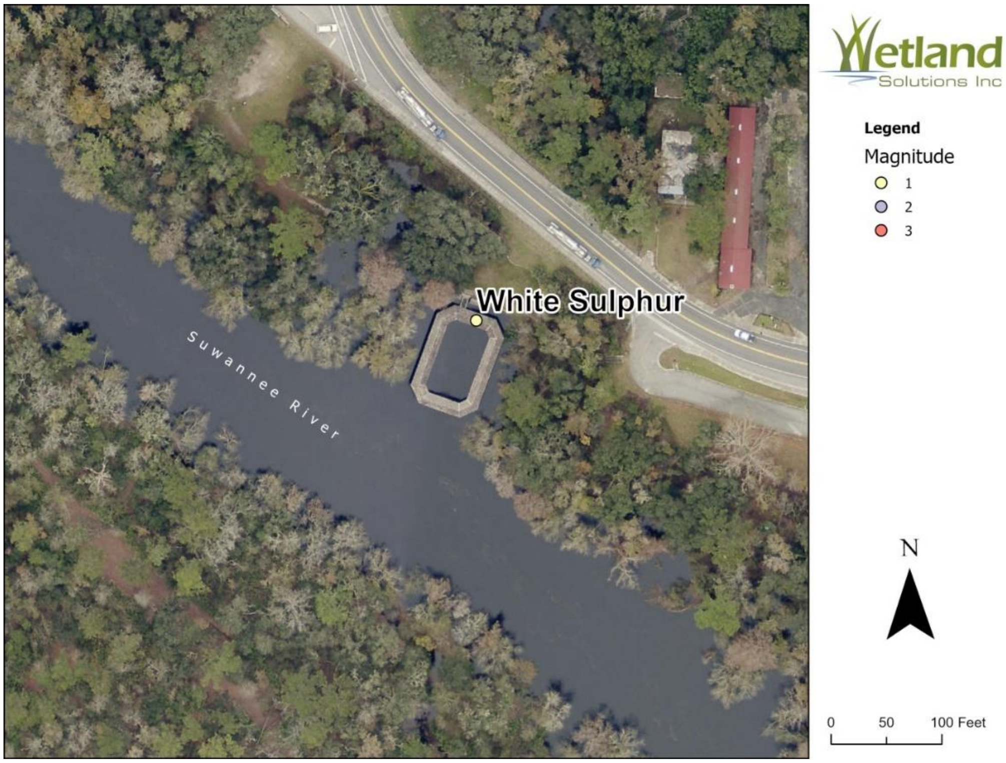


Figure 32. White Sulphur Spring Location

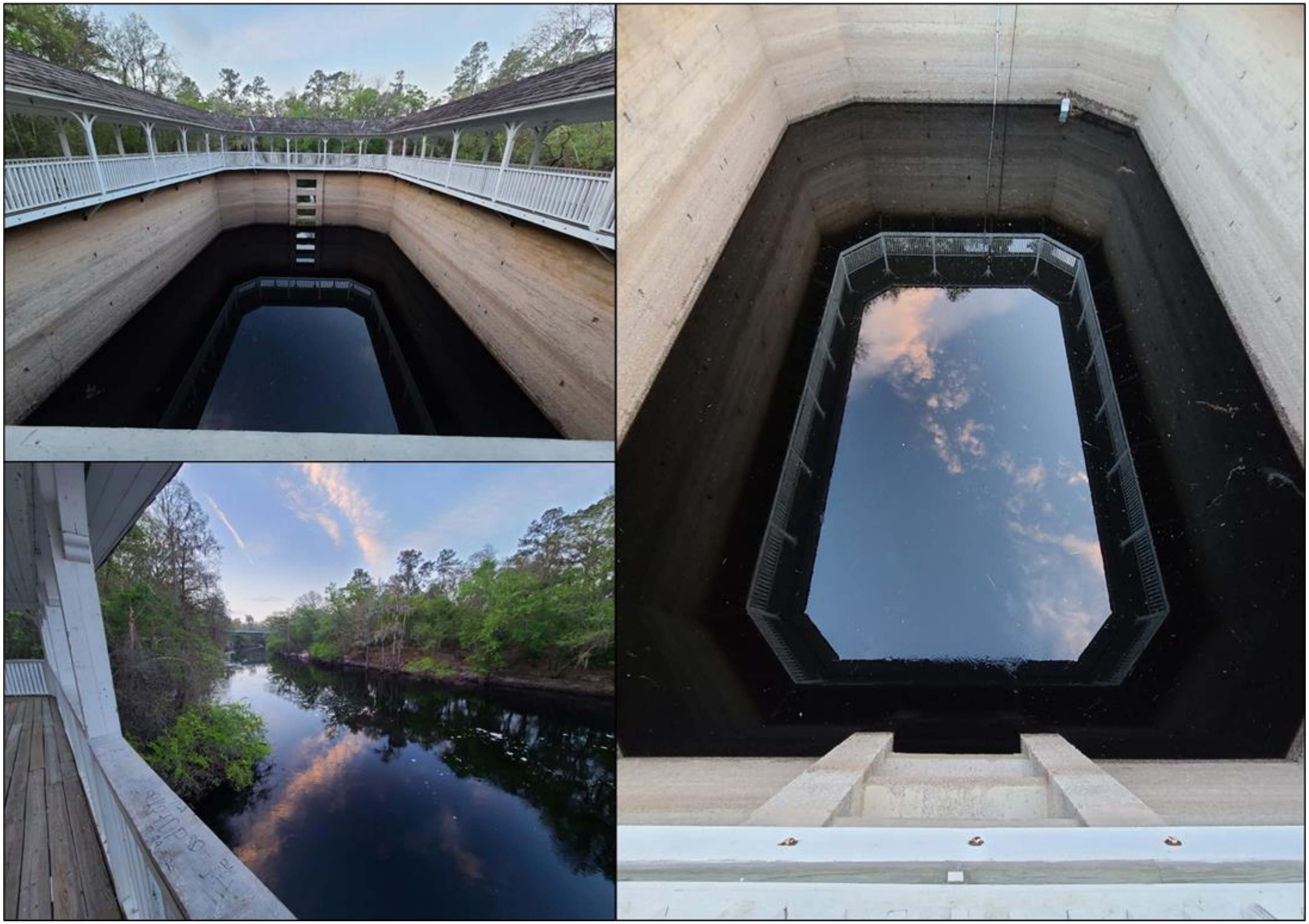


Figure 33. White Sulphur Spring: Spring Pool Toward River (Top Left), Spring Pool (Right), Suwannee River Looking Upstream (Bottom Left)

Hydrological data were first collected with some regularity from White Sulphur Spring in 1997; however, data were intermittent with periods of weekly, monthly, and quarterly data. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected infrequently since 1956, with more frequent sampling (generally quarterly) since 2016. Samples were collected slightly more frequently (52% on average) during the dry season (November through May) than during the wet season (June through October). Additional continuous in-situ water quality data are available from the SRWMD Water Data Portal for conductivity beginning in 2019. Daily park attendance data were available since 1982, with no data available between 1985 and 1997. No biological data were available.

3.2.16.1 WRV 1 – Recreation In and On the Water

Except during low river water levels, there is no direct access to the spring pool for recreation due to the concrete walls of the historic spring house. Recreation in the spring pool is further inhibited by a combination of sporadic, reduced groundwater discharge. Recreational activities may be available in the river immediately outside of the spring pool enclosure, but no recreational uses are allowed inside.

3.2.16.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

There is some potential for wildlife access to the spring, but it is limited by the enclosure around the spring. No apparent habitat exists inside the spring pool although water levels were high and the presence of vegetation could not be assessed.

3.2.16.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.16.4 WRV 4 – Transfer of Detrital Material

No detrital material is expected to be generated in this spring pool. Any detrital material entering the spring would most likely be washed in during flood conditions.

3.2.16.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.16.6 WRV 6 – Aesthetic and Scenic Attributes

This spring does not appear, based on data, to exhibit clear spring water conditions frequently. However, the spring has a unique scenic and aesthetic appeal based on the historic nature of the structure and viewing opportunities. The spring house offers excellent views of the Suwannee River and of the enclosed spring pool.

3.2.16.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

During the site visit this spring was back flowing from the river into the spring pool. Based on the data this spring appears to rarely exhibit clear water days and acts as an estavelle accepting dark water and then flowing dark water when levels in the Suwannee River decrease. No vegetation was observed and the spring is located immediately on the bank of the Suwannee River with little residence time.

3.2.16.8 WRV 8 – Sediment Loads

Sediment loads to the spring are expected to be driven primarily by flows and sediment loads on the Suwannee River. The spring house protects the spring from erosion from outside areas.

3.2.16.9 WRV 9 – Water Quality

This spring is expected to have water quality similar to the Suwannee River since flows in the spring are dominated by backflows from the river. Water quality will be evaluated based on the available data.

3.2.16.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.17 Suwannee Spring

Suwannee Spring is a second magnitude spring located in Suwannee County, approximately 7.4 miles northeast of Live Oak. This spring is located along the bank of the Suwannee River (Figure 34) and is enclosed by a concrete rock wall around the spring pool that overflows through windows at various elevations to the river. This spring is on property owner by the SRWMD and operated as a park. There is no MFL for this spring. Representative photos of the spring and conditions during the site visit are shown in Figure 35.

Figure 34. Suwannee Spring Location

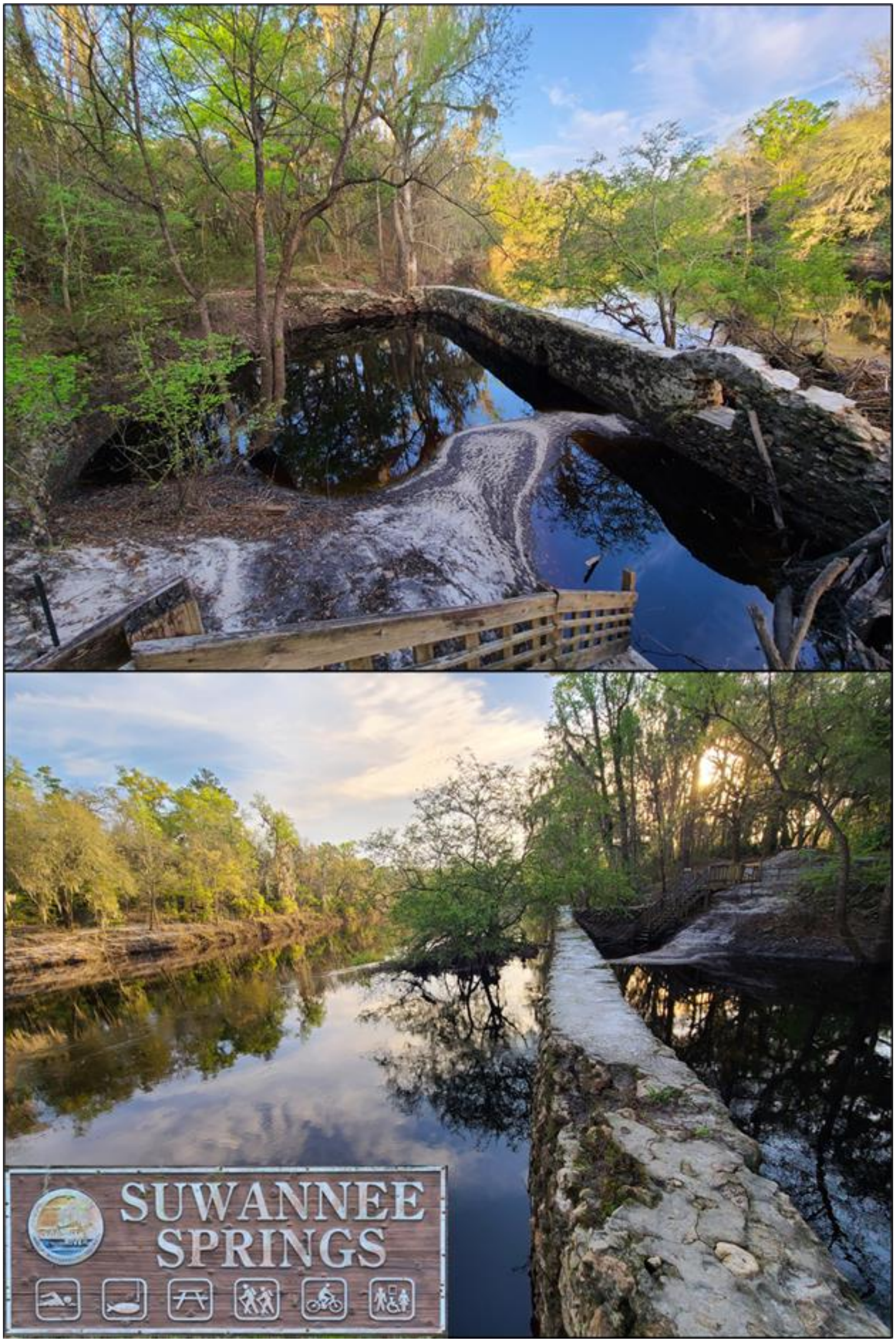


Figure 35. Suwannee Spring: Spring Pool (Top), Suwannee River and Spring (Bottom), Park Sign (Inset)

Hydrological data were first collected with some regularity from Suwannee Spring in 1961. Flow data were generally available every two months through 1970, followed by about 30 years of intermittent data collection, and generally flow every two months or quarterly beginning again in 2001. Limited water elevation data were available. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity since 1997, with more frequent sampling (mostly quarterly) since 2001. Samples were collected slightly more frequently (52% on average) during the dry season (November through May) than during the wet season (June through October). No biological or human-use data were available.

3.2.17.1 WRV 1 – Recreation In and On the Water

Recreation at Suwannee Spring is limited in the spring pool. Access is currently restricted to the spring pool, but generally includes: swimming/snorkeling, tubing, and scuba/cave-diving. Fishing, paddle craft, and motorboating are also allowed in the river outside the spring. Recreation inside the spring pool is limited by the size of the pool and the dark water during the site visit that appears to be a frequent occurrence with the spring functioning as an estavelle.

3.2.17.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

Habitat is limited within the spring pool by the rock wall that surrounds the spring pool. Some vegetation occurs in the spring pool although dark water conditions limited the ability to assess vegetation. Passage to and from the river is limited by the windows and broken section that connect the spring pool to the river.

3.2.17.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.17.4 WRV 4 – Transfer of Detrital Material

Detrital material within Suwannee Spring appears to be generated from litterfall from the treed fringe along a portion of the spring pool edge, some amount of detrital material from vegetation within the spring pool, and from material that overflows into the spring from the Suwannee River. Transfer appears to be dominated by inputs during floods from the river. Material flowing back to the river may be limited by the windows that pass flow.

3.2.17.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.17.6 WRV 6 – Aesthetic and Scenic Attributes

This spring had dark water during the site visit not offering a clear water aesthetic. The rock wall surrounding the spring offers a unique aesthetic and scenic experience with the Suwannee River as a backdrop to the spring. The area also includes scenic views of the Suwannee River near the spring.

3.2.17.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring appears to act as an estavelle and water quality is expected to mimic conditions on the Suwannee River. The size of the spring pool and flow is expected to limit residence time in the spring pool reducing the potential for treatment. The dark water conditions also did not allow for observation of vegetation that may provide treatment.

3.2.17.8 WRV 8 – Sediment Loads

The spring pool is entirely surrounded by a stone wall. Sediment loads appear to be dominated by loading from the Suwannee River during flooding.

3.2.17.9 WRV 9 – Water Quality

This spring appears to operate as an estavelle with water quality reflecting conditions in the Suwannee River. Water quality will be evaluated based on the available data.

3.2.17.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.18 Little Fanning Spring

Little Fanning Spring is a second magnitude spring located in Levy County, approximately 0.5 miles south of the City of Fanning Springs. The Little Fanning Spring pool is located approximately 500 feet south of the Fanning Spring pool (Figure 9). The spring has an approximately 0.2-mile run to the Suwannee River. This spring was considered as part of the MFL for the Lower Suwannee River, but did not have a site-specific MFL developed (Water Resource Associates, Inc., 2005). Representative photos of the spring and conditions during the site visit are shown in Figure 36.

Figure 36. Little Fanning Spring: Spring Pool (Top Left), Spring Run (Bottom Left), Manatee in Spring Run (Right)

Hydrological data were first collected with some regularity from Little Fanning Spring in 2003, with more frequent measurements since 2016 for flows (every two months) and 2013 for water elevations (daily). Water quality data were very limited with the exception of water clarity observation scoring data (generally daily) available since 2012. Daily park attendance data were also available starting in 1997. No biological data were available.

3.2.18.1 WRV 1 – Recreation In and On the Water

Little Fanning Spring is located south of the Fanning Spring pool in a more natural and heavily wooded area. This spring does not appear to see the pressure from recreation that is experienced at the Fanning Spring pool and has no spring access infrastructure or protection from access from the bank. During the site visit this spring was flowing strong with high levels that flooded a large spring pool and run, but under typical levels on the Suwannee River this spring and spring run are much smaller offering less potential access. Activities that can occur in this spring and run include: swimming/snorkeling, tubing, scuba diving, fishing, paddle craft, and motorboating. During normal water levels this spring may not accommodate all of these on- and in-water uses.

3.2.18.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring is located up an approximately 0.2-mile spring run from the Suwannee River. Under normal conditions the spring run is shallow and relatively narrow making the passage of wildlife within the spring run limited. During the site visit the Suwannee River was high and conditions within the spring pool and spring run were higher than normal and a manatee was observed in the spring run. This spring has a wide floodplain that can be flooded during higher stages providing additional wildlife habitat. Conditions around the spring pool and along the spring run are natural providing habitat for wildlife. Passage for fish may be limited during low water periods, or if flows in the spring are reduced.

3.2.18.3 WRV 3 – Estuarine Resources

See Section 3.2.4.3.

3.2.18.4 WRV 4 – Transfer of Detrital Material

This spring is largely natural with no significantly human-impacted shoreline. The spring and run have significant cover by trees that will provide litterfall. Additionally, the spring has a large floodplain area that can contribute detrital material. The site also has a relatively high presence of SAV in areas that can contribute detrital material. Flows in the spring are expected to be adequate to move much of this material downstream to the Suwannee River.

3.2.18.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.18.6 WRV 6 – Aesthetic and Scenic Attributes

Little Fanning Spring is largely natural and offers a relatively un-impacted aesthetic and scenic setting. Access to the spring is limited by a lack of facilities, but views of the spring are of a spring in a natural state. Trails are available to the mouth of the spring run where it joins the Suwannee River

3.2.18.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

During the site visit the spring had a large spring pool and large spring run including inundation in the floodplain. This condition is expected to provide a large amount of treatment potential. The spring also appeared to support a healthy stand of SAV that is expected to provide treatment during normal flow conditions. Under high water conditions the residence time is expected to be long, but under normal water conditions residence time in the spring run may limit the potential treatment that can occur.

3.2.18.8 WRV 8 – Sediment Loads

This spring is in a largely natural condition. Shorelines are largely natural limestone. Sediment runoff into the spring does not appear to be significant. Sediment entering the spring is likely to be trapped in the spring or spring run based on observed flows during the site visit, although the adequacy of velocities to convey sediment downstream should be evaluated. Sediment loading may also occur in the bottom of the spring run from the Suwannee River during floods.

3.2.18.9 WRV 9 – Water Quality

This spring was flowing high and clear during the site visit and appears to be more resistant to back-flow than Fanning Springs. Water quality will be evaluated based on the available data.

3.2.18.10 WRV 10 – Navigation

There is no commercial navigation in this spring.

3.2.19 Levy Blue Spring

Levy Blue Spring is a third magnitude spring located in Levy County, approximately 3.7 miles west of Bronson. Levy Blue Spring is owned and operated by Levy County as a county park (Figure 37). The spring has an approximately 0.3-mile long run to the Little Waccasassa River which flows to the Waccasassa River and the Gulf of Mexico. An MFL was developed for Levy Blue Spring as part of the Waccasassa River MFL (Water Resource Associates, Inc., 2006). Representative photos of the spring and conditions during the site visit are shown in Figure 38.

Figure 37. Levy Blue Spring Location

Figure 38. Levy Blue Spring: Spring Pool Looking Upstream (Top), Spring Pool Looking Downstream (Bottom)

Hydrological data were first collected with some regularity from Levy Blue Spring in 1966. Flow data were collected generally every two months through 1977, followed by about 38 years of intermittent data collection, and flow measurement every two months beginning again in 2016. Water elevation data were available through 1977 (generally monthly), with daily data from 1997 to 1999, and monthly and quarterly water elevation data beginning in 2004. Water quality, including nutrients (nitrogen and phosphorus), physical (color and secchi depths), field (temperature, pH, conductivity, dissolved oxygen, and turbidity), general inorganic (alkalinity, chloride, fluoride, and sulfate), and general organic (total organic carbon) parameters were collected with some regularity (generally quarterly) since 2010. Field parameters (temperature, dissolved oxygen, and conductivity) were also collected every two months for the period from 1966 to 1977. Samples were collected slightly more frequently (60% on average) during the dry season (November through May) than during the wet season (June through October). No biological or human-use data were available.

3.2.19.1 WRV 1 – Recreation In and On the Water

Levy Blue Spring is operated as a county park with recreation including both upland and in-water activities. A majority of the spring pool is enclosed by a concrete wall with designated access points. Recreational opportunities include: swimming/snorkeling and tubing. The spring also includes a jump platform. The swim area is designated by a rope across the run. This spring has a large full spring pool that can accommodate a large number of users.

3.2.19.2 WRV 2 – Fish and Wildlife Habitats and the Passage of Fish

This spring has a large spring pool with a relatively small spring run. Fish passage could be limited by depths in the spring run under some flow conditions. Within the spring pool a majority of the shoreline is concrete-lined reducing natural habitat. Observed vegetation was dominated by filamentous algae with one small section of emergent and floating plants in the spring pool and a small section of natural shoreline. A large number of fish were observed in the spring pool during the site visit. Vegetation within the spring run appears to provide substantial habitat.

3.2.19.3 WRV 3 – Estuarine Resources

This spring flows to the Waccasassa River which flows to tide. This spring makes up a small portion of the flow in the Waccasassa River except during particularly low-flow periods.

3.2.19.4 WRV 4 – Transfer of Detrital Material

This spring has only a short length of natural shoreline and vegetation within the spring pool. This condition is expected to limit detrital material inputs into the spring. The vegetation within the spring run is more extensive and tree cover is more complete increasing opportunities for detrital material inputs. Flows within the spring run did not appear high velocity reducing the potential for moving detrital material downstream.

3.2.19.5 WRV 5 – Maintenance of Freshwater Storage and Supply

See Section 3.2.1.5.

3.2.19.6 WRV 6 – Aesthetic and Scenic Attributes

This spring has a large spring pool that was characterized by clear blue water on the day of the site visit. The spring also has some presence of sand boils which was identified as a unique spring characteristic at Silver Glen Springs (Harris et al., 2017). This spring offers a less natural spring aesthetic, but represents how many people view and think of springs. Within the spring run and portions of the spring pool the system is more natural with wildlife-viewing opportunities, although access is limited.

3.2.19.7 WRV 7 – Filtration and Absorption of Nutrients and Other Pollutants

This spring has a large pool that is expected to provide a longer residence time. There is some vegetation within the spring pool including filamentous algae, floating aquatic plants, and emergent vegetation. This vegetation is expected to provide some treatment for water within the spring. The spring run has extensive vegetation that is expected to provide treatment.

3.2.19.8 WRV 8 – Sediment Loads

Levy Blue Spring is mostly enclosed by a concrete wall that reduces the potential for sedimentation within the spring boil. However, one portion of the spring has a "sandy beach" with the potential for sediment to be carried into the spring by users. The spring pool is relatively large limiting the potential for sediment to be conveyed downstream given inadequate velocities.

3.2.19.9 WRV 9 – Water Quality

This spring was flowing clear during the site visit. Water quality will be evaluated based on the available data.

3.2.19.10 WRV 10 – Navigation

There is no commercial navigation allowed in this spring.

3.3 Data Recommendations

A variety of entities currently collect data for the evaluated spring systems. Governmental organizations that collect data include the Suwannee River Water Management District (SRWMD), Florida Department of Environmental Protection (FDEP), Florida Park Service (FPS), United States Geological Service (USGS), and Alachua County. In addition to these groups, data are also collected by non-profit organizations including the Florida Springs Institute (FSI) and by students or researchers at various institutions (e.g. Stetson University, Santa Fe College, and University of Florida) to support research efforts. The temporal extent of this data collection is highly variable by entity and system with some data collected consistently for decades and other data collected over relatively short periods of time to support specific projects or research objectives. Additionally, some of these systems have been part of the FPS for decades while others are not part of the FPS or have only recently been acquired (e.g. Ruth B. Kirby Gilchrist Blue Springs State Park), limiting visitation data.

This report recommends consistent data collection that could provide much of the information necessary to assess specific spring WRVs. This section also presents a recommended minimum frequency with which these additional data should be collected. Not all of the considered spring systems are the same and some systems would benefit from supplemental, or more frequent data collection. The sections below are divided into physical data, water quality data, human use data, biological data, and other data. Within each section the recommended data collection is presented with a brief discussion of the value of the recommended data collection efforts. Where data are currently being collected at some springs the section is denoted with an asterisk (*). It is worth noting again that the extent of data collection varies substantially between springs and much of the data that have been collected have only been collected on a limited basis.

3.4 Physical Data

Physical data provide dimensions, structural characteristics, and measurement of physical characteristics (e.g. level and flows) for springs systems. These data are critical for evaluating WRVs in the establishment of MFLs.

3.4.1 Bathymetry*

Bathymetry of spring pools and spring runs provides data about the physical structure and configuration of the spring. Bathymetric data collection provides critical information for spring area, shape, minimum, average, and maximum depths, volume, and, in combination with flow data, nominal hydraulic residence time. This information is critical for all analyses of spring ecosystem function and important in the context of evaluating WRV 1, 2, 4, 6, 8, 9, and 10. These data are expected to be relatively stable temporally, with a recommended 5-10 year collection frequency being adequate for most systems. More frequent data collection is recommended where a significant change occurs in a spring (e.g. cave collapse, major erosion event, sediment dredging, or facility modification).

3.4.2 Water Level*

Water level data are collected at some of the springs during sampling events and continuously at other springs. These data are collected in some cases within the spring pool and/or within the spring run. Adequate information needs to be collected for a fixed reference point or benchmark, tied to a known regional datum. These data are important in the evaluation of all of the WRVs. Water level data are best collected continuously, or at least daily to capture rapidly changing hydrologic conditions. Prior to MFL development, water level data collection at the end of the run may also provide value, with additional data collection near any significant constrictions for model calibration/validation. Water level data for calibration of hydrologic modeling should be collected for a period of 1-2 years to cover a range of hydrologic conditions.

3.4.3 Flow*

Continuous flow data are collected and reported at most of the evaluated springs. A portion of the springs only have quarterly flow data. Spring flow data are important for evaluation of all of the WRVs. For systems that do not have continuous flow measurement, collection of monthly data could provide value in the development of MFLs. Springs that do not have continuous flow data should be evaluated for the potential to either add sufficient physical flow measurement, or for development of a stage-discharge relationship that can be used to estimate daily flows from daily water levels.

3.5 Water Quality Data

Water quality data are collected at most of the springs considered in this study. Data collection frequency and parameters vary between the springs.

3.5.1 Field Parameters*

These data are generally collected during all water quality sampling events at the evaluated springs, which are typically sampled monthly to quarterly. Some of the springs also include data sondes that collect these data continuously for temperature, pH, DO, and specific conductance among other parameters. These data are important in the evaluation of WRV 1, 2, 3, 4, 6, 7, 8, and 9. Collection of these data during sampling trips is likely adequate for evaluating long-term trends. However, some of these data could be valuable on a continuous basis (e.g. daily) and can be collected at a relatively low cost. This is specifically the case for temperature and specific conductance, which can provide information on the presence of dark water and backflow conditions. These sensors could be deployed at a variety of locations including the end of the run, midpoint of the run, within the spring boil, and within the spring vent at various distances from the boil to assess the extent of backflow events.

3.5.2 Nutrient Data*

These data are generally collected at most of the evaluated springs on a monthly to quarterly basis. Additionally, some of the evaluated springs include continuous collection of NO_x-N data. While quarterly data may be adequate over the longer term to track trends, more frequent data collection should occur in preparation for MFL development with at least 1-2 years of continuous NO_x-N data and at least monthly data collection for the nitrogen series, TP, and Ortho-P. In systems with a spring run these data should also be collected at the spring vent and at the end of the run. Nutrient data are important for evaluating WRV 7 and 9 and also might provide value in assessing WRV 1, 2, and 6.

3.5.3 Other Water Quality Parameters*

A variety of other water quality data are collected at some of the evaluated springs. Most of these data are collected quarterly. These data could provide information that could be used to assess some of the WRVs. Specifically, chlorophyll-a could provide information for evaluating WRV 4, 6, and 9. A small number of the evaluated springs also have continuous fDOM data that could provide information that is of value to WRV 4, 6, and 9.

For 1-2 years prior to MFL development, collection of particulate export could be of value to determine the TSS and fractionation between organic and inorganic particulates. These data should be collected quarterly and can provide value in assessing WRV 1, 4, 6, 7, 8, and 9.

3.6 Human Use Data

Human use has been assessed at a portion of the evaluated springs. These data include both park attendance and human uses, both of which are discussed below.

3.6.1 Park Attendance*

The springs that are a part of Florida State Parks all collect park attendance data. These data are typically collected daily. Additionally, Poe Spring located in an Alachua County park had some attendance data although values were sporadic and of variable quality. Where these data are available, they can be used in assessing WRV 1 and 6. At springs that do not collect user information, it is recommended that trail counters or similar equipment be deployed to determine park attendance on a continuous basis with occasional visits to validate observations.

3.6.2 Human Use*

In addition to determining park attendance, data that would be of value to assessing WRVs 1 and 6 would include detailed human use that would divide users by type of use to better understand how visitors interact with the springs. These data can be collected by an observer stationed at the spring over a period of several visits. Some methods for this type of assessment have been used in other springs (Wetland Solutions, Inc., 2010), but are labor intensive. An alternative approach for this data collection could be performed with a solar-powered security-type camera with still photos taken half-hourly to hourly. This information could be processed by reviewing the photos and categorizing users by the type of use. This would allow for easy assessment of both week and weekend days and could be used to divide uses by time of year and under variable weather and water-level conditions.

3.6.3 Visitor Surveys

To evaluate the user experience for Florida springs, a user survey could be developed with feedback solicited from park attendees. This survey could request information about people’s use types and also solicit information on their perception of the park attributes and water quality. These data could be collected continuously with feedback solicited from users on a continuous basis or less frequently (e.g. semi-annually by season). By collecting data at least annually, changing perceptions and uses could be assessed and potentially correlated to water quality, algal abundance, or other monitored attributes.

3.7 Biological Data

Biological data collection has varied substantially between the springs, with little to no data collected for most systems and only sporadic data, typically for limited parameters, in systems with data. Biological data have been collected in Florida springs for: vegetation, fish, manatees, turtles, macroinvertebrates, and general bioassessments.

3.7.1 Vegetation Data*

Vegetation data have been collected at few of the evaluated spring systems. Of the evaluated springs only Gilchrist Blue, Ichetucknee, and Poe Spring have larger data sets for vegetation. These data are generally collected at transects within the spring pool or spring run at one or more location. Data collection methods vary by spring systems, but typically include coverage by either species or vegetation type along the cross-section. These data can be important in evaluating WRV 1, 2, 4, 6, 7, and 9.

Vegetation data are critical in the development of MFLs for springs and should be collected at least semi-annually to capture seasonal changes and recreational impacts. It is recommended that these data be collected at transects, with mapping of vegetation within the spring pool and spring run to provide a more comprehensive view of the vegetative community. Based on nearly 30 years of plant community cover and species data collection by the FPS in the Ichetucknee River, recreational uses in the river have been managed to avoid significant degradation of vegetative communities.

3.7.2 Fish Data*

Limited fish data have been collected in the evaluated springs. Fish count data have been collected with slightly higher frequency in Gilchrist Blue, Ichetucknee, and Poe Spring by FSI although most data are relatively recent. Fish data are important in the evaluation of WRV 1, 2, and 6. It is recommended that fish data be collected monthly or quarterly in coordination with vegetation data collection. In addition to visual fish counts, electro-fishing may provide value for assessing fish populations in particular areas temporally.

3.7.3 Manatee Data*

Manatee data have been collected in some of the evaluated springs. However, manatee observations are generally only reported as an affirmative observation rather than as an inventory of days with and without sightings. Therefore, the count of days with observations is misleading because it provides limited understanding of the temporal extent of these observations. Manatees are a threatened species under the Endangered Species Act and are an important species that is evaluated as part of WRV 2 because of their physical size and the critical nature of warm spring water to their survival during cold periods in rivers and the Gulf of Mexico. Manatee observations have been reported primarily in Ichetucknee, Fanning, and Manatee Springs with a very small number of observations in Troy Spring. Manatee passage was the primary WRV for establishing MFLs for both Fanning and Manatee Springs. Manatee data should be collected daily with a record made of the manatee count for that day with zeros reported for days with no observations. Manatees are often transient in spring systems and observations may be challenging if only collected one time during a day. Where springs are staffed, notes should be kept when visitors report manatee observations. As an example of the challenge in collecting these data, a single manatee was observed in both Manatee Spring and in

Little Fanning Spring during site visits that were a part of this study. There were no reported observations of manatees in Little Fanning Spring.

3.7.4 Turtle Data*

Aquatic turtle data have been collected in a limited number of the evaluated springs. With the exception of Manatee Spring, Fanning Spring, Peacock Spring, and Hornsby Spring, turtle data have only been reported for a small number of sampling events. Many turtles have life history requirements that include springs (Johnston et al., 2016) and turtles should be inventoried on a quarterly basis in conjunction with visual fish counts.

3.7.5 Macroinvertebrates*

Data collection for macroinvertebrates have been limited in the evaluated springs with a small number of events for a small number of springs. Macroinvertebrates are an important part of the wildlife food chain and need to be evaluated to fully understand WRV 2. Often sampling occurs in support of MFL development, but additional sampling at least annually is likely to provide value to track long-term trends and document changes in species composition or density. More frequent sampling, at least quarterly, is recommended for at least 1-2 years prior to the development of an MFL. This sampling should also include higher elevations (shallower depths) that may receive less consistent inundation and have more relevance for MFL development.

3.7.6 Bioassessments*

A small number of bioassessments have been completed at a small number of the evaluated springs. These assessments may include stream condition index, rapid periphyton surveys, linear vegetation surveys, and habitat assessments. These data provide information about the habitat available and in some cases include macroinvertebrate data collection. Collection of these data, over time allows for evaluation of changes in spring ecosystems. Some portion of these data may be collected, in full or in part, during other sampling efforts. Collection of these data every 1-2 years can provide information on changes in springs. Quantification and identification of algae (e.g. growth habit, biomass, and ash weight) should also be included.

3.8 Other Data

A variety of other data have been collected in some of the evaluated springs. These data have included water clarity and metabolism.

3.8.1 Water Clarity Data*

A large amount of water clarity data has been collected in a portion of the evaluated springs. These are a generally daily, semi-quantitative record of the water clarity based on a visual observation and a five-level scale. This information can be used to support development of WRV 1 and 6 and is particularly applicable to RAS attributes. Water clarity is one of the most critical indicators of RAS function. Currently, these water clarity records provide one of the most comprehensive data sets for in-spring water conditions for the systems with data. These data should continue to be collected daily and all systems with staffed parks should collect these data at the spring boil and at stations along the spring run if feasible.

3.8.2 Metabolism*

Whole ecosystem metabolism (measurements of photosynthesis and respiration) is a strong indicator of overall springs' health. Corrected for changes in incoming PAR, photosynthetic efficiency is an excellent method for understanding the basis of the springs' food web. Most springs can be monitored for ecosystem metabolism by routine (monthly to quarterly) deployment of just one in-situ data sonde and light sensors. For spring runs, two sondes may be necessary to fractionate productivity in the spring pool and the downstream run.

Metabolism data collection and calculation has been completed for the Ichetucknee, Fanning, Gilchrist Blue, and Poe Springs by WSI, UF, and FSI. Metabolism has been considered in development of some of the MFLs, but further development of the relationship between metabolism and WRVs is needed. Metabolism data are important for evaluation of WRVs 2 and 7 and possibly for evaluation of WRVs 1 and 6.

3.8.3 Light Attenuation*

Light attenuation is a measure of the loss of light available in a specific wavelength range (e.g. photosynthetically active radiation) with depth (Munch et al., 2006; Wetland Solutions, Inc., 2010). Typically, a spring with clear water will have lower light attenuation and higher light transmittance (the percentage of light available at one meter of depth). Water clarity in springs is reduced by both dissolved and particulate substances. These data can be collected continuously by deploying two light sensors, one above water and one at a depth of one meter (or another depth). Bio-fouling can be an issue in the collection of these data and equipment will require maintenance to ensure accurate data collection. These data should be collected continuously by deploying a system with an automated wiper and a data logger. If properly maintained these data can provide a quantitative surrogate to the visual water clarity score previously described. These data are of value in assessing WRVs 1 and 6 and could also provide value in assessing WRVs 4, 8, and 9. These data can provide information on dark-water conditions in the spring and can likely be used to evaluate clear versus tannin-stained water following river intrusion events to quantify the extent of intrusion.

Section 4.0 Recreation, Aesthetic, and Scenic Attribute Metrics

The SRWMD is tasked with evaluating Minimum Flows and Minimum Levels (MFLs) for springs and rivers within their jurisdiction. This includes determining whether each of the ten Water Resource Values (WRVs) is applicable in the waterbody and if methods and data exist to establish a MFL for the WRV. Specifically, ***WRV 1 – Recreation In and On the Water*** and ***WRV 6 – Aesthetic and Scenic Attributes*** are the focus of this evaluation and are lumped together under the title of Recreation, Aesthetic, and Scenic (RAS) attributes. Previous springs' MFLs have generally been limited to considering these RAS WRVs in a fairly narrow context, based primarily on passage depth for watercraft or tubers within a spring run.

This section presents a variety of quantitative and qualitative metrics that can be assessed to support MFL development based on these RAS WRVs. These proposed RAS metrics can be divided into two categories, ***Attributes*** and ***Drivers***. *Attributes* refer specifically to the human uses of the specific spring ecosystem. *Drivers* refer to the physical and biological characteristics that influence human use and include: spring basin size, depth, and bathymetry; groundwater discharge and velocities; plant community composition; and wildlife utilization. As "beauty is in the eye of the beholder", aesthetic attributes are specific to individual humans' experiences and cannot be assessed *a priori*. Rather, RAS *Attributes* can be quantified best by quantifying overall human use of the spring resource as well as quantifying user experience with visitor satisfaction surveys.

4.1 Metrics for Assessment of Recreation, Aesthetic, and Scenic Attributes

RAS *attributes* are a function of human use and human perception of the condition of a spring. A variety of metrics exist for evaluating the amount of human use that occurs at springs. This section discusses metrics and standard operating procedures (SOPs) that can be used to collect data specific to RAS *attributes*.

4.1.1 Park Attendance

Park attendance data provide the coarsest measure of human use in springs parks. These data are typically collected daily and are a count of all visitors that enter the park. This information is currently collected at all of the Florida State Parks and a portion of the other local parks that have springs. For all of the springs in this study, with the exception of Hornsby Spring, the spring is the primary attraction, with varying degrees of upland land uses also available at some parks. It is important to note that park attendance may be constrained by park capacity, often defined in the management plans, and commonly associated with parking/camping limitations. Park attendance data in isolation are somewhat limited in value because specific uses cannot be quantified. However, when combined with detailed human use data, park attendance can be used to estimate percentage of use by type and total use by type.

A variety of methods exist to collect these data including: staffed counts at a ticketing booth, honor box counts, wheel counters, and trail counters (Muhar et al., 2002). Each of these methods has benefits and disadvantages. Staffed counts provide the best and most reliable data but are labor intensive. Each of the other methods should have occasional direct counts to validate and verify assumed metrics of percentage of vehicles paying, persons per vehicle, or trail counts per person every one to two years. Verification of park entrance data have been shown to be critical to accurately estimating attendance based on count methods (Kaczynski & Crompton, 2003). Park attendance should be collected daily and is critical for analysis of human uses under both WRV 1 and WRV 6, relative to other springs data such as water level, flow, water quality, vegetation, and wildlife. An example of monthly park attendance data from Manatee Springs State Park is shown in Figure 39.

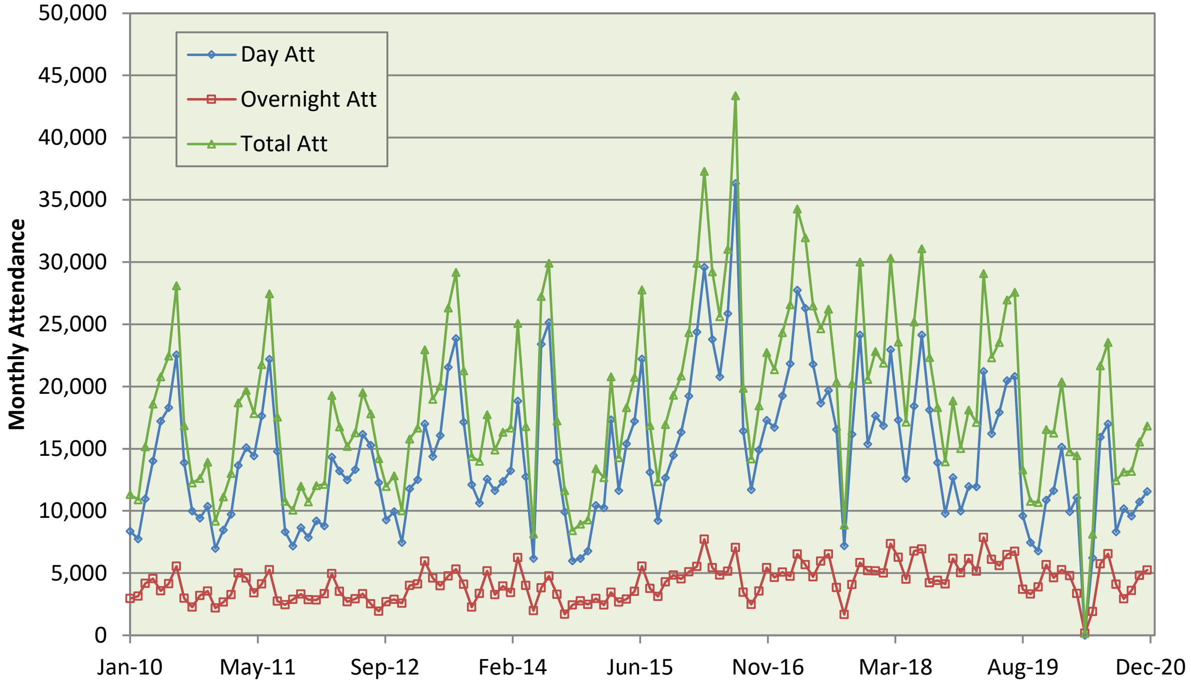


Figure 39. Manatee Springs State Park Attendance (source FPS 2010-2020)

4.1.2 Human Use

Human use data provide a detailed accounting of how users interact with a spring. These data provide detailed insight on human uses under both WRV 1 and WRV 6 separately. These data are collected based on visual observation with categorization of users into groups by use type (Wetland Solutions, Inc., 2006b, 2007, 2010). Use types applicable to WRV 1 include: wading (less than waist deep), bathing (greater than waist deep, but less than neck deep), swimming, snorkeling, scuba/cave diving, tubing, paddle craft, motorboats, tour boats, and fishing. Use types applicable to WRV 6 include: nature viewing, sunbathing, sitting, and walking. There further exists the potential for overlap of uses within WRV 1 and WRV 6 including nature viewing from a watercraft, this use requires both adequate passage depth and desirable aesthetic attributes. These uses are visually quantified on a fixed interval such as every 15 minutes or every hour. Data are then converted into person-hours of use by type. An example of human use data collected for Wekiwa Springs are shown in Figure 40.

These data can also be collected automatically by using picture or video capture on a specified interval, such as 15 minutes to an hour. Similar continuous video camera sampling methods have been used at Weeki Wachee Springs to document human use over two-week intervals (Wood, 2020). Data processing may be labor intensive, therefore the recommended sampling interval is quarterly to semi-annually, although sampling should be completed for no less than one weekday and one weekend day during each sampling event under representative weather conditions. A proposed SOP for human use data collection is presented below. Also presented in the SOP is a video/picture collection system that would allow for office analysis and reduced field effort.

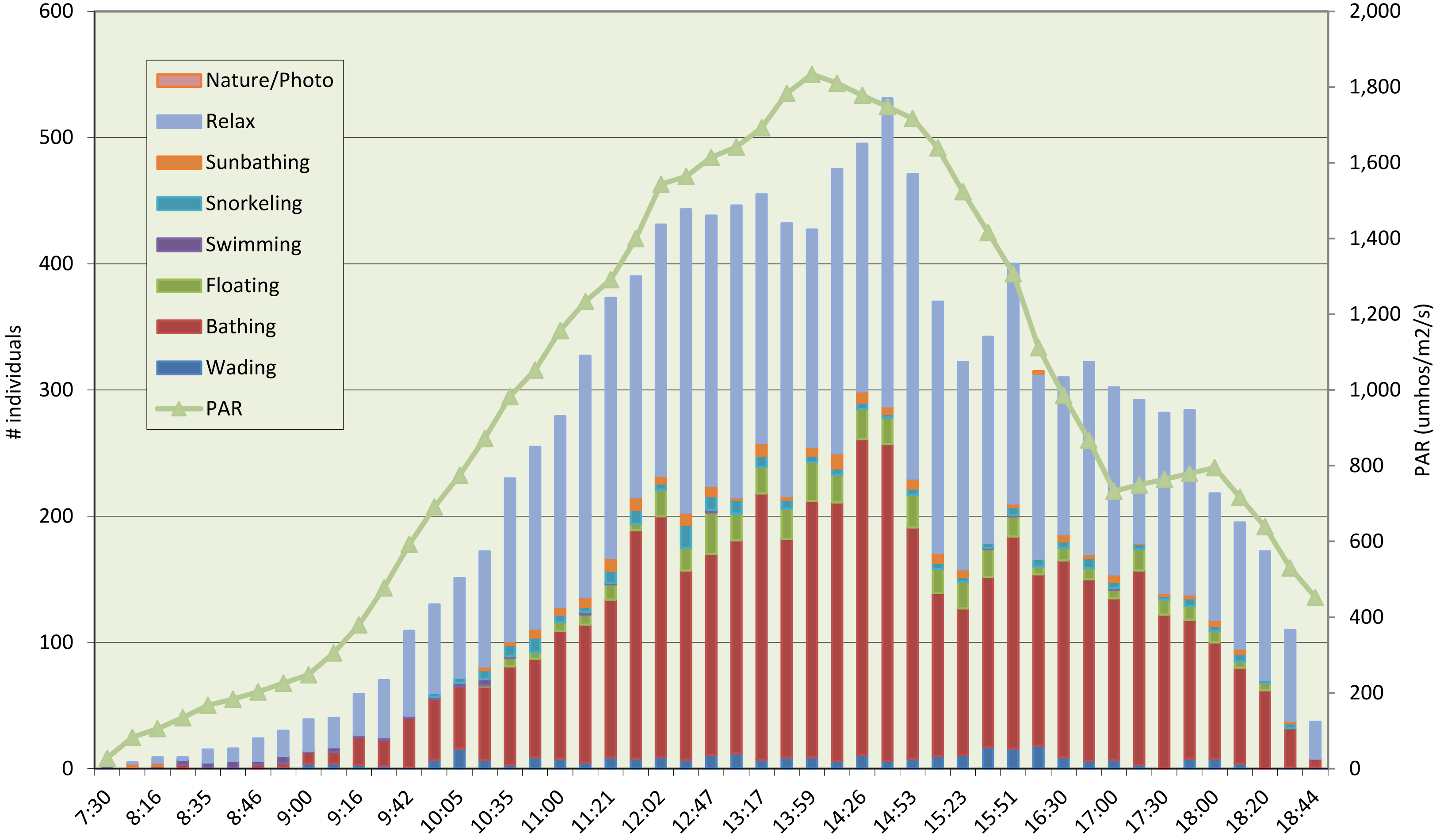


Figure 40. Example Human Use Data (Wetland Solutions, Inc., 2007)

4.1.2.1 Standard Operating Procedure- Human Use Activity

4.1.2.1.1 *Purpose*

The purpose of this SOP is to document methods for characterizing human use activity in and around spring pools and run. This SOP was developed for data to be collected by an observer stationed at a spring over a period of several visits. An alternative approach to reduce labor costs could be the installation of a camera(s) to collect still photos or video at fixed intervals and post-processing images using the methods outlined below.

4.1.2.1.2 *Materials*

- Human use activity survey field sheet (example below)
- Binoculars
- Tally counter (optional)
- Camera (optional; a solar-powered, security-type camera could be used for long-term monitoring)

4.1.2.1.3 *Procedure*

- Identify and document the survey area including the spring pool, spring run, and surrounding upland areas, if applicable.
- Count all persons within the survey area at fixed intervals (typically 15-minute intervals) for each of the activity categories defined below. Document the start and end time for each survey. Observations are generally made during the hours the park is open for springs-related activities. An example count form is shown in Table 24.
- Primary water contact activities include:
    - wading (less than waist deep),
    - bathing (greater than waist deep and less than neck deep),
    - swimming,
    - snorkeling,
    - SCUBA diving,
    - tubing,
    - paddle craft,
    - power boating,
    - tour boating, and
    - fishing.
- Primary out-of-water activities include:
    - sitting,
    - walking,

  - sunbathing, and
  - nature study.
- Individual counts are multiplied by survey interval (i.e., 0.25 hours [15 minutes]) to estimate the average person-hours for each activity throughout the period of observation.
- The total human-use during a one-day period is reported in units of person-hours as follows:

$$\sum_{t1}^{t2} no.persons.dt = \text{person-hours} \qquad \text{[Equation 1]}$$

where:

dt = survey interval (hours)

t_1 = time (start)

t_2 = time (finish)

- These person-hour estimates are in turn divided by the observation interval in hours to estimate an average number of persons involved in in-water and out-of-water activities for each day of observation.
- Areas within the zone of observation are estimated from maps and aerial photographs to normalize data on a per-area basis:

Human-Use Density = no. persons/area counted [Equation 2]

- Percentage use by type can be evaluated to determine dominate use types during various seasons or weather conditions:

% Use by Type = persons-hours by use type/daily person-hours [Equation 3]

Table 24. Human Use Activity Survey

HUMAN USE ACTIVITY SURVEY

Site ____________ **Date** ____________ **Start Time** ________ **End Time** ________ **Observer** ____________

	Numbers of People															
	In Water Activity											Out of Water Activity				
Time	Wading	Bathing	Swimming	Snorkeling	SCUBA	Tubing	Paddle Craft	Power Boating	Tour Boating	Fishing	Other	Sitting	Walking	Sunbathing	Nature Study	Other
8:00																
8:15																
8:30																
8:45																
9:00																
9:15																
9:30																
9:45																
10:00																
10:15																
10:30																
10:45																
11:00																
11:15																
11:30																
11:45																
12:00																
12:15																
12:30																
12:45																
13:00																
13:15																
13:30																
13:45																
14:00																
14:15																
14:30																
14:45																
15:00																
15:15																
15:30																
15:45																
16:00																
16:15																
16:30																
16:45																
17:00																
17:15																
17:30																
17:45																
18:00																
Note(s):																

4.1.3 Visitor Surveys

Visitor satisfaction surveys provide a method for quantifying visitor perception of spring systems relative to both WRV 1 and WRV 6. Collection of accurate data that are meaningful over a longer period of time requires development of questions and a survey structure that is generally applicable, while soliciting meaningful responses. A survey should be developed that assesses both self-reported human uses and visitor perception/satisfaction with the spring. Visitor surveys should be collected both continuously through an online survey, with more detailed surveys collected in-person at least semi-annually during different seasons. Survey data collected over time can be related to other quantifiable data including human use, water level, flow, water quality, vegetation, and wildlife. An example survey for this data collection is presented in Table 25, which was developed with consideration of surveys used in other springs projects (Florida Department of Environmental Protection, 2017a; Wetland Solutions, Inc., 2009; Wood Environment and Infrastructure Solutions, Inc., 2020).

Surveys can also be used to directly correlate aesthetics to more quantifiable metrics for springs including water quality, vegetation, and light attenuation. This correlation can be developed through a one-time or occasional survey of public perception and various attributes/drivers. A sample population can be presented pictures from various springs, taken in a uniform manner, that portray a variety of light attenuation conditions resulting from higher turbidity, higher chlorophyll concentrations, or higher tannic water content and be asked to rank the photos on a defined scale. By collecting data from a representative sample of users these data can be used to assign preference levels to measured light attenuation values and define a maximum allowable light attenuation threshold for significant harm relative to WRV 6. Similar methods could be applied for vegetation to define a maximum acceptable algal cover for example. This method was not developed further as part of this study but would warrant consideration as part of MFL development.

Table 25. Example Spring Visitor Survey

Q01 Date: ____________________

Q02 City: ____________________

Q03 County: ____________________ State: __________

Q04 Country: ____________________ Zip Code: __________

Q05 Why did you choose to visit a spring today?

____

Q06 How many people are in your travel party? __________

Q07 Is this your first visit to a spring in Florida? Y N

Q08 Is this your first visit to this spring? Y N

Q09 If Yes, how did you hear about this spring?

____

Q10 Will you come back in the near future? Y N

Q11 If Yes, Within the next 6 months? Y N Undecided
Within the next year? Y N Undecided
Within the next two years? Y N Undecided

Q12 What was your primary reason for visiting the spring?

1 = Wildlife viewing, nature study, photography
2 = Swimming, bathing, floating, snorkeling, tubing, wading
3 = Canoeing, kayaking
4 = Scuba diving
5 = Sight-seeing, sunbathing, picnicking, strolling
6 = Fishing

Q13 Check all of the following activities you participated in during this trip

1 = Wildlife viewing, nature study, photography
2 = Swimming, bathing, floating, snorkeling, tubing, wading
3 = Canoeing, kayaking
4 = Scuba diving
5 = Sight-seeing, sunbathing, picnicking, strolling
6 = Fishing

Q14 Please rate your visit to this spring:

Poor 1 2 3 4 5 6 Excellent

Q15 Please rate the water quality (clarity) during your visit:

Poor 1 2 3 4 5 6 Excellent

Q16 Please rate the water depth during your visit:

Poor 1 2 3 4 5 6 Excellent

Q17 Please rate the flow during your visit:

Poor 1 2 3 4 5 6 Excellent

4.2 Metrics for Assessment of Recreation, Aesthetic, and Scenic Drivers

RAS *drivers* are influenced by a variety of existing physical and biological conditions within a spring that are a function of the physical configuration, water quality, flow, water levels, vegetative community, and wildlife use. Proposed metrics for these RAS *drivers* are discussed in the following sections with recommendations for data collection methods and data collection frequency.

4.2.1 Bathymetry

Bathymetric mapping provides a three-dimensional understanding of a spring's configuration. These data can be evaluated in conjunction with level data and flow data to provide a variety of spring characteristics including the range of depths, average depth, volume, and when combined with flow, residence time of the spring pool and/or run. These data can also be used to develop a stage-area relationship for a spring pool which provides information about the portion of a spring's area that is available at various depths. These data can be collected by a variety of methods. Bathymetric data can be collected with a high-degree of accuracy using echo sounding equipment in conjunction with global positioning system or survey data (Bodine, 2021; Kasvi et al., 2019; Landsfeld & Jones, 2013; Wernly et al., 2016). Data can be post-processed using geographic information system software to provide a map of the physical layout of the spring and spring run with associated depths. Other alternatives include physical survey using traditional survey methods, or water depth measurements on a defined grid with adjustment based on a surveyed benchmark (such as a staff gauge). An example of manually-collected bathymetric data for Ginnie Springs is shown in Figure 41.

Bathymetry is expected to be stable in most spring systems with data collection only required every 5-10 years. More frequent mapping may be required in the event of a major physical change such as: a cave collapse, major erosion event, major flooding event (sediment deposition), facility modification, or sediment dredging.

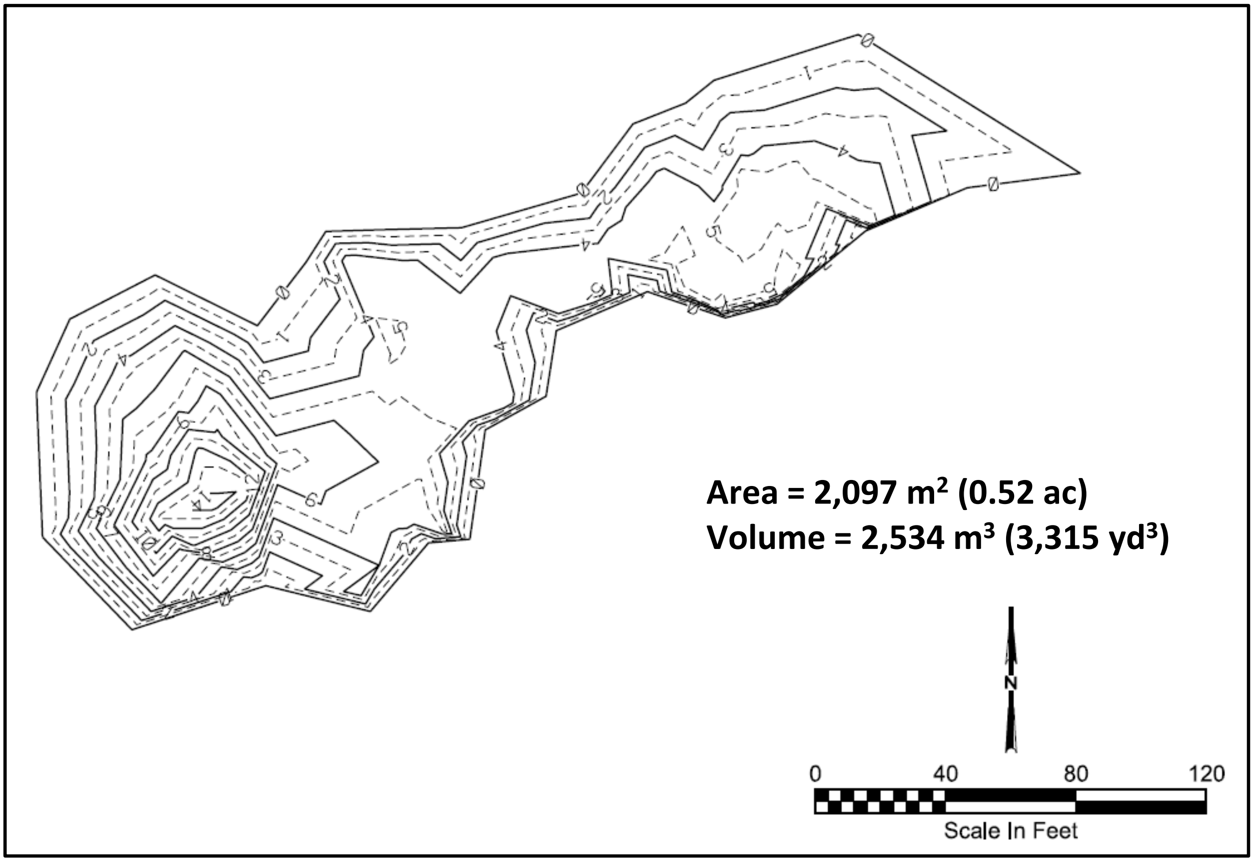


Figure 41. Bathymetric Map of Ginnie Springs (Wetland Solutions, Inc., 2013)

4.2.2 Water Level

Water level data provide information critical to evaluation of WRV 1 and WRV 6. During low water periods, access may be limited in some portions of springs or spring runs due to physical limitations (e.g. depth of a tuber over SAV or motorboat passage over a rock outcropping). While these have been the typical metrics, swimming is expected to require the greatest depth to avoid disturbance to the substrate and/or vegetation. The estimated required depth for swimming while avoiding impacts is approximately 3 feet above the substrate or vegetation with periodic depths of greater than six feet to allow for treading water (HSW Engineering, Inc., 2009). Paddle craft have been evaluated based on required depths from 0.5-1.5 feet, motorboats based on required depths of 2-2.5 feet, and tubers have been considered as requiring 1.05 feet with these depths taken as over either substrate or SAV depending on the MFL. Required depths for these uses are expected to be shallower than depths required for swimming without impacting SAV or making contact with the substrate.

Water levels can have an impact on the aesthetics of a spring system with a full spring pool presenting a visually appealing natural condition. Water depth also impacts wildlife access (e.g. manatees) which supports nature viewing. In systems that experience backflow conditions, it may be the case that adverse impacts occur to spring aesthetics during flooding events and associated dark water events. Water level should be collected at least hourly at a gaging station located in the spring boil. In systems that experience significant backflow, or with longer spring runs, one or more additional water level monitoring stations should be installed within the runs; these data can be used to calibrate hydraulic models and understand the mechanisms and severity of backflow events.

4.2.3 Flow

Flow data, like level data are a critical component of developing MFLs. Flow is also important to both WRV 1 and WRV 6 because of the flushing it provides in the spring pool and run and the aesthetic and scenic attributes it offers to observers. For example, during the March 2021 site visit, the combination of flow and level at Columbia Spring, provided a unique and appealing soundscape as flows rush down the run and into the Santa Fe River.

Flow data can be collected manually or can be estimated through a combination of manual readings and rating curves based on level readings. Some continuous flow stations also incorporate acoustic doppler meters that directly measure velocities in the channel. Data should be collected at least hourly where continuous monitoring can be developed, or at least monthly where only manual measurements can be taken.

4.2.4 Water Clarity and Light Attenuation

Water clarity and light attenuation data represent a semi-quantitative and a quantitative method, respectively for evaluating the transparency of a spring system. Water clarity data have been collected in a portion of the evaluated springs and are a semi-quantitative visual measure of how “clear” the water appears. Collected water clarity data were based on the five-point scale shown below.

- Clarity Level A - clear water with excellent clarity
- Clarity Level B – green tinted water with good clarity
- Clarity Level C - tannic river water covering the entire spring area with secchi disc readings of 4.1’ or more
- Clarity Level D - tannic river water covering the entire spring area with secchi disc readings of 4’ or less
- Clarity Level E - tannic river water entering spring (“flow reversal”) and secchi disc readings of 4’ or less

These data are observed to be semi-quantitative based on the use of a secchi disc for Clarity Levels C, D, and E, while Clarity Levels A and B allow some subjectivity. However, these data, collected by FPS, provide the best long-term dataset for the transparency of the monitored springs (Table 20) and monitoring should continue on a daily basis. Water clarity within and between Clarity Level A and B could be further quantified by the collection of horizontal secchi data during times when these conditions exist.

Light attenuation is a measure of the loss of light within a specific wavelength range with depth. The wavelength range often used in springs is photosynthetically active radiation (PAR) with a wavelength from 400 to 700 nanometers. This is the wavelength range that is generally available to plants. Clearer waters with lower concentrations of turbidity have less light attenuation and higher light transmittance. Light measurements are collected using an above-water quantum sensor and an underwater quantum sensor. For manual measurements, the underwater sensor is installed to a weighted frame and readings collected every 0.5 to one-foot depth intervals. Light attenuation is then calculated based on the above-water readings, underwater readings, and the sensor depths.

Continuous collection of light attenuation data can be completed within a spring system by installing an above-water and underwater sensor with data logging capabilities. The underwater sensor should be installed at a fixed depth on a float system (to avoid changing depths over the deployment) or installed at a stationary level (with depths estimated from monitored water level data). Extended installation of an underwater sensor will also require a wiper setup to avoid bio-fouling during deployment. Extended light data should be collected at least hourly with manual readings collected monthly to verify continuous light attenuation estimates. An example of continuous light measurements (15-min) and calculated light attenuation estimates for Jackson Blue Spring are presented in Figure 42.

A SOP has been developed for light attenuation data collection by FDEP and is a part of FT 1700: *Field Measurement of Light Penetration*. A specific SOP does not exist for long-term deployment of sensors, but some mention of long-term deployment is discussed in FT 1000: *General Field Testing and Measurement* that discusses calibration requirements. A SOP for field data collection is presented in the subsequent section.

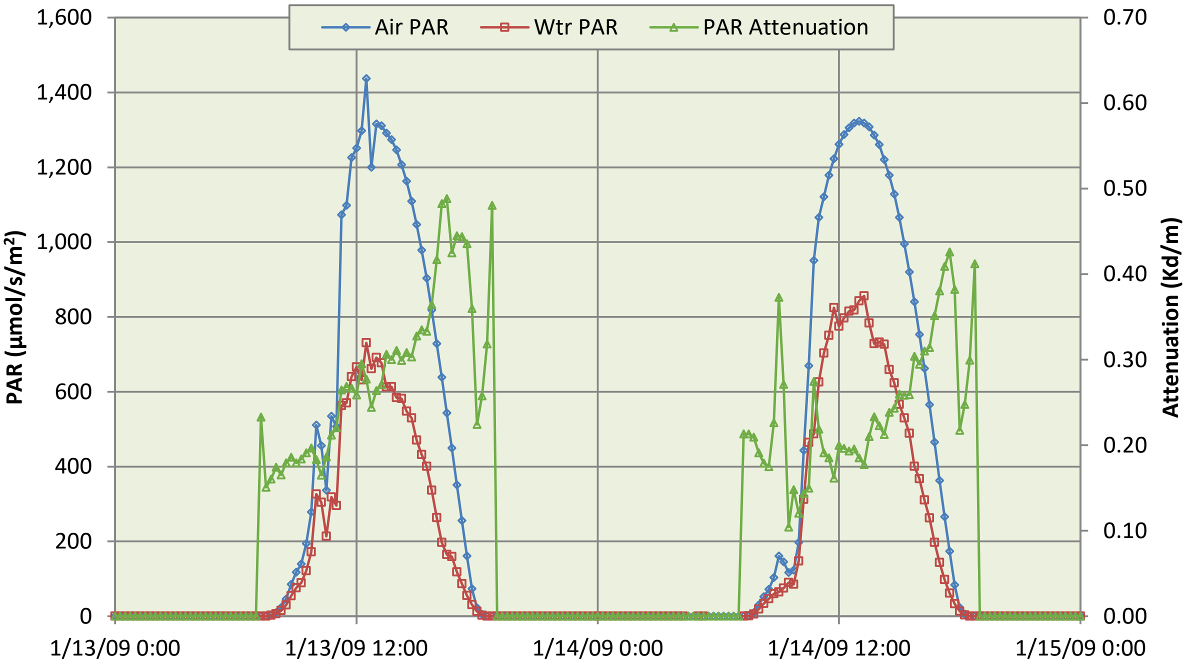


Figure 42. Continuous Light Attenuation at Jackson Blue Spring (Wetland Solutions, Inc., 2010)

4.2.4.1 Standard Operating Procedure – Light Attenuation

4.2.4.1.1 Purpose

The purpose of this SOP is to document field measurement of light penetration using Li-COR photosynthetically active radiation (PAR) sensors (wavelength range: 400-700 nm) [modified from DEP-SOP-001/01 FT 1700].

4.2.4.1.2 Materials

- LI-1500 Light Meter (or equivalent)
- LI-COR LI-190R Quantum Sensor (terrestrial) and LI-192SA Underwater Quantum Sensor (or equivalent)
- Lowering frame for underwater quantum sensor (LI-192SA)
- Mounting and leveling fixture for the above-water (terrestrial) quantum sensor (LI-190R)

The LI-1500 Light Sensor Logger provides a direct digital readout and data logging from up to three LI-COR sensors at the same time. Log manually or set up single, daily, or continual logging routines. Take advantage of the intuitive, menu-driven interface, optional GPS system, high frequency measurements up to 500 Hz, and built-in math functions.

Figure 43. Light Attenuation Field Equipment Examples (Source: LiCor.com)

4.2.4.1.3 Calibration

- Calibrate light meter following manufactures instructions (if required).
- Light sensors should be calibrated as recommend by the manufacture (e.g. every 2 years) or more frequently depending on site conditions

4.2.4.1.4 Procedure

- Field readings should be collected in an area with minimal shade.
- Lower the frame assembly with LI-192SA into the water without putting the weight on the light sensor cable. Use and independent rope, cable, or measuring tape to support the weight of the frame.
- Take readings just above the surface, just below the surface, and at 0.5 to 1-foot depth increments.
- Read both the underwater quantum sensor (LI-192SA) and the above water (terrestrial) quantum sensor (LI-190R) at each depth, following at least a ten second stabilization period.
- Begin raising the sensor when the light intensity measured by the underwater quantum sensor (LI-192SA) drops to less than 1% of the above water (terrestrial) quantum sensor (LI-190R) (or once the sensor reaches the bottom) and repeat each measurement at the previous depth locations.

4.2.4.1.5 Calculations

- Light extinction (attenuation) coefficients are calculated from these data using the Lambert-Beer equation (Wetzel, 2001):

$I_z = I_o(e\text{-}kz)$ [Equation 4]

where:

I_z = PAR at depth z

I_o = PAR at the water surface

k = diffuse attenuation coefficient, m^{-1}

z = water depth, m

4.2.5 Wildlife Use

A major attraction of springs to users is the ability to clearly see underwater and observe wildlife in their natural environment. This continues to be a major draw for visitors to springs. Specifically in springs that support manatees, visitor attendance tends to increase when manatees begin using the spring as a thermal refuge during winter periods (Wetland Solutions, Inc., 2006b). An example of seasonal manatee presence and human use at Volusia Blue Springs State Park is shown in Figure 44.

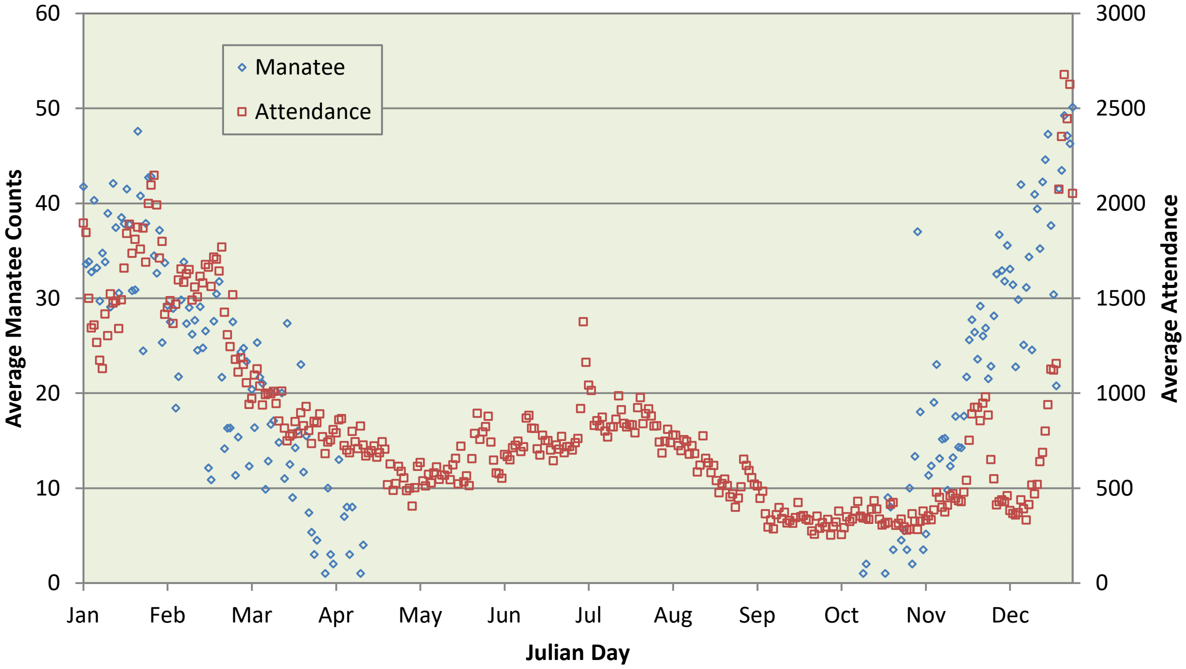


Figure 44. Volusia Blue Spring Seasonal Manatee Counts (1979-2005) and Human Use (1990-2005)

Manatee and fish counts have been completed in some portion of the springs in this study (Table 20) although data collection is of variable frequency. It is recommended that manatee counts be made daily in springs that support manatees and fish counts be completed in combination with vegetation surveys (monthly to quarterly). An example manatee count field sheet is provided in Table 26 for Manatee Springs. Several methods exist to collect fish data including visual counts by swimmers, seine counts, or underwater video surveys. Underwater video surveys have been shown to produce results that are as good, or better than, seine samples based on relatively short deployments (Work & Jennings, 2019). In addition to visual fish counts, annual electro-fishing surveys may provide another tool to evaluate species composition in specific areas.

Table 26. Proposed Example Manatee Count Field Sheet for Manatee Springs

	Time		Zone					
Date	Start	End	1	2	3	4	5	6
10/1/2021								
10/2/2021								
10/3/2021								
10/4/2021								
10/5/2021								
10/6/2021								
10/7/2021								
10/8/2021								
10/9/2021								
10/10/2021								
10/11/2021								
10/12/2021								
10/13/2021								
10/14/2021								
10/15/2021								
10/16/2021								
10/17/2021								
10/18/2021								
10/19/2021								
10/20/2021								
10/21/2021								
10/22/2021								
10/23/2021								
10/24/2021								
10/25/2021								
10/26/2021								
10/27/2021								
10/28/2021								
10/29/2021								
10/30/2021								
10/31/2021								

4.2.6 Vegetation

The coverage and community composition of vegetation in springs can have an impact on both WRV 1 and WRV 6 uses. With regard to recreation within WRV 1, the presence of large stands of SAV or algae may detract from the user experience with users feeling claustrophobic or apprehensive if they are unable to stay out of the vegetation. However, in many springs an absence of SAV may lead to a higher cover by less desirable filamentous algae, which has reduced nutrition and habitat value and can cause skin irritation and other allergic reactions depending on the species of algae. As part of WRV 6 attributes, it is expected that users would prefer a more natural aesthetic with a mix of desirable and native SAV species that support diverse wildlife and make the spring appear to be healthy and thriving. As with WRV 1, cover by filamentous algae is expected to diminish the user perception of the system.

Two primary methods are available for assessing aquatic vegetation (macroalgae and SAV), as well as substrates (detritus and bare ground) within spring systems. The first of these is establishment of monitoring line-intercept transects, generally oriented perpendicular to flow from the water's edge (Brower et al., 1998). A tape measure is stretched along a transect and all aquatic plants intercepting the vertical plane of the line are recorded. All observed plants should be identified to species or lowest possible taxonomic classification. This method is used to estimate percent cover and is particularly applicable for spring runs where vegetation can be tracked at multiple locations and document changes in vegetation communities over time. Aquatic vegetation transect data have been collected for a number of the springs in this study with a particularly exceptional long-term data set for the Ichetucknee River. The Ichetucknee River aquatic vegetation cover data measurements have been used to guide recreation on the river for decades.

Within a spring pool, line-intercept transects alone may not offer the best estimate of aquatic vegetation coverage. Due to the limited spring pool areas, mapping of vegetation communities and substrates within the spring pool will often provide better coverage estimates. This effort can be completed by a visual in-water survey of vegetation communities within the spring pool on an aerial photograph or general field sketch. Example spring mapping efforts are shown for Fanning Springs (Figure 45) and for Madison Blue Springs (Figure 46). Similar efforts have also been completed for the Rainbow River (Atkins North America, Inc & Debra Childs Woithe, Inc., 2012). It is recommended that vegetative mapping be completed at least twice annually to capture the vegetative community prior to the main in-water recreational period beginning (early spring) and near the end of the in-water recreational period (late summer). A SOP for vegetative mapping within spring pools is presented in the following section.

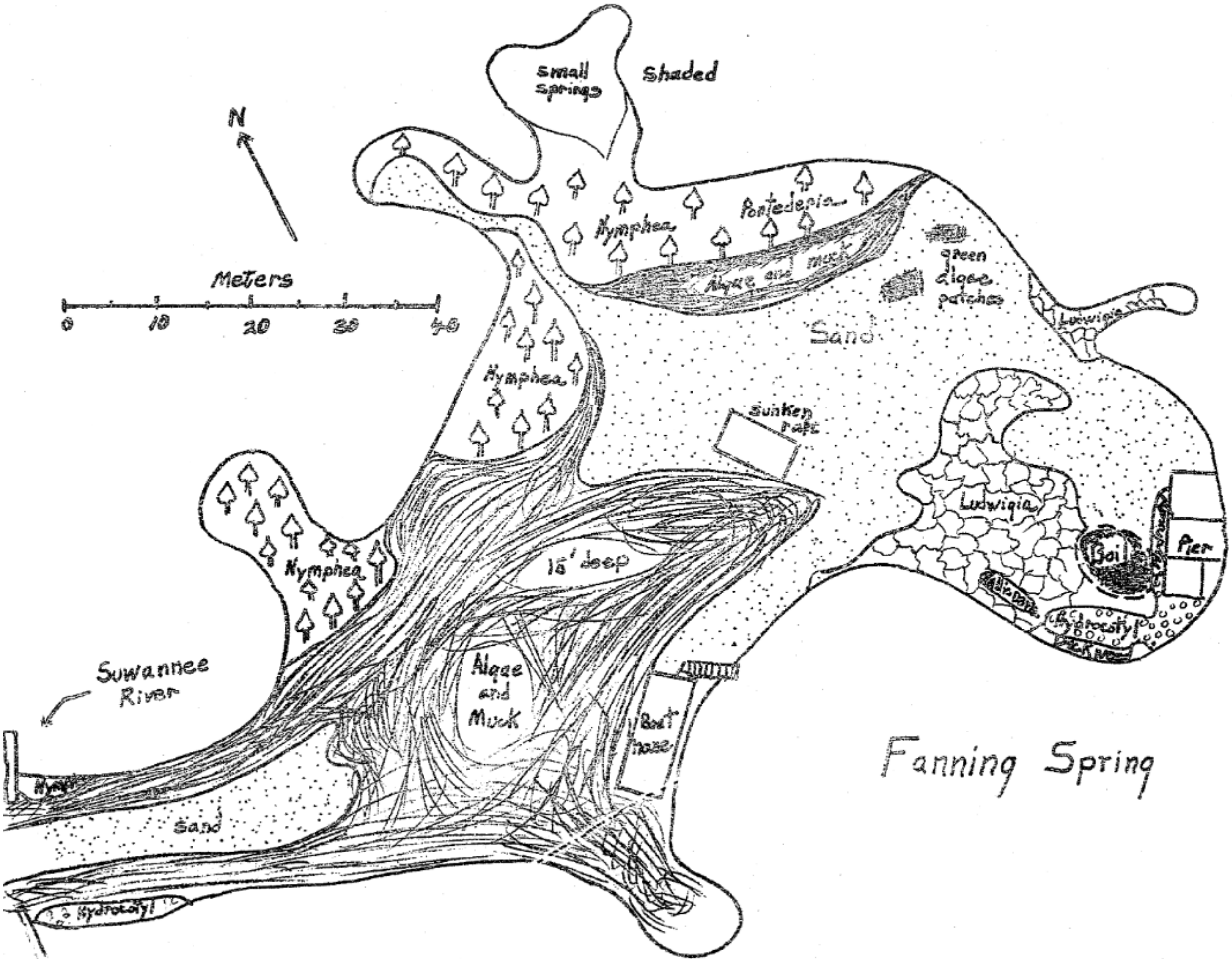


Figure 45. Fanning Springs Vegetation Map (Odum, Howard T., 1953)

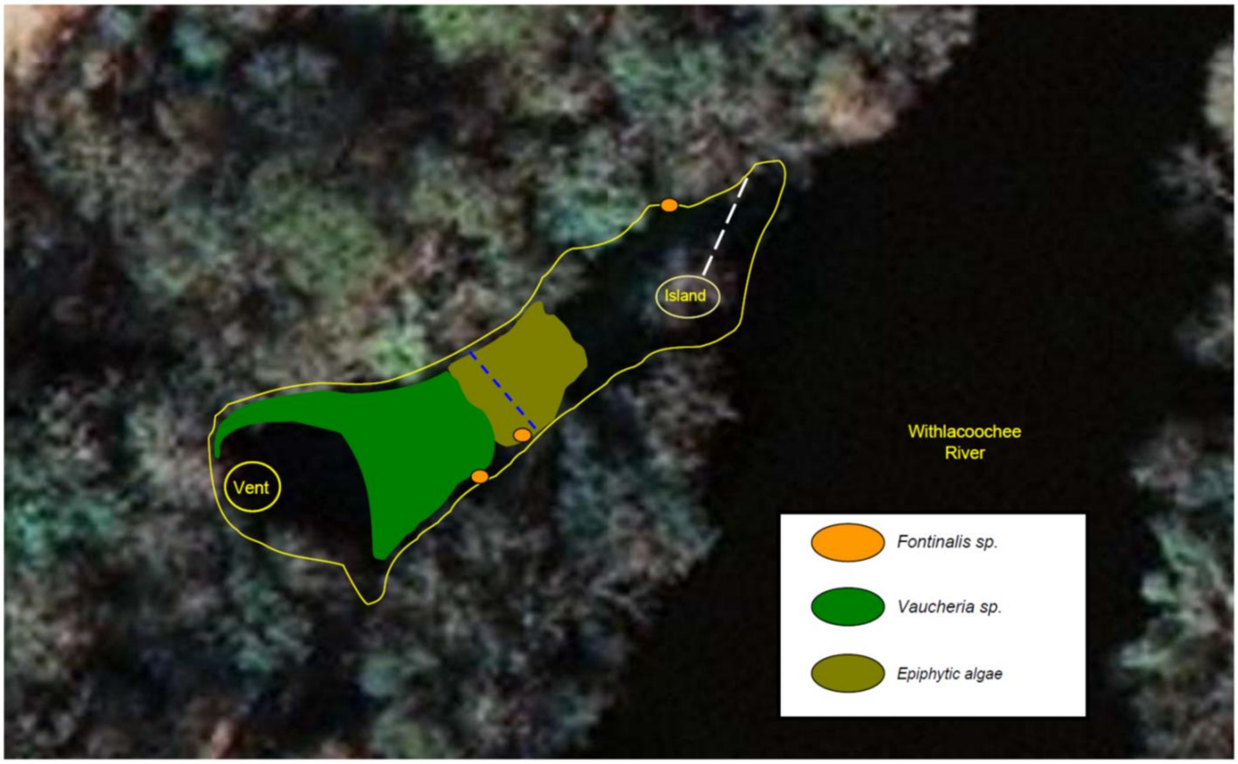


Figure 46. Madison Blue Springs Vegetation Map (Wetland Solutions, Inc., 2010)

4.2.6.1 Standard Operating Procedure – Vegetation Mapping

4.2.6.1.1 Purpose

The purpose of this SOP is to collect vegetative community characterization data that can aid in the documentation of potentially changing aquatic plant communities over time and assist in the interpretation of various biological community, human use, and water quality results. This SOP applies to plant community sampling in spring pool and run systems.

4.2.6.1.2 Materials

- Tape measure
- GPS device
- Aerial photography, if needed
- Camera

4.2.6.1.3 Procedure

- Identify the survey area and produce a general sketch of the outline of the area with the aid of an aerial photograph if needed. The survey area can be subdivided into smaller sections if necessary.
- Document aquatic vegetative cover by functional group (floating aquatic, submersed aquatic, emergent, or benthic algae) within each area at multiple sampling points. Depending on the size of the study area, locations can be defined using GPS (larger

systems) or with a subdivided grid (smaller systems). The overall survey area will typically have between 50 and 100 points, but this will be dependent on the area and aquatic vegetation diversity.

- Line-intercept transects can also be used within the spring pool and run to assist with vegetation mapping (Brower et al., 1998). These transects can be conducted from fixed start/end points and can be easily replicated for long term monitoring
- Identify the dominant plants to species or lowest possible taxonomy within each functional group.
- Estimate the canopy cover along the periphery of the survey area. This will be estimated from the edge of the bank to where the shading vegetation ends over the water surface. A convex, spherical densiometer or tape measure can be used to improve estimates of the shading width if needed.

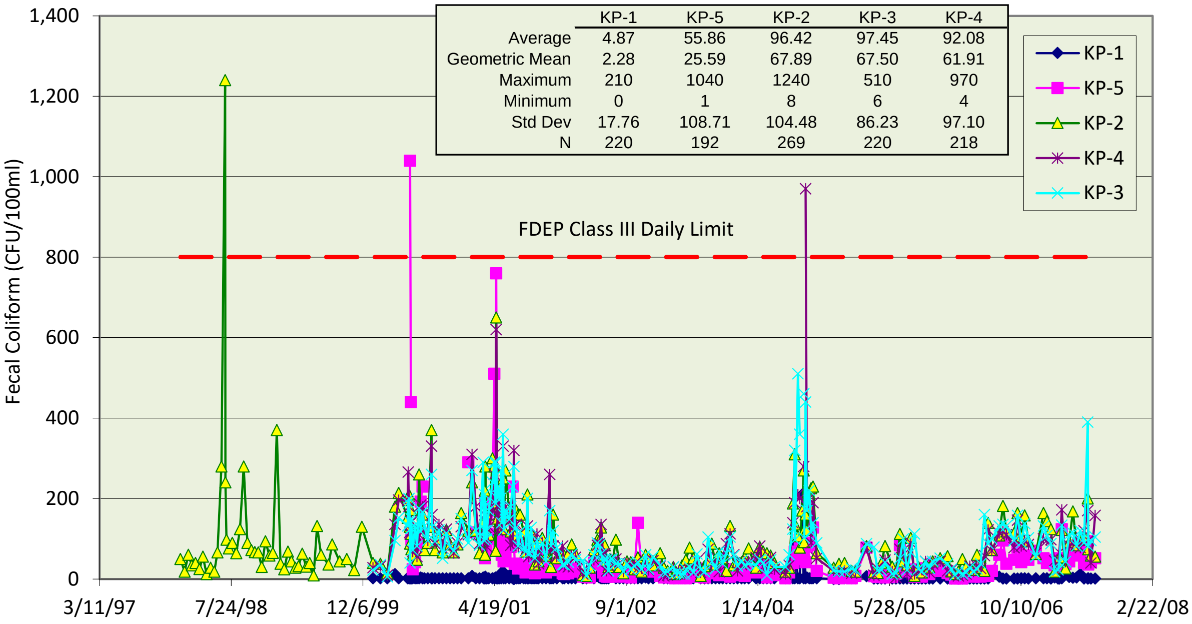
4.2.7 Water Quality

Water quality can play an important role relative to RAS attributes in spring systems and is critical for evaluation of other WRVs including 2, 3, 4, 7, 8, and 9. However, developing specific thresholds for each of a large number of parameters may prove challenging under WRV 1 or 6 due to a lack of data and specific relationships between individual parameters and flows/levels, while not necessarily capturing the effect of the parameter on human use. As an example, both in-water and out-of-water users are expected to be sensitive to light attenuation and water clarity, however this can be impacted by turbidity, algae (chlorophyll), and the presence of tannic water. From the user perspective the reason for reduced clarity is not as important as the fact that there is reduced clarity. For this reason, other metrics, such as light attenuation are expected to offer better measures of the characteristics that are of interest to users under WRV 1 and 6. These data are also more cost-effectively captured on a continuous basis than detailed water quality parameters.

Despite users likely not responding directly to many water quality parameters, there are a smaller number of parameters that are of particular importance to allowing for safe human use of spring systems. These include bacteria and pathogens that could cause sickness for in-water users. Sampling is often completed for systems that might have impairment for bacteria with sampling for total and fecal coliform. Some springs have been temporarily or permanently closed to in-water recreation due to bacterial contamination (Mace, 2017; Wetland Solutions, Inc., 2007). An example of bacterial counts at Kelly Park on Rock Springs Run is shown in Figure 47.

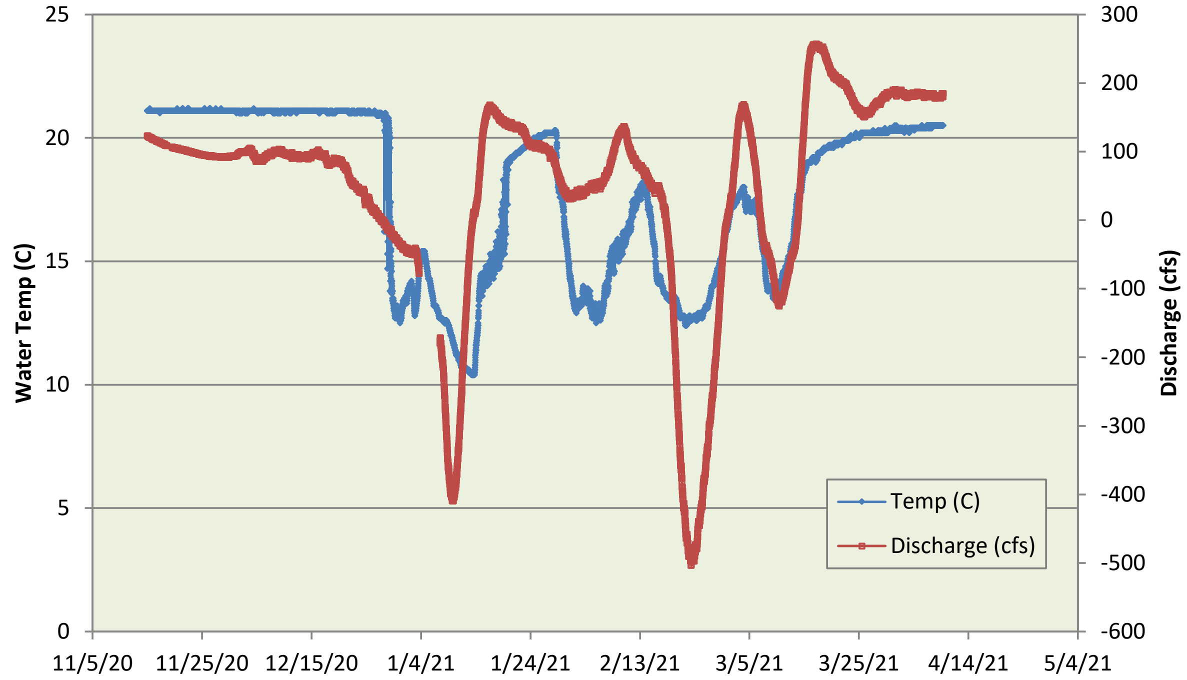
Additional water quality data that can be used to support uses under WRV 1 and WRV 6 include temperature and specific conductance in spring systems that experience reverse flow. Deployable sensors can be used to track the occurrence and severity of reverse flow by installing deployable temperature and specific conductance sensors within the spring run, spring pool, and at various depths within accessible cave systems. These sensors require limited maintenance and should be deployed to collect data at least hourly. Example data showing reverse flow events at Madison Blue Spring are shown in Figure 48.

The relationship between air and water temperature in springs is also expected to impact the type of human uses that occur within the spring. By collecting continuous water and air temperature the human use types by time of year can be evaluated with protection of certain uses prioritized seasonally. For example, in-water uses as a part of WRV 1 (wading, bathing, and swimming) are expected to occur more frequently when the air temperature is warmer than the water temperature; while out of water uses under WRV 1 (paddling and motorboating) and WRV 6 uses are expected to occur more frequently when water temperatures exceed air temperatures. Example date showing water temperature, air temperature, and attendance for Manatee Springs is shown in Figure 49.



	KP-1	KP-5	KP-2	KP-3	KP-4
Average	4.87	55.86	96.42	97.45	92.08
Geometric Mean	2.28	25.59	67.89	67.50	61.91
Maximum	210	1040	1240	510	970
Minimum	0	1	8	6	4
Std Dev	17.76	108.71	104.48	86.23	97.10
N	220	192	269	220	218

Figure 47. Fecal Coliform at Kelly Park Rock Springs Run (Wetland Solutions, Inc., 2007)



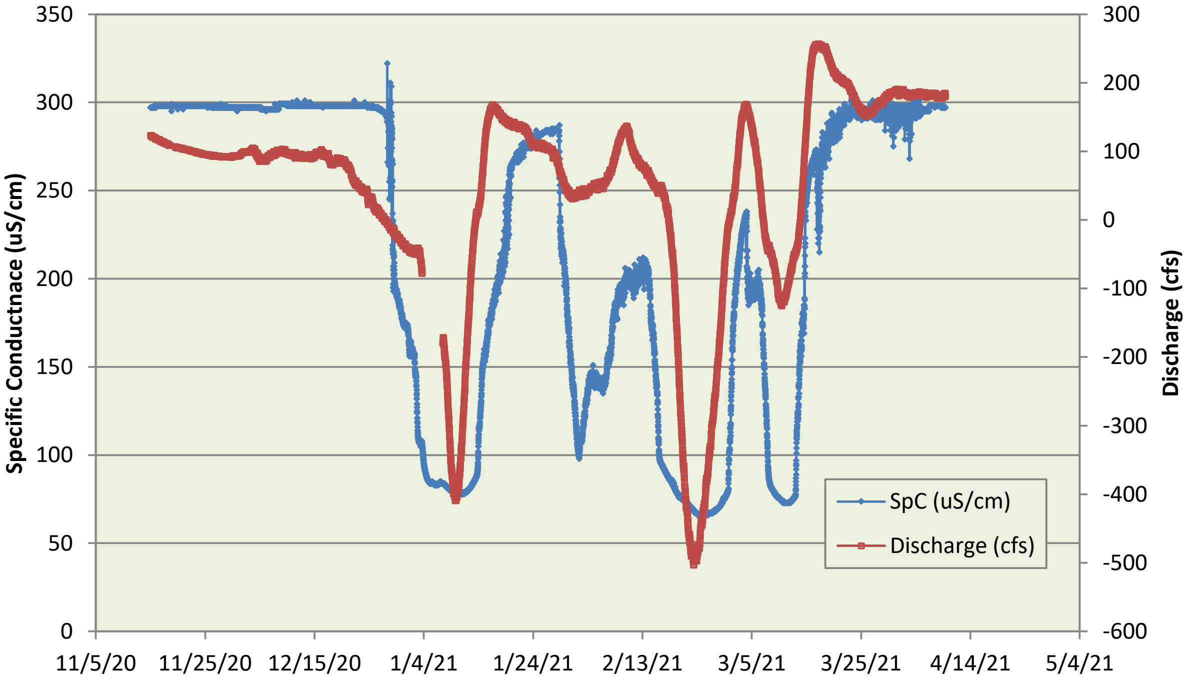


Figure 48. Madison Blue Spring Temperature, Specific Conductance, and Flow (USGS 02319302)

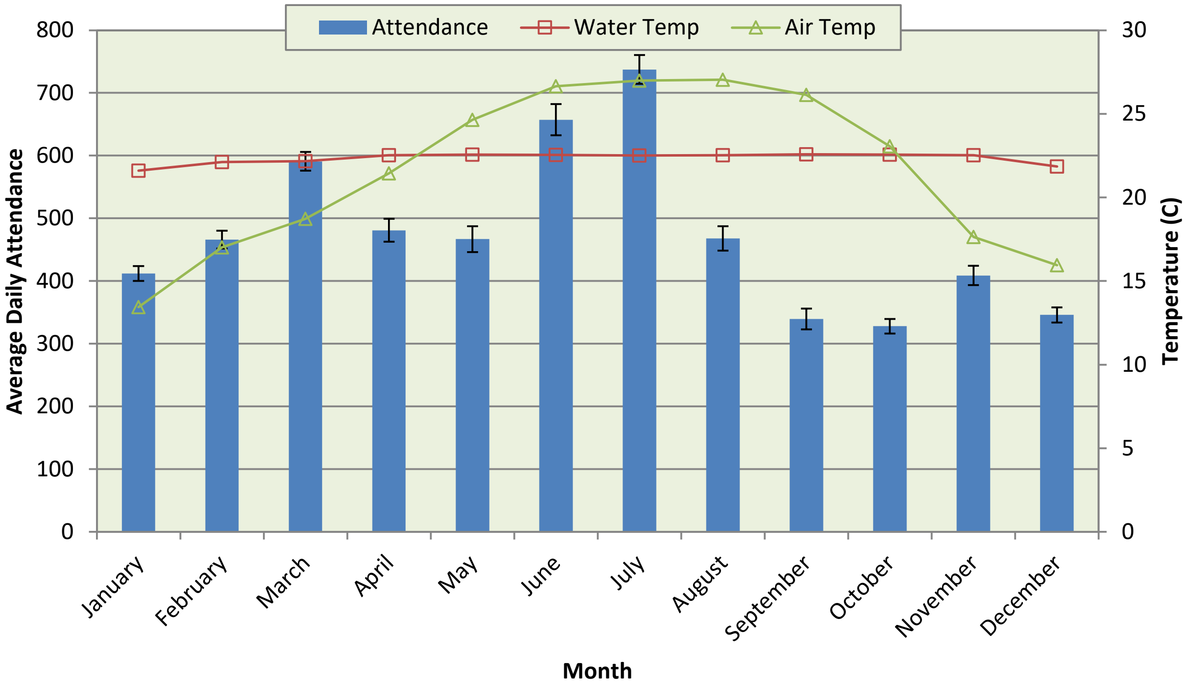


Figure 49. Manatee Springs Water and Air Temperature and Attendance

Section 5.0 Recreation, Aesthetic, and Scenic Evaluation

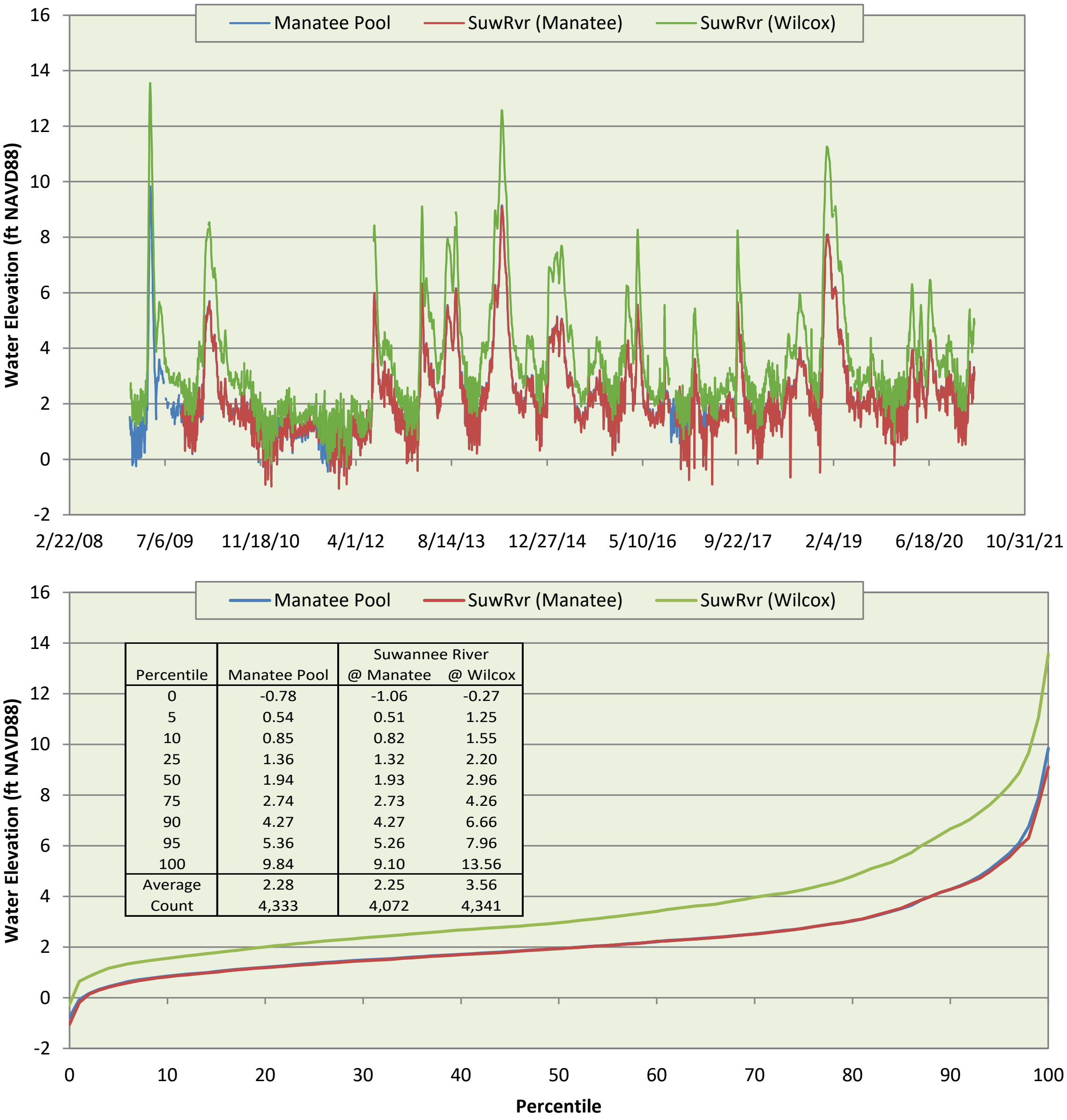
Metrics discussed as a part of this project were applied to Manatee Springs. This evaluation included analysis of relationships between flows, levels, and various spring's characteristics that had adequate data records. In some cases, this information was sufficient for providing a quantifiable assessment of a minimum flow or level that would be protective of specific RAS WRVs. In other cases where data were more limited, or where additional modeling would be required, recommendations are provided for assessment.

5.1 Flows and Levels

Flows and levels were evaluated for Manatee Springs for the available period of record (Appendix B, Table B-36). Levels and flows were generally available for the period from 2009 to present. Level data were available for both the spring pool (USGS 02323566), the Suwannee River at the mouth of the spring run (USGS 02323567), and at the upstream Suwannee River Wilcox Gage (USGS 02323500). Additionally, groundwater levels were available at a well located approximately 300 feet southeast of the spring pool since late-2014 (USGS 292921082583285). Flows were available for the spring at the same spring pool location (USGS 02323566).

5.1.1 Water Levels

Levels in Manatee Springs are highly influenced by levels on the Suwannee River during high stages with backwater conditions affecting conditions in Manatee Springs. Manatee Springs is also tidally influenced under normal conditions. Generally, levels at the spring pool and at the Suwannee River at the end of the spring run are similar with the spring pool being slightly higher during lower levels on the Suwannee River and slightly higher on the Suwannee River during flow reversals. Levels on the Suwannee River at Wilcox are generally several feet higher than at Manatee Springs. The detailed time series and flow percentiles are shown in Figure 50.

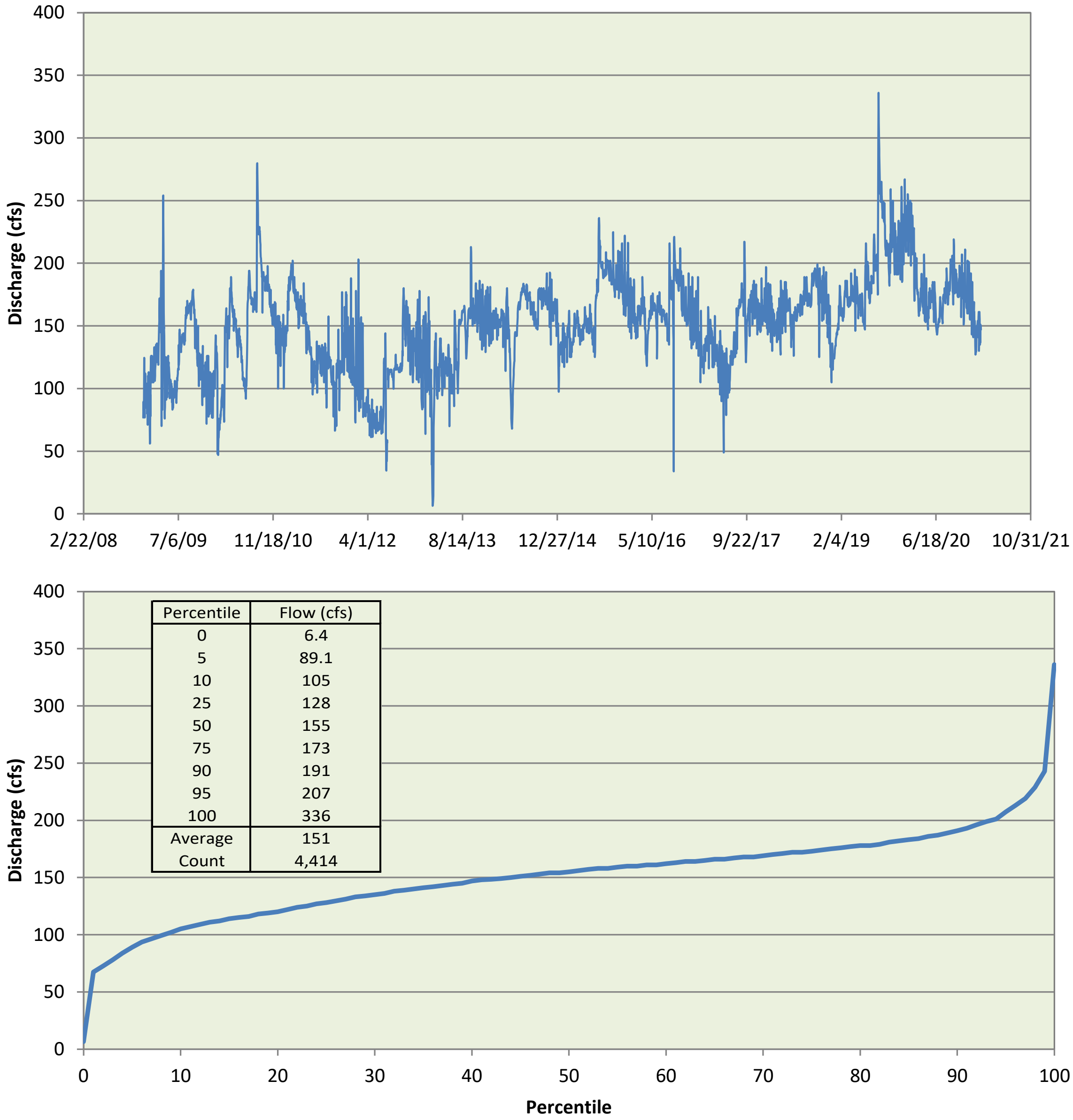


Percentile	Manatee Pool	Suwannee River @ Manatee	 @ Wilcox
0	-0.78	-1.06	-0.27
5	0.54	0.51	1.25
10	0.85	0.82	1.55
25	1.36	1.32	2.20
50	1.94	1.93	2.96
75	2.74	2.73	4.26
90	4.27	4.27	6.66
95	5.36	5.26	7.96
100	9.84	9.10	13.56
Average	2.28	2.25	3.56
Count	4,333	4,072	4,341

Figure 50. Water Elevations at Manatee Springs and in the Suwannee River

5.1.2 Spring Flows

Spring flows are recorded at the spring pool for Manatee Springs and reported on a daily basis. Over the period of record, spring flows have varied between 6 and 336 cfs with an average flow of 151 cfs and a median flow of 156 cfs. The flow data for the spring also appear to show an increasing trend that is not shown in the river flows. The cause for this increase in flows was not evaluated as part of this project.



Percentile	Flow (cfs)
0	6.4
5	89.1
10	105
25	128
50	155
75	173
90	191
95	207
100	336
Average	151
Count	4,414

Figure 51. Flows at Manatee Springs

5.1.3 Groundwater Levels

Groundwater levels were available from a well located southeast of the spring vent from 2014 through present as shown in Figure 52. Water levels at this well are observed to generally track levels in the spring pool, but are typically about one foot higher (Figure 53).

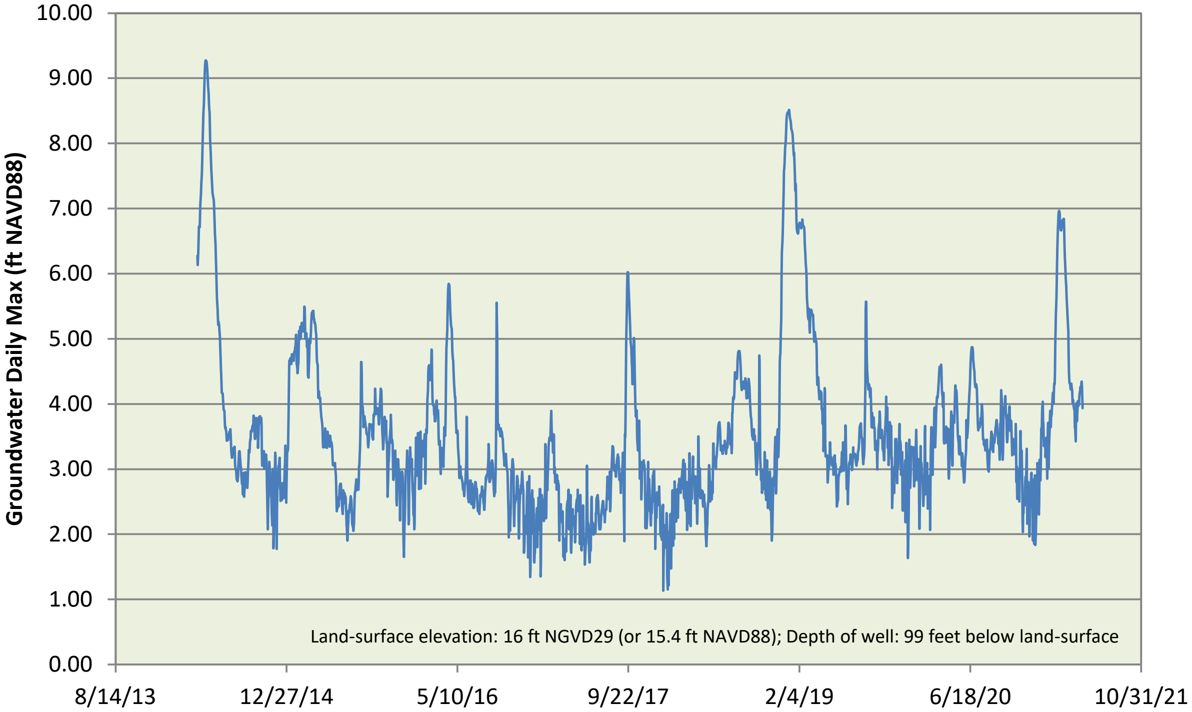


Figure 52. Well Levels near Manatee Springs

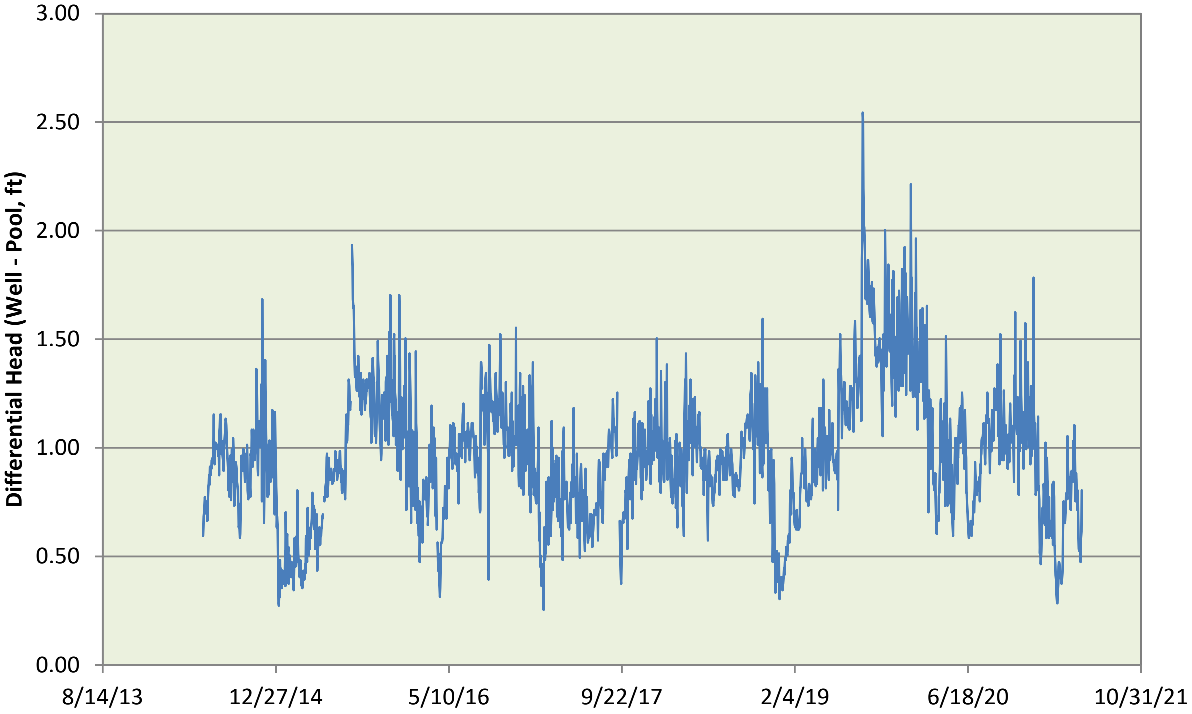
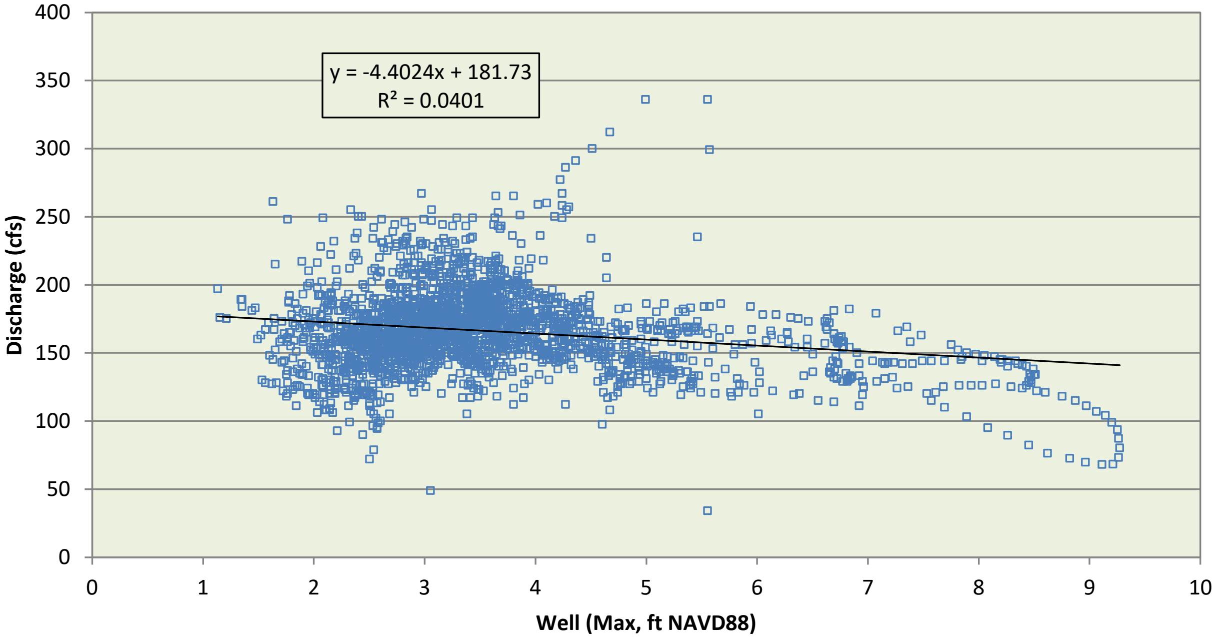


Figure 53. Difference Between Well and Manatee Springs Pool Levels

5.1.4 Flow and Level Relationships

Flow and level data sets were evaluated to determine whether clear relationships existed between spring flow and water level in the spring pool or at the well. No strong relationship was observed between either the well, or the spring pool and the discharge (Figure 54).



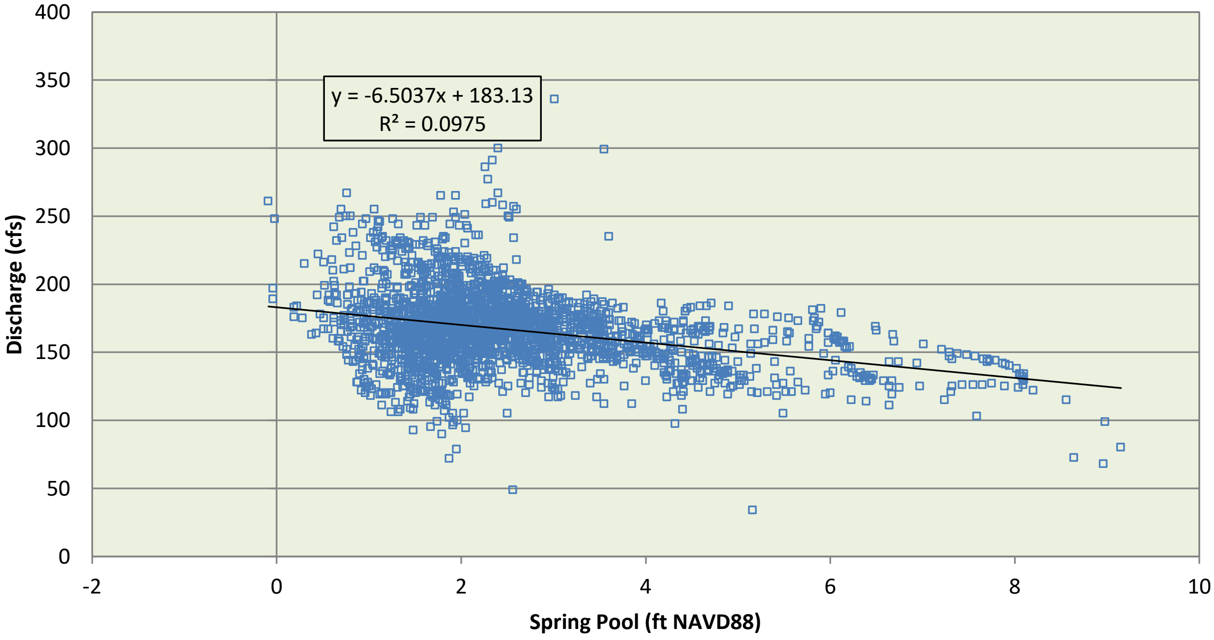


Figure 54. Discharge Versus Well Level (Top) and Spring Pool Level (Bottom)

A strong relationship was found between discharge and the differential head between the well and the spring pool (Figure 55). This comparison shows a linear increasing relationship between flows and the difference between the well and spring pool levels. This relationship is expected given that an increasing difference in levels, assuming the well is representative of the formation feeding the spring, represents increasing hydraulic head and resultant flow out of the spring vent.

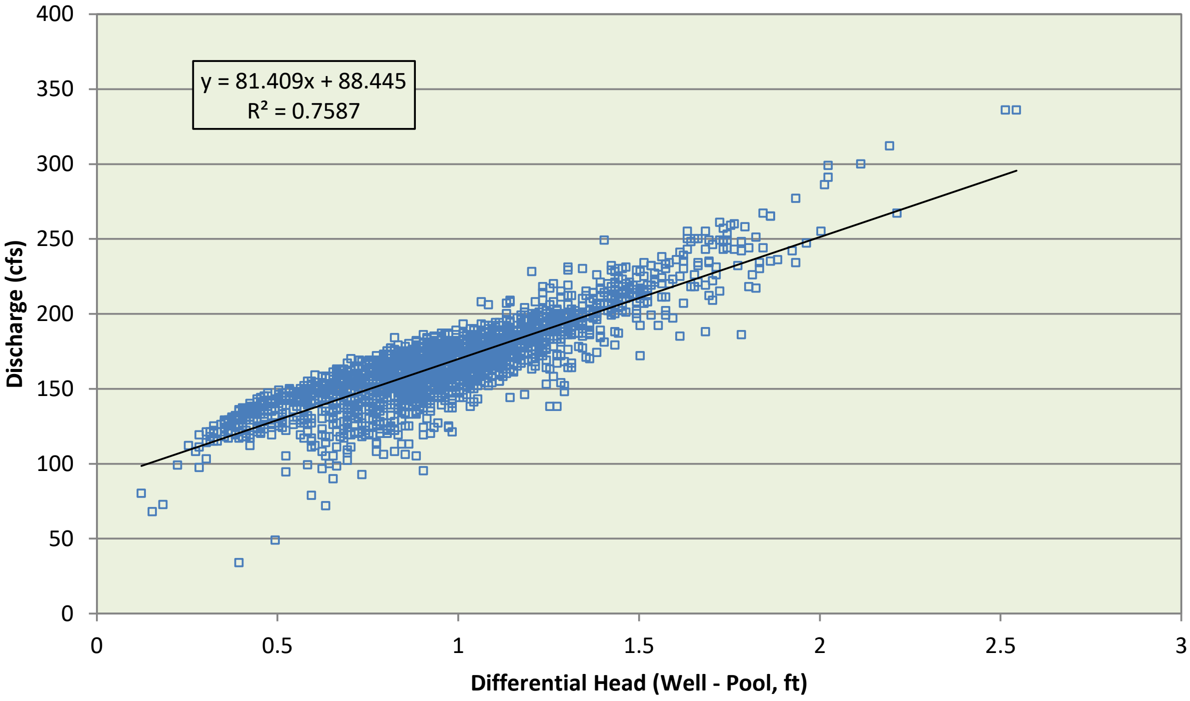


Figure 55. Discharge Versus the Difference Between Well and Spring Pool Levels

5.2 Residence Time

Because residence time influences water quality and aesthetic parameters, it has been considered as a potential metric for setting MFLs and as a metric within spring pools to ensure adequate clean water for human use (Kelly et al., 2005; Mace, 2017; Water Resource Associates, Inc., 2006). Specifically, at Gemini Springs the MFL was developed based on an assumption that a 15% increase in residence time within a reservoir downstream of the spring pool could cause a decrease in the aesthetic and scenic attributes of the spring.

To evaluate the potential sensitivity of this metric to changes in flow, the approximate volume of the Manatee Spring Pool was estimated based on bathymetric information as ~125,600 cubic-feet (Wetland Solutions, Inc., 2010). At the one percentile flow of 67 cfs the spring discharges approximately 5.8 million cubic-feet per day with a mean residence time of 31 minutes in the spring pool. Even under extreme changes in flow this metric is not expected to be sensitive enough for MFL development. In spring systems with longer runs, the volume of water may be large enough that residence time could be correlated to spring discharge and other water quality parameters such as chlorophyll and/or water clarity (Anastasiou, 2006; Janicki Environmental, Inc. & WSP, Inc., 2018).

The Florida Department of Health requires a flow through of 500 gallons of water per anticipated bather, per day for bathing facilities as codified in Chapter 64E-9 of the Florida Administrative Code. Based on the same one percentile flow of 67 cfs (43.3 MGD) the spring can legally accommodate more than 86,600 bathers per day; significantly more than the park can accommodate from the standpoint of parking, facilities, and physical space within the spring pool. The highest recorded attendance for the park is 5,012 people, which occurred on June 20, 2017. This metric is not expected to be sensitive enough for MFL development given the large flows that can support substantially more bathers than can access the spring in a single day. This is expected to be the case in all Florida springs, except where the spring has already fallen below a MFL that supports other WRVs.

5.3 Human Use

Human use is one of the quantifiable metrics of RAS WRVs. Assessment of human use can be completed by either an observer(s) stationed at the spring or collected automatically with a camera that captures the spring pool and associated upland areas with post-processing. Human use data were collected at Manatee Springs over a period of four days during August 3-6, 2009 (Wetland Solutions, Inc., 2010). Documented recreational human uses included: snorkeling, swimming, floating, scuba diving, paddle craft, and "other". Aesthetic and scenic uses included sitting/walking and "other". The most prevalent human uses were sitting/walking, snorkeling, paddle craft, swimming, floating, "other", and finally scuba diving as shown in Table 27. "Other" included motorboating, playground use, and fishing off the dock at the confluence of the Suwannee River.

Table 27. Human Use at Manatee Spring – August 3-6, 2009 (Wetland Solutions, Inc., 2010)

Human Use Activity		Average			
		No. People	Percent	People / ac	People / hr
In Water Activity	Snorkeling	80.8	63%	41.0	2.52
	Swimming	28.3	22%	14.3	0.88
	Floating	16.0	13%	8.1	0.50
	SCUBA	3.0	2%	1.5	0.09
	Total	128.0	100%	65.0	4.00
Out of Water Activity	Sitting/Walking	174.8	84%	257	5.46
	Canoe/Kayak	28.5	14%	42.0	0.89
	Other	5.0	2%	7.4	0.16
	Total	208.3	100%	307	6.51

Collection of detailed data also allow for an examination of how human use types change during the day and periods of peak use in and out of the spring as shown in Figure 56. Human use data show the range of activities and can be used to develop park management plans to protect biological communities (DuToit, 1979; Florida Department of Environmental Protection, 2000b). Collection of these data over time can allow for examination of changes in use types that can provide insight into how users interact with the spring and respond to various changes in the spring that occur year-to-year or over a longer temporal period. Because of the seasonal component to human use, WRV analyses should use seasonal periods of time rather than just annual statistics.

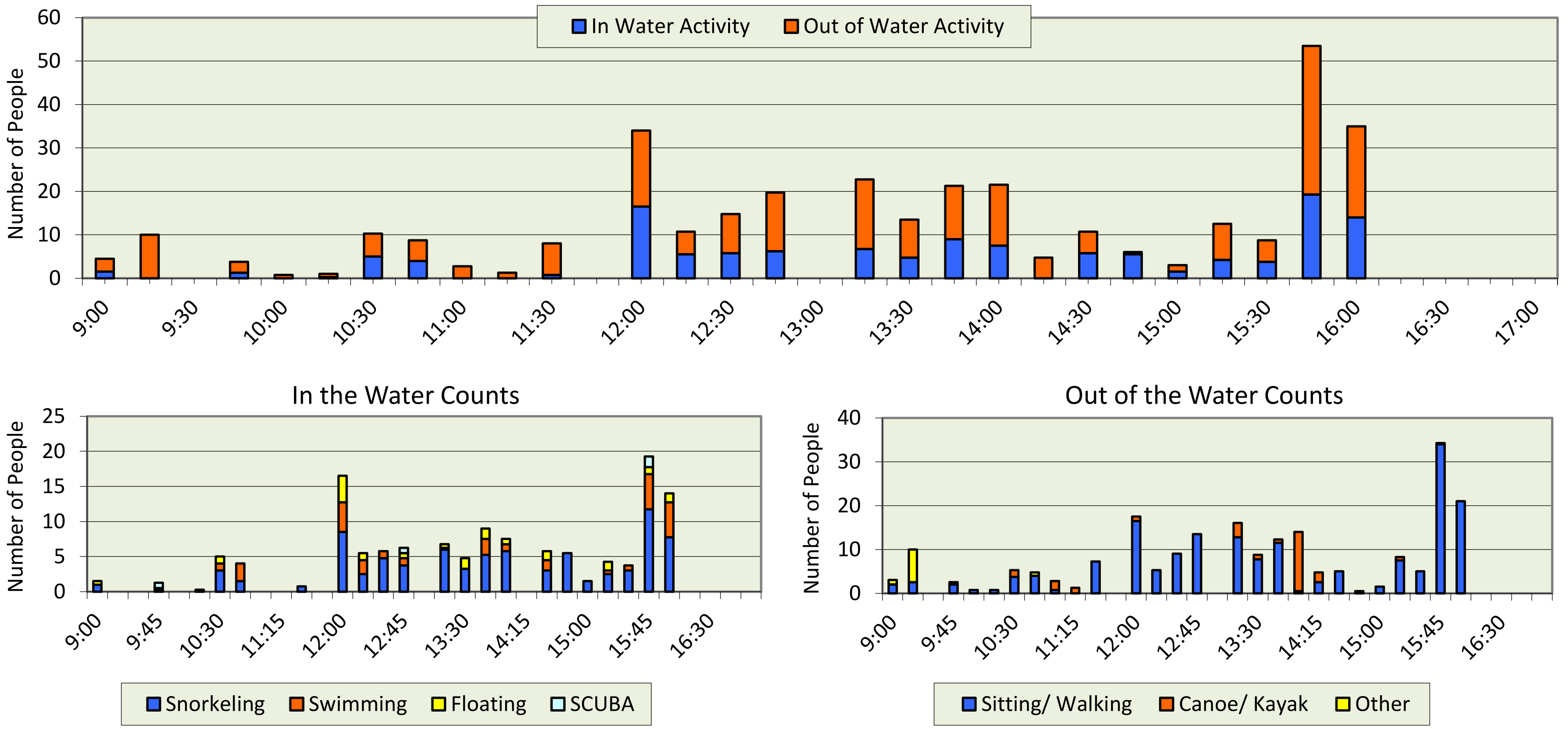


Figure 56. Detailed Human Use at Manatee Springs (Wetland Solutions, Inc., 2010)

5.3.1 Manatee Viewing

As its name suggests, Manatee Springs is used by manatees, however it is not considered a critical warm-water refuge for the species (Florida Fish and Wildlife Conservation Commission, 2021). However, with increases in the manatee population and the potential for reduced warm water discharges from coastal power plants (Laist & Reynolds, 2005), it is expected that springs may become more critical as warm-water refuges for manatees. Manatee Springs is used by manatees as a warm-water refuge during cold periods and this use appears to have increased between 1994 to 2004 (Water Resource Associates, Inc., 2005). Figure 57 shows an increase in average manatee sightings per month at Manatee Springs from 2009 to 2020. This manatee presence can cause additional human use for manatee viewing. The relationship between manatee use and wildlife viewing has been well-documented at Volusia Blue Spring, an important east coast warm-water refuge on the St. Johns River, where peak human use occurs during the winter when in-water uses are not allowed due to the large number of manatees present (Wetland Solutions, Inc., 2006b).

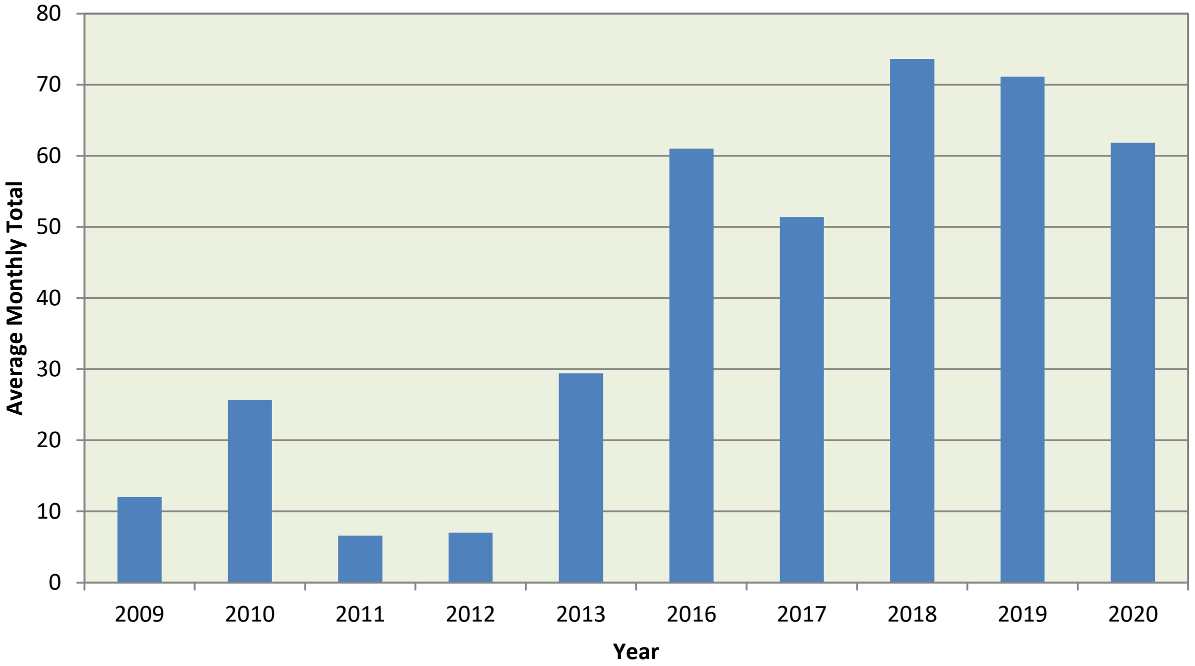


Figure 57. Average Number of Manatee Sightings per Month from 2009 to 2020 at Manatee Springs (FPS Data)

At Manatee Springs, manatee data and human use were evaluated based on manatee count data and daily attendance numbers from 2009 to 2020. These data showed no relationship between manatee count numbers and daily attendance, as shown in Figure 58. However, when reviewing park attendance in the presence/absence of manatees, both for the entire year and during the months of November through January, attendance was observed to be significantly higher when manatees were present at the spring (Wilcoxon test, $p<0.001$).

To better understand how human use may be affected by the persistent presence of manatees in the spring, a total of eight, multi-day events were evaluated when manatees were continuously present. During a majority of these events an increase in daily attendance was observed, although the effect of other potential drivers of attendance (temperature, weather, holidays, etc.) was not separately evaluated. Four of the evaluated events are shown in Figure 59.

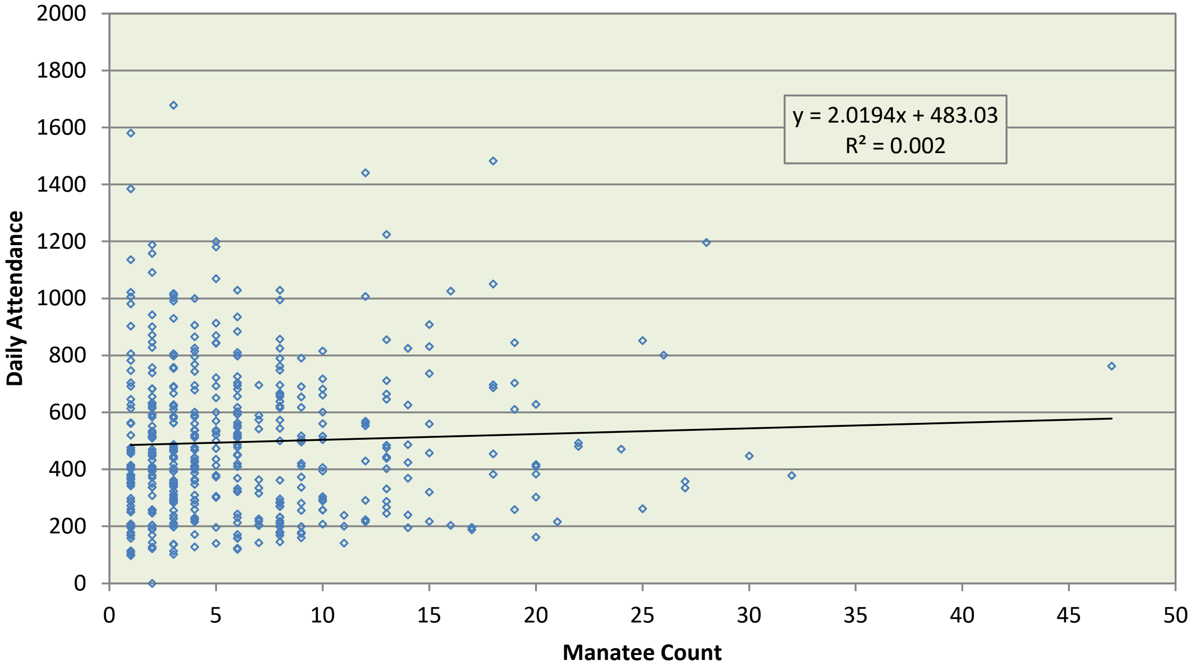


Figure 58. Manatee Count and Daily Attendance (2009-2020)

Figure 59. Manatee Count and Daily Attendance for Four December Events

5.4 Water Clarity

Water clarity is an integral feature of Florida's springs and the primary driver of the RAS WRVs that are the focus of this study. Springs water clarity is linked to spring flows and levels in several ways. Flowing groundwater flushes particulates and phytoplankton in spring systems, and at Manatee Springs, pushes tannic Suwannee River water from the spring run during normal water levels. Water clarity has been visually assessed at Manatee Springs since 2009 by the FPS, at six stations from the spring pool to the end of the spring run (Figure 60). In addition, some information is available on the number of days that experienced brown outs since 1973.

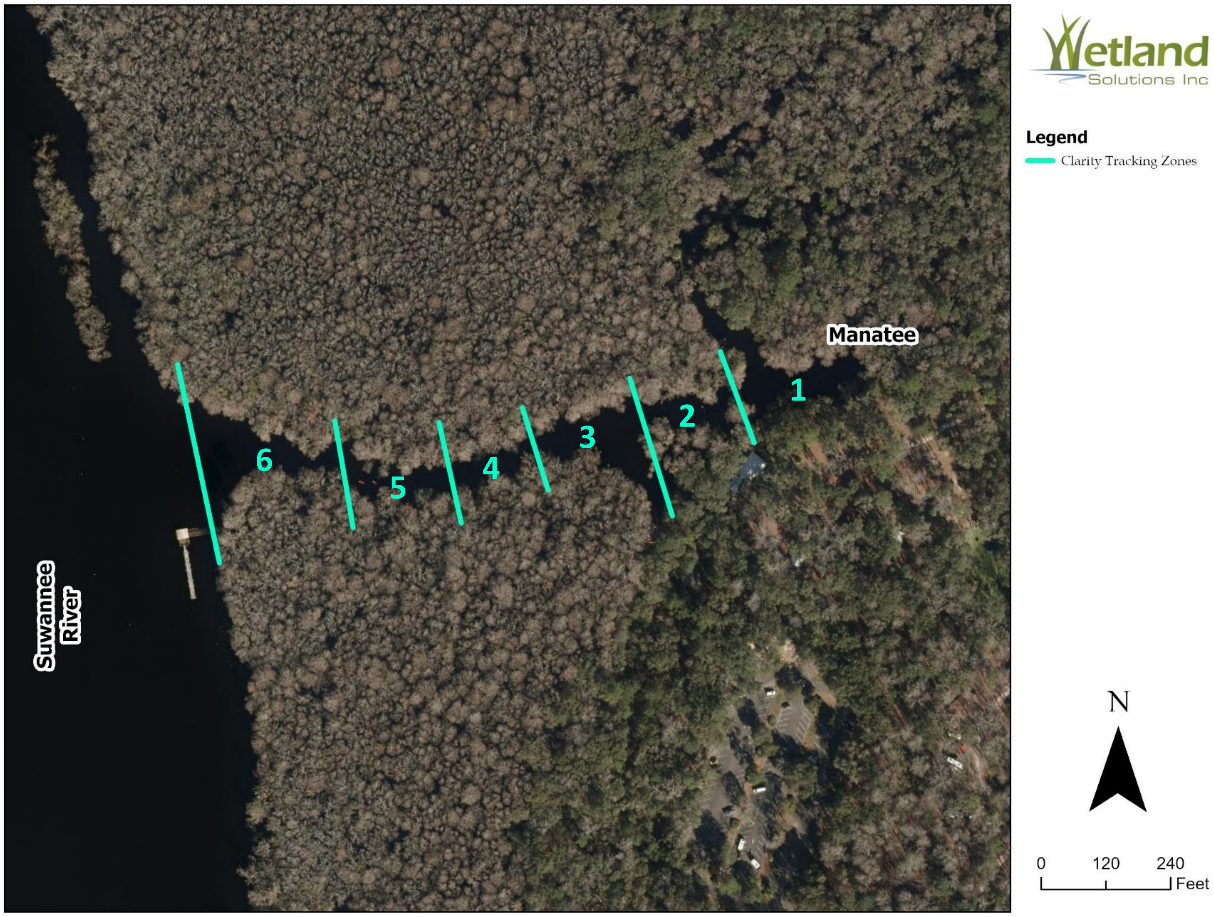


Figure 60. Water Clarity Assessment Stations (Florida Fish and Wildlife Conservation Commission & Florida Department of Environmental Protection, 2020)

5.4.1 Water Clarity and Stage

Water clarity data were evaluated based on stages at the Manatee Spring pool, stages on the Suwannee River at the Wilcox Gage, and on stages on the Suwannee River at Manatee Springs. Manatee Springs experiences decreases in clarity associated with flood stages on the Suwannee River that increase levels, cause mixing of the spring and river water (brown out conditions), or under extreme stages, cause flow reversals in the spring pool.

Water clarity data in the spring were recorded by the FPS based on visual observations for six zones on the five-level scale described below. These data show the movement of dark water upstream during high-water events on the Suwannee, which appeared to be the cause of all reduced clarity events at the spring pool.

- Clarity Level A - clear water with excellent clarity
- Clarity Level B – green tinted water with good clarity
- Clarity Level C – tannic river water covering the entire spring area with secchi disc readings of 4.1′ or more
- Clarity Level D – tannic river water covering the entire spring area with secchi disc readings of 4′ or less
- Clarity Level E – tannic river water entering spring ("flow reversal") and secchi disc readings of 4′ or less

A majority of the data were a Clarity Level A for all zones (>75% of days), with an increasingly higher frequency of lower clarity level days in downstream zones as shown in Table 28 and illustrated in Figure 61. This relationship is logical given the need for the river to rise to a level that begins to exceed the potentiometric surface before dark water can intrude all the way to the spring pool.

It is also worth noting that Manatee Springs is the most downgradient, large spring on the Suwannee River meaning that as potentiometric levels rise on the river, Floridan Aquifer levels would be expected to rise along the river increasing the potentiometric head, increasing flows, and prolonging clear water days in the spring pool at Manatee Springs. The clarity data also show that even during dark water periods, Manatee Springs only rarely experiences brown outs with reduced secchi depths (clarity level D) with even fewer documented reversals (clarity level E).

Table 28. Water Clarity Frequency by Zone (June 2009 – February 2021)

	Clarity Level				
Zone	A	B	C	D	E
1	93.2%	2.8%	3.0%	0.7%	0.3%
2	91.7%	2.8%	3.3%	1.6%	0.5%
3	85.7%	2.4%	9.8%	1.7%	0.5%
4	84.8%	2.1%	10.6%	2.0%	0.5%
5	83.6%	2.3%	11.1%	2.5%	0.5%
6	78.4%	3.1%	14.4%	2.8%	0.5%

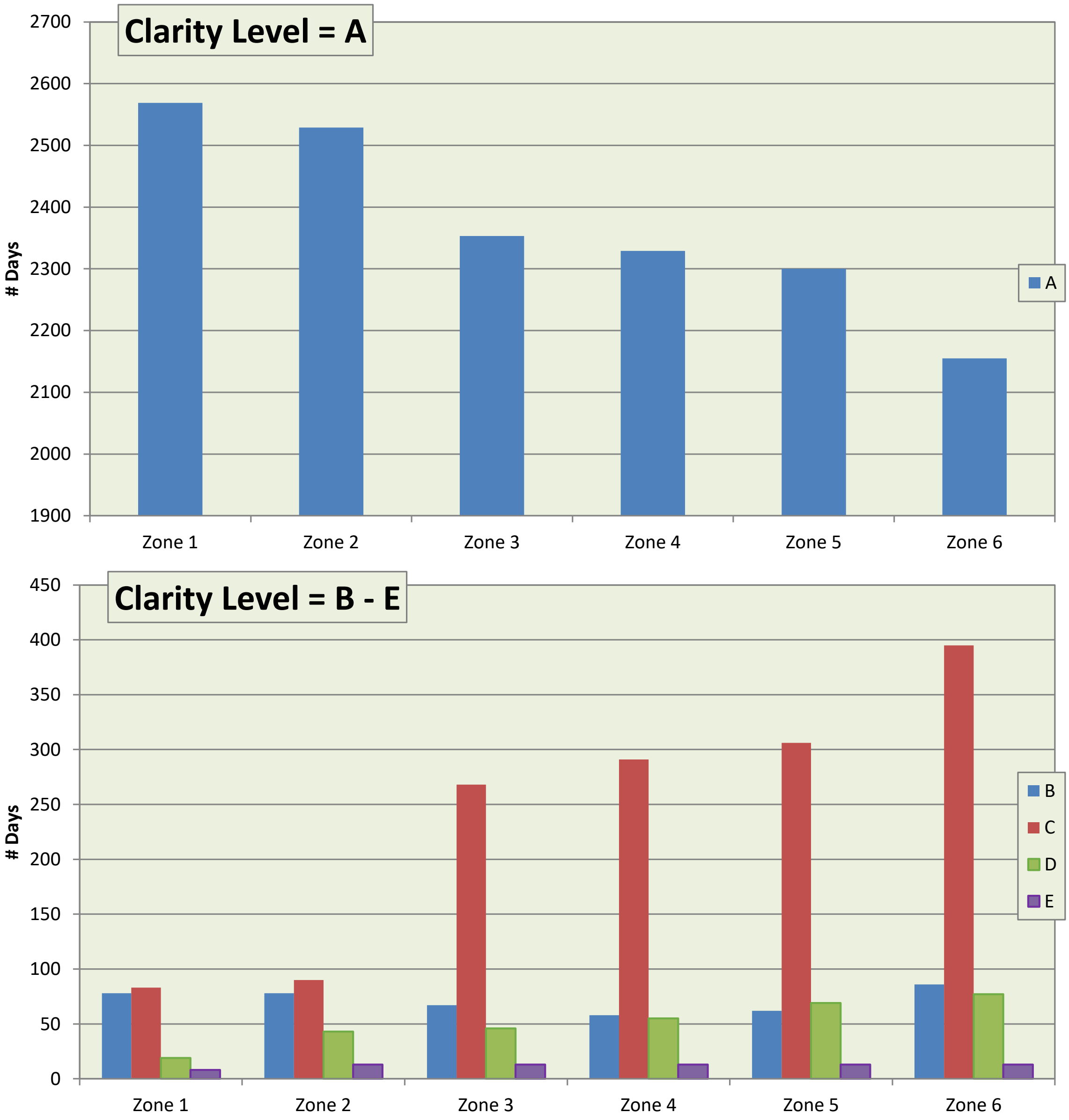


Figure 61. Water Clarity Data for Manatee River Zones (June 2009 – February 2021)

Water clarity data were compared to elevations in the spring pool for each of the clarity zones (Figure 62). These data show the generally higher levels in the spring pool that are necessary to reduce clarity. These data also illustrate the progressively lower water elevations that are necessary to cause reduced clarity in the zones further downstream in the spring run.

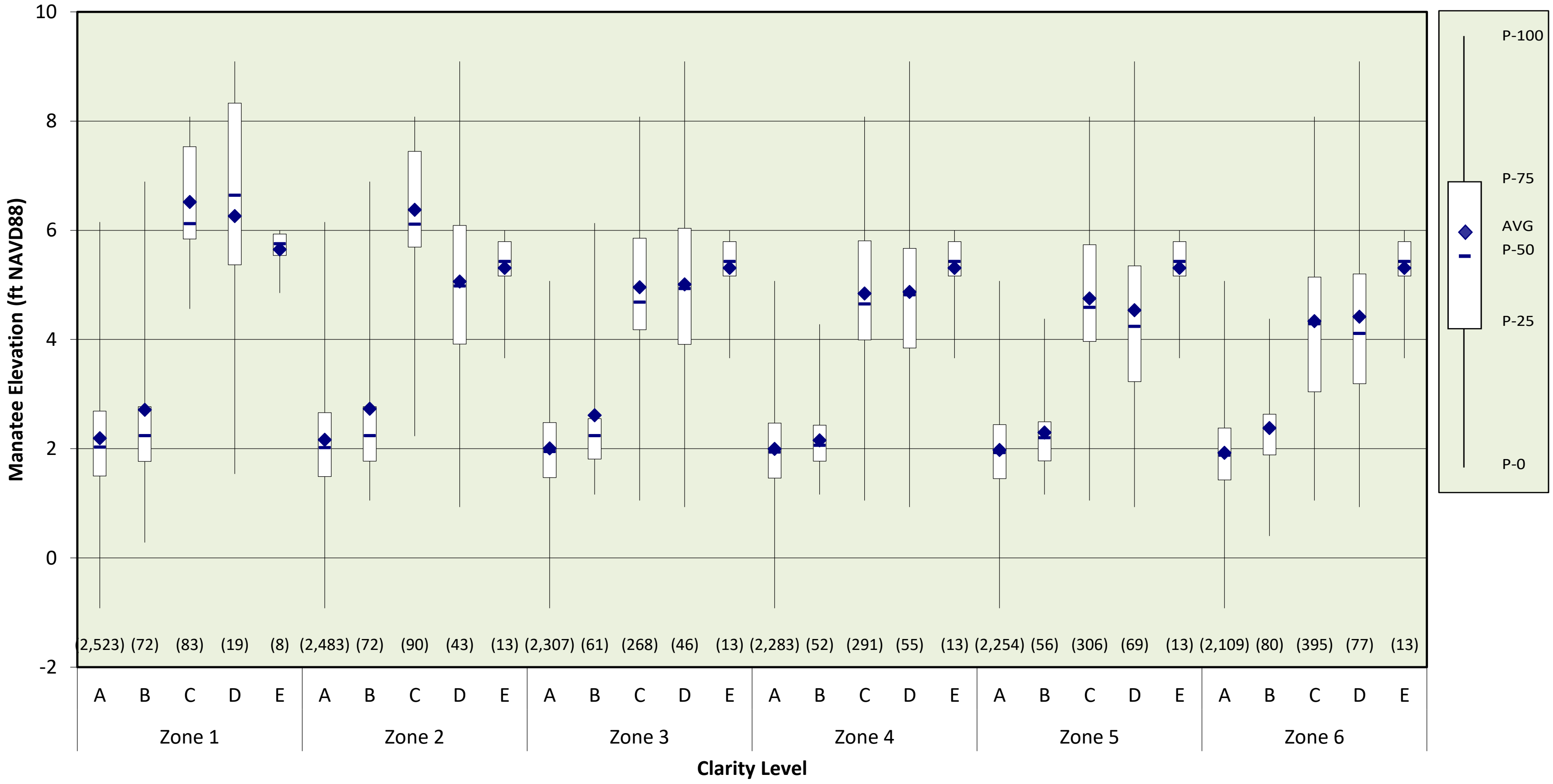


Figure 62. Water Clarity and Manatee Spring Elevation (April 2014 – February 2021)

Figure 63 illustrates this relationship for a single flooding event on the Suwannee River in June and July of 2012. This event shows that as stages on the Suwannee River begin to increase and exceed levels in the spring pool, water clarity is reduced moving upstream, until dark water reaches the spring pool (Zone 1) and the spring begins reversing (Water Clarity Score E) on July 2, 2012. This relationship then switches with water clarity improving first in the spring pool and moving downstream until water clarity is restored to Clarity Level A in all zones.

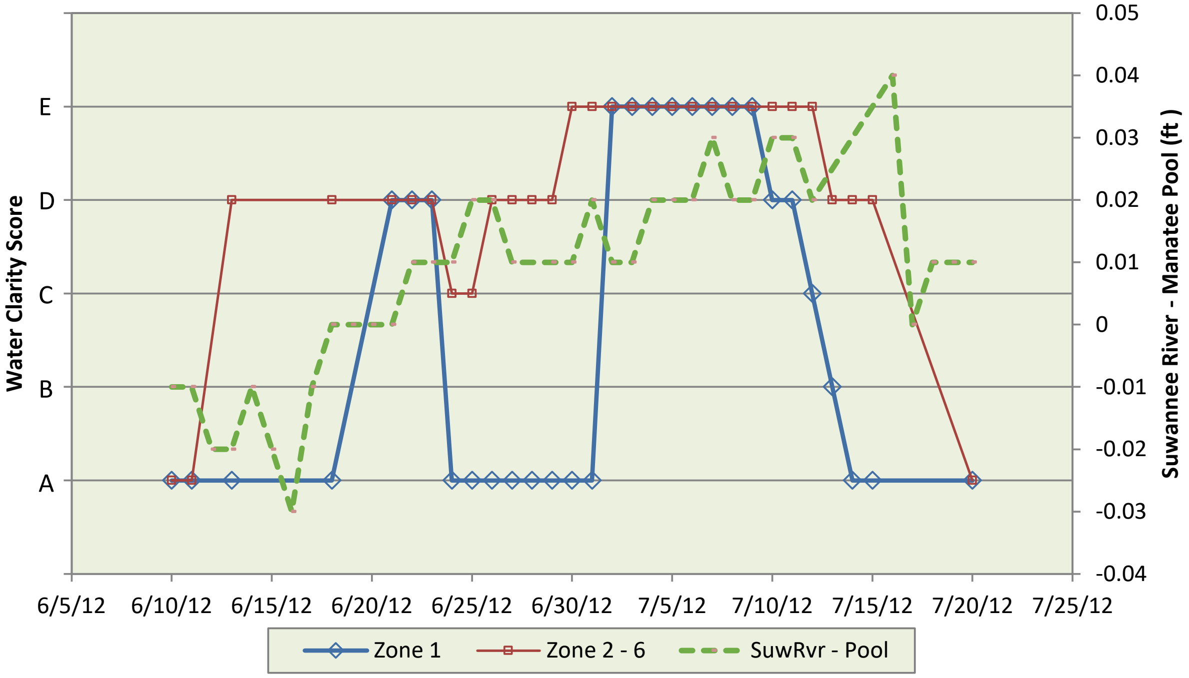


Figure 63. Manatee Springs Water Clarity June/July 2012

5.4.2 Water Clarity and Discharge

Water clarity was compared to spring discharge to evaluate the occurrence of higher or lower flows in conjunction with reduced clarity events as shown in Figure 64. These data show that flow conditions under Clarity Level A are generally higher than under Clarity Level C or D. However, flows under Clarity Level B are much higher on average than flows under Clarity Level A. This finding appears to support the concept of an increasing potentiometric surface during flood events causing increased flows after flood events. This is further supported by the description for this clarity level as “green tinted” which is an indication of mixing of tannic surface water with clearer spring flow following reversals or inundated conditions in the spring pool.

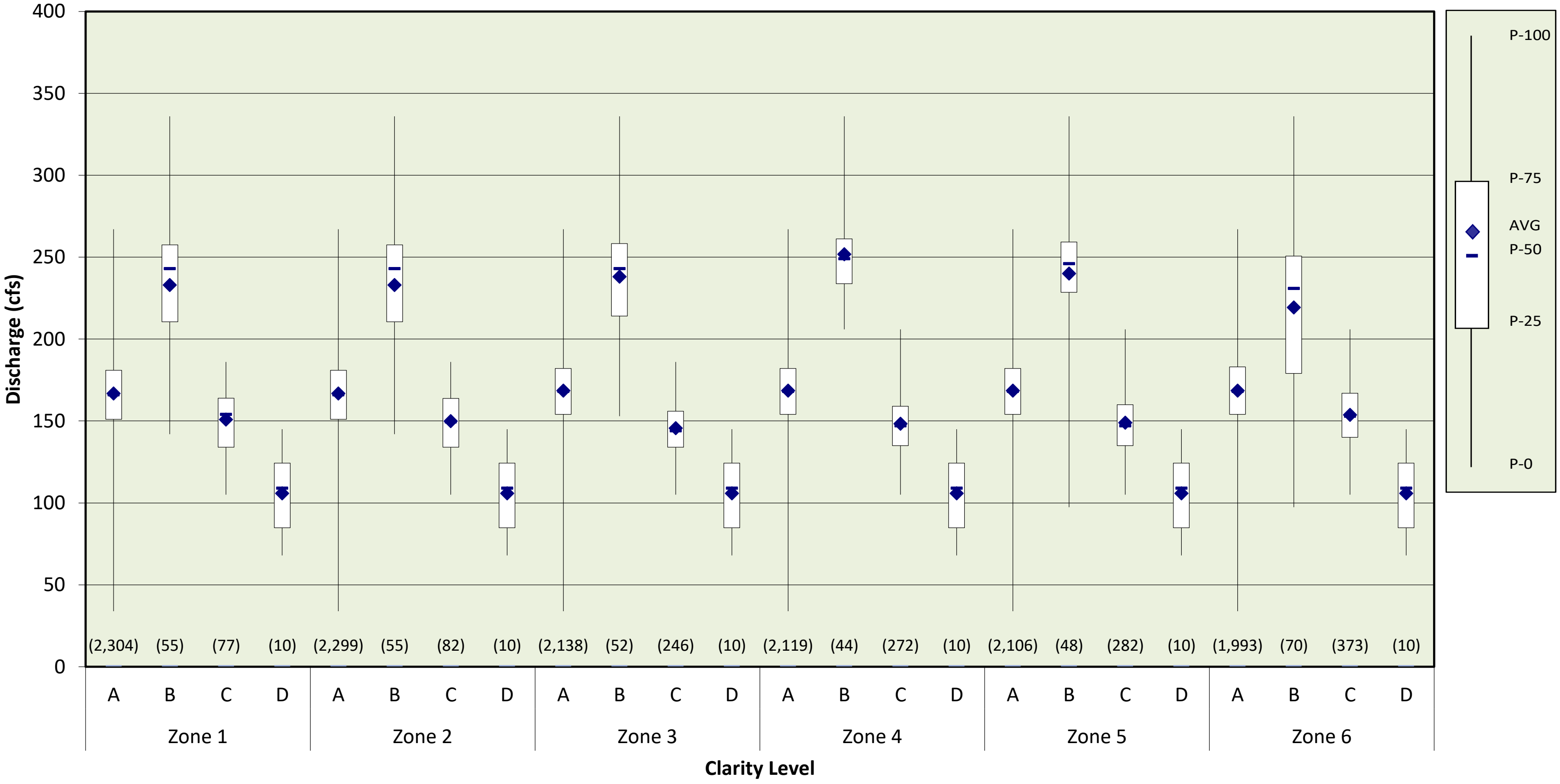


Figure 64. Water Clarity and Manatee Spring Discharge (April 2014 – February 2021)

5.4.3 Water Clarity and Field Parameters

Water clarity data were compared to field parameters that were collected from a water quality data sonde installed at the spring pool. Clarity data were compared to both water temperature and specific conductance. During periods when water levels were elevated and clarity was reduced, both temperature and specific conductance showed decreases in values (Figure 65). Specifically, the temperature relationship is dependent on the river water temperature which can be either higher or lower than the spring temperature depending on time of year. These relationships may allow for one or more field parameters to be used to provide a more continuous data record for reductions in flow or spring reversals than manually collected clarity information. These data may allow for calibration of a hydrodynamic model that can be used to estimate the frequency and duration of flow reversals under varying spring flows.

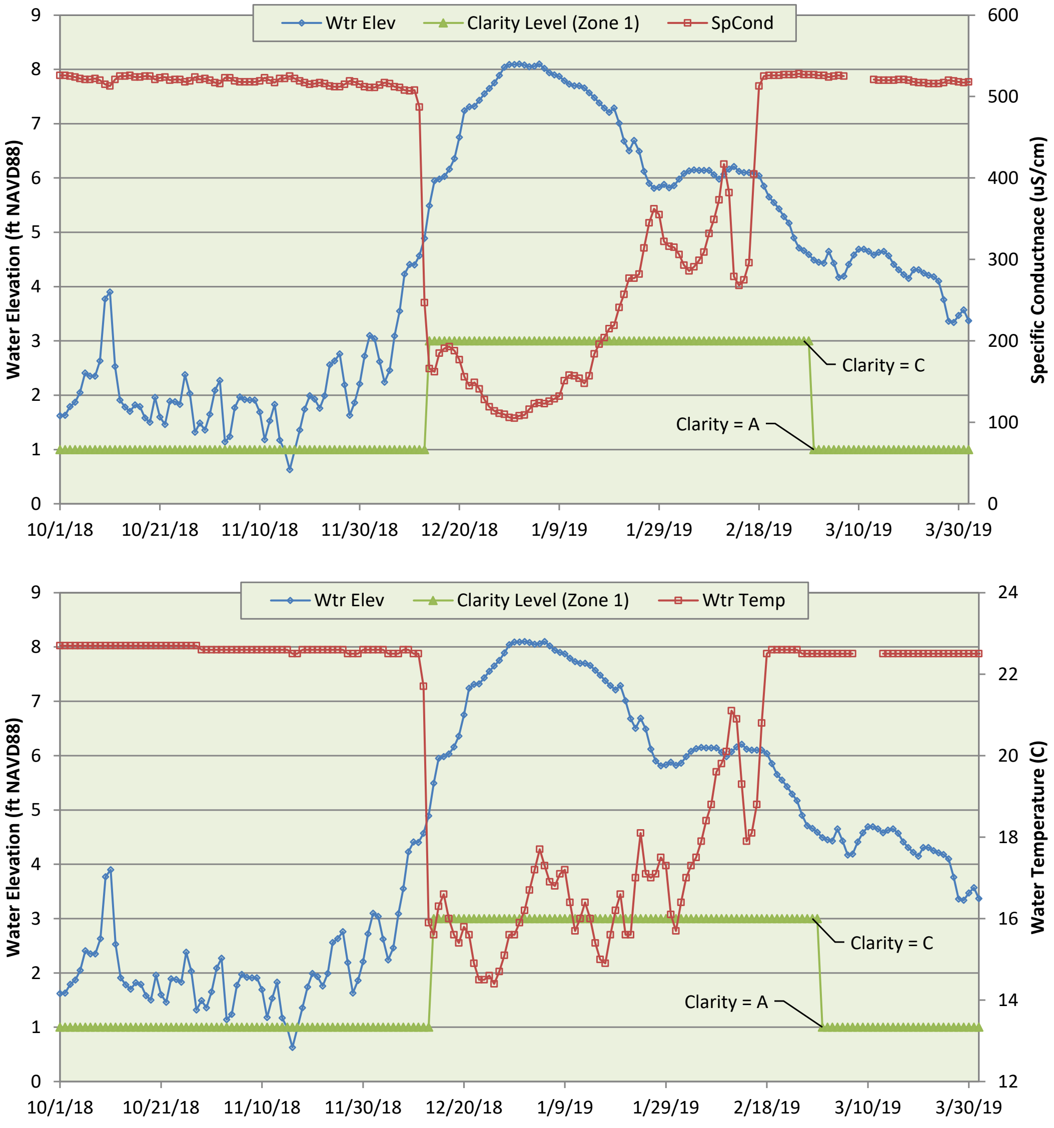


Figure 65. Field Parameters (Specific Conductance and Water Temperature), Water Clarity, and Spring Elevations

5.4.4 Water Clarity and Park Attendance

To demonstrate the relationship between water clarity and park attendance, the number of visitors accessing the park was compared to the reported water clarity at the spring pool (Zone 1). More than 93% of the water clarity days at the spring pool were Clarity Level A as shown in Table 28. Park attendance was observed to be highest on average during periods when water clarity in the spring pool was Clarity Level A (completely clear). This is not unexpected as the spring pool is closed to swimming during significant brown out events and spring users access the park primarily for the spring features. Attendance was observed to be similar on average between other water clarity levels as shown in Figure 66.

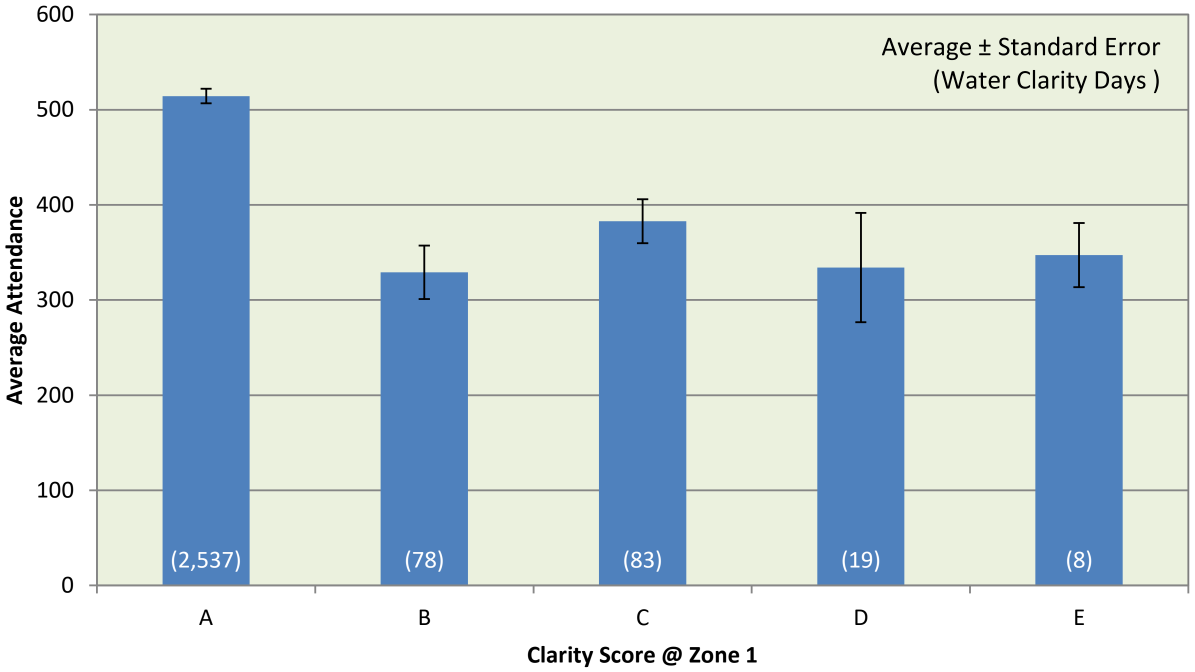


Figure 66. Spring Pool Water Clarity and Park Attendance

Statistical significance in park attendance between the water clarity groups was investigated using JMP statistical software. A significant difference in park attendance was observed between the water clarity levels (Kruskal-Wallis test, $p<0.05$). Pairwise comparisons (including AB, AC, and AD) were also significantly different (Wilcoxon test, $p<0.05$), with the exception of AE (Wilcoxon test, $p<0.227$), likely due to the limited number of Clarity Level E events.

5.4.5 Water Clarity and MFL Development

Dark water conditions are important to determination of spring MFLs for several reasons, assessment of which is expected to require more detailed hydrodynamic modeling. The primary way in which dark water conditions are important is the overall length of the dark water event and the loss of RAS attributes on the ascending and descending water clarity curve. Relative to RAS attributes, this begins when clear water is replaced by brown water and continues until the spring returns to a clear condition. The specific point at which this begins could be further quantified by collecting continuous light attenuation data in conjunction with visual water clarity assessments and public surveys of user perception. These dark water events would be expected to increase in frequency, duration, and severity under reduced flows or levels providing a quantifiable and modellable metric for MFL development.

It is expected that for a lower MFL a spring with a surface water connection would go dark more quickly, stay dark longer, take longer to return to clear conditions, and go dark more frequently impacting both WRV 1 and 6. This change in frequency and duration of dark water days can be evaluated using a hydrodynamic model and calibrated based on observed data for brown out events. Conveniently, only a relatively small number of events with reliable data may be needed to calibrate a model to evaluate the change in hydraulic head (reduction in flow) that results in significant harm to WRV 1 and/or 6. Given that flooding on the Suwannee River is not a new phenomenon, the MFL would be set based not on the occurrence of a brown out; but rather on a change in the threshold river stage required to cause a brown out, the duration of a brown out, the frequency of brown outs, or the rate at which the spring recovers following a brown out. This analysis could also be expanded to evaluate potential impacts to WRV 2, 7, or 9 if reduced light availability is expected to impact vegetation in the spring.

5.5 Bathymetry

Manatee Springs bathymetry was approximated based on data collected as part of a study of 12 Florida springs for FWC (Wetland Solutions, Inc., 2010). These data were based on the recorded water surface elevation for that day (August 4, 2009) in conjunction with an approximation of the water's edge estimated from aerial interpretation (Figure 67). The bathymetric data and water's edge location used in this report should be refined for application in the MFL context. The maximum recorded depth in the bathymetric survey was approximately 26 feet with 0 feet of depth corresponding to an elevation of 1.25 feet NAVD88. The area at each stage is shown in Figure 68. These data show that approximately 73% of the spring was less than 5 feet deep at the time of data collection, with a small, deep spring boil.

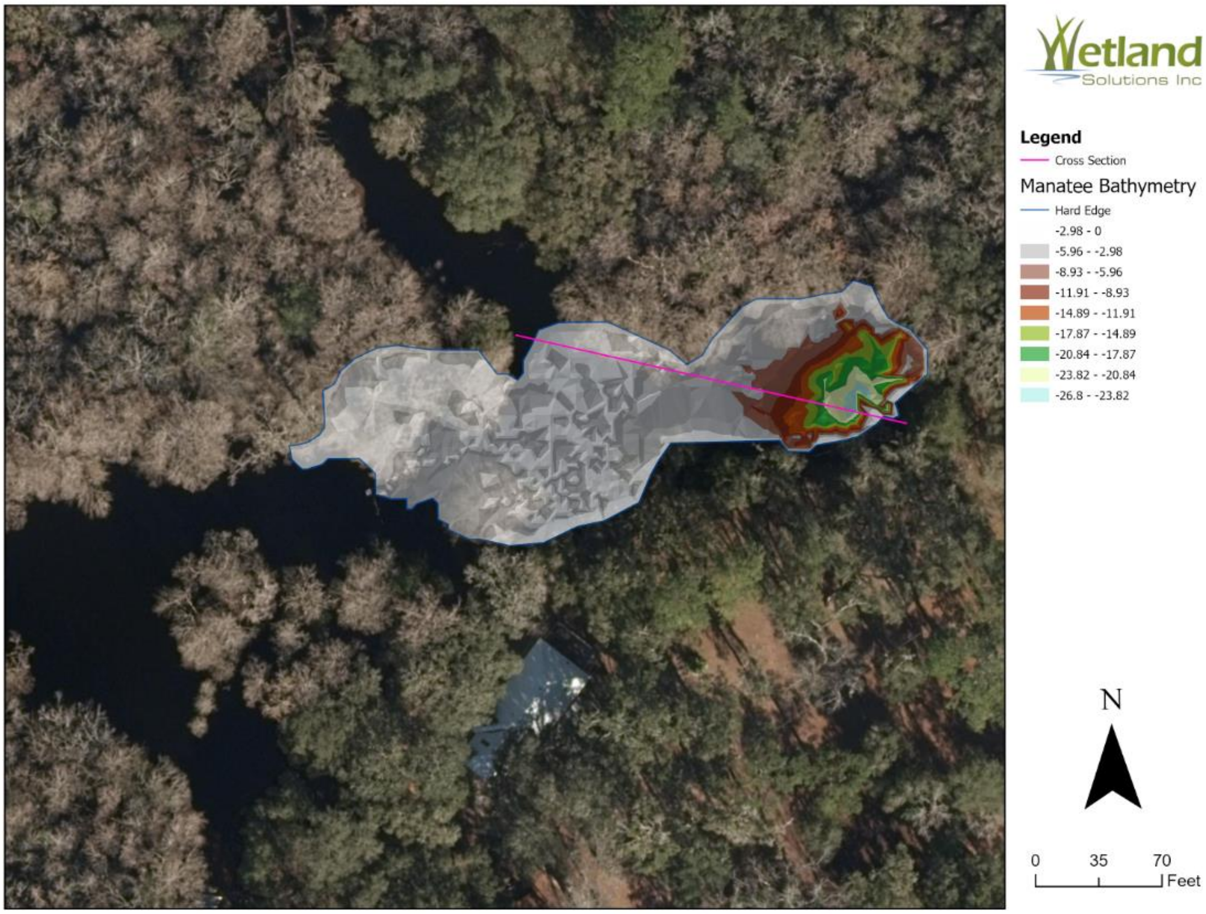


Figure 67. Manatee Springs Approximate Bathymetry

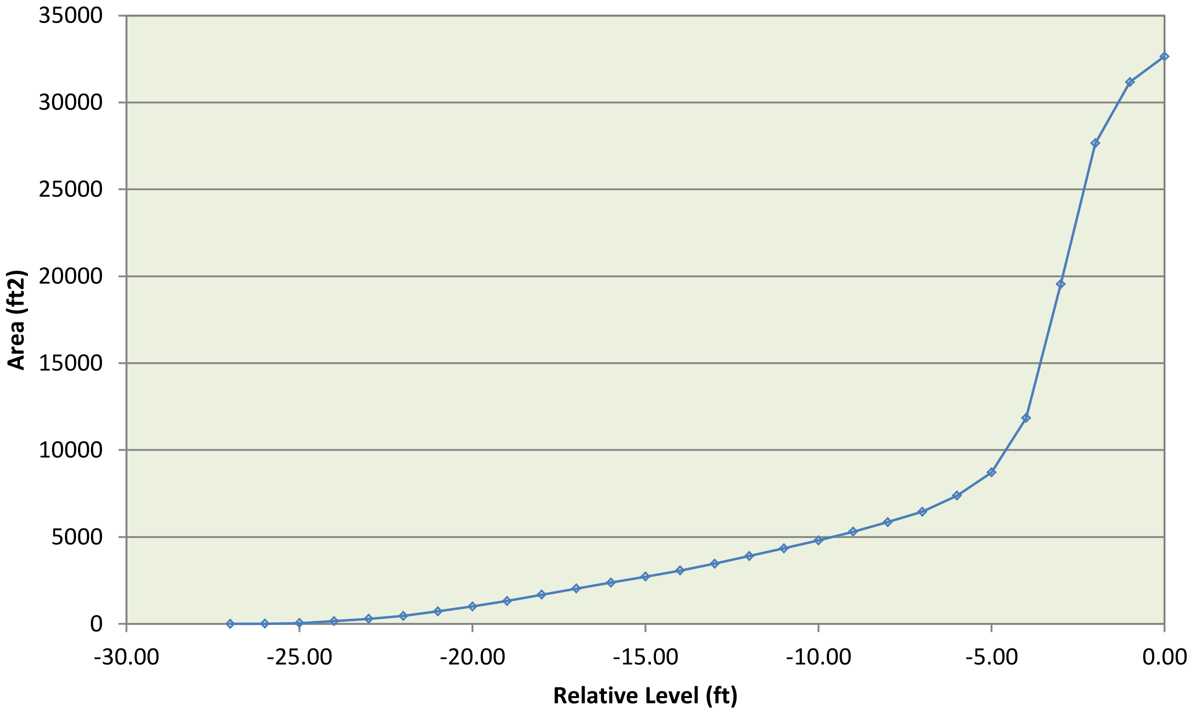


Figure 68. Manatee Spring Stage-Area Relationship

5.5.1 Recreational Access

Bathymetric data allow for calculation of areas that are available for various forms of recreation and the change in areas under varying stages. These data can be used to develop a minimum level (and corresponding flows) for the spring that protects recreational uses in the spring.

For this analysis three specific classifications for human use were evaluated, although these could be expanded, or have depth criteria modified. The first use class considered was wading, which was defined for this study as requiring between 0 and 2 feet of water. The second use class was bathing with a depth requirement of 2 to 4 feet. The third use class was swimming, which was identified as requiring greater than or equal to 4 feet of water. An example cross-section was extracted for the spring to indicate the concept of recreational depths as shown in Figure 69, with the cross-section location shown in Figure 67. This figure further illustrates the changes in use types available under a theoretical two-foot change in levels (Figure 69, upper dotted line).

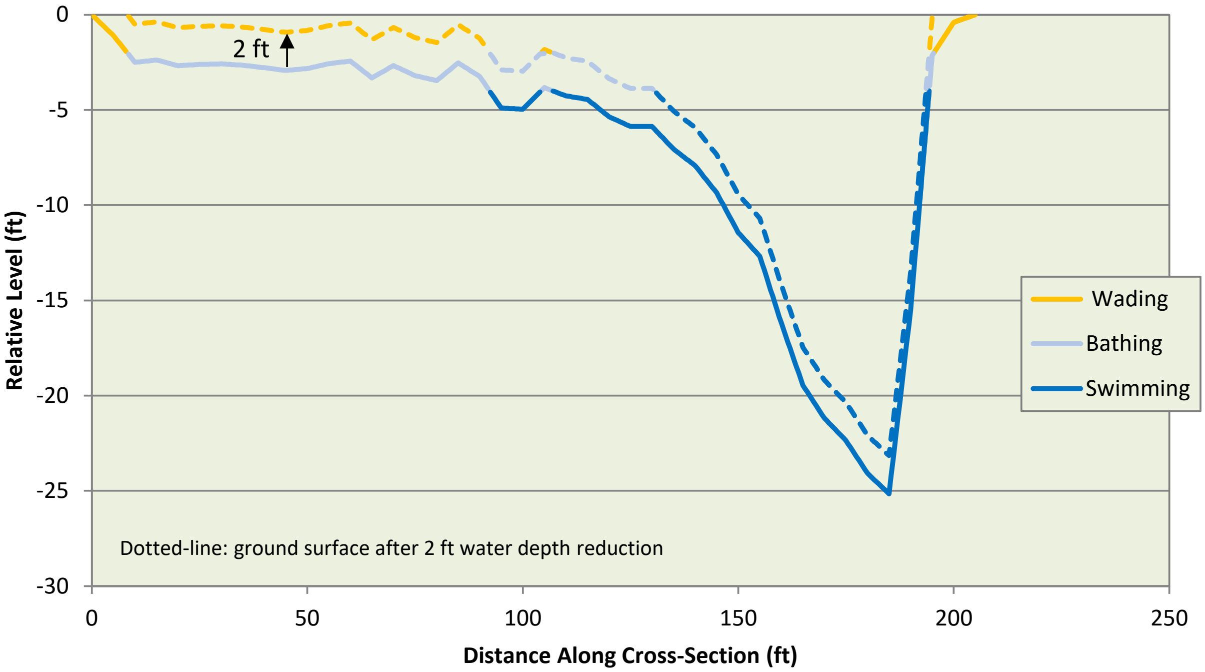


Figure 69. Bathymetric Cross-Section for Manatee Springs with Example 2-foot Water Depth Reduction

For each recreational class Microsoft Excel Solver was used to find the change in depth that corresponded to a 15% loss in the area available for that recreational use. In the case of wading (depths 0-2 feet) the allowable change in levels was 4.10 feet before a 15% loss of available area occurred. For bathing a decrease in levels of 0.48 feet caused a 15% decrease in available area. In the case of swimming the allowable change in levels was 0.57 feet before a 15% loss of available area occurred. Figure 70 shows the allowable shift by use type for the spring pool at a starting level of 1.25 feet NAVD88 (depth of 0 feet).

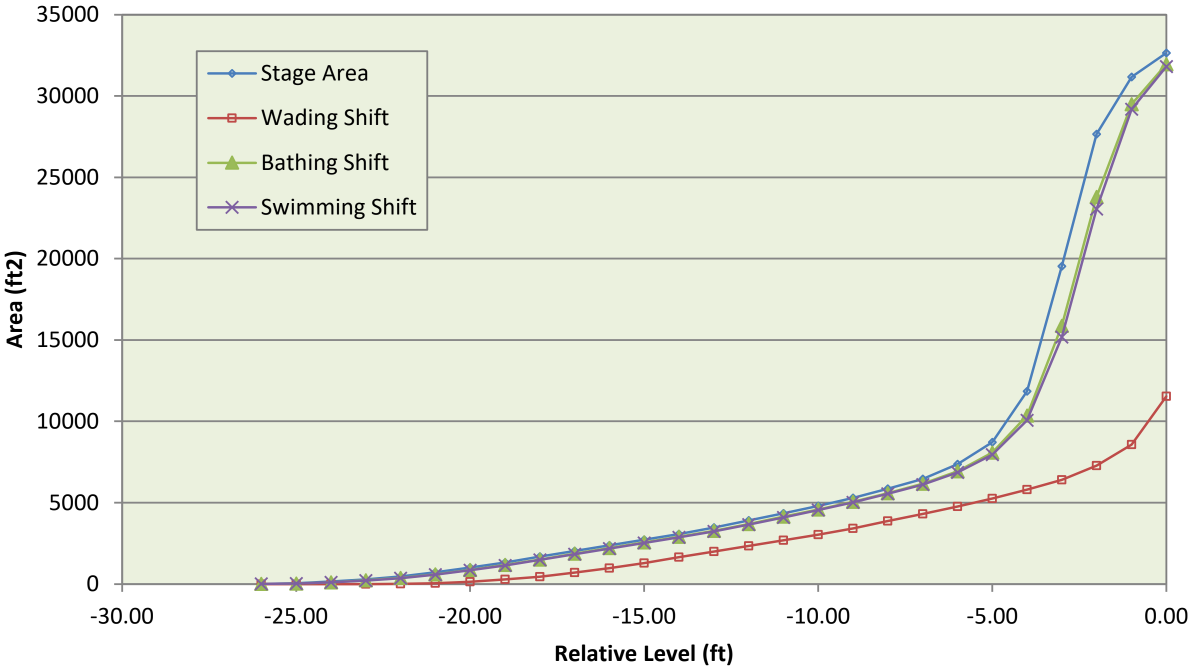


Figure 70. Stage Area with Allowable Level Changes by Use

Manatee Springs has widely fluctuating levels that are driven partially by levels on the Suwannee River. Bathymetry can be developed for the spring at a high elevation through the combination of bathymetric data and LiDAR to develop a topographic map of the spring pool and/or spring run. This can then be evaluated across a range of levels to determine the allowable thresholds for the spring under varying starting conditions as shown for a variety of examples in Table 29.

Table 29. Allowable Level Decreases Associated with Recreational Uses

Starting Water Elevation (ft NAVD88)	Allowable Level Change (ft)			Minimum Allowable Level Change (ft)
	Wading (0-2' Depth)	Bathing (2-4' Depth)	Swimming (≥4' Depth)	
1.25	4.10	0.48	0.57	0.48
1.00	3.56	0.48	0.53	0.48
0.75	3.09	0.48	0.49	0.48
0.50	2.62	0.43	0.73	0.43

Section 6.0 Conclusions and Recommendations

This study found that most MFLs developed for springs or rivers that include springs have not relied on RAS attributes in setting MFLs. Of the 26 evaluated MFLs, only one set the MFL based on protecting WRV 1 (recreational boat passage in the Wacissa River) and one set the MFL based on protecting WRV 6 (potential aesthetic changes due to residence time at Gemini Springs). Of the remaining MFLs, 17 were established based on protecting WRV 2, one based on protecting WRV 3, one based on protecting WRV 5, and seven that did not rely on a specific WRV for MFL development. This finding demonstrates the need for improved metrics for evaluating RAS attributes as part of WRV 1 and 6.

This study focused on the development of additional metrics for RAS attributes based on a combination of data collection, site visits, data analysis, and demonstration of proposed methods for a selected spring. Data were collected, organized, and summarized for 19 springs within the SRWMD. A site visit was completed for 17 of the 19 springs (excluding Poe Springs and Devil's Ear Spring) to evaluate the applicability of each WRV at the springs with a specific focus on RAS attributes. These site visits found that WRVs 1 and 6 were applicable at all 17 of the visited springs with the exception of WRV 1 at White Sulphur Spring where no recreational access to the spring pool is available.

A recommendation of this study was consistent data collection across springs to facilitate MFL development. Recommendations included collection of physical data (bathymetry, water level, and flow); water quality data (field parameters, nutrient data, and other water quality parameters); human use data (park attendance, human use, and visitor surveys); biological data (vegetation, fishes, manatees, turtles, macroinvertebrates, and bioassessments); and other data (water clarity, metabolism, and light attenuation). These data recommendations also included sampling frequencies for the proposed parameters and alternative collection techniques for some parameters. An additional recommendation was collection of public perception data for application across spring MFLs to quantify user preferences and tolerance of changes in various attributes including water color, algae coverage, and light transmission/clarity. By quantifying public perception, significant harm can be defined for various parameters as a part of WRV 6.

Following data recommendations this study evaluated RAS attributes for Manatee Springs. Manatee Springs was selected for this analysis because of data availability for attendance, human use, water quality, manatees, water clarity, bathymetry, water levels, and flows. Specifically, water clarity data available for Manatee Springs were considered to be critical relative to RAS metric development. Based on analysis of data and relationships for Manatee Springs the following results and relationships were identified:

- Based on the available period with high-frequency flow data (the past 12 years) flows showed an increasing trend at Manatee Springs. Not unexpectedly, the flows at the spring were correlated with the differential head between an adjacent well and the spring pool level.
- Residence time which has been considered as a metric was evaluated for Manatee Springs. Residence time in the spring pool is too short (~30 minutes at the one

percentile flow) to provide a meaningful MFL metric for evaluation. Residence time and the relationship to water quality and/or water clarity may provide some value in systems with a longer spring run and residence time.

- Bathing capacity which has been used as a metric in MFL development was assessed for Manatee Springs. Based on Department of Health guidelines (500 gallons/person/day), flow through the spring pool is sufficient to accommodate more than 86,000 swimmers per day, even at the one percentile flow. This is significantly more than the park can accommodate from the standpoint of area within the spring pool and all other facilities (parking, bathrooms, etc.). This metric is not sensitive enough to be valuable for MFL development.
- Manatee presence is correlated with higher park attendance in winter, providing a useful metric for MFL development. Furthermore, persistent manatee presence was correlated with increases in park attendance.
- Decreases in water clarity at Manatee Springs are due to flooding events on the Suwannee River with dark water conditions (Clarity Level C-E) being related to lower flows than clear water conditions (Clarity Level A). The highest observed flows were associated with Clarity Level B (green tinted water). Both temperature and specific conductance data in the spring pool showed the occurrence of dark water events indicating the potential value of these parameters for supplemental monitoring. Higher park attendance was correlated with better water clarity (Clarity Level A).

These findings can be applied to MFL development in a variety of ways. The predictable relationship between clarity and attendance can be evaluated by using a hydrodynamic model to evaluate changes in dark water frequency, duration, and recovery time following flow reversal events. The relationship observed between manatee presence and attendance further supports protection of manatees under WRV 6 in addition to consideration under WRV 2.

Recreational depths protected as part of WRV 1 in existing MFLs have typically been no more than 2-2.5 feet for boat passage. This depth was considered to be insufficient to protect swimming in spring pools or runs. This study proposed using bathymetric data to calculate the allowable change in levels that can occur without causing significant harm. At Manatee Springs this method was applied for three classes of recreational use with varying depth requirements (wading 0-2 feet, bathing 2-4 feet, and swimming >4 feet) to determine the area available for each form of recreation and the change in levels that would result in a 15% loss of area for that use class. This method appears to be readily applicable in most spring systems with collection of bathymetry.

Based on this study additional metrics are available to assess RAS attributes in springs during MFL development. These metrics can be applied based on a combination of existing data and supplemental data collection. Additional work is recommended to quantify public perception of springs under variable conditions. This study also recommends further development and application of the bathymetric method presented and continuous light transmittance data collection in a spring to improve and refine these techniques. By applying the findings of this study in conjunction with other studies and continued data collection, MFL development can be improved to more thoroughly account for changes to all applicable WRVs.

Section 7.0 References

Adler, J. M., Barry, S. C., Johnston, G. R., Jacoby, C. A., & Frazer, T. K. (2018). An Aggregation of Turtles in a Florida Spring Yields Insights into Effects of Grazing on Vegetation. *Freshwater Science*, *37*(2), 397–403. https://doi.org/10.1086/697541

Alenicheva, D. (2012). *Assessing Springshed Residents' Perceptions of North Central Florida Springs*. University of Florida.

Amec Foster Wheeler Environment & Infrastructure, Inc. (2016a). *Synoptic Biological Monitoring of Springs Data Collection* (Final Report No. 600397). St. Johns River Water Management District.

Amec Foster Wheeler Environment & Infrastructure, Inc. (2016b). *Minimum Flows and Levels for the Middle Suwannee River and Priority Springs* (Draft Report 600390.1). Suwannee River Water Management District.

Anastasiou, C. J. (2006). *An Investigation of the Spatial and Temporal Trends in Water Clarity: Rainbow River, Florida* (p. 65). Florida Department of Environmental Protection.

Anderson, D. (2005). *Levy Blue Springs Bathymetry* [Map].

Applied Technology and Management, Inc. (2018). *Minimum Flows and Levels Steinhatchee River, Florida* (p. 177). Suwannee River Water Management District.

Atkins. (2014). *Work Plan – St. Marks River Rise, Wakulla, and Sally Ward Springs Minimum Flows and Levels Development*. Northwest Florida Water Management District.

Atkins North America, Inc & Debra Childs Woithe, Inc. (2012). *2011 Rainbow River Vegetation Evaluation* (p. 63). Southwest Florida Water Management District.

Basso, R., Hood, J., Kelly, M., Morales, J., & Hinkle, T. (2011). *Proposed Minimum Flows and Levels for the Gum Slough Spring Run Final Report*. Southwest Florida Water Management District.

Beeler, I. E., & O'Shea, T. J. (1988). *Distribution and Mortality of the West Indian Manatee (Trichechus manatus) in the Southeastern United States: A Compilation and Review of Recent Information. Volume Two: The Gulf of Mexico Coast* (No. 88–09; p. 293). National Ecology Research Center, Gainesville Field Station.

Billington, H. E. (1995). *Use Levels, Encounters, Satisfaction, and Perceived Crowding Among Recreation Visitors to the Rainbow River* [Master of Science]. University of Florida.

Biological Research Associates. (2006). *Madison Blue Spring Third Annual Monitoring Report Biological Monitoring Specified by the Environmental Monitoring Plan Associated with Suwannee River Water Management District Water Use Permit No. 2-98-00025M, Madison County, Florida* (p. 40). Nestlé Waters North America, Inc.

Biological Research Associates. (2007). *Madison Blue Spring Fourth Annual Monitoring Report Biological Monitoring Specified by the Environmental Monitoring Plan Associated with Suwannee River Water Management District Water Use Permit No. 2-98-00025M, Madison County, Florida* (p. 52). Nestlé Waters North America, Inc.

Bodine, C. (2021). *Utility of Side Scan Sonar in Freshwater Systems*.

Bonn, M. A. (2004). *Visitor Profiles, Economic Impacts and Recreational Aesthetic Values Associated with Eight Priority Florida Springs Located in the St. Johns River Water Management District Special Publication SJ2004-SP35*. St. Johns River Water Management District.

Bonn, M. A., & Bell, F. W. (2003). *Economic Impact of Selected Florida Springs on Surrounding Local Areas*. Florida Department of Environmental Protection.

Borisova, T., Hodges, A. W., & Stevens, T. J. (2014). *Economic Contributions and Ecosystem Services of Springs in the Lower Suwannee and Santa Fe River Basins of North-Central Florida*. University of Florida.

Borisova, T., Oehlbeck, K., Bi, X., Wade, T., Hodges, A., Grogan, K., & Hei, F. (2020). Economic Value of Florida Water Resources: Contributions of Tourism and Recreation to the Economy. *EDIS*, *2020*(1), 6. https://doi.org/10.32473/edis-fe1065-2019

Borisova, T., Wade, T., Bi, X., Oehlbeck, K., & Grogan, K. (2019a). *Economic Value of Florida Water Resources: Value of Freshwater-Based Recreational Experiences*. 8.

Borisova, T., Wade, T., Bi, X., Oehlbeck, K., & Grogan, K. A. (2019b). Valuing Florida’s Water Resources: Ecosystem Services Approach. *EDIS*, *2019*(4), 6. https://doi.org/10.32473/edis-fe1064-2019

Brower, J. E., Zar, J. H., & Ende, C. von. (1998). *Field and Laboratory Methods for General Ecology* (4th ed). WCB McGraw-Hill.

Butt, P. L., Morris, T. L., & Skiles, W. C. (2007). *Swallet/Resurgence Relationships on the Lower Santa Fe River, Florida*. Water Resource Associates, Inc.

Canfield Jr., D. E., & Hoyer, M. V. (1988). Influence of nutrient enrichment and light availability on the abundance of aquatic macrophytes in Florida streams. *Canadian Journal of Fisheries and Aquatic Sciences*, *45*, 1467–1472.

Cardno. (2017). *2016 Annual Monitoring Report Madison Blue Spring*. Nestlé Waters North America Inc.

Cardno. (2018). *2017 Annual Monitoring Report Madison Blue Spring*. Nestlé Waters North America Inc.

Cardno. (2019). *2018 Annual Monitoring Report Madison Blue Spring*. Nestlé Waters North America Inc.

Cardno. (2020). *2019 Annual Monitoring Report Madison Blue Spring*. Nestlé Waters North America Inc.

Casey Harris, Fatih Gordu, Jian Di, & Andrew Sutherland. (2016). *Determination of Minimum Flows for De Leon Springs, Volusia County, Florida* (Technical Publication No. SJ2016-3; p. 85). St. Johns River Water Management District.

Chapin, K. J., & Meylan, P. A. (2011). Turtle Populations at a Heavily Used Recreational Site: Ichetucknee Springs State Park, Columbia County, Florida. *Herpetological Conservation and Biology*, *6*(1), 51–60.

Dormsjo, K. (2008). *Oxygen Mediated Grazing Impacts in Florida Springs*. University of Florida.

DuToit, C. (1979). *The Carrying Capacity of the Ichetucknee Springs and River*. University of Florida.

Edwards, T. M., & Guillette Jr, L. J. (2007). Reproductive characteristics of male mosquitofish (Gambusia holbrooki) from nitrate-contaminated springs in Florida. *Aquatic Toxicology*, *85*, 40–47. https://doi.org/10.1016/j.aquatox.2007.07.014

Evans, J. M. (2007). *Algae, Exotics, and Management Response in Two Florida Springs: Competing Conceptions of Ecological Change in a Time of Nutrient Enrichment*. University of Florida.

Faraji, S. F. G. (2017). *Ichetucknee Springs: Measuring the Effects of Visitors on Water Quality Parameters Through Continuous Monitoring*. University of Florida.

Flannery, M., Chen, X., Heyl, M., Munson, A., & Dachsteiner, M. (2008). *The Determination of Minimum Flows for the Lower Alafia River Estuary*. Southwest Florida Water Management District.

Florida Department of Environmental Protection. (1997). *Bioassessment: Ichetucknee River* (pp. 1–5).

Florida Department of Environmental Protection. (2000a). *Manatee Spring EcoSummary (2000 – 2007)*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2000b). *Ichetucknee Springs State Park Unit Management Plan*. Division of Recreation and Parks.

Florida Department of Environmental Protection. (2003a). *Fanning Springs State Park Unit Management Plan* (p. 79).

Florida Department of Environmental Protection. (2003b). *Troy Spring EcoSummary (2001 – 2003)*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2005a). *Peacock Springs EcoSummary (2002 – 2005)*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2005b). *Lafayette Blue Springs State Park Unit Management Plan* (p. 100).

Florida Department of Environmental Protection. (2007a). *Florida State Park System Economic Impact System*.

Florida Department of Environmental Protection. (2007b). *Fanning Spring EcoSummary (2000 – 2007)*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2007c). *Ichetucknee Spring EcoSummary (2000 – 2007)*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2011). *Florida State Park System Economic Impact Assessment*.

Florida Department of Environmental Protection. (2013). *Wes Skiles Peacock Springs State Park Unit Management Plan*.

Florida Department of Environmental Protection. (2016). *Madison Blue Spring State Park Unit Management Plan* (p. 156).

Florida Department of Environmental Protection. (2017a). *Gilchrist Blue Springs Survey Results – Online Survey Preliminary Public Workshop*. Florida Department of Environmental Protection, Division of Recreation and Parks.

Florida Department of Environmental Protection. (2017b). *Fanning Springs State Park Unit Management Plan*.

Florida Department of Environmental Protection. (2017c). *Troy Spring State Park Unit Management Plan*.

Florida Department of Environmental Protection. (2018a). *Stephen Foster Folk Culture Center State Park Approved Unit Management Plan* (p. 178).

Florida Department of Environmental Protection. (2018b). *Manatee Springs State Park Unit Management Plan*.

Florida Department of Environmental Protection. (2020). *Ruth B. Kirby Gilchrist Blue Springs State Park Unit Management Plan*.

Florida Department of Environmental Protection & Florida Department of Agriculture and Consumer Services. (2015). *Focused Implementation of Best Management Practices in the Santa Fe River Basin* [2015 Interim Progress Report].

Florida Fish and Wildlife Conservation Commission. (2021). *Manatee Synoptic Surveys*. FWC. http://myfwc.com/research/manatee/research/population-monitoring/synoptic-surveys/

Florida Fish and Wildlife Conservation Commission & Florida Department of Environmental Protection. (2020). *Submerged Aquatic Vegetation (SAV) Restoration Study: Ichetucknee, Fanning and Manatee Springs*.

Flowers, H. J., & Pine III, W. E. (2008). Observation of a Juvenile Gulf Sturgeon in the Santa Fe River, Florida. *Southeastern Naturalist*, *7*(3), 559–561.

Franz, D. (2002). *Crustacean Surveys in Spring Habitats of Seventeen Florida State Parks*.

Freese, R., & Sutherland, A. (2017). *Minimum Flow Determination for Alexander Springs Lake County, Florida* (Technical Publication No. SJ2017-3; p. 417). St. Johns River Water Management District. https://www.sjrwmd.com/minimumflowsandlevels/alexander-springs/

FWC. (2021). *Manatee Synoptic Survey Observation Locations* [GIS and Mapping Data]. Florida Fish and Wildlife Conservation Commission. https://geodata.myfwc.com/datasets/968b88db740d4c1eb9b125e7d94f9b17_0

Hale, J. A., & Streever, W. J. (1994). Cave Fauna Distribution within Fully-Flooded Cave Systems in Florida. *Journal of Freshwater Ecology*, *9*(3). https://doi.org/10.1080/02705060.1994.9664883

Hallas, J. F., & Magley, W. (2008). *Nutrient and Dissolved Oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z)* (p. 117) [Final Report]. Florida Department of Environmental Protection.

Harris, C., Gordu, F., Di, J., & Sutherland, A. (2016). *Determination of Minimum Flows for De Leon Springs, Volusia County, Florida* (Technical Publication No. SJ2016-3; p. 85). St. Johns River Water Management District.

Harris, C., Mouzon, N., Gordu, F., & Sutherland, A. (2017). *Determination of Minimum Flows for Silver Glen Springs, Marion and Lake Counties, Florida* (Technical Publication No. SJ2017-4; p. 185). St. Johns River Water Management District.

Herrick, G., Chen, X., Anastasiou, C., Basso, R., Mendez-Ferrer, N., Ortega, N., Rogers, D., & Leeper, D. (2019a). *Reevaluation of Minimum Flows for the Chassahowitzka River System* (p. 223). Southwest Florida Water Management District.

Herrick, G., Chen, X., Anastasiou, C., Basso, R., Mendez-Ferrer, N., Ortega, N., Rogers, D., & Leeper, D. (2019b). *Reevaluation of Minimum Flows for the Homosassa River System Final Draft* (p. 233). Southwest Florida Water Management District.

Herrick, G., Chen, X., Basso, R., Heyl, M., & Leeper, D. (2017). *Recommended Minimum Flow for the Crystal River/Kings Bay System – Revised Final Report* (p. 107). Southwest Florida Water Management District.

Herring, B. J., & Judd, W. S. (1995). A Floristic Study of Ichetucknee Springs State Park, Suwannee and Columbia Counties, Florida. *Castanea*, *60*(4), 318–396.

Heyl, M. G. (2008). *Weeki Wachee River System Recommended Minimum Flows and Levels* (p. 235). Southwest Florida Water Management District.

Heyl, M. G., Leeper, D., Basso, R., & Kelly, M. (2012). *Recommended Minimum Flows for the Chassahowitzka River System* (p. 223). Southwest Florida Water Management District.

Holland, S. M., & Cichra, C. E. (1994). *Human and Environmental Dimensions of the Recreational Use of Blue Run and Rainbow Springs State Park, Dunnellon, Florida* (p. 250). Florida Department of Natural Resources, Division of Recreation and Parks.

Holzwart, K. R., Ghile, Y., Basso, R., Leeper, D., & King, S. (2017). *Recommended Minimum Flow for the Rainbow River System – Revised Final Draft* (p. 121). Southwest Florida Water Management District.

Howard T. Odum Florida Springs Institute. (2012a). *Ichetucknee Springs Restoration Plan*. Ichetucknee Springs Working Group.

Howard T. Odum Florida Springs Institute. (2012b). *Ichetucknee Springs & River: A Restoration Action Plan* (p. 24).

Howard T. Odum Florida Springs Institute. (2015a). *Ichetucknee River Monitoring Summary (March 2014 – January 2015)*. Florida Department of Environmental Protection.

Howard T. Odum Florida Springs Institute. (2015b). *Lower Suwannee River Springs Restoration Plan*.

Howard T. Odum Florida Springs Institute. (2016a). *Kings Bay / Crystal River Springs Restoration Plan* (p. 139).

Howard T. Odum Florida Springs Institute. (2016b). *Lower Ichetucknee Baseline Assessment* (p. 141).

Howard T. Odum Florida Springs Institute. (2016c). *Wakulla Springs Baseline Ecosystem Assessment* (p. 103). Howard T. Odum Florida Springs Institute.

Howard T. Odum Florida Springs Institute. (2016d). *Wekiva River and Springs Restoration Plan* (p. 262). The Howard T. Odum Florida Springs Institute.

Howard T. Odum Florida Springs Institute. (2017). *Middle Suwannee River Springs Restoration Plan* (p. 242).

Howard T. Odum Florida Springs Institute. (2018a). *Florida Springs Conservation Plan*.

Howard T. Odum Florida Springs Institute. (2018b). *Volusia Blue Spring Restoration Plan* (p. 24).

Howard T. Odum Florida Springs Institute. (2020). *Santa Fe River and Springs Environmental Analysis – Phase 3* [Phase 3 – Final Report]. Santa Fe River and Springs Scientific Working Group.

Howard T. Odum Florida Springs Institute. (2021). *Blueprint for Restoring Springs on the Santa Fe River* (p. 32).

HSW Engineering, Inc. (2009). *Water Resource and Human Use Assessment of the Rainbow River in Marion County, Florida* (p. 146). Southwest Florida Water Management District.

HSW Engineering, Inc. (2016). *Minimum Flows and Levels for the Aucilla River, Wacissa River and Priority Springs* (p. 246). Suwannee River Water Management District.

HSW Engineering, Inc. (2019). *Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs* [Draft Report]. Suwannee River Water Management District.

HSW Engineering, Inc. (2021a). *Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs* [Final Report]. Suwannee River Water Management District.

HSW Engineering, Inc. (2021b). *Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs*. Suwannee River Water Management District.

Hupalo, R. B., Neubauer, C. P., Keenan, L. W., Clapp, D. A., & Lowe, E. F. (1994). *Establishment of Minimum Flows and Levels for the Wekiva River System* (Technical Publication No. SJ94-1; p. 98). St. Johns River Water Management District.

Huth, W. L., & Morgan, O. A. (2011). Measuring the Willingness to Pay for Cave Diving. *Marine Resource Economics*, *26*(2), 151–166. https://doi.org/10.5950/0738-1360-26.2.151

INTERA. (2013). *Hydrologic Database, Statistical Analysis, and Adjusted Historical Flow Development of Select Surface Water Stations on the Lower Santa Fe and Ichetucknee Rivers*. Suwannee River Water Management District.

Janicki Environmental, Inc. & WSP, Inc. (2018). *Exploratory Evaluation of Water Quality and Flow Relationships for the Chassahowitzka River in Support of Minimum Flows Reevaluation* (p. 88). Southwest Florida Water Management District.

Johnston, G. R., Mitchell, J. C., Munscher, E. C., Shemitz, G. A., Butt, P. L., Cole, S., & Hootman, T. (2020). Temporal Variation in a Turtle Assemblage Inhabiting a Florida Spring-Fed River. *Southeastern Naturalist*, *19*(2), 271. https://doi.org/10.1656/058.019.0207

Johnston, G. R., Mitchell, J. C., Shemitz, G. A., Butt, P. L., & Adler, J. M. (2018). Origin and Structure of a Large Aggregation of Suwannee Cooters (Pseudemys concinna suwanniensis) in a Florida Spring. *Chelonian Conservation and Biology*, *17*(1), 54–62. https://doi.org/10.2744/CCB-1290.1

Johnston, G. R., Mitchell, J. C., Suarez, E., Morris, T., Shemitz, G. A., Butt, P. L., & Knight, R. L. (2016). The Santa Fe River in Northern Florida: Effects of Habitat Heterogenity on Turtle Populations. *Bulletin of the Florida Museum of Natural History*, *54*(5), 69–103.

Kaczynski, A. T., & Crompton, J. L. (2003). A Procedure for Improving the Accuracy of Visitor Counts at State Parks. *Proceedings of the Northeastern Recreation Research Symposium*, 8.

Karst Environmental Services, Inc. (2020). *Santa Fe River Springs Biological/Botanical Survey, with Focus on Submerged Aquatic Vegetation; Selected Santa Fe River Springs, Alachua, Columbia and Gilchrist Counties, Florida May & June 2020 – Draft* (p. 121) [Draft Report]. Alachua County Environmental Protection Department.

Kasvi, E., Salmela, J., Lotsari, E., Kumpula, T., & Lane, S. N. (2019). Comparison of remote sensing based approaches for mapping bathymetry of shallow, clear water rivers. *Geomorphology*, *333*, 180–197. https://doi.org/10.1016/j.geomorph.2019.02.017

Katz, B. G., Hornsby, H. D., Bohlke, J. F., & Mokray, M. F. (1999). *Sources and Chronology of Nitrate Contamination in Spring Waters, Suwannee River Basin, Florida* (Water-Resources Investigations Report No. 99–4252). U.S. Geological Survey. http://fl-water.usgs.gov/

Kelly, M., Munson, A., Morales, J., & Leeper, D. (2005). *Alafia River Minimum Flows and Levels – Freshwater Segment* (p. 235). Southwest Florida Water Management District.

Kil, N., & Confer, J. (2005). *A Classification of Major Springs in Florida Using the Water Recreation Opportunity Spectrum Framework*. Proceedings of the 2005 Northeastern Recreation Research Symposium.

Knight, R. L., & Gutzwiller, K. J. (Eds.). (1995). *Wildlife and recreationists: Coexistence through management and research*. Island Press.

Kurz, R. C., Woithe, D. C., Notestein, S. K., Frazer, T. K., Hale, J. A., & Keller, S. R. (2004). *Mapping and Monitoring Submerged Aquatic Vegetation in Ichetucknee Springs – 2004* (p. 164) [Final Report]. Suwannee River Water Management District.

L. A. Whitford. (1956). The Communities of Algae in the Springs and Spring Streams of Florida. *Ecology*, *37*(3), 433–442.

Laist, D. W., & Reynolds, J. E. (2005). Florida Manatees, Warm-Water Refuges, and an Uncertain Future. *Coastal Management*, *33*(3), 279–295. https://doi.org/10.1080/08920750590952018

Landsfeld, J., & Jones, I. (2013, October 30). *Discharge, Mapping, Modeling and Beyond: The Hunt for Submerged Springs*.

Leeper, D. A., Flannery, M. S., Heyl, M. G., Basso, R., & Kelly, M. (2012). *Recommended Minimum Flows for the Homosassa River System* (p. 223). Southwest Florida Water Management District.

Liebowitz, D., & Cohen, M. (2013). *Environmentally Mediated Gastropod Control of Algal Proliferation in Ichetucknee Springs* (p. 74) [Final Report]. Three Rivers FNPC, Inc.

Mace, J. W. (2017). *Determination of Minimum Flows for Gemini Springs Volusia County, Florida* (Technical Publication No. SJ2017-5; p. 128). St. Johns River Water Management District.

Mattson, R. A., Hall, D. L., Szafraniec, M. L., & Guyette, M. Q. (2019). *Synoptic Biological Survey of 14 Spring-Run Streams in North and Central Florida* (No. SJ2019-2; p. 111). St. Johns River Water Management District.

McClean, J. A. R. (2005). *Manatee Springs Bathymetry Study, Levy County, FL*. Florida Department of Environmental Protection.

Mirti, T. (2001). Springflow Assessment of White Sulphur Springs. *2001 Georgia Water Resources Conference*, 4.

Morgan, O. A., & Huth, W. L. (2011). Using revealed and stated preference data to estimate the scope and access benefits associated with cave diving. *Resource and Energy Economics*, *33*(1), 107–118. https://doi.org/10.1016/j.reseneeco.2010.01.005

Muhar, A., Arnberger, A., & Brandenburg, C. (2002). *Methods for Visitor Monitoring in Recreational and Protected Areas: An Overview*. 6.

Mumma, M. T., Cichra, C. E., & Sowards, J. T. (1996). Effects of Recreation on the Submersed Aquatic Plant Community of Rainbow River, Florida. *Journal of Aquatic Plant Management*, *34*(July), 4.

Munch, D. A., Toth, D. J., Huang, C., Davis, J. B., Fortich, C. M., Osburn, W. L., Phlips, E. J., Quinlan, E. L., Allen, M. S., Woods, M. J., Cooney, P., Knight, R. L., Clarke, R. A., & Knight, S. L. (2006). *Fifty-Year Retrospective Study of the Ecology of Silver Springs, Florida* (Special Publication No. SJ2007-SP4; p. 314). St. Johns River Water Management District.

Munson, A., Kelly, M., Morales, J., & Leeper, D. (2007a). *Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs*. Southwest Florida Water Management District.

Munson, A., Kelly, M., Morales, J., & Leeper, D. (2007b). *Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs* (p. 295). Southwest Florida Water Management District.

Normandeau Associates, Inc. (2011). *Ichetucknee Springs and River Restoration Plan*. Florida Department of Environmental Protection.

NWFWMD. (2019). *Minimum Flows for the St. Marks River Rise*. Northwest Florida Water Management District.

NWFWMD. (2020). *Recommended Minimum Flows for Wakulla and Sally Ward Springs – Draft*. Northwest Florida Water Management District.

Odum, Howard T. (1953). *Productivity of Florida Springs, NONR 580 (02). The 1st semi-annual report to Biology Division, Office of Naval Research: Progress from June 1 1952 to January 31 1953.* (p. 34). University of Florida.

Pandion Systems, Inc. (2003). *Carrying Capacity Study of Silver Glen Spring and Run* (Final Report SL 982; p. 86). Florida Department of Environmental Protection.

Paulauskas, G. (2001). *Factors Associated with Satisfaction of Recreational Users of the Ichetucknee River*. University of Florida.

Politano, V. A. (2008). *Factors Affecting Perphyton Abundance on Macrophytes in a Spring-Fed River in Florida*. University of Florida.

Provancha, J., Taylor, C., Gimond, Dr. M., Wild, M., & Rouhani, Dr. S. (2012). *Carrying Capacity Assessment of Manatee Forage and Warm-water Associated with Eleven Florida Sites* [Final Report]. U. S. Department of the Interior.

Rao, D. V. (2008). *An Evaluation of Minimum Flows and Levels for the Wekiva River at the State Road 46 Bridge, Florida – Using the 1935-2004 USGS Streamflow Data* (Special Publication No. SJ2008-SP3; p. 123). St. Johns River Water Management District.

Rosenau, J. C., Faulkner, C. W., Hendry, Jr, C. D., & Hull, R. W. (1977). *Springs of Florida. Bulletin 31 (revised)* (p. 461). Department of Natural Resources. Division of Resource Management, Bureau of Geology, Florida.

Rouhani, S., Sucsy, P., Hall, G., Osburn, W., & Wild, M. (2007). *Analysis of Blue Spring Discharge Data to Determine a Minimum Flow Regime* (Special Publication No. SJ2007-SP17). St. Johns River Water Management District.

Seong, C.-H., & Wester, A. E. (2019). *Wekiva River Hydrology and Hydraulic Modeling for Minimum Flow and Level Evaluations*. St. Johns River Water Management District.

Shrestha, R. K., Alavalapati, J. R. R., Stein, T. V., Carter, D. R., & Denny, C. B. (2002). Visitor Preferences and Values for Water-Based Recreation: A Case Study of the Ocala National Forest. *Journal of Agricultural and Applied Economics*, *34*(3), 547–559. https://doi.org/10.1017/S1074070800009305

Sickman, J. O., Albertin, A., Anderson, W., Pinowska, A., & Stevenson, R. J. (2009). A Comparison of Internal and External Supply of Nutrients to Algal Mats in Two First Magnitude Springs in Florida. *Journal of Aquatic Plant Management*, *47*, 135–144.

SJRWMD. (2013). *Prevention/Recovery Strategy for Implementation of Minimum Flows and Levels for Volusia Blue Spring and Big, Daugharty, Helen, Hires, Indian, and Three Island Lakes*. St. Johns River Water Management District Division of Regulatory, Engineering, and Environmental Services.

Skiles, W. A., Hayes, A., & Butt, P. L. (1991). *Ichetucknee hydrogeology study* (p. 150). Karst Environmental Services.

Solomon, B. D., Corey-Luse, C. M., & Halvorsen, K. E. (2004). The Florida Manatee and Eco-Tourism: Toward a Safe Minimum Standard. *Ecological Economics*, *50*(1–2), 101–115. https://doi.org/10.1016/j.ecolecon.2004.03.025

Sorice, M. G., Shafer, C. S., & Ditton, R. B. (2006). Managing Endangered Species Within the Use–Preservation Paradox: The Florida Manatee (Trichechus manatus latirostris) as a Tourism Attraction. *Environmental Management*, *37*(1), 69–83. https://doi.org/10.1007/s00267-004-0125-7

SRWMD. (2017). *Minimum Flows Determination and Status Evaluation of Four Outstanding Florida Springs: Falmouth Spring, Lafayette Blue Spring, Peacock Springs, and Troy Spring Draft* (p. 8). Suwannee River Water Management District.

Steigerwalt, N. M. (2005). *Environmental Factors Affecting Aquatic Invertebrate Community Structure on Snags in the Ichetucknee River, Florida*. University of Florida.

Stevenson, R. J., Pinowska, A., Albertin, A., & Sickman, J. O. (2007). *Ecological Condition of Algae and Nutrients in Florida Springs* (Synthesis Report WM 858; p. 58). Florida Department of Environmental Protection.

Streever, W. J. (1992). Report of Cave Fauna Kill at Peacock Springs Cave System, Suwannee County, Florida. *Florida Scientist*, *55*(2), 125–128.

Strong, W. A. (2004). *Temporal Water Chemistry Trends Within Individual Springs and Within a Population of Florida Springs* [Fisheries and Aquatic Sciences]. University of Florida.

Sutherland, A. B., Freese, R., Slater, J. B., Gordu, F., Di, J., & Hall, G. B. (2017). *Minimum Flows Determination for Silver Springs Marion County, Florida* (Technical Publication No. SJ2017-2). St. Johns River Water Management District.

Suwannee River Water Management District. (2013). *Minimum Flows and Levels for The Lower Santa Fe and Ichetucknee Rivers and Priority Springs*.

SWFWMD. (2004). *The Determination of Minimum Flows for Sulphur Springs, Tampa* (p. 265). Southwest Florida Water Management District.

The Florida Springs Task Force. (2006). *Florida's Springs Strategies for Protection and Restoration* (p. 185). Florida Department of Environmental Protection.

Walsh, S. J., & Williams, J. D. (2003). *Inventory of Fishes and Mussels in Springs and Spring Effluents of North-central Florida State Parks* (p. 94) [Final Report]. Florida Park Service Service and Department of Environmental Protection.

Warren, G. L., & Bernatis, J. (2017). *Status of the Ichetucknee Siltsnail (Floridobia mica) in Coffee Spring, Ichetucknee Springs State Park, Suwannee County, Florida, November 2015*. 18.

Warren, G. L., Nagid, E. J., Strong, W. A., Tuten, T., Hohlt, D., Nelson, E., Bernatis, J., & Biologists, P. (2008). *Habitat Selection by Stream Indicator Biota: Development of Biological Tools for the Implementation of Protective Minimum Flows for Florida Stream Ecosystems* (Florida State Wildlife Grant Project No. 98502532195; p. 642). Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute.

Water Resource Associates, Inc. (2004). *Development of Madison Blue Spring-Based MFL Technical Report* (p. 236). Suwannee River Water Management District.

Water Resource Associates, Inc. (2005). *MFL Establishment for the Lower Suwannee River & Estuary, Little Fanning, Fanning & Manatee Springs* (p. 424). Suwannee River Water Management District.

Water Resource Associates, Inc. (2006). *MFL Establishment for the Waccasassa River, Estuary and Levy (Bronson) Blue Spring Technical Report* (p. 258). Suwannee River Water Management District.

Water Resource Associates, Inc. (2007). *MFL Establishment for the Upper Santa Fe River* (p. 294). Suwannee River Water Management District.

Wernly, J. F., Zajd, H. J., & Coon, W. F. (2016). *Bathymetric Survey and Estimation of Storage Capacity of Lower Sixmile Creek Reservoir, Ithaca, New York* (Open-File Report No. 2016–1157; Open-File Report, p. 26). U.S. Department of the Interior, U.S. Geological Survey.

Wetland Solutions, Inc. (2004). *Human Use and Ecological Evaluation of the Recommended Minimum Flow Regime for Blue Spring and Blue Spring Run, Volusia County* (Special Publication No. SJ2004-SP34). St. Johns River Water Management District.

Wetland Solutions, Inc. (2006a). *Ichetucknee River, Florida Ecosystem Evaluation and Impairment Assessment* [Work Plan]. Three Rivers, Inc.

Wetland Solutions, Inc. (2006b). *Human Use and Ecological Evaluation of the Recommended Minimum Flow Regime for Blue Spring and Blue Spring Run, Volusia County, Florida* (Special Publication No. SJ2007-SP19). St. Johns River Water Management District.

Wetland Solutions, Inc. (2007). *Human Use and Ecological Water Resource Values Assessments of Rock and Wekiwa Springs (Orange County, Florida) Minimum Flows and Levels Final Report* (Special Publication No. SJ2008-SP2; p. 192). St. Johns River Water Management District.

Wetland Solutions, Inc. (2009). *Final Report Water Resource Value Monitoring for Blue Spring and Blue Spring Run, Volusia County, Florida* (Special Publication No. SJ2010-SP5). St. Johns River Water Management District.

Wetland Solutions, Inc. (2010). *An Ecosystem-Level Study of Florida's Springs* (Final Report No. 08010; p. 233). Florida Fish and Wildlife Conservation Commission.

Wetland Solutions, Inc. (2011). *Ichetucknee River, Florida Assessment of the Effects of Human Use on Turbidity* (p. 45) [Final Report]. Three Rivers Trust FNPC.

Wetland Solutions, Inc. (2013). *Ginnie Springs Ecological Analysis (July 2012 – May 2013)* (p. 72) [Annual Report]. Ginnie Springs Outdoors, LLC.

Wetland Solutions, Inc. (2014). *Ichetucknee River Ecosystem Metabolism Study (2012-2013)* (p. 49). Howard T. Odum Florida Springs Institute.

Wetzel, R. G. (2001). *Limnology: Lake and river ecosystems* (3rd ed). Academic Press.

Wood Environment and Infrastructure Solutions, Inc. (2020). *Weeki Wachee Natural System Carrying Capacity Study-Analysis and Reporting (WW06) – Task #4* (p. 215) [Final Report]. Southwest Florida Water Management District.

Woodruff, A. (1993). *Florida Springs Chemical Classification and Aquatic Biological Communities*. University of Florida.

Work, K., & Jennings, C. J. (2019). Underwater video surveys provide a more complete picture of littoral fish populations than seine samples in clear Florida springs. *Marine and Freshwater Research*, *70*(8), 1178. https://doi.org/10.1071/MF18288

Wu, Q., & Bi, X. (2018). *Valuing the Recreation Visits to Florida Springs: Benefits Estimates from TCM and CVM*.

Wu, Q., Bi, X., Grogan, K., & Borisova, T. (2018). Valuing the Recreation Benefits of Natural Springs in Florida. *Water*, *10*(10), 1379. https://doi.org/10.3390/w10101379

Appendix A

Summary of Spring-Related MFLs

NWWMD – St. Marks River Rise

Adapted from “NWFWMD, 2019. Minimum Flows for the St. Marks River Rise. Northwest Florida Water Management District, Leon County, Florida."

Background

St. Marks River Rise is a blackwater river in Leon County, Florida (Figure A-1 and Table A-1). The headwaters of the St. Marks River are located in eastern Leon County. Flow in the Upper St. Marks River is primarily driven by runoff with small contributions from Chicken Branch Spring and Horn Spring. Water flows approximately 19 miles south into two swallets before resurfacing 0.6 miles south at the St, Marks River Rise. Flow within the rise is greatly increased through the addition of spring water. The estimated average long-term (1956-2017) flow rate of St. Marks River Rise is 452 cfs and is calculated as the difference between the flow entering the swallets and coming out of the River Rise. The rise flows 11.4 miles before combining with the Wakulla River and discharging into Apalachee Bay and the Gulf of Mexico. The rise and its shoreline are generally in a natural condition. The river is generally divided by shoals of shallow, out-cropped limestone with tidal effects occurring below the shoals and only minimal impacts above the shoals.

Figure A-1. St. Marks River Rise Study Area (NWFWMD, 2019)

Table A-1. St. Marks River Rise Spring Information

Spring	Magnitude	Latitude (dd)	Longitude (dd)
St. Marks River Rise	1st	30.27612	-84.14889

Minimum Flows and Minimum Levels

The proposed minimum flow was developed based on inundation of hardwood hammock habitats. The allowable reduction was found to be 33 cfs or 7.4% of the mean daily flow to cause a 15% reduction in inundation. Table A-2 provides a summary of the proposed minimum flow for St. Marks River Rise.

Table A-2. Proposed Minimum Flow for St. Marks River Rise

Spring	Average Baseline Flow	Allowable Spring Flow Reduction	
St. Marks River Rise	452 cfs	33 cfs (21 mgd)	7.4%

Baseline Period

The baseline spring flow time series was developed based on the difference in flow between the USGS St. Marks River Near Newport, FL station and the flow of the St. Marks River before flowing into the two swallets above Natural Bridge Road. The USGS 02326900 St. Marks River Near Newport, FL. Station includes data from October 1, 1956-present. Flows into the two swallets were available from October 1, 1956-present.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Safe Boat Passage - The River Rise is used for small boats, kayaking and canoeing which can be accessed through several boat ramps south of the U.S. Highway 98 bridge. Boat passage would be limited under reduced flows. A minimum or 2 feet in depth and 30 feet in continuous width are required for two motorboats to safely pass based on previous MFL reports. For canoes and kayaks, a minimum water depth of 1.5 feet deep is required for safe passage. This metric was assessed using the HEC-RAS model at transects located near the five shoals in the River Rise where access was most limited.

Other Recreation Considerations – Boat ramps and the ability to launch watercraft was also considered. While considered, it was not used for the determination in the WRV given the ability to modify these built structures to accommodate boat launches at lower water levels.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Fish Passage –There is a lack of information available regarding the passage of fish and warm water species which forces the water depth limit to be based off the deepest-bodied fish that travels through the system. Largemouth bass (*Micropterus salmoides*) are one of the many recreationally favored fish inhibiting the St. Marks River and was determined to be the deepest-bodied. The minimum water depth to accommodate a largemouth bass was 0.6 feet, with passage depths evaluated with the HEC-RAS model.

Instream Woody Habitat - Submerged woody habitat has been identified as important to invertebrates and alters streamflow characteristics creating multiple habitat types. Woody habitat was comprised of both dead and live material and was evaluated based on the frequency of time that water levels met or exceeded the mean elevation of this habitat.

Floodplain Habitat – Wetland canopy tree species were assessed as long-term hydrologic indicators. Wetland species need floods and inundation to maintain health, presence and reproduction. The frequency for which water levels met or exceeded the mean elevation of each floodplain community type was used for assessment of this criterion.

Manatee Passage - The Florida manatee is a federally threatened species under the Endangered Species Act of 1973. Manatee passage was evaluated based on maintaining a minimum passage depth of 3.8 feet across a width of 3.8 feet. This metric was evaluated using the HEC-RAS model near each of the shoals that might limit passage. The River Rise has not been considered a thermal refuge for manatees and a thermal refuge metric was not applied.

Other Fish and Wildlife Habitat Considerations – Physical Habitat Simulation (PHABSIM), and the System for Environmental Flows Analysis (SEFA) were both considered for application in the system, but no reliable relationships could be developed among channel profiles, velocities, and substrates. Maintenance of hydric soils rely on extended inundation and were considered protected by the floodplain metrics previously described.

Estuarine Resources (WRV 3)

Estuarine Habitats – Salinity and the extent of varying oligohaline zones can have impacts on a variety of plant (e.g. American eelgrass, bald cypress, arrowhead, etc.) and animal species. As flows decrease the extent of various oligohaline zones would be expected to move further inland causing possible shifts in plant and animal communities. Data collected between 2016-2017 were used to calibrate the EFDC model to evaluate a range of oligohaline zones including 0.5, 1, 2, 3, and 4 ppt for the volume, bottom surface area, and shoreline length of each zone.

Transfer of Detrital Material (WRV 4)

Spring flow generally does not contain much detrital material, rather inundation of the floodplain maintains the transfer of detrital material for species that depend on it. This WRV was not directly quantified, but rather considered protected by floodplain habitat inundation evaluated in WRV 2.

Maintenance of Freshwater Storage and Supply (WRV 5)

The Sam O. Purdom Power Generating Station uses the River Rise for cooling water withdrawals with most of the captured water returned to the River Rise. The Station is permitted through the FDEP with a maximum permitted withdrawal of 4.6 MGD. This facility is located in the lower reach of the rise and levels are primarily driven by tidal influences. This WRV was not directly quantified.

Aesthetic and Scenic Attributes (WRV 6)

Aesthetic and scenic attributes were described as addressed by WRVs 1, 2, and 3 and were not separately evaluated or quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

Floodplain function is expected to provide protection for this WRV. Floodplain inundation was evaluated as part of WRV 2 and was not separately quantified for this WRV.

Sediment Loads (WRV 8)

Transport of sediment was described as a function of flow and particularly high-flow events. This WRV was believed to be protected by the floodplain inundation flows evaluated as part of WRV 2 and was not separately quantified.

Water Quality (WRV 9)

The St. Marks River is an Outstanding Florida Water (except a 1.5-mile section between Rattlesnake Branch and the confluence with Wakulla River). This provides protection for the river by reducing the likelihood of projects that might discharge low quality water. Changes in flow were evaluated with regard to salinity, nitrate, specific conductivity, and dissolved oxygen. Changes in salinity were directly evaluated in WRV 3 and were not re-quantified. Relationships between flow and the remaining parameters were evaluated using a two-sided Mann-Kendall Test with a significance level of 0.05. A slight relationship was found for nitrate although values in the rise are very low, and less than the state standard of 0.35 mg/L for spring systems. Changes in flow were predicted to not cause exceedances of this standard. Dissolved oxygen exhibited no trend and specific conductivity displayed a slight increasing trend through time.

Navigation (WRV 10)

There are several marinas south of the study area and Sam O. Purdom Power Generating Station uses barges for fueling. Only a small amount of the study area is impacted by this commercial travel and the lower river is tidally influenced and insensitive to flow reductions. This WRV was not directly quantified.

NWFWMD – Wakulla and Sally Ward Springs

Adapted from NWFWMD, 2020. Recommended Minimum Flows for Wakulla and Sally Ward Springs - Draft. Northwest Florida Water Management District.

Background

Wakulla Spring and Sally Ward Spring are located within Edward Ball Wakulla Springs State Park in Wakulla County, Florida (Figure A-2 and Table A-3). Wakulla Spring is a first magnitude spring (>100 cfs) with an average discharge of 575 cfs (2004-2019). Sally Ward Spring is a second magnitude spring (>10 cfs), with an average discharge of 23 cfs (2004-2019) that flows approximately 0.7 miles to the southeast where it enters the Wakulla River just downstream from Wakulla Spring. Discharge from Wakulla and Sally Ward Springs, and other minor springs (Table A-3 and Figure A-3), contribute flow to the Wakulla River, designated as an OFW. Wakulla Spring flows southeast approximately 9 miles where it discharges to the St. Marks River, which flows into Apalachee Bay and finally the Gulf of Mexico.

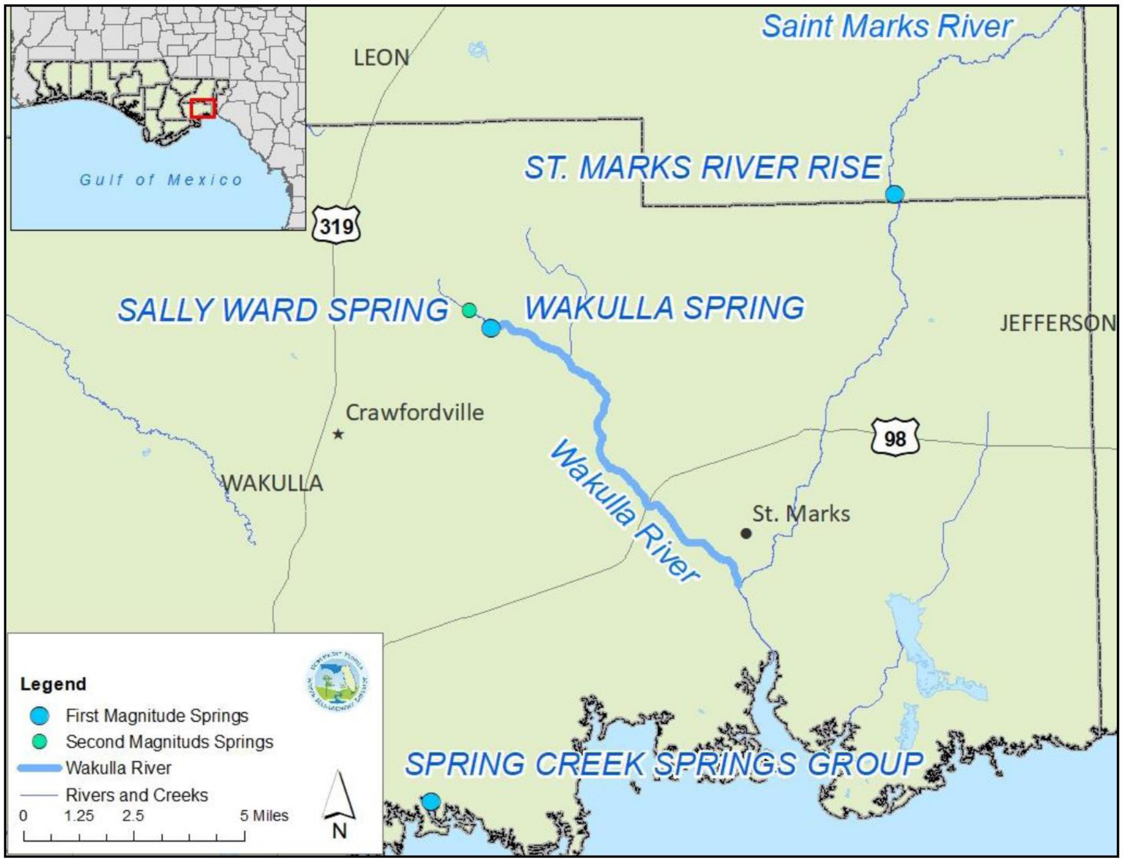


Figure A-2. Wakulla River, Wakulla Spring, and Sally Ward Spring Locations (NWFWMD, 2020)

Table A-3. Springs Associated with the Wakulla River

Spring	Mag	Latitude (dd)	Longitude (dd)	Spring	Mag	Latitude (dd)	Longitude (dd)
Wakulla Spring (OFS)	1st	30.23518	-84.30256	Mysterious Water Spring	4th	30.19610	-84.26373
Wakulla Spring Tunnel A	1st	30.23472	-84.30278	River Plantation Spring #2	4th	30.19588	-84.25948
Wakulla Spring Tunnel A-D	1st	30.23265	-84.30434	Rock Spring (Wakulla)	4th	30.22530	-84.27678
Wakulla Spring Tunnel A-K	1st	30.22879	-84.30545	Sweet Bay Spring	4th	30.23920	-84.28502
Wakulla Spring Tunnel B	1st	30.23356	-84.30207	Turn Around Spring	4th	30.23248	-84.28845
Wakulla Spring Tunnel C	1st	30.23356	-84.30207	Wakulla Sulfur Spring #2	4th	30.18288	-84.24910
Wakulla Spring Tunnel D	1st	30.23265	-84.30434	Deer Spring (Wakulla)	Unk	30.25704	-84.27561
Wakulla Spring Tunnel K	1st	30.22879	-84.30545	Harks Cry Spring	Unk	30.25050	-84.26865
Sally Ward Spring	2nd	30.24141	-84.31080	Ibis Glade Spring	Unk	30.24491	-84.26649
Homestead Spring	3rd	30.23437	-84.28120	Lolly Spring	Unk	30.24914	-84.26709
McBride Slough Spring	3rd	30.23996	-84.26949	McBride Spring #2	Unk	30.24115	-84.26838
Palmetto Spring	3rd	30.22907	-84.27161	McBride Spring #3	Unk	30.24334	-84.26768
River Plantation Spring #1	3rd	30.21238	-84.25697	Northside Spring #1	Unk	30.23753	-84.28120
Wakulla No Name Spring	3rd	30.21481	-84.26651	Northside Spring #2	Unk	30.23758	-84.28125
Wakulla Sulfur Spring #1	3rd	30.18163	-84.24865	Root Spring	Unk	30.25050	-84.26856
Chimney Spring	4th	30.22736	-84.28094	Tiger Hammock Spring	Unk	30.18367	-84.27412
Indian Spring (Wakulla)	4th	30.25080	-84.32208	Wakulla Sulfur Spring #3	Unk	30.18112	-84.24273
McBride Spring #4	4th	30.25234	-84.27170	Westside Spring	Unk	30.23545	-84.30347

Source: FDEP Florida Springs – 2016 (https://geodata.dep.state.fl.us/)
OFS – Outstanding Florida Spring

Figure A-3. Location of Springs Connected to the Wakulla River (NWFWMD, 2020)

Minimum Flows and Minimum Levels

Multiple WRV metrics were used to evaluate the recommended MFLs for Wakulla and Sally Ward Springs. Table A-4 provides a summary of the proposed minimum flow for the combined Wakulla and Sally Ward Springs System. The recommended allowable flow reduction is 59.21 cfs (38.3 mgd) or a 9.9% reduction in spring flows from average daily baseline spring flow of 598 cfs.

Table A-4. Proposed Minimum Flow for the Wakulla and Sally Ward Spring System

System	Average Baseline Flow [2]	Allowable Spring Flow Reduction	
Wakulla and Sally Ward Springs System [1]	598 cfs (386 mgd) [1]	59.21 cfs (38.3 mgd)	9.9%

[1] Represents the combined spring flows

[2] Baseline period: October 22, 2004 - December 31, 2019

Baseline Period

Baseline flow time series for Wakulla and Sally Ward Springs were developed from October 22, 2004 to December 31, 2019. Wakulla Spring flow was estimated using direct spring discharge data collected within the spring vent or estimated using relationships between downstream Wakulla River USGS flow station (USGS 02327022) when spring vent data were unavailable. Sally Ward Spring discharge data were manually collected by the District in the spring run approximately 0.5 miles downstream of the spring vent and upstream from the confluence with the Wakulla River.

NWFWMD staff concluded that there were no measurable effects of consumptive uses apparent in the baseline spring discharge time series. Seasonal variations in spring flow were examined and determined to be relatively small, therefore baseline period-of-record data were used to develop the proposed minimum flows, rather than seasonal periods.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Three metrics were used to assess the effects of Wakulla and Sally Ward Spring flow reductions on WRV 1, Recreation In and On the Water.

Safe Public Motorized Boat Passage – The critical depth for this metric was a minimum channel depth of 2.0 ft across a 30-ft continuous channel width. This metric was assessed using HEC-RAS at transects where recreational, public boat access is allowed, between Shadeville Road bridge and the confluence with the St. Marks River.

Safe motorized boat passage was possible (critical depth exceeded) under all modeled spring flow scenarios, including the lowest modeled flows (99 percent exceedance). This metric was determined to not be limiting and not considered further for MFL analysis.

Safe Canoe/Kayak Passage – The critical depth for this metric was determined by adding 1.5 ft to the thalweg elevation at HEC-RAS model transects where public canoeing and kayaking is allowed, downstream of the Shadeville Road bridge.

Safe canoe and kayak passage was possible (critical depth exceeded) under all modeled spring flow scenarios, including the lowest modeled flows (99 percent exceedance). This metric was determined to not be limiting and not considered further for MFL analysis.

State Park Boat Tour Passage – The Wakulla Springs State Park river tour boat operates along a set loop route, traveling approximately 1 mile downstream from Wakulla Spring. The critical depth for this metric was minimum channel depth of 3.0 ft (determined by measuring the vertical distance between visible water lines on tour boats and the bottom of the motor), across two 20-ft channel widths (along the right and left edges of the river). The tour boats do not pass each other and operate in a loop. This metric was assessed at HEC-RAS model transects within the established tour boat route.

Wakulla Springs State Park tour boat operation was possible (critical depth exceeded) under all modeled spring flow scenarios, including the lowest modeled flows (99 percent exceedance). The minimum modeled water depth (99 percent exceedance) was 3.28 ft which exceeded the critical depth by 0.18 ft. This metric was determined to not be limiting and not considered further for MFL analysis.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Five metrics were used to assess the effects of Wakulla and Sally Ward Spring flow reductions on WRV 2, Fish and Wildlife Habitats and the Passage of Fish.

Safe Fish Passage - Largemouth bass (*Micropterus salmoides*) were determined to be the largest bodied fish species that could potentially have passage affected by reduced spring flows, based upon documented fish species at Wakulla and Sally Ward Spring runs. The critical depth for this species was 0.6 ft above the thalweg and was assessed at all HEC-RAS transects.

Safe fish passage was possible (critical depth exceeded) under all modeled spring flow scenarios, including the lowest modeled flows (99 percent exceedance). This metric was determined to not be limiting and not considered further for MFL analysis.

Safe Manatee Passage - The critical depth for safe manatee passage was a minimum channel depth of 3.8 ft across a 3.8 ft minimum channel width. This metric was assessed at HEC-RAS model transects located in the Wakulla River. Manatee do not regularly enter the Sally Ward Spring run and the Sally Ward spring pool does not serve as a thermal refuge.

Safe manatee passage was found to be limiting at one transect (Station 41707.76), located downstream of the Wakulla River/Sally Ward Spring Run. At this station, manatee passage would be limited at Wakulla River flows below 560 cfs based on water depth conditions occurring during a mean daily high tide. This corresponds to a combined Wakulla Spring and Sally Ward Spring flow of 520 cfs, with the remaining 40 cfs associated with lateral groundwater and surface water inputs between the springs and transect. A 15% reduction in the number of days these conditions were met, resulted in a 59.21 cfs (9.9%) allowable combined Wakulla and Sally Ward spring flow reduction.

Manatee Thermal Refuge – Manatee thermal refuge was evaluated near the Wakulla Spring pool under two criteria assumed to be detrimental to manatee health, acute (<15 C° for more than four consecutive hours) and chronic (<20 C° for more than three consecutive days).

Under baseline conditions and an extreme Wakulla Spring flow reduction scenario of 30 percent, the acute temperature criteria were never observed in the model domain. Under the chronic stress criteria with a 30% Wakulla Spring flow reduction, the amount of available thermal habitat could support 1,900 manatees, which far exceeded the maximum number of manatees observed at Wakulla Spring during winter months (43 individuals). As a result, the manatee acute and thermal stress thermal criteria were determined to not be limiting and were not considered further for MFL establishment.

Shoreline Woody Habitat - Shoreline woody habitats were assessed at three floodplain HEC-RAS model transects (stations 44619, 41707.76, and 33245) located in the Wakulla River. Elevations were surveyed for both dead woody debris (twigs, branches) and live roots along or near the shoreline.

Due to the small sample size and uncertainty of the measured elevations being representative of actual woody habitats present along the Wakulla River, the woody habitats sampled were not considered for MFL determination.

Floodplain Vegetation - The inundation of floodplain habitats was evaluated for its appropriateness as a metric in this study. Elevations across 10 wetland cross-sections along the Wakulla River were surveyed and wetland edges delineated.

Review of wetland cross-sectional elevations, groundwater levels, inundation frequencies, and HEC-RAS model results, indicated that the riparian wetlands were likely not supported by Wakulla and Sally Ward spring flows, but by direct precipitation and high water-table conditions. As a result, the floodplain vegetation was not considered further for MFL establishment.

Estuarine Resources (WRV 3)

Volume, Bottom Surface Area, and Shoreline Length - Estuarine Resources metrics were designed to protect the volume, bottom surface area, and shoreline length of multiple low-salinity (oligohaline) habitats. Volume was considered as a metric to protect fish species habitat, bottom surface area to protect benthic species habitat, and shoreline length for the protection of shoreline floodplain vegetation communities.

Oligohaline habitats in the downstream portion of the Wakulla River (below Shadeville Road bridge) were shown to be relatively insensitive to Wakulla and Sally Ward spring flow reductions. A modeled spring flow reduction scenario of 30 percent resulted in changes in volume, bottom surface area, and shoreline length below the designated 15 percent change threshold. This percentage would be considerably lower if the freshwater upstream portion of the Wakulla River (above Shadeville Road bridge) were also included in this analysis. These metrics were determined to not be limiting and not considered further for MFL analysis.

The effects of sea level rise were assessed using both HEC-RAS (below Wakulla Spring) and Estuarine EFDC (below Shadeville Road bridge) models by adjusting the offshore boundary condition to sea levels predicted through 2040. Sea level rise predictions from 2020 through 2040 were obtained from the National Oceanographic and Atmospheric Association and estimated to be 2.38 mm/yr for the study area. This calculated projection accumulates to a sea level rise of 47.5 mm (1.9 inches, 0.16 ft) by 2040, resulting in no changes to water surface elevations near Wakulla and Sally Ward Springs.

The effects of sea level rise on oligohaline zones were most notable on the bottom surface area metric compared to the baseline time period, with zones <0.5 ppt and <1.0 ppt being the most sensitive. Water volume and shoreline length of oligohaline zone loss were less sensitive.

Transfer of Detrital Material (WRV 4)

Detrital material is comprised of dead organic material (largely from littoral and submerged vegetation) in the process of decomposition and is used as a food base in aquatic and wetland ecosystems. The transfer of detrital material from the floodplain into the Wakulla River relies on stormwater runoff and out of bank flows associated with high flow events. These metrics were determined to not be limiting and not considered further for MFL analysis. Due to limited quantifiable data regarding the transport of detrital material or its relationship to flow in the Wakulla River, this WRV was unable to be quantified as a metric.

Maintenance of Freshwater Storage and Supply (WRV 5)

Maintaining long-term freshwater storage for non-consumptive uses and environmental resources is the primary objective for establishing a MFL flow regime. There were no individual water use permits for surface water withdrawals on the Wakulla River. This MRV was not reviewed independently but protected as part of the overall minimum flow regime.

Aesthetic and Scenic Attributes (WRV 6)

Aesthetic and scenic attributes refer to passive uses of the Wakulla River and state park for such things as nature viewing, hiking, and photography, often associated with recreational activities. The following metrics are known to decrease the aesthetics of a system, have been used for other MFLs in Florida, and were considered for Wakulla and Sally Ward Spring runs.

Filamentous Algae – The relationship between algal cover and water velocity has been described as a subsidy-stress relationship where changes in water velocity can promote (lower velocities) or impede (higher velocities) algal growth. Due to limited quantifiable algal cover data and highly variable velocities (extensive channeling and ineffective flow areas) within the Wakulla River, this WRV was unable to be used as a reliable metric.

Nuisance and Exotic Vegetation - Nuisance and exotic vegetation is uncommon along the Wakulla River, although hydrilla (*Hydrilla verticillata*) was once prevalent near the spring pool during periods with elevated nitrate concentrations. Hydrilla density was reduced following reduced nitrate concentrations, grazing by manatees, and herbicide treatments. Limited information of nuisance and exotic vegetation cover in the Wakulla River and its relationship to flow made this metric unable to be reliably quantified.

Water Clarity – The reduction in water clarity and the decrease in the number of days that glass bottom boat tours operate in Wakulla Spring have been documented. Limited water quality data such as fluorescent dissolved organic material (fDOM), chlorophyll *a*, and turbidity were available, but existing data showed that water clarity was inversely related to spring discharge, with high water clarity correlated with reduced spring discharge. Since reductions in spring flow were determined not to be significantly harmful to water clarity, this metric was not considered further for MFL quantification.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

Information concerning the filtration and absorption of nutrients and other pollutants was unavailable for the Wakulla and Sally Ward Spring runs. As a result, this metric was unable to be quantified.

Sediment Loads (WRV 8)

Information concerning direct sediment loads, including sediment size and transport downstream, related to spring flow for Wakulla and Sally Ward Spring runs was not available, preventing direct quantification of this metric.

Water Quality (WRV 9)

Several water quality parameters were evaluated to ensure that potential reductions in spring flow would not cause significant harm to Wakulla and Sally Ward Spring water quality.

<u>Nitrate Concentrations</u> - The Florida Department of Environmental Protection adopted a statewide Total Maximum Daily Load (TMDL) of 0.35 mg/L for nitrate and implemented a Basin Management Action Plan (BMAP) for the Upper Wakulla River and Wakulla Spring in October 2015. In 2012, the largest source of nutrient loading to Wakulla Spring, the City of Tallahassee's Thomas P. Smith Water Reclamation Facility (TPS), was upgraded to reduce nitrate concentrations by approximately 80 percent. While this reduction was apparent at the spring vent, significant variability also existed with some apparent dilution effect of nitrate at higher flows.

The statistical significance from a proposed flow reduction was conducted by calculating the 95 percent confidence interval for the predicted nitrate concentration during the baseline time period (Wakulla Spring average flow of 575 cfs) and the proposed allowable 15 percent flow reduction (an 86 cfs reduction or average flow of 489 cfs) correcting for autocorrelation. The potential change in nitrate concentration from allowable spring flow reductions was found to be nonsignificant at a 95 percent level of confidence with no quantifiable change projected to occur.

<u>Water Clarity</u> – Turbidity, fDOM, and chlorophyll data from the Wakulla Spring Boat Dock (approximately 100 meters downstream from the spring vent) were available between 2015 and 2017. Each of these parameters are known to reduce water clarity with increasing concentration and displayed increasing values with increasing spring flows.

Water clarity was also discussed above under Aesthetic and Scenic Attributes (WRV 6) and reductions in spring flow were determined not to be significantly harmful to water clarity, this metric was not considered further for MFL quantification.

<u>Dissolved Oxygen and Specific Conductance</u> - Temporal trends were evaluated on annual median values during the baseline time period for dissolved oxygen and specific conductance. Both parameters displayed no statistically significant trend and did not display a relationship with flow during this period and was not considered further for MFL quantification.

Navigation (WRV 10)

This WRV refers to the navigation of commercial vessels within the study area. The Wakulla River is not used for commercial navigation; therefore, this metric was considered inappropriate for the Wakulla and Sally Ward Springs minimum flows determination.

SJRWMD – Alexander Springs

Adapted from Freese, R., & Sutherland, A. (2017). Minimum Flow Determination for Alexander Springs Lake County, Florida (Technical Publication No. SJ2017-3; p. 417). St. Johns River Water Management District. https://www.sjrwmd.com/minimumflowsandlevels/alexander-springs/

Background

Alexander Springs is a first magnitude spring in Lake County, Florida (Figure A-4 and Table A-5). Alexander Springs is located within the boundaries of the Ocala National Forest, (the second largest nationally protected forest in the United States) and the Alexander Springs Wilderness leaving it relatively unimpacted. Alexander Springs has been designated as an OFW and OFS requiring setting of an MFL no later than July 1, 2017. Alexander Springs discharges to Alexander Springs Creek which flows approximately 9.3 miles to the St. Johns River. The creek also receives significant inputs of tannin-stained water from Billie's Bay and Nine Mile Branch downstream from the head spring.

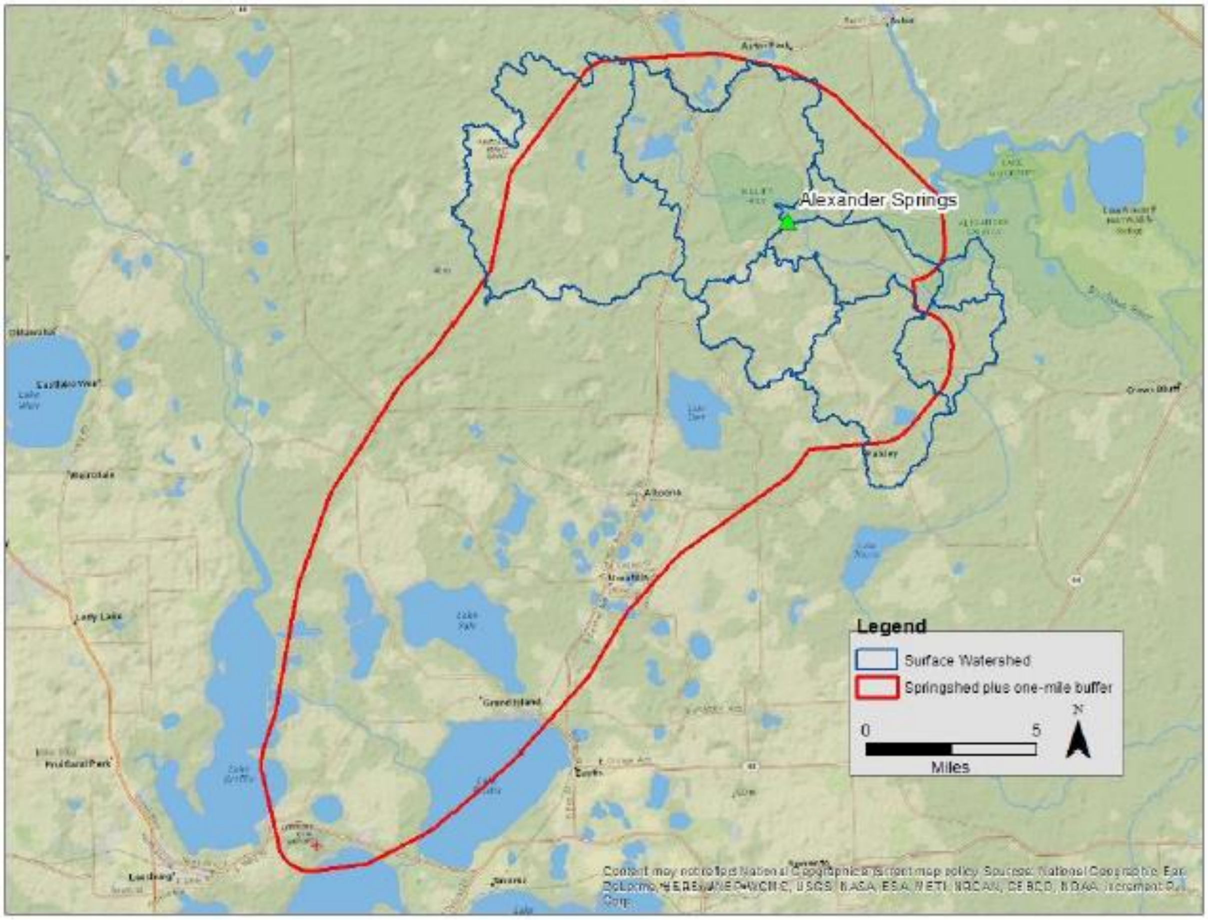


Figure A-4. Alexander Springs and Alexander Springs Springshed (Freese & Sutherland, 2017).

Table A-5. Alexander Springs Information

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Alexander Springs	1st	29.08137	-81.57590

Minimum Flows and Minimum Levels

The approved MFL for Alexander Springs is 95.7 cfs, a reduction of 7 cfs or 6.8% (Table A-6). The flow is currently reduced by an estimated 0.7 cfs with an additional allowable reduction of 6.3 cfs. The MFL was set based on the mean of other allowable flow reductions from other MFLs. Analyses completed were found to allow for a much larger flow reduction that was considered outside the bounds of previous MFLs and likely not protective of the largely unimpacted spring.

Table A-6. MFL for Alexander Springs

Spring	Average Baseline Flow	Allowable Spring Flow Reduction	
Alexander Springs	102.7 cfs	7 cfs	6.8%

Baseline Period

The baseline flow period was the observed period-of-record from 1983-2014. The mean flow was 102.7 cfs during this period. Current pumping was estimated to result in a 0.7 cfs reduction compared to pre-development conditions.

Water Resource Value Assessment

No specific WRVs were used in the setting of the MFL. Frequent highs and frequent lows were assessed based on multiple criteria from vegetation, soils, and topography as part of WRV 2 for habitat. Frequency analysis indicated that the hydrologic requirements were met under baseline conditions and were relatively insensitive to changes in flow, allowing for a 21% to 76% reduction in the mean flow.

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Significant recreational opportunities exist at Alexander Springs including: picnicking, camping, hiking, boating, paddling, scuba diving, snorkeling, fishing and swimming are allowed at Alexander. This WRV was evaluated based on the MFL and the frequency with which 1-day and 7-day recreational boating would be restricted with a 0.5-foot depth at critical transects. A significant increase was observed, although events were still “infrequent” and this WRV was considered protected.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Three factors were considered important with regard to WRV 2, sufficient depth for passage of large fish species including bowfin (*Amia calva)*, largemouth bass, *(Micropterus salmoides)*, and Florida gar *(Lepisosteus platyrhincus)*; sufficient frequency and duration of inundation in the floodplain to maintain wetland habitats and organic soils; and sufficient frequency and duration of inundation in the floodplain to facilitate bird feeding and small fish breeding habitat.

Fish Passage – This metric was considered based on a 0.8-foot passage depth across at least 25% of the channel cross-section. This was compared to the frequent low flow developed for protecting the floodplains and organic soils and found to be protected at all transects.

Estuarine Resources (WRV 3)

Alexander Springs feeds the St. Johns River, which flows to tide. The recommended MFL was anticipated to decrease flow in the St. Johns River by approximately 0.2%, which was considered to be insignificant to downstream estuaries.

Transfer of Detrital Material (WRV 4)

This WRV was considered with regard to out of bank flows that are expected to carry detrital material from the floodplain into the spring run. A HEC-RAS model was used to evaluate flow velocities in the channel. This analysis showed that flow velocities in the channel are generally lower than what is expected to cause algal scour and that will continue to be the case under the MFL.

Additionally, the frequency of 7-day and 30-day out-of-bank events were evaluated and showed a decrease in these floodplain inundation events, although large changes were observed at some transects they were considered acceptable and this WRV was considered protected by the MFL.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was considered as inter-related with the other WRVs and specific evaluation was not completed.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was considered based on 30-day and 90-day high stages when water level and clarity would optimize access. Approximately 30% reductions were observed at two of the transects for the 30-day return frequency. Critical events of a 90-day duration were described as relatively infrequent and reflect the influence of storm flows. The continued frequency of events was considered sufficient to maintain viewing patterns and the WRV was considered protected by the MFL.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was evaluated based on the HEC-RAS model and modeled changes in velocities that would impact the residence time of water in the spring run. Changes in velocity were expected to be minimal and removal of nutrients and pollutants might increase under longer residence times. This WRV was considered protected based on the MFL.

This WRV was also considered based on 14-day and 30-day duration high stage events that allow the river to interact with the adjacent swamp. Frequencies were observed to decrease under the MFL. Based on the change in frequency and professional judgement the WRV was considered protected by the MFL.

Sediment Loads (WRV 8)

This WRV was considered with regard to imported "beach" sand that was placed in the vicinity of the head spring about 40 years ago. This material washes into the spring during storm events and has required occasional cleanout, estimated to be needed approximately every 3-5 years.

The HEC-RAS model was used to evaluate changes in flow velocity. Based on the MFL, velocities were modeled to only change minimally not resulting in significant changes to sediment transport velocities or this WRV.

Water Quality (WRV 9)

No important relationships between flow reduction and water quality were found and this MFL was considered protective of this WRV.

Navigation (WRV 10)

Ecotourism and commercial fishing vessels do not operate in the Alexander Springs Run and this WRV was not evaluated.

SJRWMD – De Leon Springs

Adapted from ”Harris, C., Gordu, F., Di, J., Sutherland, A., 2016. Determination of Minimum Flows for De Leon Springs, Volusia County, Florida Draft (Technical Publication No. SJ2017-4). St. Johns River Water Management District."

Background

De Leon Spring is a second magnitude spring located in the 625-acre De Leon Springs State Park, Volusia County (Figure A-5 and Table A-7). The spring is highly altered and includes a half-acre concrete-sided spring pool that has been used for public recreation for more than 100 years. The pool discharges over a manmade waterfall structure into Spring Garden Run, Lake Woodruff, and Lake Dexter before reaching the St. Johns River. De Leon Springs is federally designated critical habitat for manatees as a thermal refuge by the U.S. Fish and Wildlife Service (USFWS). The spring levels are controlled by the manmade outfall structure although Spring Garden Run levels are controlled by water levels further downstream. De Leon Springs also includes a long history of use including by Native Americans as evidenced by the discovery of some of the oldest dugout canoes in North America. Other cultural resources include burial mounds, shell mounds, and middens.

Figure A-5. De Leon Springs and Spring Garden Run, Volusia County, Florida.

Table A-7. De Leon Spring Information

Spring	Magnitude	Latitude (dd)	Longitude (dd)
De Leon Spring	2nd Magnitude	29.13418	-81.36275

Minimum Flows and Minimum Levels

The recommended MFL for De Leon Spring was a mean flow of 25.6 cfs and was set based on no further reduction to warm-water habitat for manatees (Table A-8).

Table A-8. Minimum Flow for De Leon Spring

Spring	Baseline Flow	Minimum Flow (cfs)	Reduction
De Leon Spring	25.6 cfs	25.6 cfs	0%

Baseline Period

The baseline flow time series was based on the flow record from 1965-2016, with an average flow of 25.6 cfs. This baseline flow includes an estimated 2.6 cfs (9.3%) reduction due to groundwater pumping. Flows were based on the combination of direct measurements, continuous measurements, and a stage/discharge relationship for the spring.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Activities in De Leon Spring include swimming, snorkeling, instructed diving, fishing, boating and wildlife viewing. This WRV was considered protected by the MFL and was not directly quantified. However, the EFDC Model was used to evaluate changes in water residence time within the boil and spring run although the MFL was considered protective of current residence times.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Salinity –The EFDC Model was used to create theoretical salinity changes with a reduction in flow. Modeled changes in salinity were insufficient to demonstrate stress to wildlife or vegetative communities

Manatee – De Leon Springs and Spring Garden Run are designated as critical habitat for manatees in winter to provide thermal refuge when temperatures in the St. Johns River fall. The EFDC Model was used to evaluate changes in temperature resulting from changes in flow (both increases and decreases). Pumping in the springshed has been estimated to reduce flows by 10.3%. A no-pumping scenario was developed to estimate temperatures in the absence of pumping and the decrease in warm-water habitat that is already occurring. The modeled changes in pumping were observed to cause between a 0% and 26% loss of warm-water volume.

Estuarine Resources (WRV 3)

Spring discharge is a very small contribution to the St. Johns River flows. Based on a simple calculation of the impact associated with spring flows ceasing completely a change of no more than 0.05 ppt was estimated in the St. Johns River at Jacksonville, which was considered negligible. Given no proposed change in flows this resource was considered unimpacted.

Transfer of Detrital Material (WRV 4)

Transfer of detrital material is expected to be decreased at lower flows, although this WRV was not directly quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

The proposed MFL will maintain the spring pool elevation and nearby potentiometric surface at its current level, protecting existing and future permitted water users. This WRV was not directly quantified.

Aesthetic and Scenic Attributes (WRV 6)

This WRV is closely tied to WRV 1 and was expected to be protected by maintaining current flows. This WRV was not directly quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

Mats of bacteria exist in the spring vents that might provide some treatment of water exiting the aquifer although this treatment was not quantified.

Sediment Loads (WRV 8)

Most sediment is thought to have been brought to the system through runoff, wind, or reverse flows up Spring Garden Run. Spring discharge transports these sediments downstream and the proposed minimum flow level should maintain that distribution.

Water Quality (WRV 9)

Water quality degradation is prohibited in De Leon Springs and Spring Garden Run due to designation as an OFW in 1986. Because the baseline flow is being maintained no change is expected. This WRV was not directly quantified.

Navigation (WRV 10)

Navigation at De Leon Spring includes canoes, kayaks, motorboats, and paddle boards. Because the water levels in Spring Garden Run are primarily dependent on the St. Johns River levels and levels in the boil are controlled by the waterfall, navigation is not applicable as a WRV.

SJRWMD – Gemini Springs

Adapted from Mace, J. W. (2017). Determination of Minimum Flows for Gemini Springs Volusia County, Florida (Technical Publication No. SJ2017-5; p. 128). St. Johns River Water Management District.

Background

Gemini Springs is defined as a second magnitude spring, although the recent discharge record yields a range that would define the spring as a third magnitude spring with flows less than 10 cfs. The spring is part of the 210-acre Gemini Springs County Park in DeBary, Florida (Figure A-6 and Table A-9). Two spring vents make up Gemini Springs, which flow into a 1.3-acre impoundment. Water overflows from this reservoir over a weir before entering Gemini Springs Run which flows approximately 2 miles to Lake Monroe. The water from Gemini Springs has trace amounts of salt, presumably due to relic seawater present in the contributing aquifer. The St. Johns River and Lake Monroe can overwhelm the flow from Gemini Springs during high water events, resulting in reduced flows due to backwater conditions. Gemini Springs County Park is free to the public and includes picnic facilities, trails, and fishing and boating below the weir. A Spring-to-Spring trail connects Gemini Springs to Green Spring Park, 4.5 miles away and a 2.5-mile trail that connects Gemini Springs to Lake Monroe County Park. The maximum recorded discharge from Gemini Springs is 13 cfs with a minimum recorded flow of 6.2 cfs, and a median discharge of 9.6 cfs between 1995 and 2015.

Figure A-6. Gemini Springs in Volusia County, Florida (Mace, 2017)

Table A-9. Gemini Spring Information

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Gemini Spring	2nd	28.86257	-81.31141

Minimum Flows and Minimum Levels

The minimum flow for Gemini Springs was set based on a 15% increase in residence time in the reservoir which corresponded to a 15% reduction in spring flow to a mean flow of 9.3 cfs (Table A-10). This metric was developed based on perceived changes in water quality based on increased residence time in the reservoir. These perceived water quality impacts were then expected to impact aesthetic and scenic attributes and fish and wildlife habitat although those attributes were not quantitatively evaluated. The Gemini Springs MFL is currently being met and is expected to be met in the 20-year planning horizon.

Table A-10. Minimum Flow for Gemini Springs

Spring	Unimpacted Flow	Minimum Flow	Reduction
Gemini Spring	10.9 cfs	9.3 cfs	15%

Baseline Flow

The baseline flow time series was based on the flow record from 1995-March 2015, with a median flow of 9.6 cfs and an average flow of 9.8 cfs. This baseline flow includes an estimated 1.0 cfs reduction due to groundwater pumping. Flows were based on the measurements by the USGS and SJRWMD.

Water Resource Value Assessment

Gemini Springs consists of two separate components: the springs upstream of the reservoir and Gemini Springs Run downstream of the reservoir. For the purposes of the MFL the spring run was not considered as it is backwater-controlled by Lake Monroe and the St. Johns River.

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

No in-water uses are allowed in the reservoir or springs due to elevated levels of enterococci bacteria.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Freshwater habitat for fish and snails were considered in the MFL. Conditions that were considered protective of fish and wildlife were not specifically evaluated. Instead, they were considered protected by the proposed MFL that limited withdrawals based on an increase in residence time of 15% in the reservoir.

Estuarine Resources (WRV 3)

This WRV was not evaluated.

Transfer of Detrital Material (WRV 4)

This WRV was not evaluated.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not evaluated.

Aesthetic and Scenic Attributes (WRV 6)

Recreation is not allowed in Gemini Springs or the reservoir, therefore aesthetic and scenic attributes were the only human WRVs considered. Gemini Springs Park is a natural sightseeing attraction. An economic study showed that a reduction in aesthetics and other scenic values would decrease the visitors to the park. This WRV was not quantitatively evaluated, but rather considered protected by the same increase in residence time of 15% in the reservoir. This change in residence time was proposed because of the potential for phytoplankton growth in the springs and reservoir that would detract from the aesthetic and scenic attributes and from the wildlife habitat.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not evaluated.

Sediment Loads (WRV 8)

This WRV was not evaluated.

Water Quality (WRV 9)

Water quality was not quantitatively evaluated because of increasing trends in nitrate-nitrogen associated with increasing flows and the lack of a relationship in calcium and flows.

Navigation (WRV 10)

This WRV was not evaluated.

SJRWMD – Silver Glen Springs

Adapted from "Harris, C., Mouzon, N., Gordu, F., Sutherland, A., 2017. Determination of Minimum Flows for Silver Glen Springs, Marion and Lake Counties, Florida (Technical Publication No. SJ2017-4). St. Johns River Water Management District, Palatka, Florida.

Background

Silver Glen Springs is a first magnitude spring, located in Ocala National Forest in Marion County (Figure A-7 and Table A-11). Average flows in Silver Glen Springs are 102.2 cfs (1984-2015) with an estimated current reduction in spring flows of 2.1 cfs. Silver Glen Springs emerges from one of the largest and longest underwater cave systems in the St. Johns River Basin. Silver Glen Springs flows approximately 0.6 miles from the vent to Lake George. The spring has a cultural occupation record of more than 7,000 years with evidence of large shell mounds built atop mortuaries. The spring vent and run is located in the Silver Glen Springs Recreational Area. At the recreation area activities include swimming, hiking, boating, fishing, wildlife and spring viewing. Silver Glen Springs is designated by the U.S. Fish and Wildlife Service (FWS) as critical habitat for the Florida manatee as a thermal refuge. The south shore of the spring run has been owned and operated as a private hunting club since 1909. In 1990, the Silver Glen Springs cave crayfish was identified as a native species endemic to Silver Glen Springs. This species has since been suggested for inclusion on the Endangered Species list.

Figure A-7. Silver Glen Spring, Lake George and Astor locations in Ocala National Forest (Harris et al., 2017)

Table A-11. Silver Glen Springs Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Silver Glen Springs	1st	29.24585	-81.64361

Minimum Flows and Minimum Levels

The proposed MFL for Silver Glen Springs is a reduction of no more than 2.5% (2.6 cfs) from the historical no-pumping condition, for an average flow of 99.6 cfs (Table A-12). Based on current pumping conditions causing a flow reduction of 2.1 cfs, the MFL allows no more than an additional 0.5 cfs of reduction. The MFL was set based on maintaining the designated critical thermal refuge for manatees in Silver Glen Springs.

Table A-12. MFL for Silver Glen Springs

Spring	Average Baseline Flow	Allowable Spring Flow Reduction	
Silver Glen Springs	102.2 cfs	2.6 cfs	2.5%

Baseline Period

The baseline period for flow analysis was from 1984-2015. The mean flow was 102.2 cfs for this period. Modeled flow reductions based on 2010 groundwater modeling were 2.1 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Recreation at Silver Glen Springs includes swimming and snorkeling in the spring pool and fishing, boating, and wildlife viewing in the spring run. Decreased water velocities could cause impacts to recreation including increased sedimentation and increased algal cover by filamentous species.

Water Velocity - The EFDC model was used to calculate the water velocities and their effect on the recreation at Silver Glen Springs. The model was run based on current conditions, a 1% reduction, and a 10% reduction. The model found that changes in flows were expected to cause only minor changes in velocities within the spring run. This relationship was not directly quantified with regard to an impact to the WRV.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

A variety of important species use Silver Glen Springs including: striped bass, manatees, the Silver Glen Springs cave crayfish, and two rare snail species.

Water Temperature – Silver Glen Springs is a designated thermal refuge for manatees. A reduction in flow in the spring will result in a decrease in the thermal refuge within the spring and run. The thermal refuge was modeled using the EFDC model to evaluate the change in thermal refuge that resulted from a 1%, 5%, and 10% decrease in spring flows. This analysis found that reductions in excess of 5% would be expected to cause a significant decrease in warm-water habitat while a 0.5% reduction would have no impact.

Summer temperatures are also important at Silver Glen Springs because of the use of the spring by striped bass which rely on the spring as a cool-water refuge during summer. This cool-water condition was not explicitly modeled.

Salinity – Silver Glen Springs has a higher salinity level than the nearby Lake George with a difference of about 0.34 ppt. The EFDC model was used to model salinity levels and found that the levels were in the tolerance ranges of the species present in the spring system at both a 1% and 10% flow reduction.

Importance of water quality for other macroinvertebrates – Two rare snails, *Aphaostracon pycnum* and *Floridobia floridana* were found at Silver Glen Springs. Any changes to the system from a decrease in flow levels, has the potential to negatively affect the two snail species although no baseline data were available for analysis.

Estuarine Resources (WRV 3)

Silver Glen and other surrounding springs cause Lake George to have higher salinity levels than the St. Johns River upstream of just downstream of the lake. The reduction allowed by the MFL is not expected to cause observable downstream changes in salinity. An impact to this WRV was not directly quantified.

Transfer of Detrital Material (WRV 4)

A reduction in flow would have an effect on water velocity which could reduce the transport of algae, cyanobacteria, heterotrophic microbes, and detritus. Based on the EFDC modeling of water velocities any change is expected to be small. An impact to this WRV was not directly quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

Maintenance of the potentiometric surface near its current levels was described as potentially important to the structural integrity of the extensive cave system at Silver Glen Springs (Figure A-8) although an impact to this WRV was not directly quantified.

Figure A-8. Silver Glen Springs Cave System

Aesthetic and Scenic Attributes (WRV 6)

Aesthetic and scenic attributes at Silver Glen Springs include the water clarity, wildlife, cultural resources, and sandboil springs. These resources are not expected to be impacted by the MFL. An impact to this WRV was not directly quantified.

Water Clarity –The EFDC model was used to determine the mean percent spring water versus the percent of water from Lake George. This was assessed at a 1% and 10% flow reduction. This analysis showed that impacts were primarily confined to the lower one-third of the spring run.

Sandboil springs – The sandboil springs are a unique visitor experience at Silver Glen Springs. A study was completed of these features that found that at lower flows in Silver Glen Springs the sandboils were more erratic than at higher spring flows although data were insufficient for MFL development based on this WRV.

Water levels – The extensive cultural resources at Silver Glen Springs have been well-preserved because of consistent inundation that has protected against organic decay. Reduction in flow at Silver Glen Springs could cause decreases in flows or levels that could result in exposure and cultural resource degradation although these are expected to be protected under the MFL.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered relevant and changes were not directly quantified.

Sediment Loads (WRV 8)

A particle size fraction analysis was performed to evaluate sediment transport in the spring run. The mean particle size of 0.228 mm was found to require approximately 1.7 cm/s for transport and 20 cm/s for entrainment. The transport velocity was found to occur in at least 25% of the spring run under normal flows. Under a 10% flow reduction scenario, flows were estimated to fall below the transport velocity in more than 75% of the spring run during three occasions in winter of 2010-11. The MFL was expected to be protective and an impact to this WRV was not directly quantified.

Water Quality (WRV 9)

Flow in Silver Glen Springs were lower in 2010-2016 in comparison than the average spring flows before 2010. These separate periods were compared, but an impact to this WRV was not quantified.

Navigation (WRV 10)

Levels in the spring run are generally controlled by the St. Johns River. An impact to this WRV was not quantified.

SJRWMD – Silver Springs Group

Adapted from "Sutherland, A.B., Freese, R., Slater, J.B., Gordu, F., Di, J., Hall, G.B., 2017. Minimum Flows Determination for Silver Springs Marion County, Florida (Technical Publication No. SJ2017-2). St. Johns River Water Management District."

Background

Silver Springs is a first magnitude spring located in Marion County (Figure A-9 and Table A-13). The Silver Springs Group is composed of at least 30 springs and 69 vents within the first 3,900 feet of the Silver River. Silver Springs and the Silver River were designated as OFWs in 1988 and Silver Springs was designated as an OFS in 2016. The Silver River flows approximately five miles before joining the Ocklawaha River upstream of Rodman Reservoir. The 4,230 acres of Silver Springs State Park encloses the Silver Springs headwaters and a portion of the spring run. The entire river is contained in the Ocklawaha River Aquatic Preserve. The extensive public land ownership allows for general access to recreation in the springs and river. One of the attractions in Silver Springs and River is the glass-bottomed boat rides allowing an underwater view of the aquatic life. Silver Springs State Park receives more than 400,000 visitors in a year.

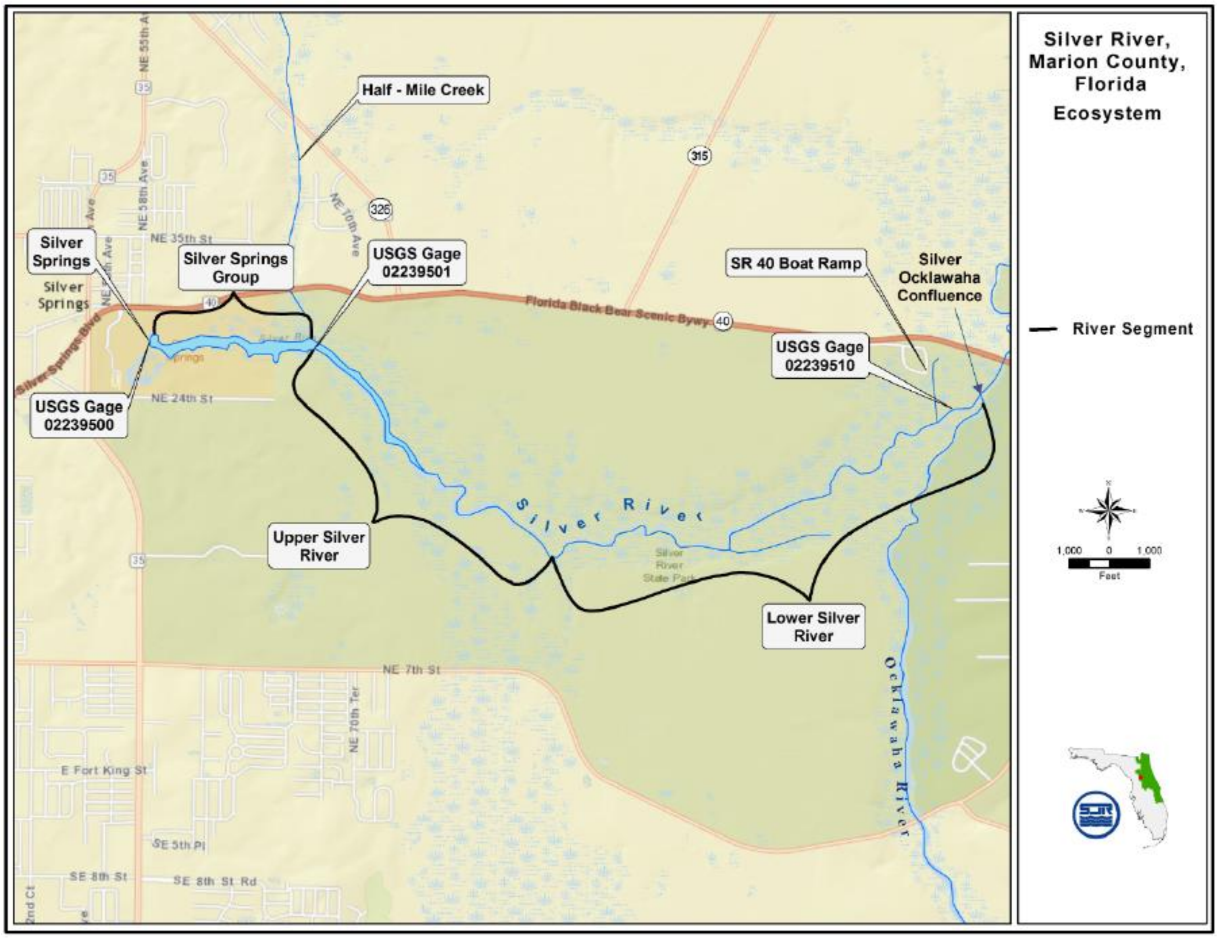


Figure A-9. Silver Springs Group and Silver River in Marion County, Florida (Sutherland et al., 2017)

Table A-13. Silver Springs Group Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Silver Springs Group	1st	29.21620	-82.05264

Minimum Flows and Minimum Levels

The MFL was based on protecting higher elevation floodplain habitats with three criteria developed: frequent high, minimum average, and frequent low conditions (Table A-14). The frequent low was found to be the most constrained and allowed a 6% reduction in flows, protecting 94% of the long-term average flows. Of the allowable 6% reduction, approximately 3.5% has already occurred, leaving an additional allowable reduction of 2.5%. Based on projections, it is expected that the MFL for the frequent low flow will be violated in approximately 2025 and the MFL is in prevention. The MFL was set based on no specific WRV, but rather on protecting the floodplain systems adjacent to the spring run. These functions were characterized as most directly related to WRV 2 and 7.

Table A-14. MFL for the Silver Springs Group

Flow Condition	Flow (cfs)	Duration (days)	Return Interval (years)
Frequent High (FH)	828	30	5
Minimum Average (MA)	638	180	1.7
Frequent Low (FL)	572	120	3

Baseline Flow

Silver Springs has displayed a complex relationship between flow and stage that exhibited a clear shift in the year 2000 with higher stages at lower flows. Because of the uncertainty in this relationship the District decided to use the period from 1946 to 2014 for MFL evaluation with an approximate average flow of 700 cfs. Based on groundwater modeling, current withdrawals were estimated to cause a flow reduction of 26 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

The Silver River is accessible by kayaks, canoes, and motorboats. The passage of watercraft is dependent on critical water depth during low-flow conditions. To accommodate the passage of two motorboats a minimum of 50 feet of width with a minimum of 2.5-feet of depth for motor clearance was applied. Clearance was evaluated at shallow-water transects along the river and found to be protected by the MFL, although the number of events when the critical depth was provided did decrease under the MFL. This WRV was not used to develop the MFL but was considered protected by the established MFL.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Three factors of particular concern for the WRV included: passage of bowfin (*Amia calva*), largemouth bass, (*Micropterus salmoides*), and Florida gar (*Lepisosteus platyrhincus*); sufficient frequency and duration of inundation in the floodplain to support wildlife; and water temperatures to support manatees.

Fish Passage - To sustain fish passage, a critical depth of 0.8 feet of water depth across 25% of the channel width was required. This criterion was never exceeded in any of the evaluated cross-sections.

Floodplain Inundation – Hardwood swamps adjacent to the Silver River require inundation for maintenance and provide habitat for fish, birds, and wetland vegetation. This analysis evaluated the number of 30-day continuous inundation events over the period of record. Thirty days was considered protective of fish spawning in flooded areas. The number of inundation events at the transects were observed to decrease under the MFL regime.

A second criterion evaluated for floodplain inundation was protection of organic soils in the floodplain. This analysis considered 180 days of non-continuous water levels at or above 0.33 feet below land surface to be protective of organic soils. This analysis showed a decrease in the number of 180-day inundation events under the MFL.

Manatee – Both manatee passage and temperature thresholds were evaluated. Manatee passage was modeled to require a centerline depth of at least 5 feet with a duration of one day. Thermal requirements were specified to be temperatures greater than 68^0F. These constraints were not exceeded at any of transects in either the no-pumping or MFL scenario.

Estuarine Resources (WRV 3)

Based on the St. Johns River Water Supply Impact Study, the MFL reduction in flow at Silver Springs would have very little impact on the St. Johns River Estuary. This WRV was not used to set the MFL.

Transfer of Detrital Material (WRV 4)

Flooding events are important for the transfer of detrital material from the floodplain to the river. Modeling was used to evaluate the change in frequency for 7-day and 30-day inundation events in the floodplain to carry detrital material into the river. The frequency of these events was estimated to decrease in frequency in the MFL but was considered protected.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not directly quantified but considered protected if the other nine WRVs were protected.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was evaluated based on bank full conditions on the river and the lower of the two top-of-bank elevations with 30-day and 90-day low-stage continuously not exceeded. This criterion was observed to increase under the MFL regime. This criterion was partially based on anecdotal evidence of clearer water conditions at lower stages, which may be correlated to less tannic water input from the floodplain, although this relationship was not clearly shown in the data record.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was assessed based on two conditions: in-channel velocity and floodplain inundation frequency. Velocities of 0.82 ft/s have been shown to be related to maximum gross primary productivities (GPPs). This condition was assessed and shown to be protected by the MFL. The second condition was floodplain inundation where additional nutrient treatment can occur. Both 14-day and 30-day exceedances were modeled based on wet detention pond treatment. This analysis showed a reduction in these events under the MFL, but the WRV was considered protected.

Sediment Loads (WRV 8)

This WRV was evaluated by using the HEC-RAS model to test velocity at river transects. This analysis found that there was a decrease in frequency for both the 7-day and 30-day duration continuous high-flow events. Given small, modeled changes in flow velocities this WRV was considered protected by the MFL.

Water Quality (WRV 9)

Silver Springs has exhibited an increase in nitrates and attached algae with an associated decrease in transparency. To evaluate nitrate a TMDL was developed for Silver Springs which showed that significant decreases in nitrate loading (79%) would be required to reach desirable concentrations of 0.35 mg/L in the springs. Relationships were developed between key water quality parameters and discharge. The study concluded that few significant relationships existed between flow and water quality such that no degradation was anticipated.

Navigation (WRV 10)

This WRV was evaluated in the same way as WRV 1. This considered an operational depth of 2.5 feet for watercraft to not contact the bottom. This metric was considered as four transects for the no-pumping and MFL with a 1-day and 7-day duration. The frequency of low water events that would preclude access was shown to increase under the MFL, but the WRV was determined to be protected.

SJRWMD – Minimum Flow Levels and Regime for Volusia Blue Spring

Adapted from "Rouhani, S., Sucsy, P., Hall, G., Osburn, W., Wild, M., 2007. Analysis of Blue Spring Discharge Data to Determine a Minimum Flow Regime (Special Publication No. SJ2007-SP17). St. Johns River Water Management District, Palatka, Florida.

Wetland Solutions, Inc., 2006. Human Use and Ecological Evaluation of the Recommended Minimum Flow Regime for Blue Spring and Blue Spring Run, Volusia County, Florida (Special Publication No. SJ2007-SP19). St. Johns River Water Management District.

Background

Volusia Blue Spring is a first magnitude spring located in Blue Spring State Park, an approximately 2,500-acre park in Volusia County (Figure A-10 and Table A-15). Blue Springs and the run are designated as an Outstanding Florida Water (OFW). The spring run flows 2,336 feet to its confluence with the St. Johns River. The average long-term discharge of the spring is 157 cfs for the period-of-record between 1932 and 2006. Blue Spring is one of the three major warm-water refuges (along with Crystal River and the Homosassa River) for manatees, and the only on the eastern coast for the St. Johns River manatee population. This attracts large numbers of recreational users who visit the park for manatee viewing. Furthermore, the spring and spring run were designated critical habitat for the Florida Manatee under the Endangered Species Act (ESA) in 1977. Use of the spring by manatees has increased since the time of this designation. Blue Spring Run also provides habitat for two endemic snail species.

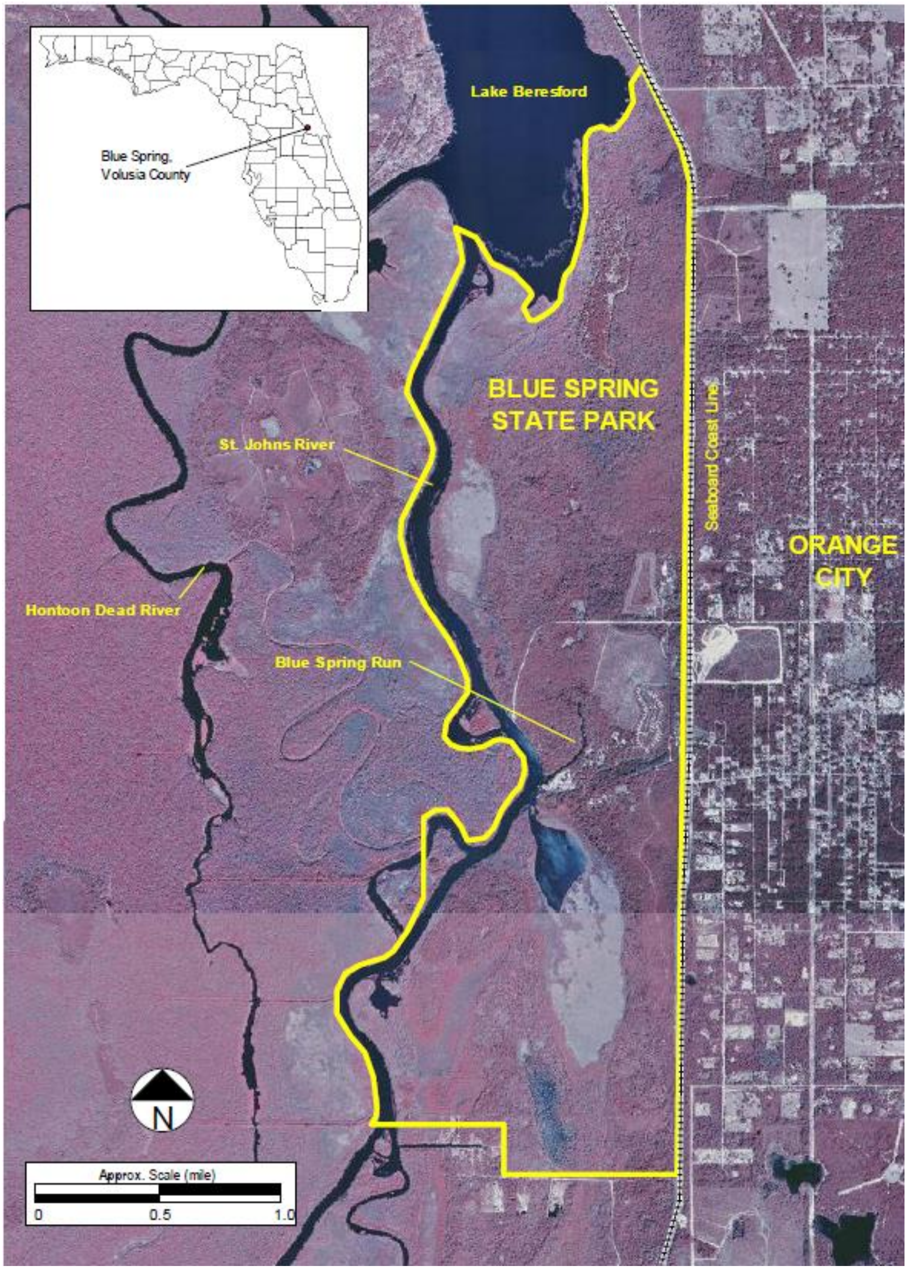


Figure A-10. Blue Spring State Park and Volusia Blue Spring in Volusia County, Florida (Wetland Solutions, Inc., 2006b)

Table A-15. Volusia Blue Spring Information

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Volusia Blue Spring	1st	28.94749	-81.33959

Minimum Flows and Minimum Levels

The proposed MFL for Volusia Blue Spring is based on the critical, winter warm-water refuge provided to manatees by the spring and spring run. The recommended minimum long-term mean flow was developed in five phases (Table A-16).

Table A-16. Minimum Flow for Volusia Blue Spring

Spring	Baseline Flow	Time Period	Minimum Flow (cfs)	Reduction
Volusia Blue Spring	157 cfs	Effective Date-3/31/2009	133	15%
		4/1/2009-3/31/2014	137	13%
		4/1/2014-3/31/2019	142	10%
		4/1/2019-3/31/2024	148	6%
		After 4/1/2024	157	0%

Baseline Period

The baseline flow time series was based on the flow record from 1932-2006, with an average flow of 157 cfs. Flows were based on the combination of direct measurements and a stage/discharge relationship for the spring run.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Recreation at Blue Spring includes swimming, fishing, education, canoeing, kayaking, bird watching, manatee watching, snorkeling, scuba diving, boating, water skiing, and use of personal watercraft. This WRV was not found to be directly related to flow. However, human use in winter is tied to manatee use and manatee use is based on the flows in the spring, making human use indirectly related to spring flow. An impact to this WRV was not directly quantified.

Swimming and scuba diving were also considered during the non-manatee season and were described as possibly impacted by water clarity and temperature. However, the MFL was expected to protect these uses.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

The primary species assessed for this WRV was the manatee.

<u>Manatee Thermal Refuge</u> – An EFDC model was used to find the relationship between flow and useable warm-water lengths. Useable warm-water length was defined as the portion of the run with a bottom temperature greater than 68 degrees Fahrenheit and a depth greater than or equal to 5 feet. Catastrophic conditions were used as the 50-year extreme event lasting 3 days or more, where adequate refuge was defined as the spring run's actual manatee carrying capacity exceeding the required manatee carrying capacity. Increasing populations of manatees were used to recommend the phased increase in MFLs.

Estuarine Resources (WRV 3)

A reduction in flows was estimated to result in a minimal impact on the estuary. Based on a previous study, a 320 cfs maximum withdrawal near Deland, a town north of Blue Spring, was found to still protect the estuary. The initial 25 cfs reduction, reducing to 0 cfs over time, was included in this 320 cfs and was therefore considered protective of the estuary.

Transfer of Detrital Material (WRV 4)

No existing data was available to estimate the production and transport of detrital material. The relatively small flow change allowed by the MFL in conjunction with the return to current flows over time was considered protective of this WRV.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not considered relevant given a lack of freshwater storage and supply.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was considered a primary use of Blue Spring and closely tied to WRV 1. Aesthetic and scenic attributes associated with Blue Spring State Park included: viewing scenery, watching wildlife, breathing clean air, and swimming in clean water on a hot day. This WRV was not directly quantified although recommendations were made to survey visitors to determine their perception of flow.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not directly quantified due to a lack of data although a variety of methods were proposed.

Sediment Loads (WRV 8)

Sediment loads were observed to be variable in the system and the MFL was expected to immeasurably impact this WRV. Sediment load removal was estimated based on baseline data.

Water Quality (WRV 9)

Water quality in the spring shows variability that is likely greater than what the MFL might cause. Temperature, pH, specific conductance, hardness, calcium, and silica were identified as parameters that might be impacted by the temporary changes in flows allowed under the MFL, although changes were not expected to cause violations of water quality criteria.

Navigation (WRV 10)

Boating is not allowed in Volusia Blue Spring. Therefore, this WRV was not used in the assessment of the proposed MFL.

SJRWMD – Wekiva Springs

Adapted from Hupalo, R.B., Neubauer, C.P., Keenan, L.W., Clapp, D.A., Lowe, E.F., 1994. Establishment of Minimum Flows and Levels for the Wekiva River System (Technical Publication No. SJ94-1). St. Johns River Water Management District.

Background

Wekiva Springs and the Wekiva River System is a first magnitude springs group located in east-central Florida (Figure A-11 and Table A-17). The main spring in the system is Wekiwa Spring which is a second magnitude spring. The Wekiva River System includes: the Wekiva River, Little Wekiva River, Black Water Creek, Rock Springs Run, Sulphur Run, and Seminole Creek. A large portion of the river system is designated as an OFW and as an Aquatic Preserve. Eight springs were also included in the MFL study and had MFLs developed. These include, with their magnitude in parentheses: Messant Spring (2nd), Miami Spring (3rd), Palm Spring (3rd), Rock Spring (2nd), Sanlando Spring (2nd), Seminole Spring (2nd), Starbuck Spring (2nd), and Wekiwa Spring (2nd).

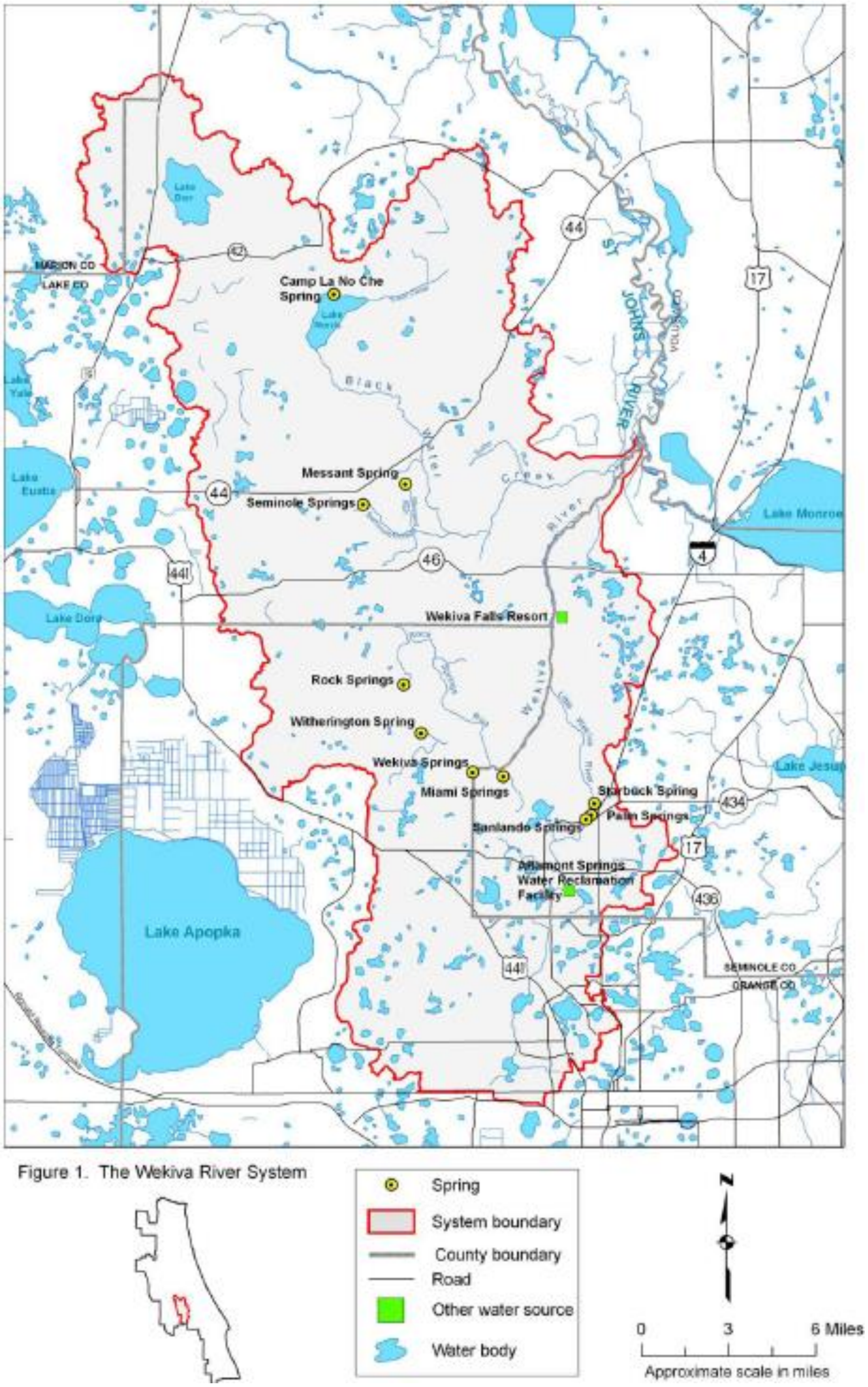


Figure A-11. Wekiva Springs in East-Central Florida (Hupalo et al., 1994)

Table A-17. Wekiva Spring System and Spring Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Wekiva Spring	1st	-9063544.202	3352159.477
Messant Spring	2nd	28.85584	-81.49889
Miami Springs	3rd	28.71016	-81.44303
Palm Springs	3rd	28.69113	-81.39284
Rock Springs	2nd	28.75645	-81.50174
Sanlando Springs	2nd	28.68871	-81.39530
Seminole Springs	2nd	28.84556	-81.52278
Starbuck Springs	2nd	28.69700	-81.39115
Wekiwa Springs	2nd	28.71189	-81.46042

Minimum Flows and Minimum Levels

MFLs for the Wekiva River System were set in 1992 and included five MFLs for the waterbody. These included: the Minimum Infrequent High, Minimum Frequent High, Minimum Average, Minimum Frequent Low, and Minimum Infrequent Low. In addition to these criteria four phased water restrictions were developed between the Minimum Frequent Low and Minimum Infrequent Low at 15% phased water reductions: Phase 1, Phase 2, Phase 3, and Phase 4. The MFL is summarized in Table A-18. Additionally, MFLs and Minimum Groundwater Levels were established for eight springs that are associated with the Wekiva River System (Table A-19).

Table A-18. Wekiva River MFL at the State Road 46 Bridge

MFL Category	Level (ft NGVD29)	Flow (cfs)	Duration (days)	Return Period (years)
Minimum Infrequent High	9.0	880	≥7	≤5
Minimum Frequent High	8.0	410	≥30	≤2
Minimum Average	7.6	240	≤180	≥1.7
Minimum Frequent Low	7.2	200	≤90	≥3
Phase 1 Restriction	7.0	190	N/A	N/A
Phase 2 Restriction	6.9	180	N/A	N/A
Phase 3 Restriction	6.7	160	N/A	N/A
Phase 4 Restriction	6.5	150	N/A	N/A
Minimum Infrequent Low	6.1	120	≤7	≥100

Table A-19. Wekiva River System Springs MFLs and Minimum Groundwater Levels

Spring Name	County	Head (ft NGVD29)	Discharge (cfs)
Messant Spring	Lake	32	12
Miami Springs	Seminole	27	4
Palm Springs	Seminole	27	7
Rock Springs	Orange	31	53
Sanlando Springs	Seminole	28	15
Seminole Springs	Lake	34	34
Starbuck Springs	Seminole	31	13
Wekiwa Springs	Orange	24	62

Water Resource Value Assessment

The ten WRVs included in the current MFL determination methodology had not been developed at the time of establishment for the Wekiva River System MFL. The criteria and methods applied are discussed in additional detail in a more general framework rather than for specific WRVs.

The development of MFLs for the Wekiva River System were developed around maintaining the range of ecological services provided by the river system and associated floodplains. A total of five flows/levels were considered that included: the Minimum Infrequent High, Minimum Frequent High, Minimum Average, Minimum Frequent Low, and Minimum Infrequent Low. Survey data and vegetative sampling information were used with water level and flow data to develop frequency duration curves for levels and flows at SR44 and SR46. Stage and flow values were then evaluated for a range of durations (1, 7, 14, 30, 60, 120, and 183 days) and return periods (2, 5, 10, 25, 50, 100 years).

Minimum Infrequent High – This flow/level was developed to provide inundation of riparian wetlands at a frequency sufficient to transport sediment, detritus, nutrients, and propagules into the river system.

Minimum Frequent High – This flow/level was set to provide habitat for stream biota that use floodplain habitat for portions of their life stages.

Minimum Average – This flow/level was set to maintain hydric soils, to avoid encroachment of upland species into the wetland plant communities, and to protect recreational uses of the river.

Minimum Frequent Low – This flow/level was set to protect low water conditions when many floodplain plant species regenerate. This level was also identified as potentially impeding some recreational uses.

Minimum Infrequent Low – This flow/level is indicative of an extreme drought when significant ecological impacts may occur. This level should be infrequent enough and of short enough duration to allow the system to readily recover.

Fish Passage – Minimum requirements for fish passage were defined as a depth of 0.6 feet in areas with bare substrates, or as 1.0 feet in areas with eelgrass across at least 25% of the bankfull channel width. At least 10% of the passage width was contiguous at each evaluated cross-section.

Spring Flows – A rainfall spring flow model was developed to estimate spring flows based on rainfall for eight springs in the system that had occasional USGS flow data collected. Minimum spring flows were set based on a 4.5-6 year recurrence interval 1-day low-flow event.

SRWMD – Aucilla River, Wacissa River, and Priority Springs

Adapted from HSW Engineering, Inc., 2016. Minimum Flows and Levels for the Aucilla River, Wacissa River and Priority Springs. Suwannee River Water Management District, Live Oak, Florida.

Background

The Aucilla River originates from artesian springs in Central Georgia and flows approximately 89 miles before reaching the Gulf of Mexico. Along its length, in the vicinity of the Cody Scarp, the river goes underground and re-emerges at Nutall Rise. Below Nutall Rise the Wacissa River joins the Aucilla River significantly increasing flows, particularly during dry periods (Figure A-12 and Table A-20). The Wacissa River is fed by a combination of more than 12 springs and runoff from adjacent swamps. Both rivers are classified as OFWs. Nutall Rise, Wacissa Headspring, and Big Blue Spring are first magnitude springs with the remaining springs: Buzzard Log, Cassidy, Garner, JEF63991, JEF63992, JEF63993, Jefferson Blue, Little Blue, Log, Minnow, and Thomas classified as second magnitude springs.

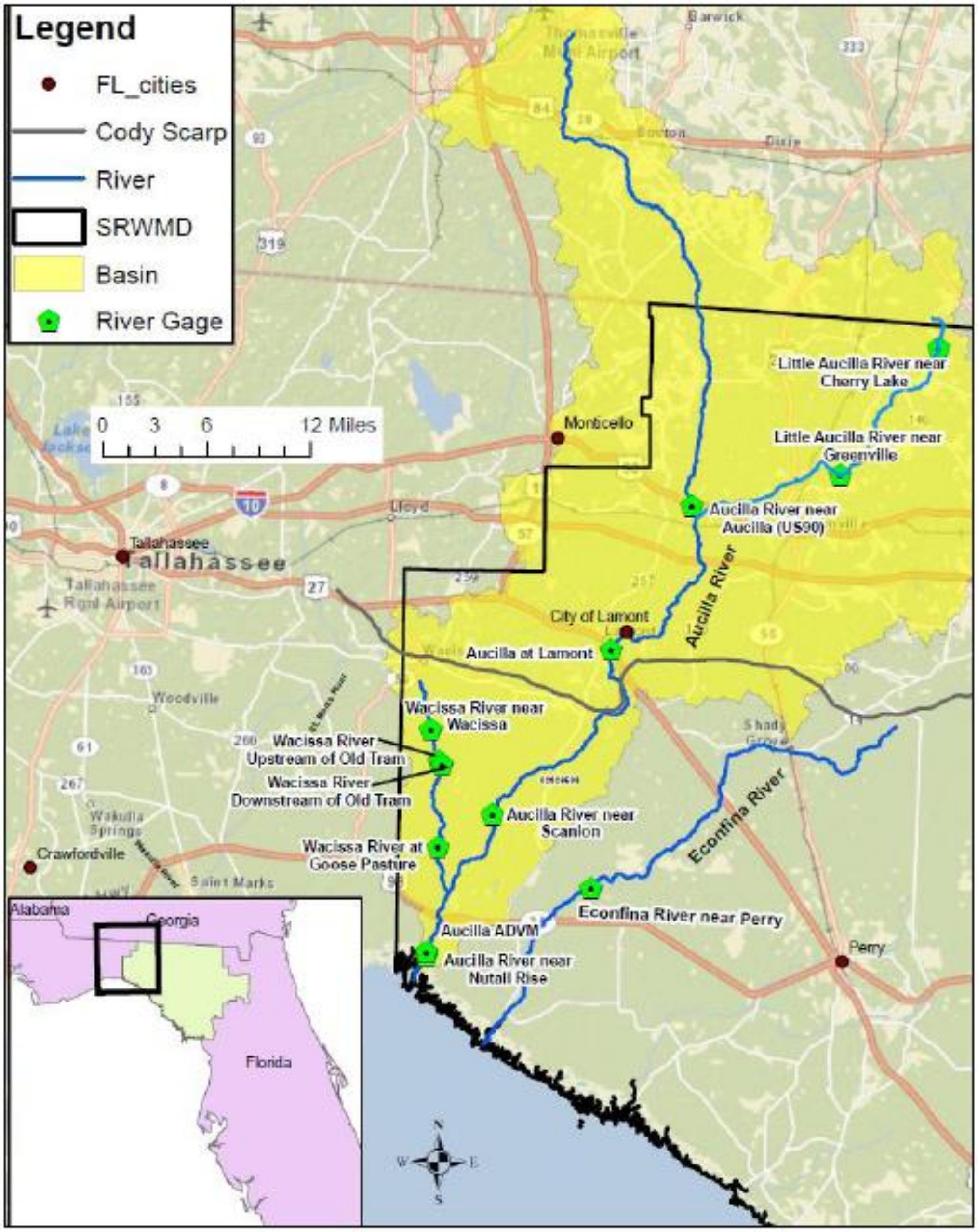


Figure A-12. Aucilla and Wacissa River System (HSW Engineering, Inc., 2016)

Table A-20. Aucilla and Wacissa Spring Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Big Blue Spring	1st	30.32776	-83.98483
Buzzard Log Spring	2nd	30.33008	-83.98688
Cassidy Spring	2nd	30.33268	-83.98899
Garner Spring	2nd	30.33036	-83.98310
JEF63991	2nd	30.32497	-83.98582
JEF63992	2nd	30.32322	-83.98670
JEF63993	2nd	30.30231	-83.97960
Jefferson Blue Spring	2nd	30.33054	-83.98893
Little Blue Spring	2nd	30.33082	-83.98905
Log Spring	2nd	30.34054	-83.99301
Minnow Spring	2nd	30.33454	-83.98658
Nutall Rise	1st	30.15049	-83.96330
Thomas Spring	2nd	30.33973	-83.99228
Wacissa Headspring (OFS)	1st	30.33987	-83.99143

Minimum Flows and Minimum Levels

Specific MFLs were not developed for the springs, rather the MFL developed for the Aucilla River was applied to Nutall Rise and the MFL developed for the Wacissa River was applied to the Wacissa Spring Group (Table A-21).

Aucilla River and Nutall Rise

The MFL for the Aucilla River and Nutall Rise is a 6.5% reduction when flows at the Lamont gage are less than or equal to 355 cfs to protect salinity zones in the lower river, a 13% reduction for flows up to 558 cfs to protect bank habitat, and a 17% flow reduction for flows greater than 558 cfs to protect floodplain habitat.

Wacissa River and Wacissa Springs Group

The MFL for the Wacissa River and the Wacissa Springs Group is a 5.1% reduction for flows up to 376 cfs to protect recreational uses (motorboating) and a 7.3% reduction for flows greater 376 cfs to protect instream habitat.

Table A-21. MFL for the Aucilla and Wacissa Springs

System (Assessment Location)	Gage Flow	Reduction
Aucilla River and Nutall Rise (Lamont Gage)	≤355 cfs	6.5%
	>355-558 cfs	13%
	>558 cfs	17%
Wacissa River and Springs Group (Wacissa Gage)	≤376 cfs	5.1%
	>376 cfs	7.3%

Baseline Period

The baseline flow period for the Aucilla River at the Lamont gage was from 1951-2014. At the Wacissa gage the baseline flow period was from 2001-2014. Specific flow statistics were not reported for either gage.

Water Resource Value Assessment

No WRVs were evaluated specifically for the springs, rather the MFLs that were applicable to the river were applied to the springs. Given that flow from Nutall Rise and the Wacissa Springs Group comprise a significant portion of the baseflow of the river, WRVs evaluated for the river are generally applicable to the springs.

A summary of the quantitative metrics used to relate each WRV to flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was considered applicable to the rivers, particularly with regard to boating.

Aucilla River

The metric used was a 15% decrease in the amount of time that paddling is viable, based on a stage of 48 feet at the Lamont gage. The number of days that paddling was viable at current flows was evaluated with a 15% reduction in the number of days when paddling could occur applied. This yielded an allowable flow reduction of 34.2% (69 cfs) for a flow of 201 cfs at the Lamont gage.

Wacissa River

The Wacissa River was evaluated with regard to powerboat use with a required depth of 2 feet across a width of 30 feet. A HEC-RAS model was used to identify the limiting cross-section and the limiting flow to allow for the safe boat passage criteria to be met. This occurred at a flow of 357 cfs, which is exceeded approximately 50% of the time. This frequency was decreased by 15% which occurred at a 5.1% (19 cfs) flow reduction for a flow of 376 cfs at the Wacissa gage.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was considered applicable for the rivers and was evaluated based on fish passage, fish habitat, macroinvertebrates, bird foraging, woody habitat, and floodplain inundation.

Aucilla River

Fish Passage – Fish passage was evaluated as a minimum depth of 0.8 feet across a minimum of 25% of the evaluated cross-section. A HEC-RAS model was used to evaluate flows for limiting cross-sections to provide the required depth. This yielded an allowable reduction of 30.1% (22cfs) for a flow of 73 cfs at the Lamont gage.

Wildlife Habitat – Fish habitat was evaluated for three habitat criteria: in-channel flows, overbank flows, and floodplain flows. The SEFA model was used to evaluate habitat suitability under current and reduced flows for instream habitat. The most restrictive metric was the shallow/fast guild with an allowable reduction of 35.2%. Riparian habitat was evaluated by using the HEC-RAS model and calculating the wetted perimeter. For each segment the flow reduction that resulted in a 15% decrease in habitat availability was calculated, with an allowable flow reduction of 12% for a flow of 170 cfs at the Lamont gage. For floodplain habitat the HEC-RAS model was used with ArcGIS to evaluate the wetland area flooded at various flow rates. A flow of 1,054 cfs was found to be an inflection point with fewer wetlands above the elevation at this flow. A 15% reduction in the floodplain inundated was found to occur at a 17% (184 cfs) flow reduction for a flow of 1,054 cfs at the Lamont gage.

Wacissa River

Fish Passage – Fish passage was evaluated in the same manner as for the Aucilla River, but fish passage was not found to be a restrictive criterion for the Wacissa River and occurred at almost the lowest flow ever recorded for the river.

Wildlife Habitat – Habitat was modeled in the same way as for the Aucilla River, using SEFA modeling for the in-stream habitat. Insufficient data were available to evaluate floodplain habitat. For in-stream habitat largemouth bass fry, bluegill fry, and shallow/slow habitat guilds were found to be the most sensitive with flow reduction of 7-9% causing a greater than 15% reduction in habitat.

Estuarine Resources (WRV 3)

This WRV was considered applicable with regard to maintaining salinity ranges in the lower river to protect estuarine resources including shoreline length in salinity zones. An EFDC model was developed for the lower river to evaluate the habitat and shoreline length available at varying salinity concentrations. The lowest salinity block (0-2 ppt) was found to be the most sensitive with the greatest reductions in volume, bottom area, and shoreline length. Bottom area was found to be the most sensitive with a 15% reduction in availability occurring at a 6.5% flow reduction. The 0-5 ppt shoreline habitat was found to experience a 15% reduction in availability with a 7.9% flow reduction.

Transfer of Detrital Material (WRV 4)

This WRV was not evaluated for the river or springs.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not evaluated for the river or springs.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was considered important because of the whitewater rapids available in some segments and the natural setting. This WRV was not directly quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not directly evaluated. This WRV was expected to be protected more effectively by reducing nutrient loads rather than by maintaining a specific flow regime.

Sediment Loads (WRV 8)

This WRV was considered to be important along some portions of the river based on the archaeological importance of the river. Insufficient sediment data was available for direct quantification.

Water Quality (WRV 9)

This WRV was not directly evaluated. This WRV was considered protected based on the OFW designation. This WRV was expected to be protected more effectively by reducing loads rather than maintaining a specific flow regime.

Navigation (WRV 10)

This WRV was not evaluated for the river or springs.

SRWMD – Falmouth Spring, Lafayette Blue Spring, Peacock Spring, and Troy Spring

Adapted from Amec Foster Wheeler Environment & Infrastructure, Inc. (2016). Minimum Flows and Levels for the Middle Suwannee River and Priority Springs (Draft Report 600390.1). Suwannee River Water Management District.

Background

The Middle Suwannee River segment is a 92-mile portion of the river that extends from Ellaville to Wilcox. This river segment includes 22 priority springs including Falmouth, Lafayette Blue, Peacock, and Troy Springs (Figure A-13 and Table A-22). Three of these springs are first magnitude (Falmouth, Lafayette Blue, and Troy) while Peacock is a second magnitude spring. Lafayette Blue, Peacock, and Troy Springs all flow to the Suwannee River while Falmouth Spring is comprised of two vents with a short run between the two vents that conveys flow from one vent to the second vent with no other surface water connection.

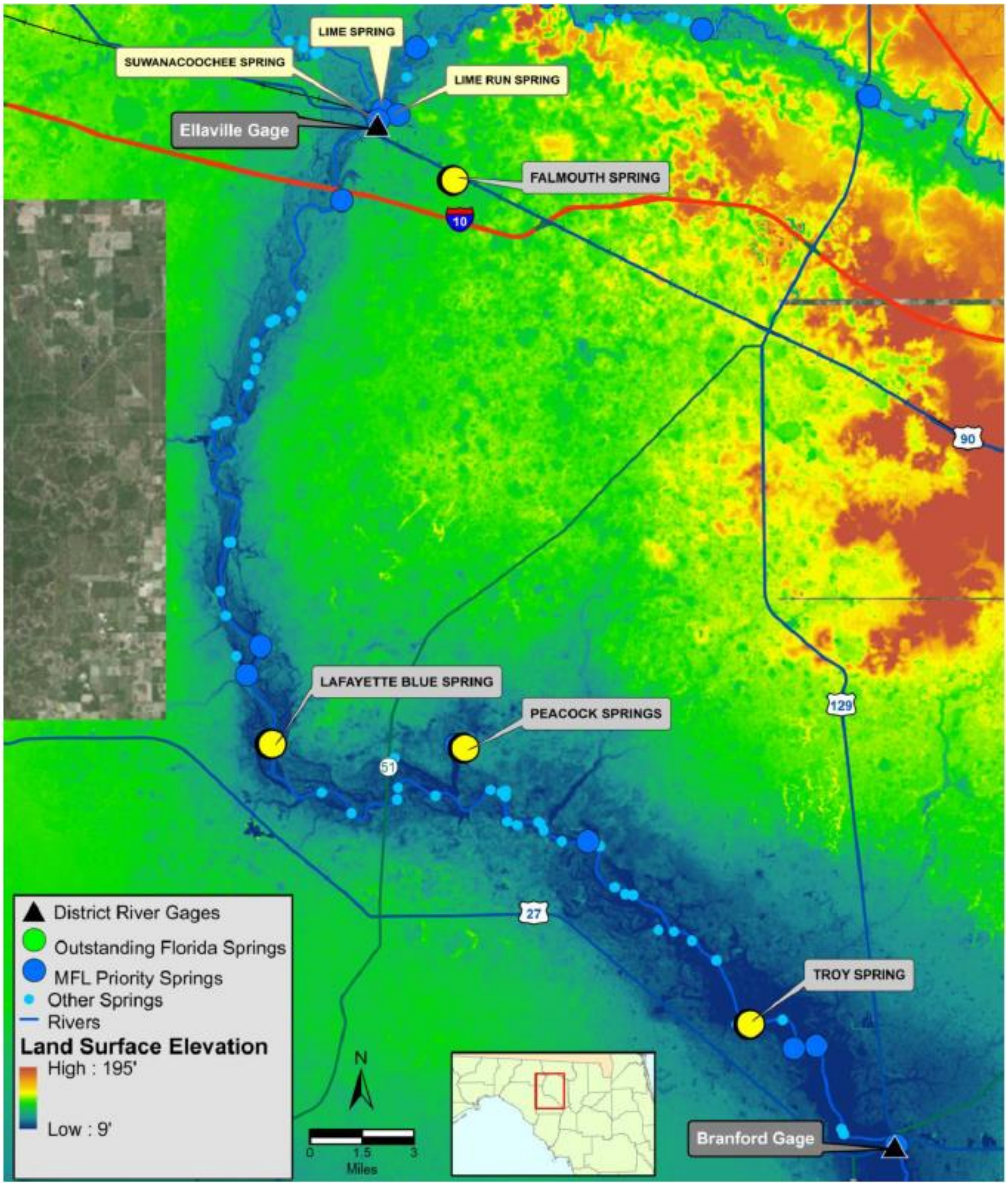


Figure A-13. Middle Suwannee River Including Falmouth, Lafayette Blue, Peacock, and Troy Springs (Amec Foster Wheeler Environment & Infrastructure, Inc., 2016b)

Table A-22. Falmouth, Lafayette Blue, Peacock, and Troy Springs' Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Falmouth	1st	30.36117	-83.13501
Lafayette Blue	1st	30.12584	-83.22613
Peacock	2nd	30.12323	-83.13316
Troy	1st	30.00604	-82.99753

Minimum Flows and Minimum Levels

The MFL proposed for Falmouth, Lafayette Blue, Peacock, and Troy Springs is a 9.9% reduction from historic flows (Table A-23). These recommended decreases were based on the allowable decrease at the relevant river flow gage based on the MFL set for the river itself, rather than the springs. Falmouth Spring had a recommended 15% allowable decrease which was reduced to 9.9% to be consistent with the other springs, while providing an additional level of conservatism.

Table A-23. MFL for Falmouth, Lafayette Blue, Peacock, and Troy Springs

Spring	Approx. Baseline Median Flow (cfs)	Reduction
Falmouth	52	9.9%
Lafayette Blue	61	9.9%
Peacock	41	9.9%
Troy	99	9.9%

Baseline Flow

Specific baseline periods were not described for each spring. Approximate baseline flows were taken from a figure provided in the MFL document.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was evaluated in the river based on a boat passage depth of 2 feet over a minimum 30-foot width using HEC-RAS modeling at limiting cross-sections. This WRV was not evaluated for springs individually.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was evaluated for both passage and habitat metrics. Generally, these metrics were not considered directly for the springs, but only for the main river channel, with the exception of fish passage into Peacock Springs.

Fish Passage – This WRV was evaluated in the river with a minimum depth of 0.8 feet across at least 25% of the channel width with no single width increment less than 10% using HEC-RAS modeling. This WRV was also evaluated specifically for fish passage in and out of Peacock Springs, but not for any of the other three springs of interest. Gulf sturgeon passage within the river was evaluated based on a minimum 3 foot depth over a 15 foot channel width.

Fish Habitat – Habitat modeling was completed using the System for Environmental Flow Analysis (SEFA) model. The model was developed based on data collection at five locations associated with shoals that were considered to be most vulnerable to flow changes. The largemouth bass fry stage was found to be most vulnerable species and life stage evaluated and showed that a 9.9% flow reduction at the Lafayette Blue Shoal would cause significant harm.

Riparian, Floodplain, and Deep Swamp Habitat – Higher flow habitats were evaluated based on HEC-RAS modeling of higher flows. These flows were assessed in the same method as low flows with the modeled decrease in flows evaluated based on modeling of a decrease in flows that would result in a more than 15% decrease in the frequency of the requisite flow.

Estuarine Resources (WRV 3)

This WRV was not considered relevant or quantified.

Transfer of Detrital Material (WRV 4)

This WRV was not considered relevant or quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not considered relevant or quantified.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was considered relevant but was considered to have inadequate data for quantification.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered relevant or quantified.

Sediment Loads (WRV 8)

This WRV was evaluated for medium and high river flows based on a regression of bankfull and top of ridge regressions, respectively. This modeling evaluated flows that exceeded the bankfull and top of ridge crests with an allowable 15% reduction in the number of days that exceeded these levels. This WRV was not evaluated for the springs independently.

Water Quality (WRV 9)

This WRV was considered relevant but was considered to have inadequate data for quantification.

Navigation (WRV 10)

This WRV was not considered relevant or quantified.

SRWMD – Madison Blue Spring

Adapted from “Water Resource Associates, Inc. (2004). Development of Madison Blue Spring-Based MFL Technical Report (p. 236). Suwannee River Water Management District."

Background

Madison Blue Spring is a first magnitude spring located in Madison Blue State Park, Madison County, Florida (Figure A-14 and Table A-24). The spring is located west of the Withlacoochee River and south of the SR 6 Bridge and makes up about 23.7% of the measured total spring discharge into the river. The spring flow is highly influenced by the Withlacoochee River’s water stages. When the river stage is lower than the discharge of the spring, Madison Blue Spring discharges into the river. When the river is at higher stages the discharge reverses and colored river water can enter the spring and backflow into the Floridan Aquifer. The land surrounding the spring is part of Madison Blue Spring State Park. About 24,000 feet of cave system have been mapped associated with Madison Blue Spring and the cave is thought to be the fourth longest underwater cave in the United States.

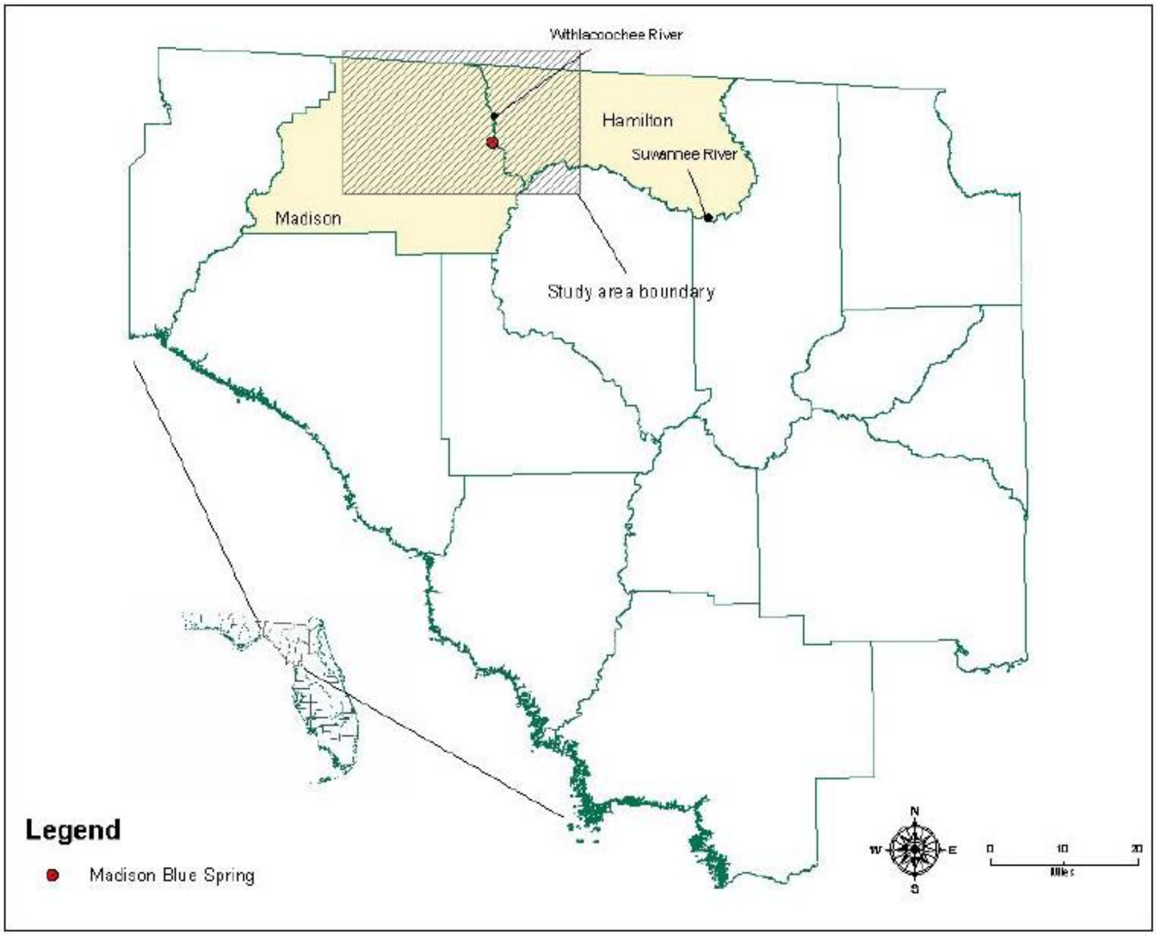


Figure A-14. Madison Blue Spring (Water Resource Associates, Inc., 2004)

Table A-24. Madison Blue Spring Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Madison Blue Spring	1st	30.48001	-83.24444

Minimum Flows and Minimum Levels

The proposed minimum flow for Madison Blue Spring is 70 cfs when the Pinetta gage is 55 feet (NGVD29) or less, which maintains a median flow of 100 cfs at the spring (Table A-25). This reduction is suggested to be reassessed five years after the adoption of the MFL along with the collection of associated data.

Table A-25. Minimum Flow for Madison Blue Spring

Spring	Minimum Flow
Madison Blue Spring (Pinetta Gage ≤55 ft)	70 cfs

Baseline Period

No baseline flow was available, only a single 120 cfs measurement from 6/15/1998 was reported.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Madison Blue Spring State Recreation Area is managed under the Suwannee River State Park Plan. This plan covers activities such as picnicking, swimming, and scuba diving. This WRV was evaluated based on maintaining a full spring pool and an adequate spring flow to support recreation at the spring. This WRV was not directly quantified due to a lack of available information.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

The minimum water level to allow fish passage was considered to be 0.6 feet. This depth was considered across a range of flows between 52 and 100 cfs. Inflection points in the relationship between inundated surface area and fish-passable area were developed and three candidate minimum flows were developed. At a flow of 70 cfs the loss of shoal habitat for fish passage was 0.4 acres (7.7%) and for inundation was 0.3 acres (5.6%). These changes were considered small and unlikely to cause significant harm. This was the primary WRV used to develop the MFL.

Estuarine Resources (WRV 3)

This WRV was not considered to be applicable for MFL development.

Transfer of Detrital Material (WRV 4)

This WRV was not considered to be applicable for MFL development.

Maintenance of Freshwater Storage and Supply (WRV 5)

The Madison Blue Spring Springshed includes District-permitted water users. Reduction of discharge could create legal conflicts for these users. A comparison of early (pre-1972) to later (post-1972) data showed a decreasing trend in higher flow events in the spring. However, insufficient data existed to develop an MFL based on this WRV. The proposed MFL provides maintenance of existing permitted water users.

Aesthetic and Scenic Attributes (WRV 6)

This WRV is closely associated with WRV 1, spring pool clarity, and spring water levels. This WRV was not directly quantified because of a lack of definitive data. The MFL of 70 cfs is described as providing a median flow of 100 cfs which is considered protective of this resource.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered to be applicable for MFL development.

Sediment Loads (WRV 8)

This WRV was not considered to be applicable for MFL development.

Water Quality (WRV 9)

This WRV was not directly quantified, but low dissolved oxygen in the Withlacoochee River at low flows in the river could mean that dissolved oxygen levels in the spring are particularly important during these periods. Insufficient data for the spring were available to evaluate this relationship in the river. Furthermore, this relationship was identified as possibly more important for developing an MFL for the river, rather than for the spring.

Navigation (WRV 10)

This WRV was not considered to be applicable for MFL development.

SRWMD – Lower Santa Fe and Ichetucknee River and Priority Springs

Adapted from HSW Engineering, Inc., 2021. Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs. Suwannee River Water Management District.

SRWMD, 2013. Minimum Flows and Levels for The Lower Santa Fe and Ichetucknee Rivers and Priority Springs. Suwannee River Water Management District.

Background

The Lower Santa Fe River begins at the Santa Fe River Rise, the re-emergence of the Santa Fe River near High Springs, and extends to the confluence with the Suwannee River (Figure A-15 and Table A-26). This river segment is approximately 30 miles and includes the Ichetucknee River. A total of 17 priority springs are located within this river segment including 11 that discharge directly to the Santa Fe River and six that are located within the Ichetucknee River System. The Santa Fe River is designated as an OFW and this river reach includes multiple OFSs including: the Ichetucknee Springs Group, Columbia, Devils Ear, Hornsby, Poe, and Treehouse Springs. The initial MFL for this system was developed in 2013 and has been recently re-evaluated although the updated MFL has not yet been adopted.

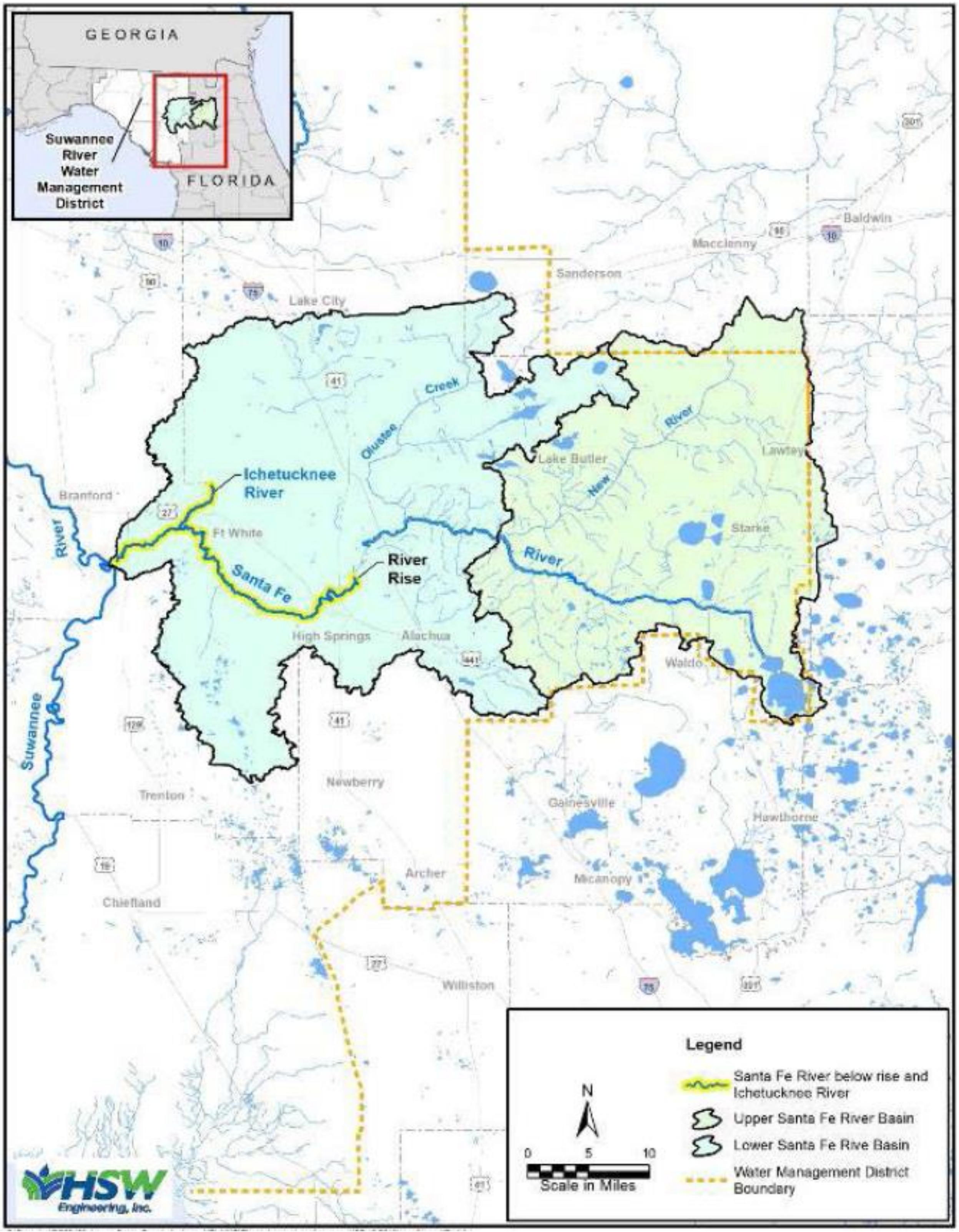


Figure A-15. Lower Santa Fe and Ichetucknee Rivers (HSW Engineering, Inc., 2021b)

Table A-26. Ichetucknee and Santa Fe River Spring Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Santa Fe Rise	1st	29.87401	-82.59160
ALA112971 (Treehouse) Spring	1st	29.85492	-82.60021
Hornsby Spring,	2nd	29.85039	-82.59322
Columbia Spring	1st	29.85413	-82.61198
Poe Spring	2nd	29.82576	-82.64895
COL101974 (Unnamed) Spring	2nd	29.83406	-82.67671
Rum Island Spring	2nd	29.83352	-82.67984
Devil’s Ear Spring (Ginnie Spring Group)	1st	29.83540	-82.69670
July Spring	1st	29.83618	-82.69640
GIL1012973 (Siphon Creek Rise)	1st	29.85623	-82.73302
Ichetucknee Head Spring	1st	29.98425	-82.76186
Mission Spring	2nd	29.97626	-82.75791
Devil’s Eye	2nd	29.97370	-82.76002
Grassy Hole	2nd	29.96786	-82.75968
Mill Pond	2nd	29.96664	-82.75992
Blue Hole Spring	1st	29.98056	-82.75839

Minimum Flows and Minimum Levels

The proposed MFLs for the Lower Santa Fe and Ichetucknee Rivers were developed as flows at existing gaging stations (Table A-27).

Ichetucknee River MFL

The Ichetucknee River MFL was a 10 cfs flow reduction for the median flow of 356 cfs (2.8% reduction) at the Highway 27 gage, based on a shift in woody habitat and hydric soils.

Santa Fe River and Associated Springs MFL

Other springs were captured in the MFL for the Lower Santa Fe River. The MFL for the Fort White gage was a flow reduction of 103 cfs for the median flow if 1,270 cfs (8.1% reduction) and was based on fish passage. The MFL at the US441 gage was a proportional shift to the reduction allowed at the Fort White gage. The MFL at the US441 gage was a flow reduction of 50 cfs for the median flow of 552 cfs (9.0% reduction).

Table A-27. MFLs for the Ichetucknee and Santa Fe River Springs

System	Baseline Flow	Allowable Flow Reduction	
Ichetucknee River	356 cfs	10 cfs	2.8%
Santa Fe River (Fort White Gage)	1,270 cfs	103 cfs	8.1%
Santa Fe River (US441 Gage)	552 cfs	50 cfs	9.0%

Baseline Period

The baseline flow period for both the Ichetucknee and Santa Fe Rivers was from 1933-2015. Data sets were estimated and in-filled based on a variety of methods. Specific flow statistics were not reported for either gage.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was not directly evaluated with regard to individual springs along the Lower Santa Fe River.

This WRV was evaluated for the Ichetucknee River with a particular focus on recreational tubing within the upper segments of the river and damage to SAV plant communities. A large tuber was found to require approximately 1.05 feet of water above the threshold SAV elevation. HEC-RAS modeling was used to evaluate depths at gage flows along the river. The critical cross-section was identified and the flow required to maintain the threshold depth was evaluated at the Highway 27 gage. An allowable 15% decrease in the number of days tubing was available was found to allow a 12.4% decrease in flows (40 cfs) at the Highway 27 gage.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was not directly evaluated with regard to individual springs along the Lower Santa Fe River.

This WRV was evaluated with regard to fish passage and wildlife habitat in the Ichetucknee River. HEC-RAS modeling was used to evaluate depths for flows along the river to evaluate fish passage. SEFA modeling was used to evaluate instream habitats at two locations on the Ichetucknee River.

Fish Passage – Fish passage was evaluated based on a depth of 0.8 feet across at least 25% of the limiting cross-section based on HEC-RAS modeling. In the Ichetucknee River this was found to allow a 11.9% decrease (39 cfs) at the Highway 27 gage before a 15% reduction in the available days with supporting flows occurred at a flow of 322 cfs.

Instream Habitat – Instream habitat was evaluated using SEFA modeling of the available habitat for various life stages of species of interest. Largemouth bass juveniles were found to be the most sensitive species on the Ichetucknee River. The allowable flow reduction associated with a 15% decrease in the metric was 5% (18 cfs) at the Highway 27 gage for a flow of 356 cfs.

Woody Habitat – This metric was evaluated based on an allowable decrease in the number of days when this habitat was inundated. The allowable flow reduction associated with a 15% decrease in the metric was 2.6% (10 cfs) at the Highway 27 gage for a flow of 378 cfs.

Manatee Thermal Refuge – A correlation between January-February temperatures and flows at the Highway 27 gage was developed to evaluate the development of a thermal refuge at the confluence of the Ichetucknee and Santa Fe Rivers. A flow of 297 cfs was found to provide a temperature of 68 degrees Fahrenheit. The allowable flow reduction associated with a 15% decrease in the metric was 9.0% (29 cfs) at the Highway 27 gage for a flow of 326 cfs.

Hydric Soils – Threshold flows to protect hydric soils were evaluated and showed an allowable flow reduction of 2.4% (10 cfs) associated with a 15% reduction at the Highway 27 gage for a flow of 417 cfs.

Submerged Aquatic Vegetation – Optimum velocity ranges for SAV transects on the Ichetucknee River were evaluated based on HEC-RAS modeling of three transects and sub-optimal velocities. The flow at which velocities fall below the 0.8-2.3 ft/s threshold was between 271 and 431 cfs for the three cross-sections. The allowable flow reduction associated with a 15% decrease in the metric was 2.4% (11 cfs) at the Highway 27 gage for a flow of 442 cfs.

Estuarine Resources (WRV 3)

This WRV was not directly quantified.

Transfer of Detrital Material (WRV 4)

This WRV was not directly quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not directly quantified.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not directly quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not directly quantified.

Sediment Loads (WRV 8)

This WRV was evaluated based on maintaining bankfull flow conditions. For the Ichetucknee River the allowable flow reduction associated with a 15% decrease in the metric was 4.4% (15 cfs) at the Highway 27 gage for a flow of 343 cfs.

Water Quality (WRV 9)

This WRV was not directly quantified.

Navigation (WRV 10)

This WRV was not directly quantified.

SRWMD – Upper Santa Fe River and Springs

Adapted from Water Resource Associates, Inc., 2007. MFL Establishment for the Upper Santa Fe River. Suwannee River Water Management District, Live Oak, Florida.

Background

Three springs were identified as located within the Upper Santa Fe River (Figure A-16 and Table A-28). The largest of these is Santa Fe Spring a historic first magnitude spring that is described as contributing a majority of flows during droughts, but little flow at higher stages. The spring is an estavelle with flow reversals occurring at high river levels. A second spring identified as COL61982 was estimated to have a discharge of 1 cfs in 1998. The final spring identified in this reach was Worthington Spring, the site of a historic spa that had been abandoned by 1972. This spring was estimated to have a flow of less than 1 cfs, which appeared to have decreased to zero resulting from the bulldozing of historic structures into the spring. The Upper Santa Fe River goes completely underground at River Sink before re-emerging approximately 2.8 miles away at River Rise where the Lower Santa Fe River begins. The Santa Fe River and Olustee Creek are both designated as OFWs.

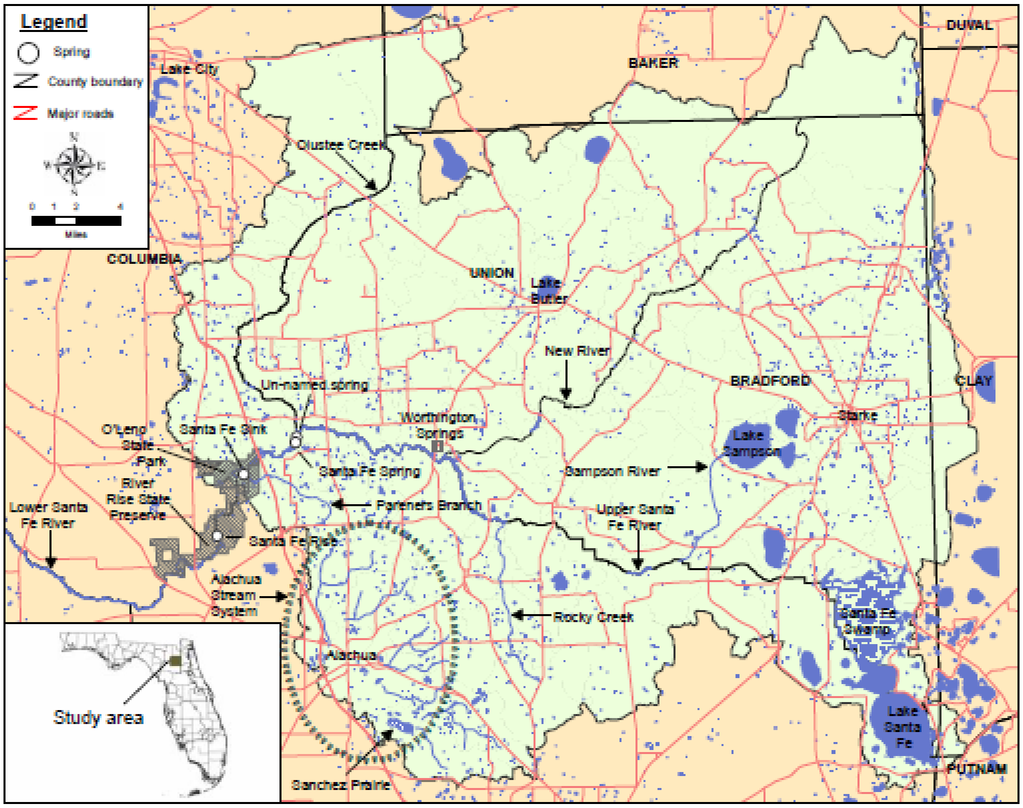


Figure A-16. Upper Santa Fe River and Santa Fe Springs (Water Resource Associates, Inc., 2007)

Table A-28. Santa Fe Spring Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Santa Fe Spring	1st	29.93476	-82.53018

Minimum Flows and Levels

No specific MFL was specified for Santa Fe Spring. The spring appears to function as an estavelle, discharging during low water periods and back-flowing during high river stages. The exact relationship between spring flows and river stages was evaluated, but a specific MFL was not developed. The plumbing of the underground flows is complex and unclear in this area.

Water Resource Value Assessment

No WRVs were evaluated for Santa Fe Spring or the other springs specifically and no MFL was established for the springs.

Recreation In and On the Water (WRV 1)

The WRV was not evaluated for the spring.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

The WRV was not evaluated for the spring.

Estuarine Resources (WRV 3)

The WRV was not evaluated for the spring.

Transfer of Detrital Material (WRV 4)

The WRV was not evaluated for the spring.

Maintenance of Freshwater Storage and Supply (WRV 5)

The WRV was not evaluated for the spring.

Aesthetic and Scenic Attributes (WRV 6)

The WRV was not evaluated for the spring.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

The WRV was not evaluated for the spring.

Sediment Loads (WRV 8)

The WRV was not evaluated for the spring.

Water Quality (WRV 9)

The WRV was not evaluated for the spring.

Navigation (WRV 10)

The WRV was not evaluated for the spring.

SRWMD – Steinhatchee River and Springs

Adapted from Applied Technology and Management, Inc., 2018. Minimum Flows and Levels Steinhatchee River, Florida. Suwannee River Water Management District, Live Oak, Florida.

Background

The Steinhatchee River is a highly karst system that includes numerous springs (Figure A-17 and Table A-29). Two major springs exist in the river system: Steinhatchee River Rise and Beaver Creek Spring. Steinhatchee River Rise originates primarily from Steinhatchee River Sink where all flows in the Steinhatchee River under approximately 500 cfs go underground before re-emerging in the river rise. Additional flow beyond the volume carried in the river upstream of the sink also appears to emerge from the river rise. Beaver Creek Spring is a second magnitude spring based on an approximate flow of 75 cfs in 1999.

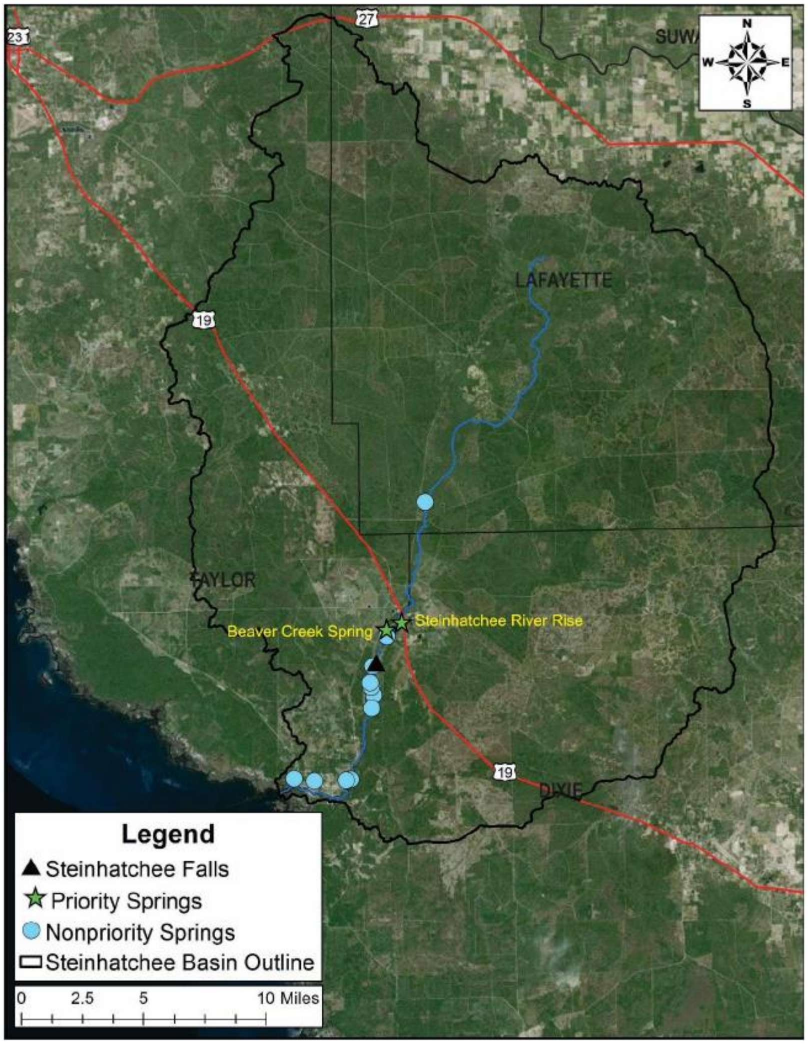


Figure A-17. Steinhatchee River and Springs (Applied Technology and Management, Inc., 2018)

Table A-29. Steinhatchee River Priority Spring Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Steinhatchee River Rise	1st	29.76989	-83.32498
Beaver Creek Spring	2nd	29.76140	-83.33500

Minimum Flows and Minimum Levels

Specific MFLs were developed for the springs based on protection of the estuarine resources. The allowable flow reduction for the springs is an 11.5% flow reduction for each spring (Table A-30).

Table A-30. MFL for Steinhatchee River Priority Springs

System	Reduction
Steinhatchee River Rise	11.5%
Beaver Creek Spring	11.5%

Baseline Period

The baseline flow period for the Steinhatchee River was from 1951-2015. The median flow for this period was 102 cfs.

Water Resource Value Assessment

No WRVs were evaluated specifically for the springs, rather the WRVs that were applicable to the river were evaluated and the non-flood based MFL was applied to the evaluated springs.

A summary of the quantitative metrics used to relate each WRV to flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was considered applicable for the Steinhatchee River but was not specifically evaluated for the priority springs.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was considered applicable for the Steinhatchee River but was not specifically evaluated for the priority springs.

Estuarine Resources (WRV 3)

This WRV was considered applicable for the Steinhatchee River, and while not specifically evaluated for the priority springs the freshwater inputs of the springs are considered critical to protecting this resource. The limiting resource for the river was the salinity habitat available at flows below 858 cfs when an 11.5% reduction was allowed.

Transfer of Detrital Material (WRV 4)

This WRV was considered to be less important in the river and was not evaluated for the river or springs.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not evaluated for the river or springs.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was considered important for Steinhatchee Falls but was not specifically evaluated due to a lack of quantitative information.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not evaluated for the river or springs.

Sediment Loads (WRV 8)

This WRV was considered to be less important in the river and was not evaluated for the river or springs.

Water Quality (WRV 9)

This WRV was not evaluated for the river or springs although the freshwater portion of the river is impaired for fecal coliform.

Navigation (WRV 10)

This WRV was considered applicable for the Steinhatchee River but was not specifically evaluated because navigation occurs solely in the lower river where levels are tidally-controlled.

SRWMD – Lower Suwannee River & Estuary, Little Fanning, Fanning & Manatee Springs

Adapted from Water Resource Associates, Inc., 2005. MFL Establishment for the Lower Suwannee River & Estuary, Little Fanning, Fanning & Manatee Springs. Suwannee River Water Management District, Live Oak, Florida.

Background

The Lower Suwannee River and Estuary comprises the lower portion of the Suwannee River; the Suwannee River Estuary; and Fanning, Little Fanning, and Manatee Springs (Figure A-18 and Table A-31). The Lower Suwanee River begins at the Wilcox Gage and extends to the Suwannee Delta in the Gulf. The Suwannee River is designated as an OFW and Aquatic Preserve. The river has also been identified as an "Endangered Ecosystem" because of the lack of dams, diversions, or navigation projects and is classified by the Nature Conservancy as a "critical watershed to protect freshwater biodiversity". A portion of the MFL area also lies within the Big Bend Aquatic Preserve and the area includes multiple national Wildlife Refuges, state parks, a wildlife management area, and other state lands. The Lower Suwannee River also includes two first magnitude springs that were evaluated in this MFL: Fanning Springs and Manatee Springs. Portions of the Suwannee River have been designated as Critical Habitat for the Gulf sturgeon, a federally threatened species. Springs along the river also provide important winter refuge for manatees.

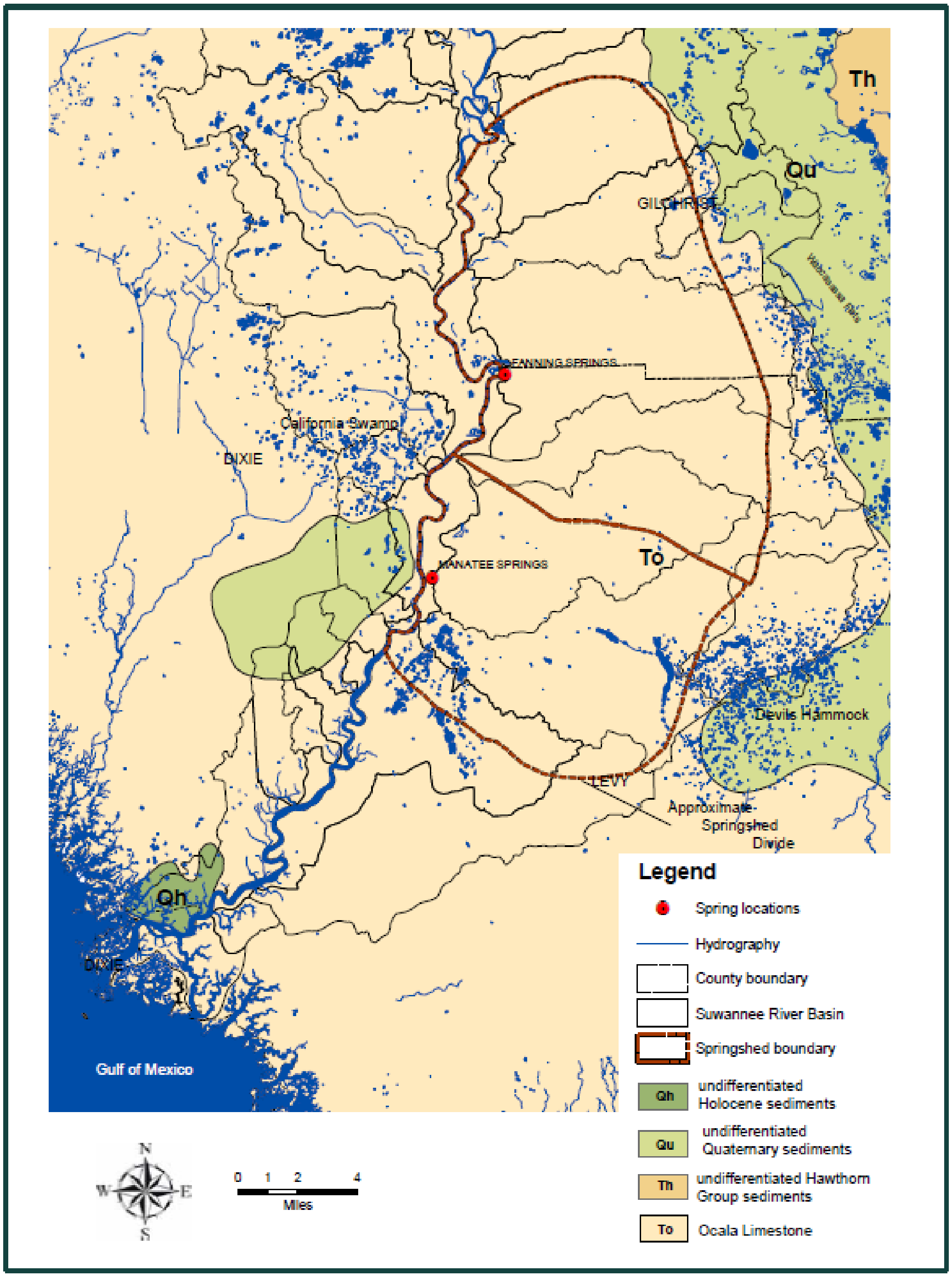


Figure A-18. Lower Suwannee River MFL Area (Water Resource Associates, Inc., 2005)

Table A-31. Lower Suwannee River Springs' Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Manatee Spring	1st	29.48914	-82.97695
Fanning Springs	1st	29.58774	-82.93541
Little Fanning Spring	2nd	29.58640	-82.93554

Minimum Flows and Minimum Levels

The Lower Suwannee River includes three springs that were individually considered in the MFL (Table A-32). Two of these springs had individual MFLs set to protect specific WRVs: Manatee and Fanning. These individual MFLs are discussed in the following sections.

Manatee Springs

The proposed MFL for Manatee Springs was set as a minimum spring discharge of 130 cfs from November 1 through April 30 to preserve the extent of the thermal refuge of the Florida manatee during the winter months and no more than a 10% reduction throughout the year. The flow was based on a modeled relationship of spring to river discharge and the volumetric extent of the thermal refuge. The MFL was based on the relationship of spring discharge to river stage, avoidance of significant adverse impacts to recreation and aesthetic values, winter manatee thermal refuge, and water availability in the springshed.

Fanning Springs/Little Fanning Springs

The MFL for Fanning Springs was set to maintain a manatee passage depth of 5 feet in the spring run. This depth corresponded to a minimum spring stage elevation, of 2.71 feet (NGVD29) during the winter months (November 1 through April 30). In addition, throughout the year the historic flow regime will not be decreased by more than 10%. The recommended median flow for the Lower Suwannee River of 7,600 cfs will control the spring run elevation and allow the 2.71 feet stage to be met 85% of the time. The MFL was based on the relationship of spring discharge to river stage, avoidance of significant adverse impacts to recreation and aesthetic values, winter manatee thermal refuge, and water availability in the springshed.

Lower Suwannee River

The MFL for the Lower Suwannee River was set to protect SAV in the summer months and to protect levels in Fanning Springs in the winter months (November 1 – April 30). The summer (May 1 – October 31) MFL was set based on maintaining SAV communities at a flow of 6,600 cfs, which was estimated to put 3.5% of SAV communities at risk. The winter (November 1 – April 30) MFL was set at 7,600 cfs to maintain the Fanning Spring stage at 2.71 feet (NGVD29) approximately 85% of the time to allow for manatee access. The MFL is summarized in Table A-32.

Table A-32. MFL for the Lower Suwannee River, Manatee Springs, and Fanning Springs

System	Allowable Reduction		
	Flow (cfs)	Level (ft NGVD29)	Reduction (%)
Manatee Springs (Nov. 1 - Apr. 30)	130		
Manatee Springs (May 1 – Oct. 31)			10%
Fanning Springs (Nov. 1 - Apr. 30)		2.71	
Fanning Springs (May 1 – Oct. 31)			10%
Lower Suwannee River (Nov. 1 - Apr. 30)	7,600		
Lower Suwannee River (May 1 – Oct. 31)	6,000		

Baseline Flow

Manatee Springs had a baseline flow period for the period from May 27, 2001 - May 31, 2005. The median flow for this period was 106 cfs.

Fanning Springs had a baseline flow period for the period from May 27, 2001 - May 31, 2005. The median flow for this period was 73 cfs. Fanning Springs experiences reverse flows when stages in the Suwannee River exceed approximately 9 feet above mean sea level.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Recreation is a major use of Fanning and Manatee Springs and includes swimming, scuba diving, boating, water sports, recreational fishing, kayaking, and canoeing. Both springs are popular and heavily utilized. Reducing flow would increase “dark water” intrusion from the Suwannee River. Maintaining an acceptable spring discharge for recreation was considered for each spring, but no quantitative analysis was developed for this WRV.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Manatee Spring and Fanning Spring act as a secondary warm water refuge (WWR) for the Florida Manatee during the winter months. Fish also use the Lower Suwannee River although no shallow shoal areas exist that would restrict use.

Thermal Model – A temperature model was used to evaluate the temperature effects resulting from the Manatee Spring discharge and the thermal refuge offered by the spring. The CE-QUAL-W2 Model was used to evaluate river temperatures and was calibrated to data from February -April 2004. Flows were varied for the river and spring independently between the 25th and 75th percentiles to determine the change in temperatures resulting from a change in the proportion of flow delivered by the spring. This modeling showed that the extent of warm water increased as spring flows increased as a proportion of total river flow. Based on the results the potential minimum flow during the cold season was set at the median flow from the period from 2001 to 2005 of 130 cfs for the cold season from November 1 through April 30.

Stage Analysis – The thermal refuge at Fanning Springs was evaluated based on a survey of the spring run bottom elevation and the highest point along the run with a 5-foot passage depth in the spring run to allow access by manatees. This resulted in an elevation of 2.71 feet (NGVD29) in the spring run providing the 5-foot passage depth. The flow that corresponded to more than an 85% probability of the 2.71-foot passage elevation being exceeded was 7,600 cfs at the Wilcox Gage.

Estuarine Resources (WRV 3)

This WRV was considered for the Lower Suwannee River, but was not specifically quantified for the evaluated spring systems.

Transfer of Detrital Material (WRV 4)

Transfer of detrital material was not considered as a WRV value for the springs although it was noted that under high river stages water backflows from the river into the springs carrying some organic material that is deposited in the caves. The effect of this material was not evaluated given an identified lack of studies that have considered this input.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was considered although not directly quantified for the springs. The importance of this WRV was highlighted with regard to the goal of establishing MFLs to provide for permitted water uses while not causing "significant harm" to the water resource.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was evaluated to maintain full spring boils, minimize dark water backflows from the river, and to maintain stages in the spring runs. This WRV was not separately quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

Manatee Spring and Fanning Spring have records of increasing nitrate concentrations, but both spring systems were identified as having minimal nutrient sorption capabilities given their short spring runs and residence times. This WRV was not quantified.

Sediment Loads (WRV 8)

This WRV was not considered with regard to the evaluated springs.

Water Quality (WRV 9)

Nitrates in the springs are increasing although no relationship was found with flow or levels. These increases were identified to be tied to land uses in the springsheds and this WRV was not quantified.

Navigation (WRV 10)

The Lower Suwannee River was not considered to support commercial shipping or barge traffic and was not evaluated.

SRWMD - Waccasassa River, Estuary and Levy (Bronson) Blue Spring

Adapted from Water Resource Associates, Inc., 2006. MFL Establishment for the Waccasassa River, Estuary and Levy (Bronson) Blue Spring Technical Report. Suwannee River Water Management District, Live Oak, Florida.

Background

Levy Blue Spring is a third magnitude spring located in Levy County within a county park (Figure A-19 and Table A-33). Levy Blue Spring is contained within a concrete wall around the spring boil and includes swimming and diving platforms as well as picnic areas. Levy Blue Spring drains from a 0.3-mile spring run into the Little Waccasassa River, a tributary to the Waccasassa River about 0.2 miles upstream of the confluence. The Waccasassa River has been designated as an OFW and is regarded as a river with high conservation value given the highly protected nature of large sections of the river and floodplain. Levy Blue Spring provides 10-25% of the average Upper Waccasassa River flow at US19. During wet periods this decreases to as little as 5% and during dry periods it can comprise 100% of the river flow.

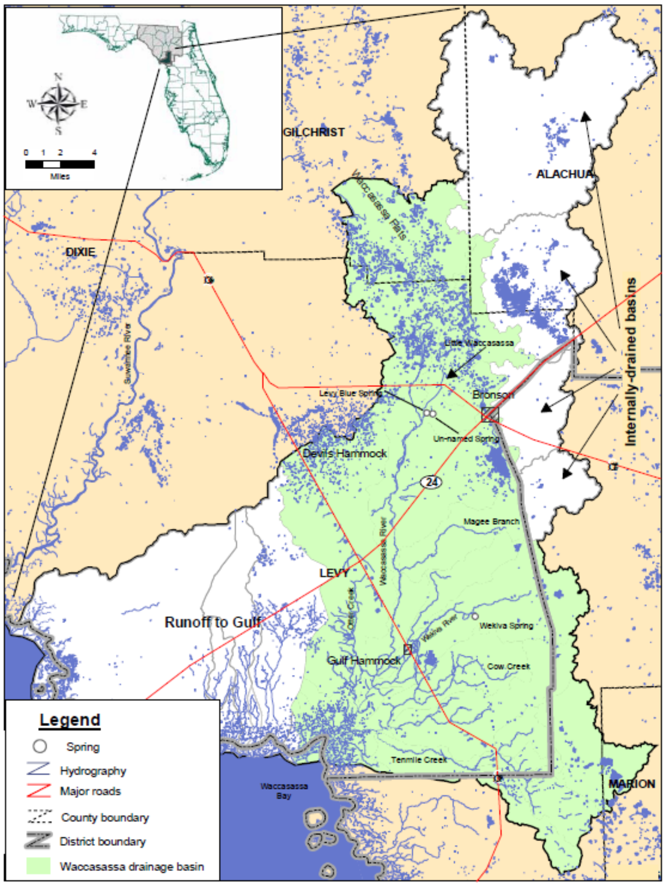


Figure A-19. Levy Blue Spring in Levy County, Florida (Water Resource Associates, Inc., 2006)

Table A-33. Levy Blue Spring Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Levy Blue Spring	3rd	29.45076	-82.69897

Minimum Flows and Minimum Levels

The recommended MFL for Levy Blue Spring was set at 90% of the Baseline Flow Duration Curve resulting in a 10% decrease across the historic range of flows (Table A-34). This MFL would result in a shift in the median flow from 6.9 cfs to 6.2 cfs.

Table A-34. MFL for Levy Blue Spring

System	Baseline Flow	Allowable Flow Reduction	
Levy Blue Spring	6.9 cfs	0.7 cfs	10%

Baseline Period

Baseline flows for Levy Blue Spring were developed from a small number of manual flow readings combined with a continuous well data set. The median simulated flow was 6.9 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was evaluated based on Department of Health bathing criteria that provide for 500 gallons per bather per 24 hours. Based on this criterion the load was thousands of bathers per day and a relatively large change in flows would not result in this criterion being limiting.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was considered minimally relevant and addressed in the MFL for the Waccasassa River, not in the MFL for the spring.

Estuarine Resources (WRV 3)

This WRV was not considered relevant to MFL development.

Transfer of Detrital Material (WRV 4)

This WRV was not considered relevant to MFL development.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was evaluated based on the critical importance of Levy Blue Spring to the Upper Waccasassa River and adjacent wetlands during median and low-flow periods. The MFL proposed to allow for a 10% flow decrease to provide some additional use although the exact rationale for this proposed decrease was not provided.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not considered relevant to MFL development.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered relevant to MFL development.

Sediment Loads (WRV 8)

This WRV was not considered relevant to MFL development.

Water Quality (WRV 9)

This WRV was not considered relevant to MFL development.

Navigation (WRV 10)

This WRV was not considered relevant to MFL development.

SWFWMD – Alafia River

Adapted from Flannery, M., Chen, X., Heyl, M., Munson, A., Dachsteiner, M., 2008. The Determination of Minimum Flows for the Lower Alafia River Estuary. Southwest Florida Water Management District.

Kelly, M., Munson, A., Morales, J., Leeper, D., 2005. Alafia River Minimum Flows and Levels - Freshwater Segment. Southwest Florida Water Management District, Brooksville, Florida.

Background

Lithia and Buckhorn Springs are both second magnitude springs located along the Alafia River in Hillsborough County (Figure A-20 and Table A-35). Both Lithia and Buckhorn Spring have had MFLs developed as part of the Alafia River MFL. Lithia Springs is located in a County-operated Park and consists of two spring vents each of which feeds a short spring run before discharging to the Alafia River. The park allows swimming, canoeing, camping, and day use. Lithia Springs Major is the subject of this MFL. Lithia Springs has a strong annual cycle with higher flows in fall following the rainy season and lower flows in spring after the dry season.

Buckhorn Springs is located on private property about 4 miles west of Lithia Springs. Buckhorn Springs is comprised of four springs and many smaller vents. Buckhorn Springs Main is the largest of the spring vents and included as part of this MFL. Buckhorn Springs includes a permitted use for processing water for Cargill, Inc. (the private landowner). The spring pool empties into Buckhorn Creek which flows approximately 0.4 miles before reaching the Alafia River.

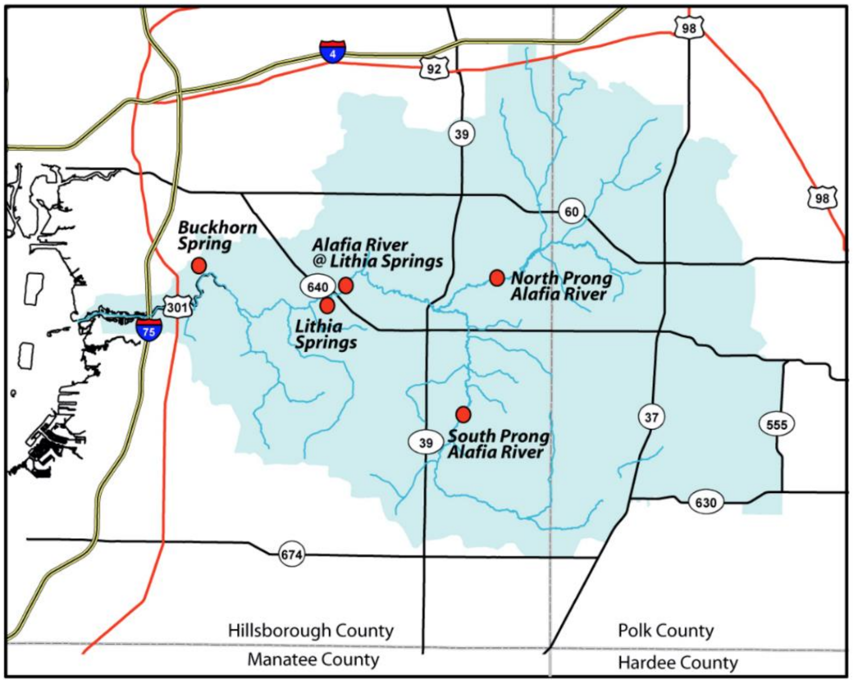


Figure A-20. Lithia and Buckhorn Springs (Kelly et al., 2005)

Table A-35. Lithia and Buckhorn Spring Locations

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Lithia Spring	2nd Magnitude	27.86628	-82.23146
Buckhorn Spring	2nd Magnitude	27.86628	-82.23146

Minimum Flows and Minimum Levels

Lithia Springs Major and Buckhorn Spring Main

No MFL was specifically developed for Lithia Springs Major or Buckhorn Springs Main. The MFL developed for the Upper Alafia River (Kelly et al., 2005) recommended delaying approval of an MFL for Lithia Springs Major and Buckhorn Springs Main until the MFL was developed for the Lower Alafia River and Estuary. The MFL developed for the Lower Alafia River and Estuary (Flannery et al., 2008) did not specifically set an MFL for either spring, but considered them incorporated in the MFL for the lower river.

Water Resource Value Assessment

No specific MFL was set for either spring. WRV 1 and 2 were evaluated in a limited context in the Upper Alafia River MFL. A summary of the quantitative metrics used to relate each WRV to flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Lithia Springs was evaluated with regard to swimming based on Department of Health “bathing load” criteria, which found that a flow of 0.218 MGD was allowable to support the maximum 436 individuals that should be in the spring at any given time. This was slightly increased to 0.3855 MGD assuming that 30% of the maximum number of park visitors planned to use spring for swimming. This WRV was not considered protective of the resource.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Habitat was evaluated in Lithia Springs Major Run using the PHABSIM for several fish species and macroinvertebrate diversity. This model showed that at a 5% flow reduction a greater than 15% habitat impact occurred for various life history stages and spawning activities occurred. These results were not used to develop an MFL because the PHABSIM results were potentially not accurate during periods when the Alafia River exceeded 70 cfs at the Lithia gage, the habitat available in the spring run was less than available in the river, and because no rare or listed species were present in the spring run.

Habitat was evaluated in Buckhorn Creek downstream of Buckhorn Springs Main using the PHABSIM for several fish species and macroinvertebrate diversity. The system was evaluated based on two flow records one for the estimated spring flow and the second for flows in the creek. The flow record for estimated spring flows showed that up to a 15% flow reduction could occur before habitat was reduced by more than 15%. The flow record for the creek showed that 5% reductions July-October, 10% flow reductions April-June and November-February, and 20% flow reductions in March could occur before a 15% reduction in habitat availability occurred. These results were not used in the development of the MFL because the Lower River and

Estuary were being evaluated and it was felt that MFL may be contingent on flow from the spring.

Estuarine Resources (WRV 3)

This WRV was not considered or evaluated.

Transfer of Detrital Material (WRV 4)

This WRV was not considered or evaluated.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not considered or evaluated.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not considered or evaluated.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered or evaluated.

Sediment Loads (WRV 8)

This WRV was not considered or evaluated.

Water Quality (WRV 9)

This WRV was not considered or evaluated.

Navigation (WRV 10)

This WRV was not considered or evaluated.

SWFMWD – Chassahowitzka River System

Adapted from Herrick, G., Chen, X., Anastasiou, C., Basso, R., Mendez-Ferrer, N., Ortega, N., Rogers, D., Leeper, D., 2019. Reevaluation of Minimum Flows for the Chassahowitzka River System. Southwest Florida Water Management District.

Heyl, M.G., Leeper, D., Basso, R., Kelly, M., 2012. Recommended Minimum Flows for the Chassahowitzka River System. Southwest Florida Water Management District.

Background

The Chassahowitzka Springs Group is a second magnitude spring system that feeds the Chassahowitzka River and Bay (Figure A-21 and Table A-36). The Chassahowitzka River flows approximately 5.6 miles to the Gulf of Mexico and is a designated OFW and a designated SWIM Priority Waterbody. The Chassahowitzka Springs Group includes 17 named springs, with the entire system tidally-influenced. An MFL was developed for the Chassahowitzka River System in 2012 (Heyl et al., 2012) and re-evaluated in 2019 (Herrick et al., 2019a). The initial MFL report identified a 9% reduction as allowable, while maintaining no more than a 15% reduction in associated WRVs. The 2013 MFL evaluation had an allowable flow reduction of 9%, however based on public comments and Governing Board approval a 3% reduction was adopted, with a stipulation to re-evaluate by 2019. In addition to the MFL for the Chassahowitzka River System site-specific numeric nutrient criteria (NNC) were developed for the river and estuary and a total maximum daily load (TMDL) was developed for the springs. The NNC were 0.44 mg/L for TN, 0.021 mg/L for TP, and 3.9 µg/L for chlorophyll-a. The TMDL for the identified springs was 0.23 mg/L for nitrate-nitrogen.

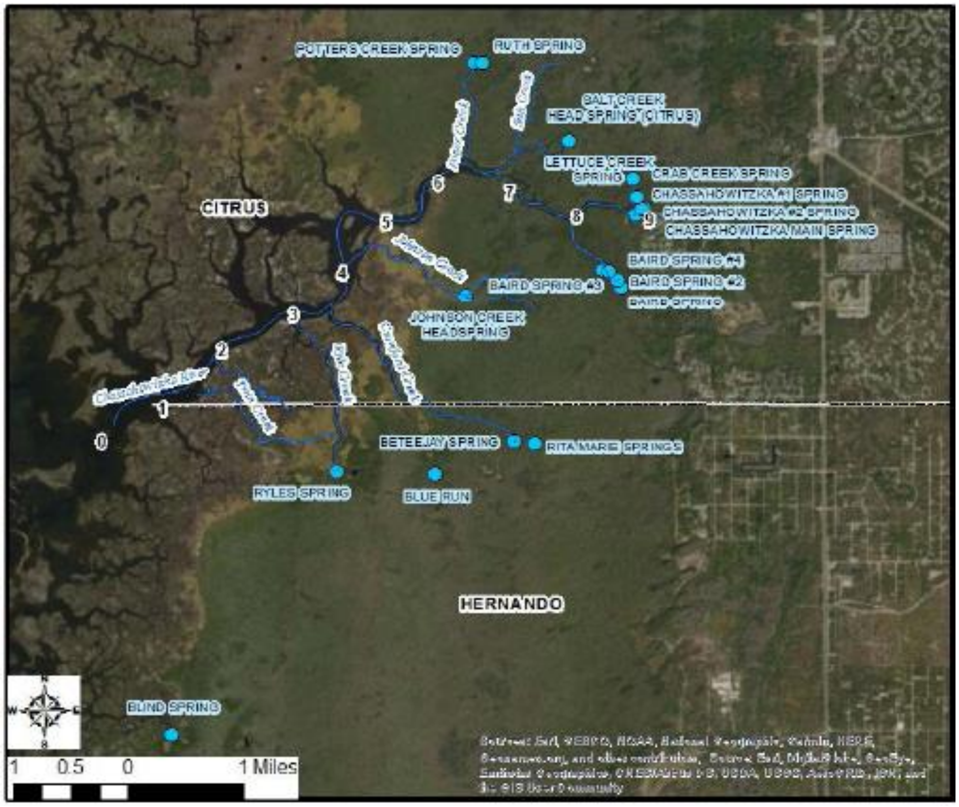


Figure A-21. Chassahowitzka River System (Herrick et al., 2019a)

Table A-36. Chassahowitzka River System Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Chassahowitzka River	2nd	28.71550	-82.57616

Minimum Flows and Levels

The MFL for the Chassahowitzka River System was adopted in 2013 and allowed a 3% reduction in baseline flows. This MFL also identified re-evaluation six years after initial adoption. The MFL has since been re-evaluated in 2019. The updated MFL identifies an allowable 8% reduction in flows to cause a 15% reduction in salinity-based and temperature-based habitats (Table A-37). Existing groundwater withdrawals were modeled to cause a 1.4% reduction in flows.

Table A-37. MFL for the Chassahowitzka River System

System	Baseline Flows	Allowable Flow Reduction	
Chassahowitzka River	59.7	4.7 cfs	8%

Baseline Period

The baseline flow period for the Chassahowitzka River System was from 1997-2016. The long-term average approved flow for this period was 58.9 cfs. Based on groundwater modeling, existing withdrawals account for a 1.4% decrease. The long-term un-impacted flows were calculated to be 59.7 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was not directly quantified but considered protected by the tidal influences and the 8% flow reduction which is not expected to decrease water levels.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was evaluated based on hydrodynamic modeling with LAMFE to evaluate the extent of salinity habitats and shoreline vegetation. LAMFE was also used to evaluate temperature-based habitats for common snook and manatees to protect habitat during colder winter months. An 8% reduction in flows was found to correspond to a 15% loss of temperature-based habitat volume for snook and to a 15% loss of salinity-based bottom area and volume for salinity less than or equal to 1 psu.

Estuarine Resources (WRV 3)

The entire Chassahowitzka River System was considered estuarine because of tidal influences along the entire length of the river. This WRV was not independently evaluated but considered as part of WRV 2.

Transfer of Detrital Material (WRV 4)

This WRV was not directly quantified but considered protected by the temperature-based and salinity-based reductions.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was evaluated based on application of the Northern District Model (NDM) which indicated that current and predicted future withdrawals would not be limited by the MFL.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not directly quantified but considered to be intrinsically linked to WRV 2. Filamentous algae were considered as a possible target for MFL development, but there was insufficient data to develop a statistical relationship to flow. The MFLs established based on the LAMFE modeling of level, salinity, and temperature was expected to prevent filamentous algae growth that might occur as a result of further flow reductions.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not directly quantified but considered protected based on the evaluation of water quality parameters in WRV 9.

Sediment Loads (WRV 8)

This WRV was not directly quantified but considered protected by the temperature-based and salinity-based reductions.

Water Quality (WRV 9)

This WRV was evaluated by examining trends in water quality parameters and changes in flows. Relationships between nitrate and flows were inconsistent between spring vents and that decreased flows would not result in increasing nitrate concentrations.

Chlorophyll concentrations were evaluated based on post-hoc analysis which showed an increasing concentration of chlorophyll at lower flows. This analysis showed that the 8% proposed flow reduction would result in a 9-13.5% chance of exceeding the 3.9 ug/L threshold. This was not considered analogous to a 15% loss of habitat or resource.

Navigation (WRV 10)

This WRV was not directly quantified but considered protected by the tidal influences and the 8% flow reduction which is not expected to vary significantly based on spring flows.

SWFWMD – Crystal River/Kings Bay

Adapted from "Herrick, G., Chen, X., Basso, R., Heyl, M., Leeper, D., 2017. Recommended Minimum Flow for the Crystal River/Kings Bay System – Revised Final Report. Southwest Florida Water Management District, Brooksville, Florida.

Background

The Crystal River/Kings Bay System is a first magnitude spring system located in Citrus County, Florida (Figure A-22 and Table A-38). The system includes more than 70 spring vents in Kings Bay that discharge to Crystal River which flows approximately six miles to the Gulf of Mexico. The Crystal River/Kings Bay System is designated an OFW, a SWIM Priority Water Body, and the Crystal River Springs Group is designated as an OFS.

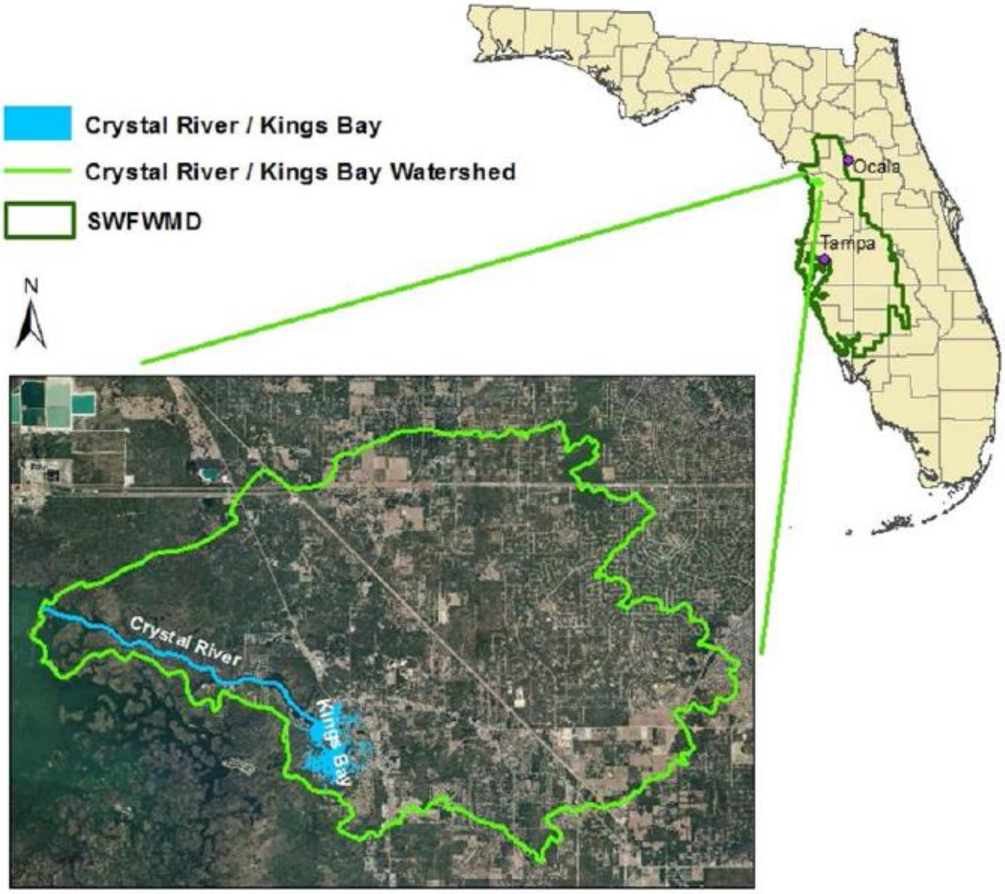


Figure A-22. Crystal River/Kings Bay System (Herrick et al., 2017)

Table A-38. Crystal River/Kings Bay System Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Kings Bay Spring Group (OFS)	1st Magnitude	28.90433	-82.62388

Minimum Flows and Minimum Levels

The proposed minimum flow for the Crystal River/Kings Bay System is an 11% reduction from the long-term, tidally-filtered average flow of 456 cfs (adjusted for groundwater withdrawals), or a long-term, tidally-filtered average flow of 406 cfs (Table A-39). The MFL was set based on comments from the peer review committee and an allowable 15% reduction in the availability of low salinity (<0.5 ppt) natural and vegetated shoreline. Re-evaluation of the MFL was recommended within ten years of adoption.

Table A-39. MFL for Kings Bay Spring Group

System	Baseline Flow	Allowable Flow Reduction	
Kings Bay Spring Group	456 cfs	50 cfs	11%

Baseline Period

The baseline flow period for the Kings Bay Spring Group was from 2002-2015. The average flow was 447 cfs. Groundwater modeling was used to estimate the flow reduction due to current withdrawals. These reductions were estimated to be about 1.1% in 2014.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was not directly evaluated but considered related to other evaluated WRVs.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Salinity-based habitats and thermal refuge for manatees were considered as part of this WRV. Tidal fluctuations in the system were considered to be the main driver of levels making passage of fish irrelevant to the setting of MFLs.

Salinity and temperature were modeled using the UnLESS3D three-dimensional, unstructured hydrodynamic model. This model divided the spring system into 3,030 horizontal cells and 14 vertical layers. Salinity was evaluated based on determining the available habitat at each 30-minute interval and averaging it across the nine-year simulation period. The volume of water with salinity 2 ppt was found to be the most restrictive with a 12% decrease in flows causing a 15% loss of habitat.

Similarly, the model results were used to evaluate available manatee thermal refuge at each 30-minute interval for two conditions (<20 degrees Celsius for three days, or <15 degrees Celsius for four hours) at a minimum depth of 3.8 feet. The habitat availability was compared between the baseline flow and the proposed MFL to evaluate the change in suitable habitat. The modeled available habitat showed a 15% decrease at a flow reduction of 9%, but adequate habitat was identified as available to “several hundred thousand manatees”, many more than ever observed in the system. The MFL report is of the opinion that more than adequate manatee habitat exists for current and future populations and tat modeled decreases are not relevant to developing MFLs.

Estuarine Resources (WRV 3)

This WRV included evaluation of salinity-based resources as part of WRV 2.

Transfer of Detrital Material (WRV 4)

This WRV was not directly quantified because of a described lack of relevant data.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not directly evaluated but is considered to be an intrinsic part of setting MFLs and balancing the other WRVs while providing water supply.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not directly evaluated, but concerns considered included water clarity, reduction of algal blooms, and tourist viewing of manatees. No conclusive links were identified between flows and water clarity or chlorophyll-*a* concentrations. Manatee habitat was evaluated under WRV 2.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was discussed in the context of expanding SAV communities to improve water clarity and was not directly evaluated, but rather considered protected based on evaluation of salinity-based criteria.

Sediment Loads (WRV 8)

This WRV was not directly evaluated but considered related to other evaluated WRVs.

Water Quality (WRV 9)

This WRV was evaluated for salinity and temperature, both of which had a relationship to flow. These parameters were already evaluated in the context of WRV 2. Other parameters were not observed to have a relationship with flow and were not evaluated.

Navigation (WRV 10)

This WRV was not directly evaluated because of the tidal influences in the system that are expected to control navigation rather than an MFL.

SWFMWD – Gum Slough Spring Run

Adapted from Basso, R., Hood, J., Kelly, M., Morales, J., Hinkle, T., 2011. Proposed Minimum Flows and Levels for the Gum Slough Spring Run Final Report. Southwest Florida Water Management District.

Background

The Gum Slough Spring Run is a second magnitude spring system located primarily in Sumter County, originating near the Marion/Sumter County line (Figure A-23 and Table A-40). The spring run includes five second magnitude springs and one third magnitude spring. The spring run travels approximately six miles to the southwest where it flows into the Withlacoochee River. Land adjacent to Gum Slough Spring Run is primarily composed of wetlands, undeveloped areas, and undeveloped "urban" land uses to the north. The mean daily discharge of the system is 98 cfs.

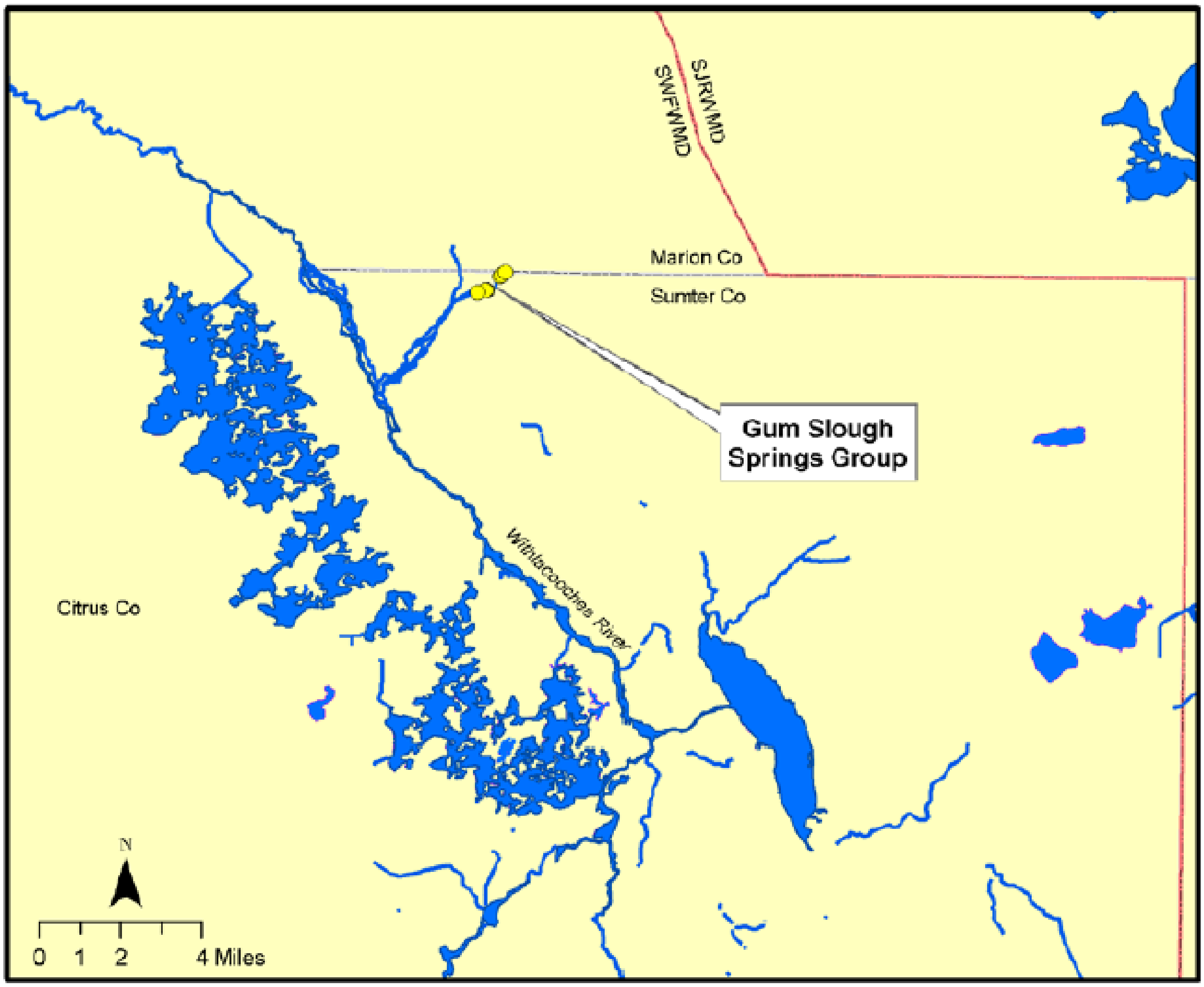


Figure A-23. Gum Slough Spring Run in Sumter County, Florida (Basso et al., 2011)

Table A-40. Springs Physical Descriptions

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Gum Spring Main	2nd Magnitude	28.95872	-82.23152

Minimum Flows and Minimum Levels

The MFL for Gum Slough Springs Run was an allowable 9% reduction from the historical flow record based on causing a 15% loss of habitat using PHABSIM modeling; with surface water withdrawals prohibited from depressing flows below 35 cfs for the year to maintain a fish passage depth of 0.6 feet across shoals while maximizing the inundated river channel (Table A-41).

Table A-41. Minimum Flow for Gum Slough Spring Run

System	Type	Minimum Flow
Gum Slough Springs Run	Annual Reduction	9%
	Surface Withdrawals	35 cfs

Baseline Period

The baseline flow period for the Gum Slough Springs Run was from 2003-2010. The median flow for this period was 84 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was not evaluated but considered protected under WRV 2.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This was the only WRV that was specifically evaluated in the setting of the MFL. This WRV was considered with regard to maintaining fish passage and wildlife habitat.

Fish Passage - The WRV was evaluated based on allowing fish passage at shoal areas. A HEC-RAS model was developed for the system to model depths at critical cross-sections under varying flow conditions. A flow of greater than 35 cfs was found to provide a minimum of 0.6 feet of depth at shoals to allow for fish passage.

Wetted Perimeter Inflection Point – The WRV considered the loss of wetted perimeter as a function of decreasing flows. This method relies on finding an inflection point in the relationship where small changes in depth cause proportionally larger changes in wetter perimeter. HEC-RAS was used to evaluate wetted perimeters for a variety of locations under varying flows and found a flow of less than the lowest modeled flow of 35 cfs was protective of this resource.

In-Channel Habitats – This habitat was evaluated using PHABSIM to quantify changes in habitat as a function of changes in flow/depth. This modeling relies on establishing a variety of cross-sections where specific life stages of specific species are evaluated based on changes in habitat availability. The shallow, slow fish guild was found to be the most sensitive with a 15% loss of habitat at a flow decrease of 9%.

Woody Habitats – The WRV was assessed based on the availability of woody habitat which provides the greatest habitat per unit area for macroinvertebrate secondary production. These habitats must have inundation of an adequate duration and frequency to support these communities. Exposed roots and snags were separately evaluated. Exposed roots were found to have a 12% allowable flow reduction and snags were found to have an allowable 24% reduction.

Estuarine Resources (WRV 3)

This WRV was not considered.

Transfer of Detrital Material (WRV 4)

This WRV was not considered.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not considered.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not considered.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered.

Sediment Loads (WRV 8)

This WRV was not considered.

Water Quality (WRV 9)

This WRV was not considered.

Navigation (WRV 10)

This WRV was not considered.

SWFMWD – Upper Hillsborough River and Crystal Springs

Adapted from Munson, A., Kelly, M., Morales, J., Leeper, D., 2007. Proposed Minimum Flows and Levels for the Upper Segment of the Hillsborough River, from Crystal Springs to Morris Bridge, and Crystal Springs. Southwest Florida Water Management District.

Background

Crystal Springs is a second magnitude spring system located in Pasco County (Figure A-24 and Table A-42). The spring discharges to the Hillsborough River from one main vent and three minor vents. The spring is dammed just upstream of the confluence with the Hillsborough River creating a spring pool that was historically popular with visitors. The property is now operated as a private educational park. A portion of the flow from the spring is sold as bottled water. The spring has experienced a clear decline in flows, 50% of which has been attributed to anthropogenic sources. During low-flow periods Crystal Springs contributes a majority of the flow in the Upper Hillsborough River.

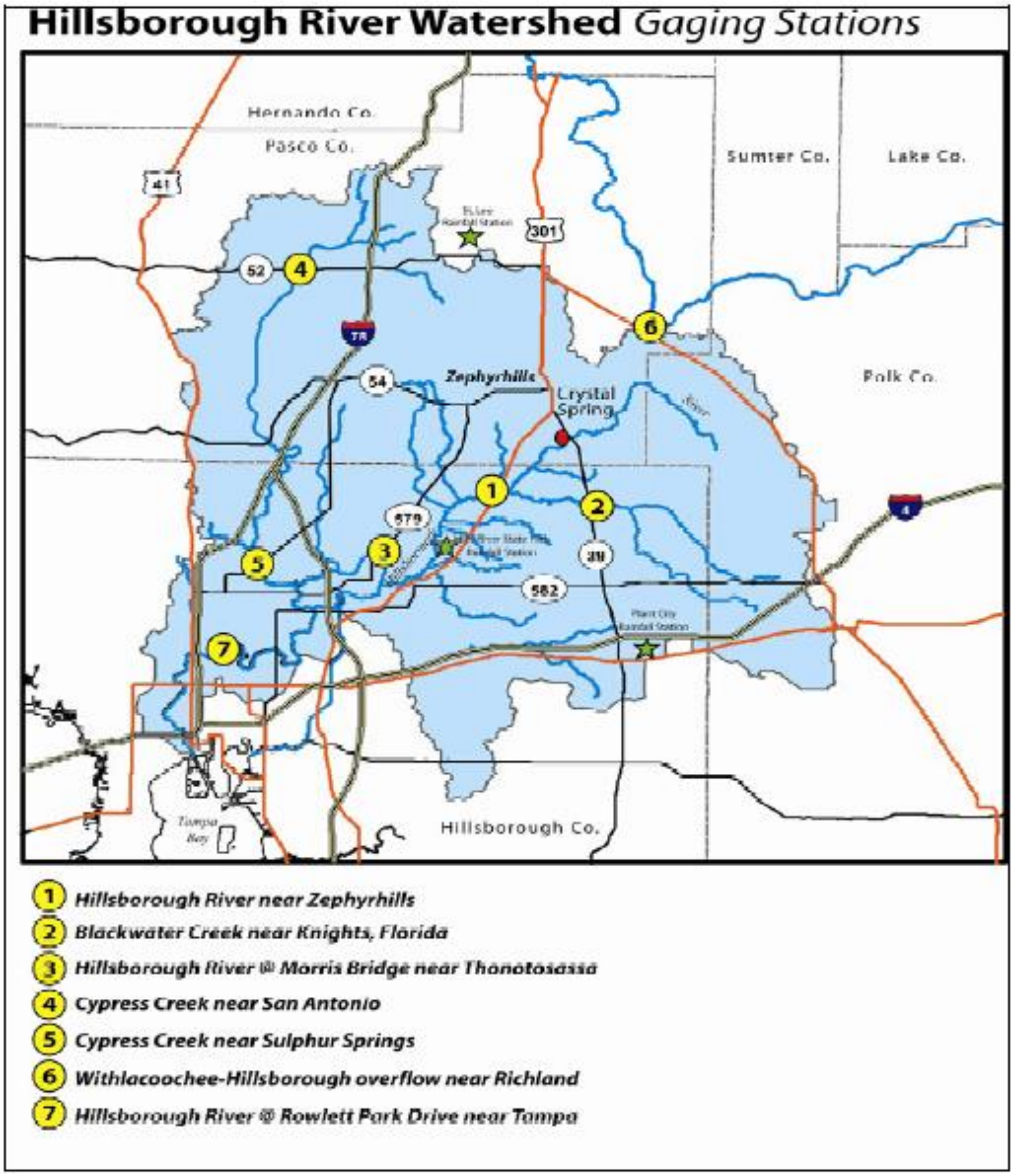


Figure A-24. Upper Hillsborough River and Crystal Spring (Munson et al., 2007b)

Table A-42. Crystal Springs Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Crystal Springs	2nd	28.18220	-82.18515

Minimum Flows and Minimum Levels

The MFL for Crystal Springs was set based on maintaining low flows in the Upper Hillsborough River. The MFL was set such that the Crystal Springs flow would support at least 85% of the available habitat for the Block 1 (April 20-June 24) MFL of 52 cfs for the Hillsborough River at the Morris gage. The flow corresponding to a 15% reduction in habitat in the

Hillsborough River was 46 cfs. Based on plot analyses it was projected that a 16% flow decrease would be allowed during the Atlantic Multi-decadal Oscillation (AMO) cool-phase and a 24% flow decline during the AMO warm-phase for the long-term flows at Crystal Springs to achieve the required MFL of 46 cfs (Table A-43). Currently spring flows are less than the MFL of 46 cfs and the spring is below the proposed significant harm threshold. The spring lies within the area covered by the Northern Tampa Bay recovery plan which is expected to increase flow rates in the spring. No further recovery strategy was recommended until the existing strategy could be evaluated.

Table A-43. MFL for Crystal Springs

System	Minimum Flow	Reduction
Crystal Springs	46 cfs	16%

Baseline Period

The baseline flow period for Crystal Springs was complicated by the impacts of groundwater withdrawals on flows at the spring. A variety of techniques were used to estimate a baseline flow.

Water Resource Value Assessment

No specific WRVs were evaluated for Crystal Spring. Rather the MFL was set based on maintaining the MFL in the Hillsborough River.

Recreation In and On the Water (WRV 1)

This WRV was not considered.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was not evaluated for the MFL but was the limiting WRV for the Hillsborough River. The Crystal Spring MFL was then defined to support flows in the Hillsborough River to protect these WRVs.

Estuarine Resources (WRV 3)

This WRV was not considered.

Transfer of Detrital Material (WRV 4)

This WRV was not considered.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not considered.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not considered.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered.

Sediment Loads (WRV 8)

This WRV was not considered.

Water Quality (WRV 9)

This WRV was not considered.

Navigation (WRV 10)

This WRV was not considered.

SWFWMD – Homosassa River System

Adapted from Herrick, G., Chen, X., Anastasiou, C., Basso, R., Mendez-Ferrer, N., Ortega, N., Rogers, D., Leeper, D., 2019. Reevaluation of Minimum Flows for the Homosassa River System Final Draft. Southwest Florida Water Management District.

Background

The Homosassa River System is located along the western coast of Florida and includes the Homosassa Springs Group and Run (Figure A-25 and Table A-44). The Homosassa Springs Group is a first magnitude springs group with a long-term average flow of 146 cfs, and 24 named spring vents. The Homosassa River flows approximately 8 miles before it discharges to the Gulf of Mexico near Shell Island in the Homosassa Bay Region. The entirety of the river system is tidally influenced. The Homosassa River System is within the SWFWMD. The original MFL for the Homosassa River System was developed in 2012, adopted in 2013, with an updated MFL developed in 2019. The original MFL found an allowable 3% decrease in flow to avoid salinity changes in the river. The 2019 MFL allows up to a 5% reduction in flows based on thermal refuge volume. Much of the land in and around the Homosassa River System is in public ownership including the Homosassa Springs State Park. In addition to an MFL this spring also has had a NNC developed for the estuary and river and a TMDL developed for the springs. The NNC were set as 0.51 mg/L for total nitrogen, 0.028 mg/L for total phosphorus, and 7.7 ug/L for chlorophyll-a. The TMDL for the identified springs was 0.23 mg/L for NO_X-N.

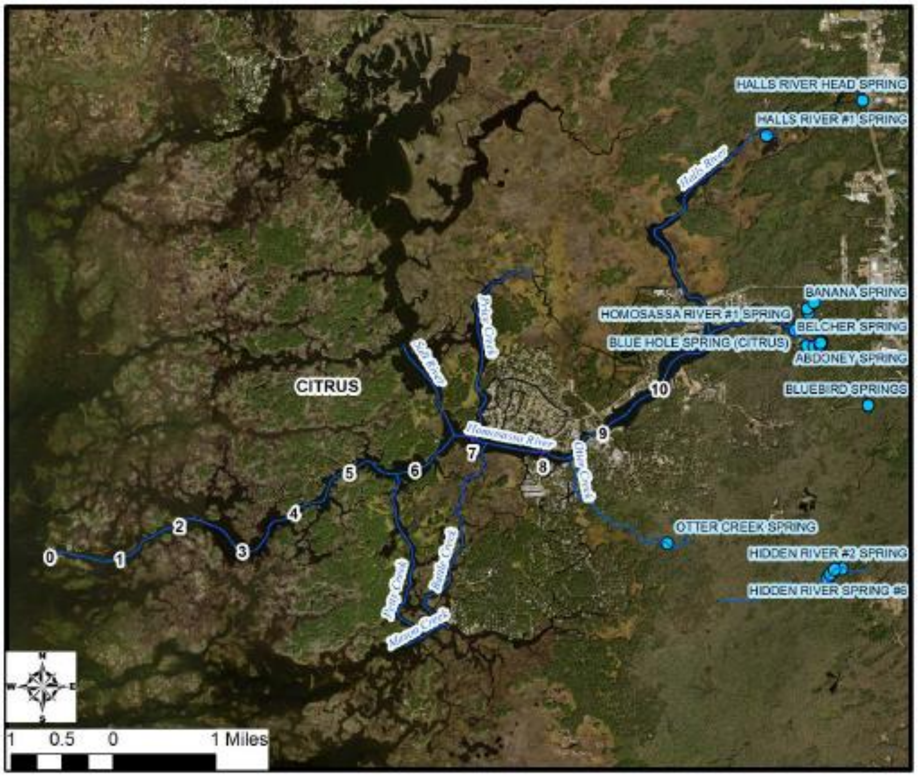


Figure A-25. Homosassa River System in Citrus County, Florida (Herrick et al., 2019b)

Table A-44. Homosassa River System Springs Location

Spring	Mag.	Lat. (dd)	Long. (dd)
Homosassa Group	1st	28.79963	-82.58848

Minimum Flows and Minimum Levels

The recommended MFL for the Homosassa River System are 95% of flows that would occur in the absence of withdrawal impacts allowing up to a 5% reduction (Table A-45). The MFL was based on temperature-thresholds for the common snook. Current withdrawals were modeled to be a 1.9% reduction with a projected demand increase of 3.0% by 2035. The long-term median combined flow was 146 cfs. Adjusted for withdrawal impacts of 1.9% the long-term unimpacted median flow was 149 cfs. The minimum median flow was 141 cfs.

Table A-45. MFL for the Homosassa River System

System	Unimpacted Flow	Minimum Median Flow	Allowable Flow Reduction
Homosassa River System	149 cfs	141 cfs	5%

Baseline Flow

The baseline flow period for the Homosassa River System was for the period from 2000-2017. The median flow for this time period was 146 cfs. Two flow gauges were used with “approved” data combined. Withdrawal impacts were modeled to account for a reduction of 1.9% when compared to the “no-pumping” condition.

Water Resource Value Assessment

All WRVs were considered. The degree of quantitative assessment varied by parameter, but in some cases included modeling, surveys, sample collection, etc. A summary of the metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

Recreation was considered through assessment of changes in levels, salinity, and temperature. Water levels in the Homosassa River are tidally-influenced such that a 5% flow decrease is not expected to cause decreases in water levels. This WRV was not directly quantified.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

Wildlife habitat was evaluated based on levels, salinity, and temperature. The river system provides habitat for a variety of fresh and saltwater species that are supported by the natural salinity variation within the river. As with recreation, water levels are not expected to see significant variation with changes in flows given the tidal influences.

The Laterally-Averaged Model for Estuaries (LAMFE) was used to model changes in salinity and temperature habitats under reduced flows. Temperature-based habitat was considered with regard to the Florida manatee and common snook. Additionally, salinity was evaluated with regard to snook. The most sensitive salinity habitats were the bottom area and volume of water less than or equal to two practical salinity units. Snook were found to have the most sensitive habitat criterion with a flow reduction of 5% causing a 15% loss in critical temperature-based habitat.

Estuarine Resources (WRV 3)

Estuary resources were found to be protected by preservation of salinity fluctuations. This WRV was not separately quantified.

Transfer of Detrital Material (WRV 4)

Detrital material is typically realized by floodplain inundation when material is suspended, moved downstream, and deposited in downstream areas. Flows established based on salinity and temperature were found to be adequate for downstream transport of detrital material. This WRV was not directly quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

Groundwater modeling was used to support freshwater supply. These predictions did not indicate that the proposed minimum flows would cause impacts and were believed protected through permit conditions for water use permits. This WRV was not directly quantified.

Aesthetic and Scenic Attributes (WRV 6)

Aesthetic and scenic attributes were expressed as inextricably tied to other values in the Homosassa River System. These criteria were directly considered with regard to temperature and salinity impacts evaluated for habitat and recreation considerations. Filamentous algae is considered a nuisance and was evaluated, but habitat requirements were not found to be different enough from beneficial SAV to be evaluated. Relationships between filamentous algae and nitrate were considered, but changes in flows were not expected to cause changes in nitrate. Water velocity was also considered but was described as primarily tidally-driven not allowing for assessment of changes associated with velocity.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

Water quality was considered with analysis showing that a majority of flow was derived from spring flows. Therefore, changes in spring flow were not expected to cause changes in concentrations. This WRV was not directly quantified.

Sediment Loads (WRV 8)

Sediment loads, as with detrital material are expected to be primarily loaded during flooding events. Changes in sediment loads were expected to be minimal with the recommended minimum flow. This WRV was not directly quantified.

Water Quality (WRV 9)

Water quality was considered based on evaluating trends and relationships with flows. Nitrate was of particular interest and was found to decrease with distance downstream in the river. Of the 11 spring vents that have been monitored, only one spring was found to have a relationship between flow and nitrate with the remaining ten springs not showing a relationship. Based on the lack of a clear relationship, nitrate was dropped from evaluation. Chlorophyll-a was found to have a relationship with flows and was evaluated. A decrease in flow of 5% was expected to increase the relative risk of exceeding the 7.7 ug/L by 8-12.5%. The risk of a change in chlorophyll-a was not considered to be analogous to a 15% loss of habitat and therefore was not used to define significant harm.

Navigation (WRV 10)

Navigation was considered based on bathymetry and flows. As with other values that considered flow and depth, the nature of tidal influences was not expected to lead to significant changes based on the recommended minimum flow. This WRV was not directly quantified.

SWFWMD – Rainbow River System

Adapted from Holzwart, K.R., Ghile, Y., Basso, R., Leeper, D., King, S., 2017. Recommended Minimum Flow for the Rainbow River System - Revised Final Draft. Southwest Florida Water Management District, Brooksville, Florida.

Background

The Rainbow River System is a first magnitude spring located in Marion County (Figure A-26 and Table A-46). The Rainbow River System is the fourth largest spring-fed river in Florida. The springs and river hold several state and federal designations. The Rainbow Springs Group is designated as an OFS and the Rainbow River System is designated an OFW, an Aquatic Preserve, and a SWIM priority waterbody. The river flows 5.7 miles before discharging into the Withlacoochee River, upstream of Lake Rousseau, which flows into the Gulf of Mexico.

The springshed averages 741 square miles with a mean annual springflow of 690 cfs for the flow record between 1931 and May 2015. The springshed includes portions of Levy, Marion, and Alachua Counties. The Upper Rainbow River has exceptional water clarity (over 200 feet horizontally) with that number reducing to an average of 38 to 47 feet in the lower river. The average water temperature is 74˚ F year around. Water depths vary from 4 to 25 feet along the river. There are no tidal influences and due to the dominance of spring flow, the average annual variation in water levels is less than one foot.

In 1909, the Inglis Dam was constructed twelve miles downstream of the Rainbow River confluence with the Withlacoochee River, forming the 4,200-acre impoundment, Lake Rousseau. In 1969, The United States Army Corps of Engineers (USACE), built the Inglis lock neighboring the dam as part of the Cross Florida Barge Canal (CFBC) project. The CFBC directed water from the downstream Withlacoochee River to the Gulf of Mexico. The CFBC and associated control structures have a significant elevating effect on the Rainbow River due to backwater effects from Lake Rousseau. The Rainbow Headsprings area was acquired in 1990 by the Florida Parks Service and converted into a state park. Kayaking, canoeing, boating, tubing, swimming, snorkeling, scuba diving, fishing and sightseeing are some of the attractions at the park.

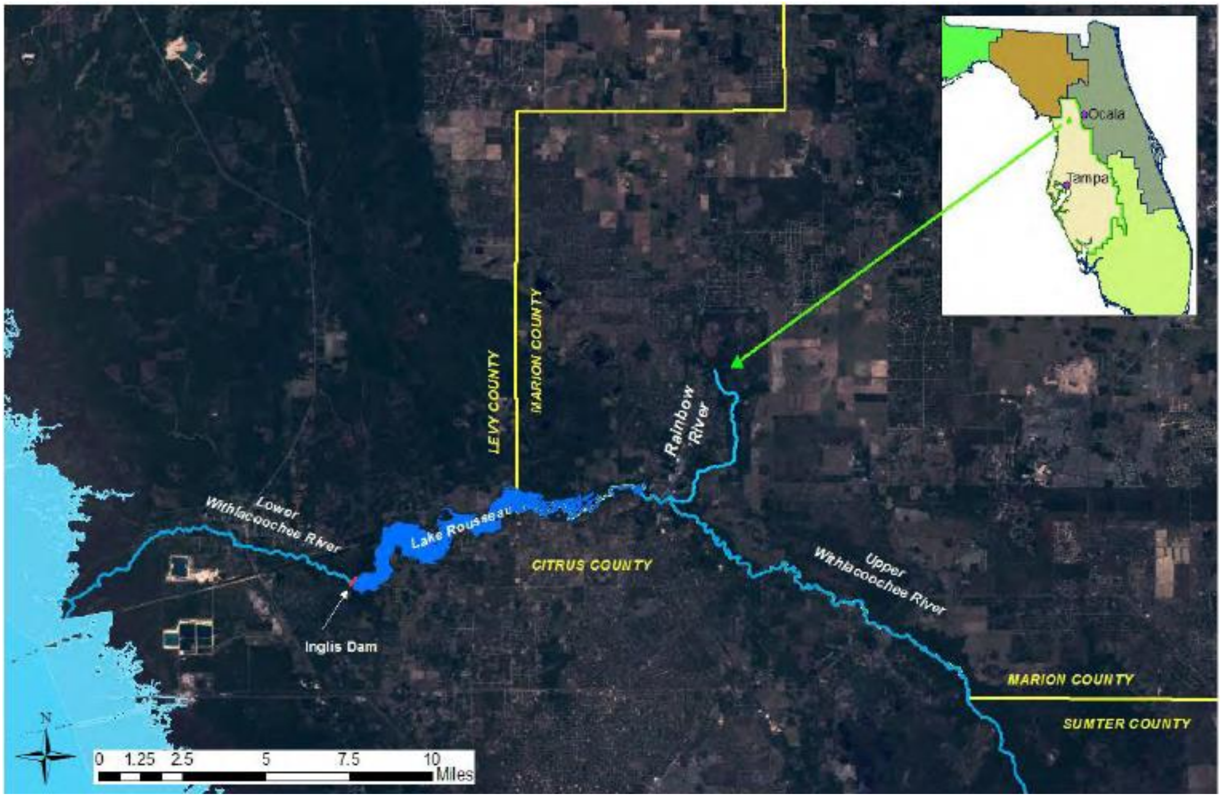


Figure A-26. Rainbow River In Marion County, Florida (Holzwart et al., 2017)

Table A-46. Rainbow River Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Rainbow River	N/A	29.04919	-82.44781
Rainbow Spring Group (OFS)	1st Magnitude	29.10247	-82.43746

Minimum Flows and Minimum Levels

The MFL was based on the inundation of the floodplain wetland habitat, with a maximum of a 5% reduction allowed. The MFL is a long-term average flow of 649 cfs, from the baseline flow of 683 cfs (Table A-47). The MFL further recommended reevaluation within ten years of MFL adoption based on additional data and information.

Table A-47. MFL for the Rainbow Springs Group

System	Baseline Flow	Minimum Flow	Reduction
Rainbow River	683 cfs	649 cfs	5%

Baseline Period

The baseline flow period for the Rainbow River System was from 1965-2015 with a long-term average of 677 cfs. Groundwater withdrawals were modeled to account for existing flow reductions. This modeling indicated a flow impact of 1.7% for the system. When adjusted for current withdrawals, the long-term average flow was 683 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was considered relevant for the Rainbow River System given the wide variety of human uses that include motor boating, tubing, swimming, canoeing, kayaking, snorkeling, fishing, and scuba diving. This WRV was not directly quantified but was considered protected by protection of WRV 2.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was used to set the MFL based on protecting the habitats available to wildlife and fish passage within the channel. This also included the maintenance of floodplain wetlands and habitat.

Fish Passage – A HEC-RAS model was used to evaluate wetted perimeter and fish passage under a variety of flow conditions. Fish passage was considered based on adding 0.6 feet to the minimum cross-section elevation to provide fish access through limiting cross-sections. This model was also used to assess fish habitat based on evaluation of the wetted perimeter at each cross-section under varying flows.

Habitat Modeling – A PHABSIM model was developed to assess habitat along the river for differing flow conditions at three representative locations. At each of these locations habitat suitability curves were developed for 18 representative functional and taxonomic groups. Habitat availability for various life stages were developed based on the HEC-RAS modeled flows.

Instream Woody Habitat – Woody material provides valuable habitat for macroinvertebrates that is critical to production. At 11 locations, two cross-sections were evaluated with regard to instream woody debris. Mean exposed root and snag habitat elevations were determined by cross-section with the HEC-RAS model used to assess loss of habitat. A 15% change was assessed at each cross-section to evaluate minimum flows to protect this habitat.

Floodplain Inundation – The HEC-RAS model was used to develop an inundation analysis for floodplain habitat along the river. Fifteen flow scenarios were evaluated for 15 Withlacoochee stage scenarios. Acres of inundation were evaluated for each combination of flow and stage for both historic conditions adjusted for withdrawals and for flows reduced by 5%, 10%, 15%, and 20%. Habitat availability was compared for the historic conditions adjusted for withdrawals and the various reduced flow scenarios to determine the flow decrease which resulted in a 15% decrease in available habitat. A 5% flow decrease was found to correspond to a 15% decrease in habitat availability.

Estuarine Resources (WRV 3)

The Rainbow River System is isolated from the Withlacoochee River Estuary by Lake Rousseau. This WRV was not considered relevant in setting the MFL.

Transfer of Detrital Material (WRV 4)

This WRV was considered relevant and was addressed through the modeling completed for WRV 2. Protection of this WRV included maintaining floodplain inundation and connection to the river channel which provides organic material to the system.

Maintenance of Freshwater Storage and Supply (WRV 5)

The freshwater storage any supply should be enough to protect non-consumptive uses and environmental values including wetland ecology. The District's Water Use Permitting Program protects this WRV and it was not directly quantified.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not directly evaluated but was considered protected through wildlife and recreation-based attributes.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was evaluated indirectly through the habitat-based evaluations made for WRV 2. This WRV was protected based on maintaining connection to floodplain wetlands, river channel sediments, and plant communities.

Sediment Loads (WRV 8)

This WRV considered the transport of the sediment within the Rainbow River and considered this metric protected by the MFL.

Water Quality (WRV 9)

This WRV was evaluated based on water quality sampling and trends within the river. Despite significantly increasing nitrate concentrations no obvious water clarity changes have occurred in the river. Furthermore, no clear trend was identified between decreasing flows and increasing nitrate concentrations or changes in water clarity. This WRV was not used in setting the MFL, but further study was recommended.

Navigation (WRV 10)

This WRV was considered based on the tour boats or boats carrying scuba divers and snorkelers. This WRV was evaluated in conjunction with WRV 1 and was not separately evaluated.

SWFWMD – Sulphur Springs

Adapted from SWFWMD, 2004. The Determination of Minimum Flows for Sulphur Springs, Tampa. Southwest Florida Water Management District, Brooksville, Florida.

Background

Sulphur Spring is a second magnitude spring located in a small park in Tampa, Florida (Figure A-27 and Table A-48). The average flow of the spring over the past 20 years has been 34 cfs. The spring is located in a highly urbanized area and the spring pool is surrounded by a circular concrete wall. Water leaving the spring is diverted to the spring run that flows approximately 500 feet to the Hillsborough River, but can also be diverted into the City's water supply and the Hillsborough Reservoir. Water is withdrawn from the spring to meet water supply needs during periods of impending water shortages and withdrawals have only occurred 11 percent of the time since 1991. Swimming was historically allowed in the spring, but high bacteria levels caused swimming to be discontinued in the 1980s. Spring flows have also been identified as a critical source of water to the Lower Hillsborough River to support minimum flows in the river.

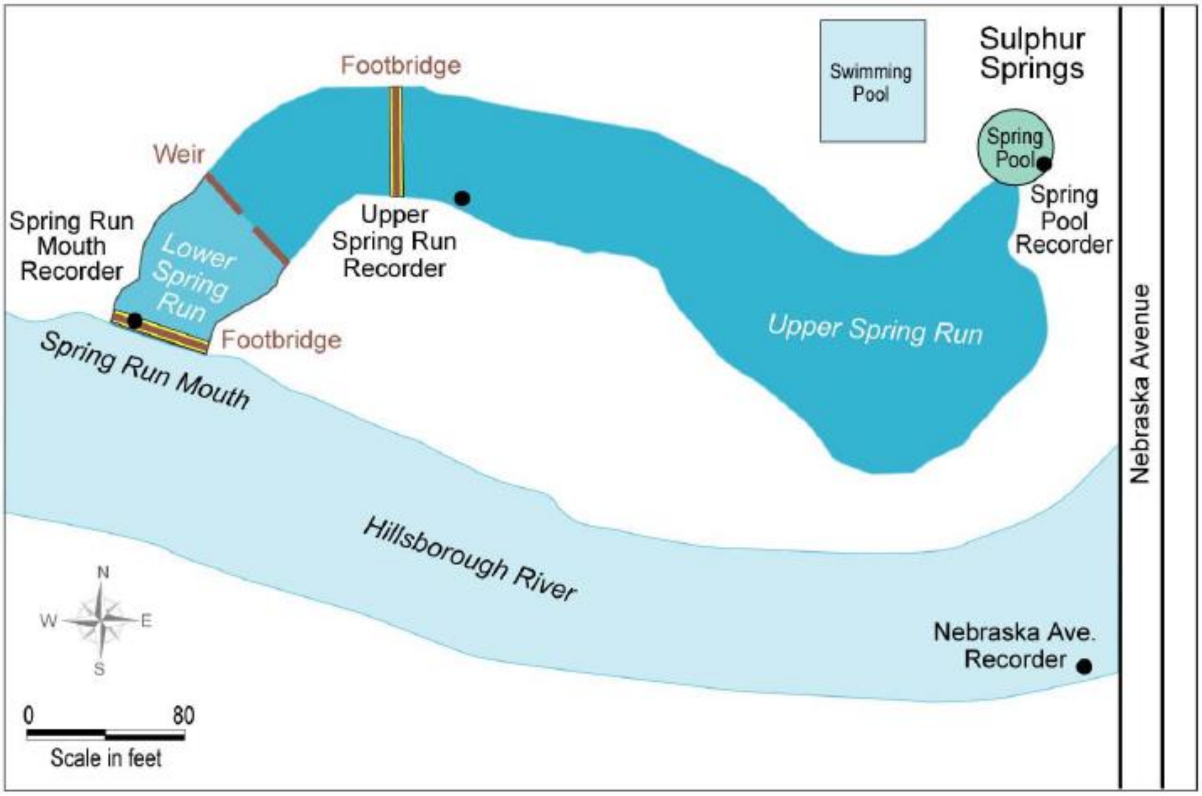


Figure A-27. Sulphur Spring in Hillsborough County, Florida (SWFWMD, 2004)

Table A-48. Sulphur Springs Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Sulphur Springs	2nd	28.02113	-82.45164

Minimum Flows and Minimum Levels

The proposed MFL for Sulphur Springs is 18 cfs, but may be reduced to 13 cfs when water levels in the Hillsborough River Reservoir fall below 19 feet (NGVD29), and may be reduced to 10 cfs during low tide, as long as it does not result in salinity incursions into the upper spring run (defined as salinity 1 ppt above the salinity in the spring pool). In addition, the MFL requires a flow of 18 cfs when temperatures of surface or bottom waters in the Lower Hillsborough River fall below 15 degrees Celsius (Table A-49).

Table A-49. MFL for Sulphur Spring

Condition	Flow (cfs)
MFL when Hillsborough River Reservoir >19 feet	18
MFL when Hillsborough River Reservoir <19 feet	13
MFL when Hillsborough River Reservoir <19 feet and low tide	10
MFL when Lower Hillsborough River <15°C	18

Baseline Flow

The baseline flow for Sulphur Spring is 31.4 cfs for the period from 1991-2002. Correcting flow for the City of Tampa withdrawals yields an average flow of 34.3 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

The WRV was not considered applicable. In-water uses do not exist in the spring because of elevated bacteria levels since the 1980s.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was used in developing the MFL based on three goals: minimizing incursion of high salinity water in the upper spring run, maintaining low salinity habitats in the Lower Hillsborough River, and maintaining a thermal refuge for manatees in the winter.

Minimizing Incursion of High Salinity Water into the Upper Spring Run – High salinity water has impacted macroinvertebrate communities in the Sulphur Springs Run during previous low flow periods. These communities were identified as important to secondary consumers and warranting protection by minimum flows that protect lower salinity waters. Data collection and analysis were used to evaluate the habitat and inundation under varying flows. This analysis showed that flows less than 18 cfs caused some sub-tidal areas to become inter-tidal areas exposing some of the most diverse habitat to the air during low tides in the upper spring run. These minimum flow findings further showed that an occasional reduction to 13 cfs (return period of 2-3 years) should not be harmful to the spring run communities.

Maintain Low Salinity Habitats in the Lower Hillsborough River – Sulphur Springs provides an important source of low salinity water in the Lower Hillsborough River during periods of low flows. To protect this low salinity habitat a 10 cfs flow diversion to the base of the dam was identified as a flow that would provide a net benefit during periods of no flow at the dam. Hydrodynamic modeling of salinity in the lower river was completed to examine the impacts of varying Sulphur Springs flows on the Lower Hillsborough River. This modeling showed that spring flows of 10 cfs helped maintain the 4 ppt and 11 ppt salinity zones in the lower river that are protective of important plant and macroinvertebrate species. This modeling also showed that this flow was more protective of these resources during low tide and recommended a tidally-based flow reduction allowing less flow during low tide.

Maintain Thermal Refuge for Manatees – A CE-QUAL-W2 model was developed for the lower river to evaluate the thermal regime. This model was used to estimate the temperatures in the Lower Hillsborough River based on the discharge provided by Sulphur Springs. This water is critical during winter when temperatures in the river fall below 15 degrees Celsius. Only the evaluated flow of 18 cfs maintained water temperatures within 2 degrees Celsius of the historical baseline and were considered protective.

Estuarine Resources (WRV 3)

This WRV was not considered applicable, although the spring flow does help support minimum flows in the Lower Hillsborough River.

Transfer of Detrital Material (WRV 4)

This WRV was not considered applicable.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not directly evaluated for the spring although the spring is used during periods of water shortages to supplement Tampa's water supply.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not considered applicable.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not considered applicable.

Sediment Loads (WRV 8)

This WRV was not considered applicable.

Water Quality (WRV 9)

This WRV was not considered applicable.

Navigation (WRV 10)

This WRV was not considered applicable.

SWFWMD – Weeki Wachee River System

Adapted from Heyl, M.G., 2008. Weeki Wachee River System Recommended Minimum Flows and Levels. Southwest Florida Water Management District, Brooksville, Florida.

Background

Weeki Wachee Spring is a first magnitude spring located in Hernando County. Flows from Weeki Wachee Spring feed the Weeki Wachee River which flows approximately 7.4 miles from the headspring to the Gulf of Mexico (Figure A-28 and Table A-50). The Weeki Wachee River has a compressed estuarine section that is shorter than other west coast rivers. Mud and Salt Springs provide additional flow to the Weeki Wachee River near the outlet to the Gulf complicating salinity in the lower river.

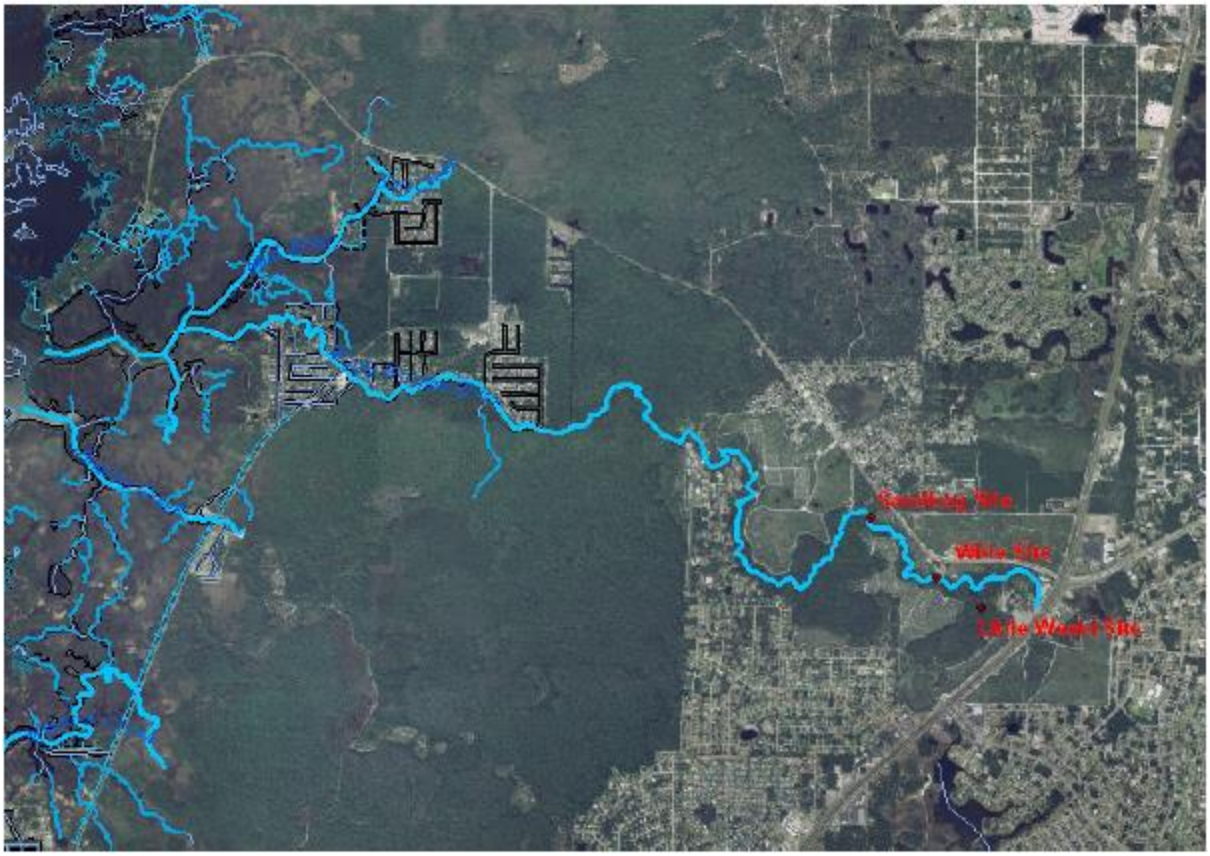


Figure A-28. Weeki Wachee River System (Heyl, 2008)

Table A-50. Weeki Wachee River Location

Spring	Magnitude	Latitude (dd)	Longitude (dd)
Weeki Wachee River	1st	28.51718	-82.57315

Minimum Flows and Minimum Levels

The MFL for the Weeki Wachee River System is maintenance of 90% of the baseline flow, or a 10% decrease in baseline flows (Table A-51). The MFL was based on the average of allowable flow decreases for the evaluated parameters. This approach did not rely on a specific WRV but lumped the results of the WRVs.

Table A-51. MFL for the Weeki Wachee River

System	Baseline Flow	Reduction
Weeki Wachee River	162 cfs	10%

Baseline Period

The baseline flow period for the Weeki Wachee River was from 1984-2004. The average flow for the baseline period was 162 cfs. Groundwater modeling was used to estimate the flow reduction due to current withdrawals. These reductions were estimated to be about 17 cfs.

Water Resource Value Assessment

A summary of the quantitative metrics used to relate each WRV to spring flow and assess potential effects from flow reductions are described below.

Recreation In and On the Water (WRV 1)

This WRV was not quantified.

Fish and Wildlife Habitats and the Passage of Fish (WRV 2)

This WRV was evaluated for a variety of criteria including: fish habitat, invertebrate habitat, manatee thermal refuge, benthic community, mollusc, and salinity. Fish and invertebrate sampling were completed under higher flow levels and could not be readily adjusted for the flow differences. For this reason, these data were not used to develop the MFL.

Manatee Thermal Refuge – The EFDC model was used to evaluate the area of 15 degree Celsius and 20-degree Celsius water that was available under a variety of conditions and a minimum depth of 3 feet. Flows were then reduced with volumes and areas of suitable temperature evaluated. Reductions that caused a greater than 15% loss were then determined. Based on the availability of habitat in excess of the population of manatees seeking refuge in the spring the 15% loss was considered unreasonably restrictive and not applied to MFL development.

Benthos – Benthos was evaluated in the context of salinity zones within the river. A loss of habitat of 15% was evaluated for each salinity zone. Salinity was evaluated based on the volume or bottom area at a given salinity at a given flow, the adjusted flow was then back calculated as the flow required to maintain a 15% reduction in the volume or bottom area at the evaluated salinity.

Mollusc – The mollusc criteria was based on maintaining at least 85% of the abundance of three native taxa based on changes in salinity. The method for determining the adjusted flow was using a salinity-abundance relationship for the evaluated species and back-calculating the flow that would result in the reduced habitat salinity. This relationship was evaluated for three species

Fish and Macroinvertebrate Habitat – Habitat was evaluated using the PHABSIM at three locations along the river for a variety of characteristic species and life stages. Flows were then reduced in the model until a 15% reduction in habitat occurred for the evaluated species and life stage.

Identified flow reductions that resulted in a 15% loss of the evaluated criteria ranged from flow reductions of 6.0% to 15.8% for Block 1 and from 4.2% to 17.2% for Block 3. The selected MFL was taken as the average of these flow reductions, or about 10% for both blocks.

Estuarine Resources (WRV 3)

This WRV was not quantified although salinity zones within the river were evaluated as part of WRV 2.

Transfer of Detrital Material (WRV 4)

This WRV was not quantified.

Maintenance of Freshwater Storage and Supply (WRV 5)

This WRV was not quantified.

Aesthetic and Scenic Attributes (WRV 6)

This WRV was not quantified.

Filtration and Absorption of Nutrients and other Pollutants (WRV 7)

This WRV was not quantified.

Sediment Loads (WRV 8)

This WRV was not quantified.

Water Quality (WRV 9)

This WRV was not quantified.

Navigation (WRV 10)

This WRV was not quantified.

Appendix B

Database Inventory

Columbia Spring

Table B-1 provides a summary of monitoring station metadata for Columbia Spring with station locations identified in Figure B-1. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), and SRWMD. No biological data were identified for this system.

Table B-1. Columbia Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLFSI	COLUMBIA SPRING	29.85411	-82.61195	W,Q	FDEP WIN
2	21FLGW	9676	29.85411	-82.61195	W	STORET
3	21FLSUW	127910	29.85409	-82.61192	W	FDEP WIN
4	21FLSUW	2321977	29.85389	-82.61167	W,Q	SRWMD
5	21FLSUW	COL010C1	29.85389	-82.61194	W,Q,S	SRWMD, STORET
6	USGS	2321977	29.85389	-82.61222	W,Q	USGS NWIS

[1] 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage;

A temporal daily data availability summary (Figure B-2), period of record statistics (Table B-2), and seasonal distribution summary (Table B-3) were developed from available data for Columbia Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

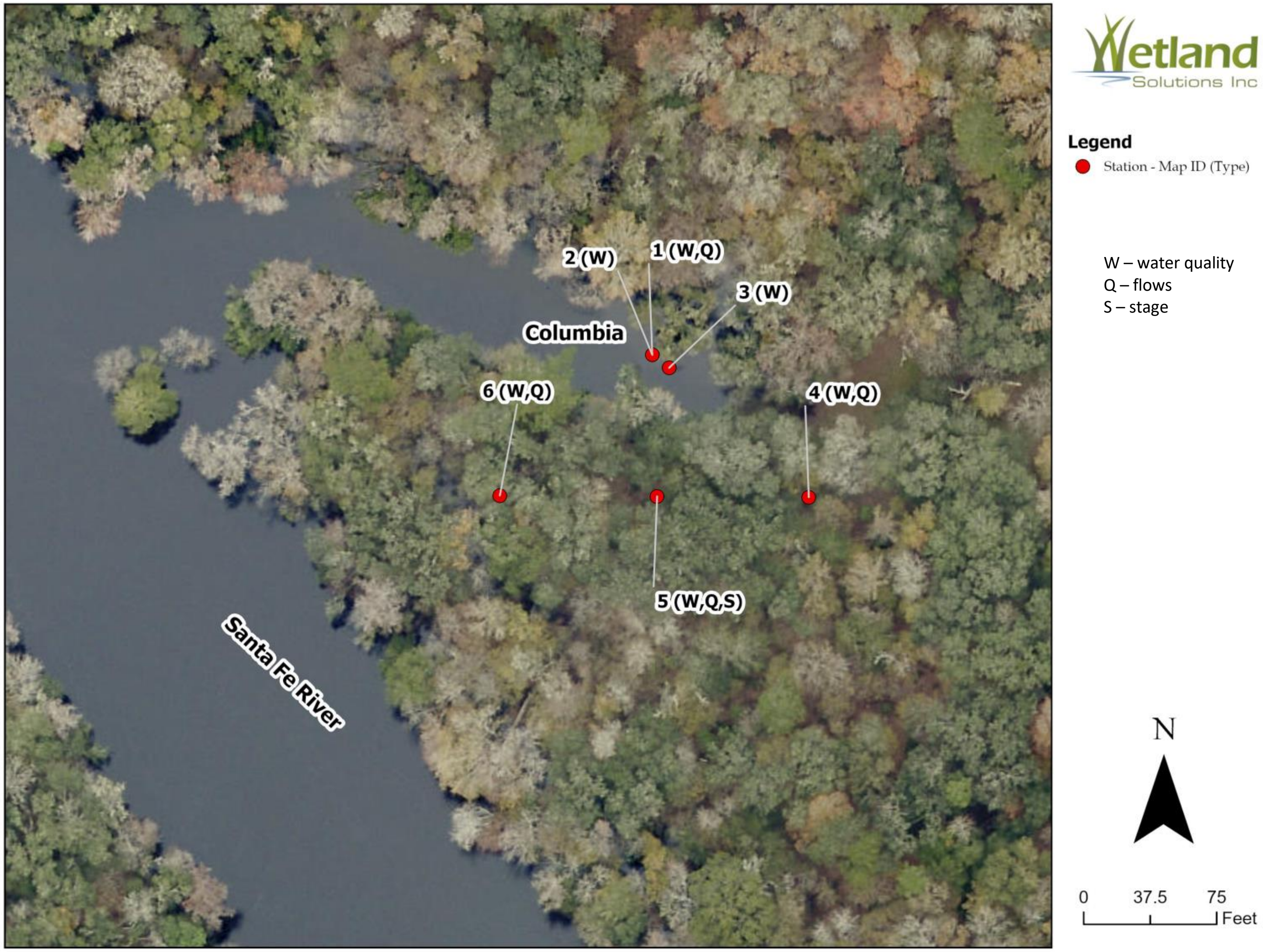


Figure B-1. Columbia Spring Station Locations

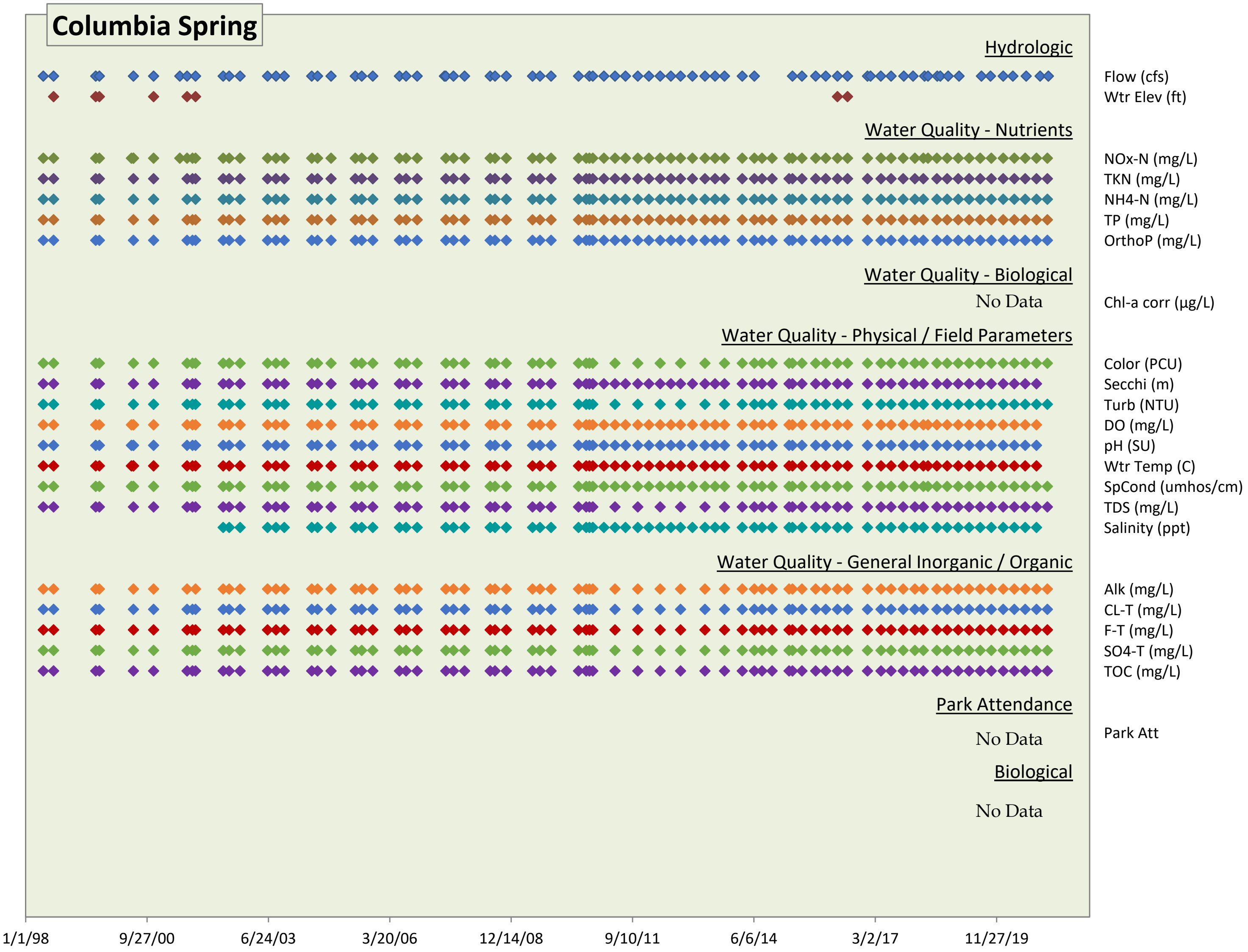


Figure B-2. Columbia Spring Temporal Data Availability Chart

Table B-2. Columbia Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	12/1942	1/2021	77	---	130	0.00	15.5	37.1	93.3	181	317	423	
Wtr Elev (ft)	8/1998	7/2016	8	---	14.8	2.10	2.11	2.86	6.20	32.4	32.9	33.9	
Water Quality - Nutrients													
NOx-N (mg/L)	5/1998	1/2021	81	0%	0.282	0.014	0.055	0.140	0.260	0.410	0.507	0.810	
TKN (mg/L)	5/1998	1/2021	77	5%	0.602	0.040	0.150	0.310	0.503	0.810	1.21	1.56	
NH4-N (mg/L)	5/1998	1/2021	76	51%	0.031	0.004	0.007	0.011	0.020	0.041	0.080	0.095	
TP (mg/L)	5/1998	1/2021	77	0%	0.156	0.057	0.084	0.101	0.126	0.175	0.257	0.820	
OrthoP (mg/L)	5/1998	1/2021	77	0%	0.110	0.030	0.064	0.082	0.102	0.122	0.181	0.305	
Water Quality - Physical / Field Parameters													
Color (PCU)	5/1998	1/2021	71	1%	151	10.0	18.3	30.0	125	213	321	600	
Secchi (m)	5/1998	10/2020	76	28%	1.09	0.150	0.490	0.600	1.00	1.20	1.72	4.80	
Turb (NTU)	5/1998	1/2021	71	15%	1.85	0.240	0.300	0.529	0.788	1.46	2.60	38.2	
DO (mg/L)	5/1998	10/2020	79	0%	2.94	0.600	1.71	2.24	2.70	3.42	4.59	7.41	
pH (SU)	4/1977	10/2020	79	0%	7.20	6.07	6.89	7.11	7.26	7.38	7.52	7.79	
Wtr Temp (C)	4/1977	10/2020	80	0%	22.9	15.1	19.9	21.7	23.0	24.4	25.3	28.1	
SpCond (umhos/cm)	4/1977	1/2021	81	0%	386	97.5	219	333	415	473	504	572	
TDS (mg/L)	5/1998	1/2021	71	3%	271	80	209	230	279	307	334	383	
Salinity (ppt)	6/2002	10/2020	67	0%	0.167	0.050	0.100	0.115	0.200	0.208	0.225	0.240	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	5/1998	1/2021	70	0%	116	14.1	49.4	99.6	124	145	159	171	
CL-T (mg/L)	5/1998	1/2021	71	0%	15.5	7.45	11.2	14.0	15.4	16.3	18.6	31.4	
F-T (mg/L)	5/1998	1/2021	71	1%	0.211	0.100	0.130	0.172	0.222	0.250	0.275	0.344	
SO4-T (mg/L)	5/1998	1/2021	71	1%	58.4	1.95	19.0	43.7	60.0	73.1	92.7	104	
TOC (mg/L)	5/1998	1/2021	71	3%	15.9	0.933	3.32	5.71	13.1	21.8	38.9	53.2	

Table B-3. Columbia Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	12/1942	1/2021	77	11.7%	0.0%	1.3%	10.4%	2.6%	16.9%	11.7%	15.6%	2.6%	10.4%	14.3%	2.6%	
Wtr Elev (ft)	8/1998	7/2016	8	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	12.5%	37.5%	12.5%	0.0%	25.0%	0.0%	
Water Quality - Nutrients																
NOx-N (mg/L)	5/1998	1/2021	81	9.9%	0.0%	2.5%	11.1%	3.7%	16.0%	11.1%	16.0%	2.5%	12.3%	13.6%	1.2%	
TKN (mg/L)	5/1998	1/2021	77	10.4%	0.0%	2.6%	11.7%	1.3%	14.3%	11.7%	16.9%	2.6%	13.0%	14.3%	1.3%	
NH4-N (mg/L)	5/1998	1/2021	76	10.5%	0.0%	2.6%	11.8%	1.3%	14.5%	11.8%	17.1%	2.6%	11.8%	14.5%	1.3%	
TP (mg/L)	5/1998	1/2021	77	10.4%	0.0%	2.6%	11.7%	1.3%	14.3%	11.7%	16.9%	2.6%	13.0%	14.3%	1.3%	
OrthoP (mg/L)	5/1998	1/2021	77	10.4%	0.0%	2.6%	11.7%	1.3%	14.3%	11.7%	16.9%	2.6%	13.0%	14.3%	1.3%	
Water Quality - Physical / Field Parameters																
Color (PCU)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
Secchi (m)	5/1998	10/2020	76	9.2%	0.0%	2.6%	11.8%	1.3%	14.5%	11.8%	17.1%	2.6%	13.2%	14.5%	1.3%	
Turb (NTU)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
DO (mg/L)	5/1998	10/2020	79	8.9%	0.0%	2.5%	11.4%	3.8%	15.2%	11.4%	16.5%	2.5%	12.7%	13.9%	1.3%	
pH (SU)	4/1977	10/2020	79	8.9%	0.0%	2.5%	12.7%	2.5%	15.2%	11.4%	16.5%	2.5%	12.7%	13.9%	1.3%	
Wtr Temp (C)	4/1977	10/2020	80	8.8%	0.0%	2.5%	12.5%	3.8%	15.0%	11.3%	16.3%	2.5%	12.5%	13.8%	1.3%	
SpCond (umhos/cm)	4/1977	1/2021	81	9.9%	0.0%	2.5%	12.3%	3.7%	14.8%	11.1%	16.0%	2.5%	12.3%	13.6%	1.2%	
TDS (mg/L)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
Salinity (ppt)	6/2002	10/2020	67	10.4%	0.0%	3.0%	13.4%	0.0%	14.9%	13.4%	14.9%	1.5%	13.4%	13.4%	1.5%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	5/1998	1/2021	70	7.1%	0.0%	2.9%	12.9%	1.4%	15.7%	8.6%	18.6%	2.9%	12.9%	15.7%	1.4%	
CL-T (mg/L)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
F-T (mg/L)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
SO4-T (mg/L)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	
TOC (mg/L)	5/1998	1/2021	71	7.0%	0.0%	2.8%	12.7%	1.4%	15.5%	8.5%	18.3%	2.8%	14.1%	15.5%	1.4%	

Devil's Ear Spring

Table B-4 provides a summary of monitoring station metadata for Devil's Ear Spring with station locations identified in Figure B-3. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), and SRWMD. USGS 2322402 appears to be located between Little Devil Spring and Devil's Eye Spring, however the station description identifies it as Devil's Ear Spring Near High Springs.

No biological data were identified for this system.

Table B-4. Devil's Ear Spring Stations

Map ID	Organization ID	Location ID	Latitude	Longitude	Type [3]	Source
1	21FLGW	9677	29.83535	-82.69660	W,Q	STORET
2	21FLGW	39970	29.83535	-82.69660	W	STORET
3	21FLSUW	129210	29.83534	-82.69661	W	FDEP WIN
4	21FLSUW	DER010C1	29.83534	-82.69661	W	SRWMD
5	21FLSUW	DEVILCOMPLEX[2]	29.83534	-82.69661	Q	SRWMD
6	USGS	2322402	29.83500	-82.69667	Q	USGS NWIS

[1] 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; USGS - U.S. Geological Survey
[2] includes Devil's Ear, Devil's Eye, and Little Devil's System
[3] W – water quality; Q – flows;

A temporal data availability summary (Figure B-4), period of record statistics (Table B-5), and seasonal distribution summary (Table B-6) were developed from available data for Devil's Ear Spring.

Attendance data were requested from Ginnie Springs Outdoors, but no response was received.

Figure B-3. Devil's Ear Spring Station Locations

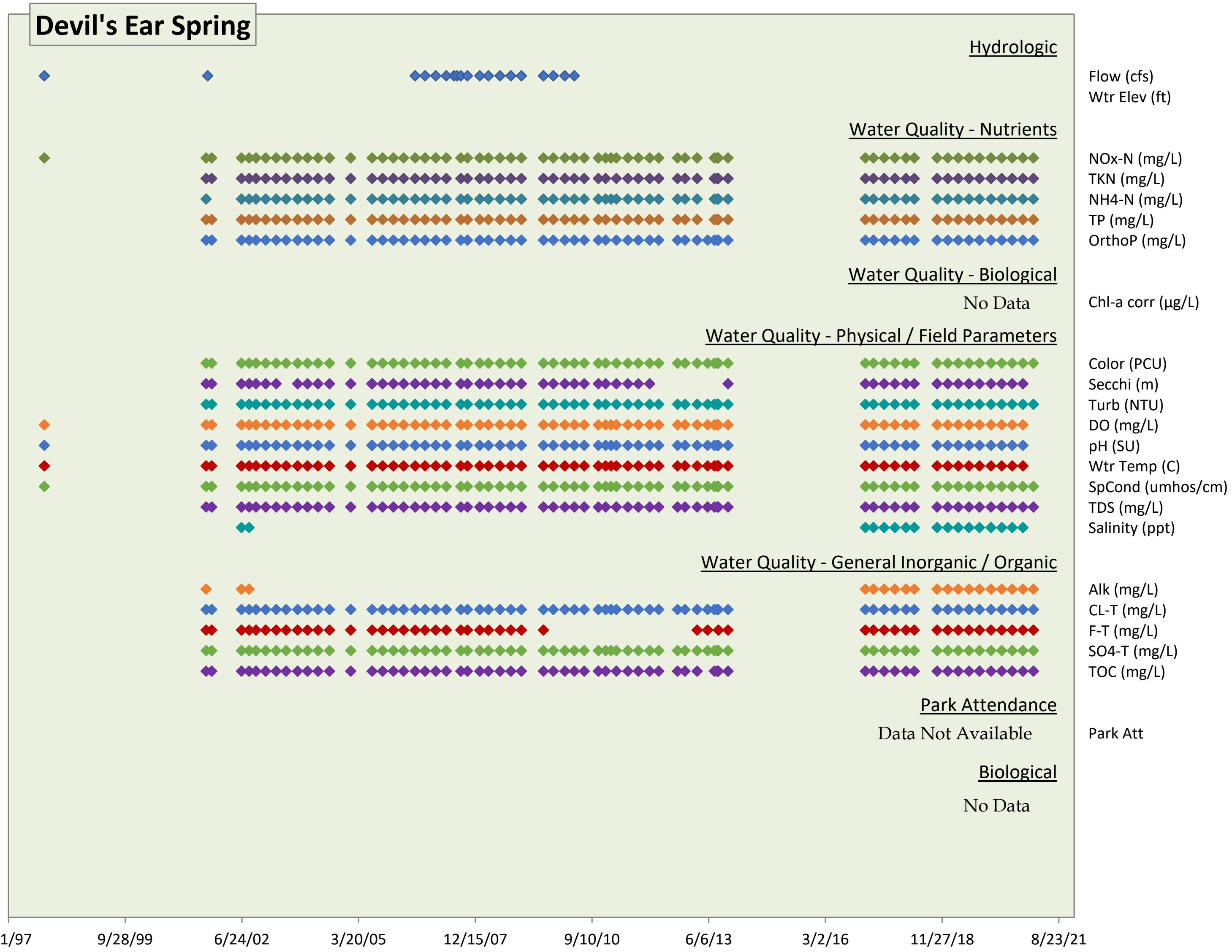


Figure B-4. Devil's Ear Spring Temporal Data Availability Chart

Table B-5. Devil's Ear Spring Database Inventory and Statistics

Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	11/1997	4/2010	19	---	169	48.0	85.6	114	155	204	245	472	
Water Quality - Nutrients													
NOx-N (mg/L)	11/1997	1/2021	65	0%	1.57	0.420	1.30	1.40	1.60	1.70	1.91	2.22	
TKN (mg/L)	8/2001	1/2021	63	51%	0.110	0.036	0.045	0.078	0.094	0.140	0.189	0.405	
NH4-N (mg/L)	8/2001	1/2021	63	95%	0.010	0.0013	0.003	0.006	0.010	0.010	0.012	0.050	
TP (mg/L)	8/2001	1/2021	63	0%	0.046	0.035	0.039	0.041	0.045	0.048	0.057	0.077	
OrthoP (mg/L)	8/2001	1/2021	64	0%	0.043	0.031	0.038	0.041	0.043	0.045	0.049	0.055	
Water Quality - Physical / Field Parameters													
Color (PCU)	8/2001	1/2021	64	66%	6.75	1.35	2.15	3.18	5.00	5.00	9.69	56.2	
Secchi (m)	8/2001	10/2020	55	20%	7.77	1.00	2.30	5.10	7.90	9.95	11.3	20.9	
Turb (NTU)	8/2001	1/2021	64	31%	0.217	0.050	0.100	0.100	0.150	0.251	0.435	1.00	
DO (mg/L)	11/1997	10/2020	66	0%	3.18	2.14	2.51	2.88	3.14	3.52	3.77	5.21	
pH (SU)	11/1997	10/2020	66	0%	7.26	6.89	7.10	7.20	7.30	7.33	7.40	7.67	
Wtr Temp (C)	11/1997	10/2020	66	0%	22.5	18.6	21.6	22.4	22.6	23.0	23.5	25.0	
SpCond (umhos/cm)	11/1997	1/2021	67	0%	378	132	360	376	388	394	405	410	
TDS (mg/L)	8/2001	1/2021	64	0%	217	181	202	209	214	226	236	248	
Salinity (ppt)	6/2002	10/2020	17	0%	0.191	0.170	0.176	0.190	0.190	0.200	0.200	0.200	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	8/2001	1/2021	19	0%	176	148	168	172	176	180	186	192	
CL-T (mg/L)	8/2001	1/2021	65	0%	7.85	6.10	6.60	7.10	7.80	8.60	9.09	11.4	
F-T (mg/L)	8/2001	1/2021	49	2%	0.120	0.040	0.106	0.110	0.120	0.130	0.140	0.170	
SO4-T (mg/L)	8/2001	1/2021	65	2%	14.6	1.95	12.0	13.0	14.0	15.0	18.5	29.1	
TOC (mg/L)	8/2001	1/2021	63	63%	1.38	0.300	0.704	1.00	1.00	1.18	2.38	10.6	

Table B-6. Devil's Ear Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	11/1997	4/2010	19	21.1%	0.0%	0.0%	15.8%	0.0%	5.3%	21.1%	5.3%	5.3%	21.1%	5.3%	0.0%	
Water Quality - Nutrients																
NOx-N (mg/L)	11/1997	1/2021	65	21.5%	4.6%	0.0%	18.5%	0.0%	1.5%	18.5%	7.7%	1.5%	20.0%	6.2%	0.0%	
TKN (mg/L)	8/2001	1/2021	63	22.2%	3.2%	0.0%	19.0%	0.0%	1.6%	19.0%	7.9%	1.6%	20.6%	4.8%	0.0%	
NH4-N (mg/L)	8/2001	1/2021	63	22.2%	4.8%	0.0%	19.0%	0.0%	1.6%	19.0%	7.9%	1.6%	19.0%	4.8%	0.0%	
TP (mg/L)	8/2001	1/2021	63	22.2%	3.2%	0.0%	19.0%	0.0%	1.6%	19.0%	7.9%	1.6%	20.6%	4.8%	0.0%	
OrthoP (mg/L)	8/2001	1/2021	64	21.9%	3.1%	0.0%	18.8%	1.6%	1.6%	18.8%	7.8%	1.6%	20.3%	4.7%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	8/2001	1/2021	64	21.9%	3.1%	0.0%	18.8%	1.6%	1.6%	18.8%	7.8%	1.6%	20.3%	4.7%	0.0%	
Secchi (m)	8/2001	10/2020	55	23.6%	1.8%	0.0%	20.0%	0.0%	1.8%	20.0%	5.5%	0.0%	23.6%	3.6%	0.0%	
Turb (NTU)	8/2001	1/2021	64	21.9%	3.1%	0.0%	18.8%	1.6%	1.6%	18.8%	7.8%	1.6%	20.3%	4.7%	0.0%	
DO (mg/L)	11/1997	10/2020	66	19.7%	4.5%	0.0%	18.2%	1.5%	1.5%	19.7%	7.6%	1.5%	19.7%	6.1%	0.0%	
pH (SU)	11/1997	10/2020	66	19.7%	4.5%	0.0%	18.2%	1.5%	1.5%	19.7%	7.6%	1.5%	19.7%	6.1%	0.0%	
Wtr Temp (C)	11/1997	10/2020	66	19.7%	4.5%	0.0%	18.2%	1.5%	1.5%	19.7%	7.6%	1.5%	19.7%	6.1%	0.0%	
SpCond (umhos/cm)	11/1997	1/2021	67	20.9%	4.5%	0.0%	17.9%	1.5%	1.5%	19.4%	7.5%	1.5%	19.4%	6.0%	0.0%	
TDS (mg/L)	8/2001	1/2021	64	21.9%	3.1%	0.0%	18.8%	1.6%	1.6%	18.8%	7.8%	1.6%	20.3%	4.7%	0.0%	
Salinity (ppt)	6/2002	10/2020	17	17.6%	5.9%	0.0%	23.5%	0.0%	5.9%	17.6%	5.9%	0.0%	23.5%	0.0%	0.0%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	8/2001	1/2021	19	21.1%	5.3%	0.0%	21.1%	0.0%	5.3%	15.8%	10.5%	0.0%	21.1%	0.0%	0.0%	
CL-T (mg/L)	8/2001	1/2021	65	21.5%	4.6%	0.0%	18.5%	1.5%	1.5%	18.5%	7.7%	1.5%	20.0%	4.6%	0.0%	
F-T (mg/L)	8/2001	1/2021	49	22.4%	4.1%	0.0%	18.4%	2.0%	2.0%	18.4%	8.2%	0.0%	22.4%	2.0%	0.0%	
SO4-T (mg/L)	8/2001	1/2021	65	21.5%	4.6%	0.0%	18.5%	1.5%	1.5%	18.5%	7.7%	1.5%	20.0%	4.6%	0.0%	
TOC (mg/L)	8/2001	1/2021	63	22.2%	3.2%	0.0%	19.0%	0.0%	1.6%	19.0%	7.9%	1.6%	20.6%	4.8%	0.0%	

Falmouth Spring

Table B-7 provides a summary of monitoring station metadata for Falmouth Spring with station locations identified in Figure B-5. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Fish and vegetation data were available from Stetson University (Kirsten Work, unpublished data).

Table B-7. Falmouth Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLBRA	3422Z-A	30.36113	-83.13488	W	STORET
2	21FLFSI	SUW1-S1	30.36112	-83.13500	W	FDEP WIN
3	21FLGW	10499	30.36116	-83.13499	W	STORET
4	21FLSUW	127933	30.36111	-83.13500	W	FDEP WIN
5	21FLSUW	2319520	30.36056	-83.13500	W,Q	SRWMD
6	21FLSUW	FAM010C1	30.36111	-83.13500	W,Q,S	SRWMD, STORET
7	Stetson	Falmouth	30.36110	-83.13500	V,F	Stetson
8	UF	Falmouth Spring	30.36111	-83.13500	W	Strong, 2004
9	USGS	2319520	30.36111	-83.13528	W,Q,S	USGS NWIS

[1] 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey
[2] W – water quality; Q – flows; S – stage; V – vegetation; F - fish

A temporal data availability summary (Figure B-6), period of record statistics (Table B-8), and seasonal distribution summary (Table B-9) were developed from available data for Falmouth Spring.

Additional continuous *in-situ* water quality data are available from USGS NWIS[15] for water temperature, specific conductance, dissolved oxygen, pH, and NOx-N from 9/25/2015 to 2/10/2021[16]. These data are not included in the SRWMD OFS database.

---

[15] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02319520
[16] date website was accessed; visit above link for updated period of record

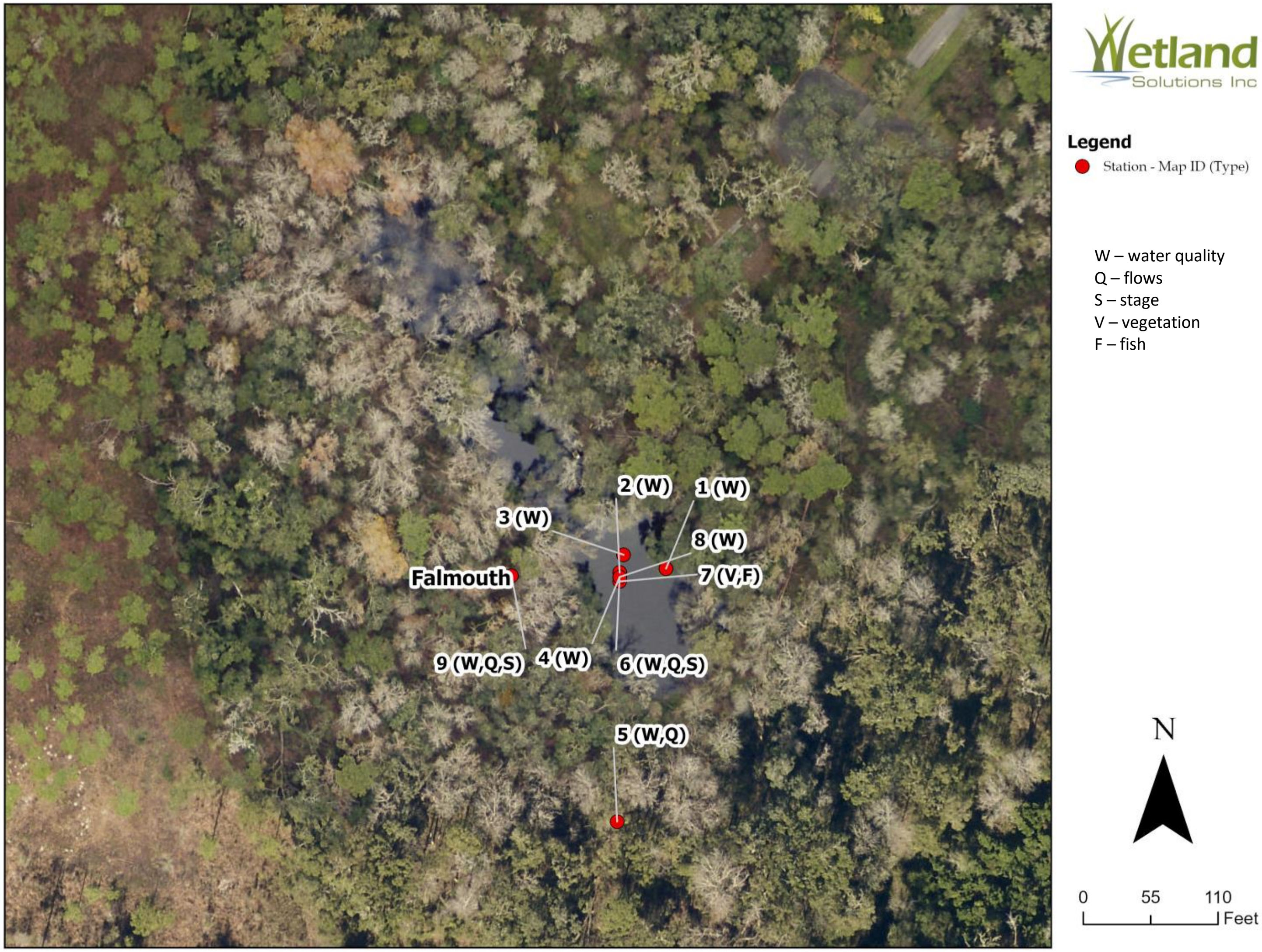


Figure B-5. Falmouth Spring Station Locations

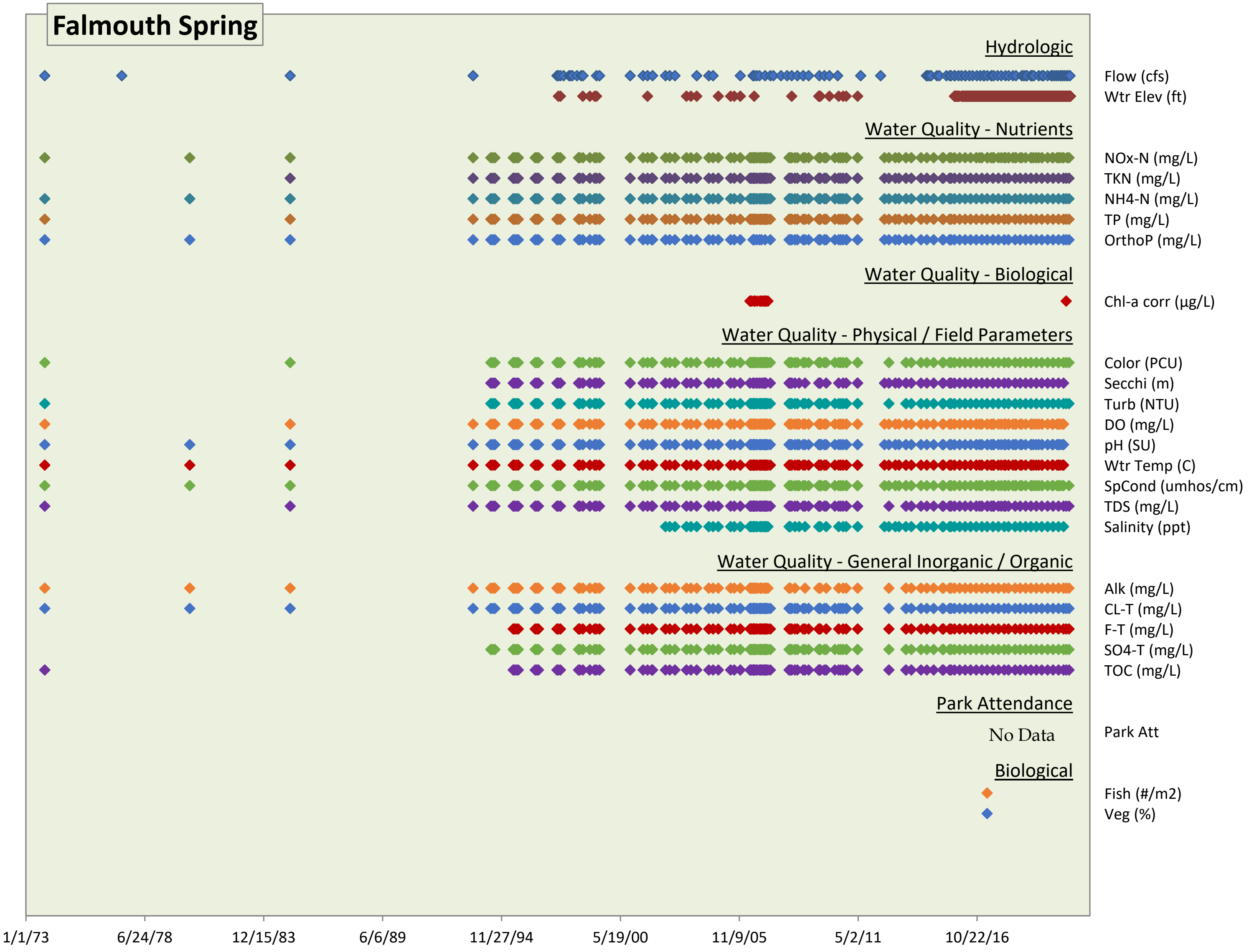


Figure B-6. Falmouth Spring Temporal Data Availability Chart

Table B-8. Falmouth Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	1/1908	2/2021	111	---	46.1	-549	0.00	7.08	47.4	98.3	159	360	
Wtr Elev (ft)	7/1997	2/2021	1,893	---	34.5	0.00	32.4	32.9	34.0	35.7	38.2	48.5	
Water Quality - Nutrients													
NOx-N (mg/L)	11/1973	1/2021	142	3%	0.890	0.003	0.201	0.538	0.932	1.20	1.42	2.46	
TKN (mg/L)	3/1985	1/2021	120	24%	0.250	0.00	0.055	0.080	0.153	0.288	0.553	1.28	
NH4-N (mg/L)	11/1973	1/2021	120	71%	0.032	-0.013	0.003	0.010	0.015	0.020	0.050	1.10	
TP (mg/L)	11/1973	1/2021	121	4%	0.064	0.003	0.036	0.041	0.050	0.064	0.100	0.590	
OrthoP (mg/L)	11/1973	1/2021	106	2%	0.049	0.003	0.030	0.033	0.040	0.047	0.069	0.450	
Water Quality - Biological													
Chl-a corr (µg/L)	5/2006	12/2020	17	88%	1.67	0.820	1.00	1.00	1.10	2.60	2.60	2.60	
Water Quality - Physical / Field Parameters													
Color (PCU)	11/1973	1/2021	117	3%	45.3	1.00	5.00	7.00	13.0	31.5	78.9	800	
Secchi (m)	6/1994	10/2020	100	24%	1.42	0.250	0.500	0.750	1.00	1.25	2.11	11.0	
Turb (NTU)	11/1973	1/2021	116	18%	1.06	0.100	0.215	0.280	0.400	0.876	1.88	11.0	
DO (mg/L)	11/1973	10/2020	141	0%	1.40	0.00	0.220	0.400	0.640	1.20	4.20	13.2	
pH (SU)	11/1973	10/2020	142	0%	7.17	5.14	6.84	7.09	7.20	7.31	7.46	8.66	
Wtr Temp (C)	11/1973	10/2020	142	0%	21.1	15.2	20.1	20.7	21.1	21.4	21.9	27.6	
SpCond (umhos/cm)	11/1973	1/2021	143	0%	359	53.6	289	353	379	402	414	471	
TDS (mg/L)	11/1973	1/2021	125	1%	210	10.0	186	203	215	229	238	273	
Salinity (ppt)	6/2002	10/2020	77	0%	0.157	0.030	0.100	0.127	0.180	0.200	0.200	0.210	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	11/1973	1/2021	103	1%	172	5.00	145	172	186	194	203	220	
CL-T (mg/L)	11/1973	1/2021	119	1%	5.20	1.00	4.00	4.70	5.00	5.90	6.85	9.49	
F-T (mg/L)	6/1995	1/2021	107	3%	0.134	0.020	0.097	0.110	0.130	0.150	0.180	0.320	
SO4-T (mg/L)	6/1994	1/2021	115	3%	11.3	0.200	8.50	10.0	11.1	13.0	14.0	21.0	
TOC (mg/L)	11/1973	1/2021	113	9%	5.38	0.00	0.792	1.10	2.17	5.45	10.6	44.5	
Biological													
Fish (#/m2)	4/2017	4/2017	1	---	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	
Veg (%)	4/2017	4/2017	1	---	54.4	54.4	54.4	54.4	54.4	54.4	54.4	54.4	

Table B-9. Falmouth Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	1/1908	2/2021	111	9.9%	7.2%	2.7%	9.0%	6.3%	15.3%	8.1%	12.6%	2.7%	10.8%	9.0%	6.3%	
Wtr Elev (ft)	7/1997	2/2021	1,893	7.9%	7.7%	8.2%	7.6%	8.1%	8.0%	8.3%	8.5%	7.9%	9.4%	8.8%	9.6%	
Water Quality - Nutrients																
NOx-N (mg/L)	11/1973	1/2021	142	8.5%	2.8%	4.9%	11.3%	1.4%	13.4%	16.2%	14.1%	1.4%	13.4%	9.2%	3.5%	
TKN (mg/L)	3/1985	1/2021	120	9.2%	2.5%	5.8%	10.0%	1.7%	12.5%	18.3%	13.3%	1.7%	13.3%	9.2%	2.5%	
NH4-N (mg/L)	11/1973	1/2021	120	9.2%	2.5%	5.8%	10.0%	1.7%	12.5%	18.3%	13.3%	1.7%	12.5%	10.0%	2.5%	
TP (mg/L)	11/1973	1/2021	121	9.1%	2.5%	5.8%	9.9%	1.7%	12.4%	18.2%	13.2%	1.7%	13.2%	9.9%	2.5%	
OrthoP (mg/L)	11/1973	1/2021	106	8.5%	0.9%	5.7%	11.3%	0.0%	13.2%	19.8%	14.2%	0.9%	14.2%	9.4%	1.9%	
Water Quality - Biological																
Chl-a corr (µg/L)	5/2006	12/2020	17	11.8%	11.8%	5.9%	0.0%	11.8%	5.9%	11.8%	5.9%	5.9%	5.9%	11.8%	11.8%	
Water Quality - Physical / Field Parameters																
Color (PCU)	11/1973	1/2021	117	8.5%	2.6%	5.1%	10.3%	1.7%	12.8%	17.9%	12.8%	1.7%	13.7%	10.3%	2.6%	
Secchi (m)	6/1994	10/2020	100	9.0%	2.0%	5.0%	11.0%	1.0%	14.0%	18.0%	15.0%	2.0%	12.0%	9.0%	2.0%	
Turb (NTU)	11/1973	1/2021	116	8.6%	2.6%	4.3%	10.3%	1.7%	12.9%	18.1%	12.9%	1.7%	13.8%	10.3%	2.6%	
DO (mg/L)	11/1973	10/2020	141	7.8%	2.8%	5.0%	11.3%	1.4%	13.5%	15.6%	15.6%	1.4%	13.5%	9.2%	2.8%	
pH (SU)	11/1973	10/2020	142	7.7%	2.8%	4.9%	11.3%	1.4%	13.4%	16.2%	15.5%	1.4%	13.4%	9.2%	2.8%	
Wtr Temp (C)	11/1973	10/2020	142	7.7%	2.8%	4.9%	11.3%	1.4%	13.4%	16.2%	15.5%	1.4%	13.4%	9.2%	2.8%	
SpCond (umhos/cm)	11/1973	1/2021	143	8.4%	2.8%	4.9%	11.2%	1.4%	13.3%	16.1%	15.4%	1.4%	13.3%	9.1%	2.8%	
TDS (mg/L)	11/1973	1/2021	125	8.0%	3.2%	4.8%	10.4%	1.6%	12.8%	16.8%	13.6%	1.6%	13.6%	9.6%	4.0%	
Salinity (ppt)	6/2002	10/2020	77	10.4%	3.9%	6.5%	9.1%	2.6%	10.4%	15.6%	13.0%	1.3%	14.3%	11.7%	1.3%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	11/1973	1/2021	103	7.8%	2.9%	5.8%	7.8%	1.9%	14.6%	17.5%	15.5%	1.9%	10.7%	11.7%	1.9%	
CL-T (mg/L)	11/1973	1/2021	119	8.4%	2.5%	5.0%	10.1%	1.7%	12.6%	18.5%	13.4%	1.7%	13.4%	10.1%	2.5%	
F-T (mg/L)	6/1995	1/2021	107	9.3%	2.8%	4.7%	9.3%	1.9%	13.1%	17.8%	13.1%	1.9%	13.1%	10.3%	2.8%	
SO4-T (mg/L)	6/1994	1/2021	115	8.7%	2.6%	4.3%	10.4%	1.7%	13.0%	18.3%	13.0%	1.7%	13.9%	9.6%	2.6%	
TOC (mg/L)	11/1973	1/2021	113	8.8%	2.7%	4.4%	10.6%	1.8%	12.4%	17.7%	12.4%	1.8%	14.2%	10.6%	2.7%	
Biological																
Fish (#/m2)	4/2017	4/2017	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Veg (%)	4/2017	4/2017	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

Fanning Springs

Table B-10 provides a summary of monitoring station metadata for Fanning Springs with station locations identified in Figure B-7. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Water clarity data and manatee count observations were provided by the FDEP FPS. Fish and vegetation data were available from Stetson University (Kirsten Work, unpublished data), mussel data from USGS, and bioassessment data from FDEP. Fanning Springs State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-10. Fanning Springs Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	21020096	29.58789	-82.93542	W	STORET
2	21FLBRA	3422S-A	29.58778	-82.93571	W	STORET
3	21FLBRA	FANNINGBRA	29.58768	-82.93618	B	FDEP
4	21FLFSI	SUW1-S8	29.58775	-82.93566	W	FDEP WIN
5	21FLGW	9678	29.58759	-82.93530	W	STORET
6	21FLGW	Fanning Springs	29.58778	-82.93571	W,S,M	FDEP FPS
7	21FLGWMS	FAN010C1P	29.58756	-82.93542	S	STORET
8	21FLSUW	127896	29.58763	-82.93535	W	FDEP WIN
9	21FLSUW	2323502	29.58722	-82.93556	W,Q,S	SRWMD
10	21FLSUW	FAN010C1	29.58722	-82.93556	W,Q	SRWMD, STORET
11	Stetson	Fanning	29.58760	-82.93530	V,F	Stetson
12	UF	Fanning Springs	29.58778	-82.93571	W	Strong, 2004
13	USGS	Fanning Springs	29.58781	-82.93575	MI	Walsh & Williams, 2003
14	USGS	2323502	29.58889	-82.93533	W,Q,S	USGS NWIS
15	USGS	293515082560800	29.58750	-82.93556	W,Q	USGS NWIS

[1] 21FLA - FL Dept. of Environmental Protection, Northeast District; 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGWMS- FDEP Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish; M – manatees; MI – macroinvertebrates; B - Bioassessment

Water clarity observations by the FDEP FPS are collected using a semi-quantitative scoring method as outlined below. Numeric scoring was also added to the SRWMD OFS database based on FDEP FPS observations (1=A, 2=B, etc.).

- Clarity Level A - clear water with excellent clarity
- Clarity Level B – green tinted water with good clarity
- Clarity Level C - tannic river water covering the entire spring area with secchi disc readings of 4.1’ or more
- Clarity Level D - tannic river water covering the entire spring area with secchi disc readings of 4’ or less

- Clarity Level E - tannic river water entering spring ("flow reversal") and secchi disc readings of 4' or less

A temporal data availability summary (Figure B-8), period of record statistics (Table B-11), and seasonal distribution summary (Table B-12) were developed from available data for Fanning Springs. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Additional continuous *in-situ* water quality data are available from USGS NWIS[17] for water temperature, specific conductance, dissolved oxygen, pH, and NOx-N from 7/3/2014 to 2/9/2021[18]. These data are not included in the SRWMD OFS database.

Turtle populations have been monitored three times per year within Fanning Springs since 2010 by the Turtle Survival Alliance (TSA). The number of individuals per species that have been marked to date include the following (Eric Munscher, personal communication). A manuscript with these data is currently in peer review, following acceptance detailed data will become available.

- River cooter (*Pseudemys concinna*) – 204
- Peninsular cooter (*Pseudemys floridana peninsularis*) – 11
- Florida red-bellied cooter (*Pseudemys nelson*) – 3
- Yellow-bellied slider (*Trachmeys scripta scripta*) – 23
- Loggerhead musk turtle (*Sternotherus minor)* – 133
- Common musk turtle (*Sternotherus odortatus*) – 16
- Common snapping turtle (*Chelydra serpentina*) – 1
- Alligator snapping turtle (*Macrochelys temminckii*) – 1

---

[17] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02323502

[18] date website was accessed; visit above link for updated period of record

Figure B-7. Fanning Springs Station Locations

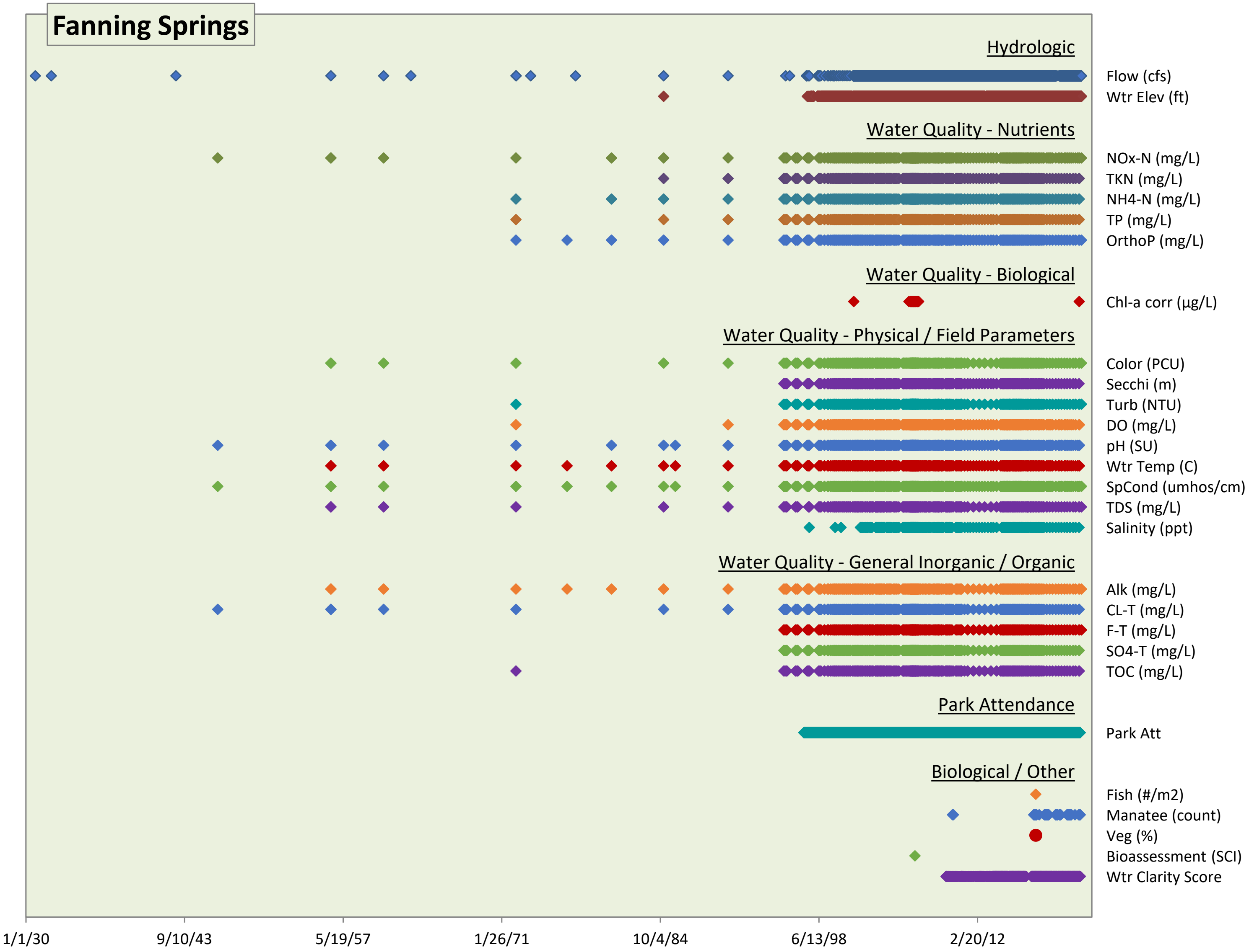


Figure B-8. Fanning Springs Temporal Data Availability Chart

Table B-11. Fanning Springs Database Inventory and Statistics

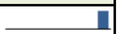
Parameter	Period of Record		Count	Percent BDL	Average	Percentile 0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	10/1930	2/2021	7,114	---	68.1	-108	34.9	56.0	71.5	85.0	97.5	247	
Wtr Elev (ft)	1/1985	2/2021	8,059	---	4.14	0.27	2.24	2.73	3.37	4.93	7.22	45.0	
Water Quality - Nutrients													
NOx-N (mg/L)	7/1946	2/2021	300	0%	4.96	0.00	3.47	4.33	5.00	5.61	6.17	21.0	
TKN (mg/L)	1/1985	11/2020	263	53%	0.148	-0.030	0.040	0.059	0.087	0.155	0.250	1.70	
NH4-N (mg/L)	4/1972	11/2020	268	86%	0.025	-0.002	0.002	0.009	0.020	0.021	0.060	0.300	
TP (mg/L)	4/1972	11/2020	266	1%	0.072	0.020	0.060	0.063	0.068	0.073	0.084	0.380	
OrthoP (mg/L)	4/1972	2/2021	247	0%	0.060	0.025	0.041	0.053	0.061	0.065	0.071	0.290	
Water Quality - Biological													
Chl-a corr (µg/L)	6/2001	11/2020	25	76%	1.1	0.700	1.00	1.00	1.00	1.05	1.10	2	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1956	2/2021	261	79%	10.3	0.00	1.000	5.00	5.00	5.00	5.00	450	
Secchi (m)	6/1995	11/2020	238	20%	2.85	0.450	1.00	1.80	2.50	3.92	4.74	13.1	
Turb (NTU)	4/1972	2/2021	264	31%	0.315	0.00	0.080	0.100	0.165	0.250	0.477	9.20	
DO (mg/L)	4/1972	12/2020	295	0%	2.34	0.750	1.70	1.95	2.23	2.51	2.98	8.40	
pH (SU)	7/1946	12/2020	304	0%	7.20	6.05	7.00	7.10	7.20	7.30	7.39	8.03	
Wtr Temp (C)	4/1956	12/2020	303	0%	22.5	15.9	22.1	22.3	22.4	22.5	22.8	47.9	
SpCond (umhos/cm)	7/1946	2/2021	306	0%	534	65.5	432	455	479	503	522	19,301	
TDS (mg/L)	4/1956	2/2021	268	1%	274	0.00	240	258	277	294	312	458	
Salinity (ppt)	8/1997	11/2020	185	0%	0.218	0.030	0.200	0.200	0.220	0.240	0.250	0.280	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1956	2/2021	235	0%	192	5.90	175	186	197	204	210	221	
CL-T (mg/L)	7/1946	11/2020	265	0%	10.2	1.00	8.24	9.26	10.2	11.0	12.2	15.1	
F-T (mg/L)	6/1995	2/2021	249	4%	0.109	0.00	0.066	0.090	0.110	0.120	0.154	0.374	
SO4-T (mg/L)	6/1995	11/2020	255	0%	23.1	2.75	18.7	20.8	23.0	24.7	27.9	49.9	
TOC (mg/L)	4/1972	11/2020	257	42%	2.66	-0.240	0.400	0.620	1.00	1.67	6.37	42.0	
Park Attendance													
Park Att	3/1997	12/2020	8,707	---	650	0.00	101	323	514	802	1,217	17,125	
Biological / Other													
Fish (#/m2)	3/2017	3/2017	1	---	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	
Manatee (count)	12/2009	12/2020	187	---	3.70	1.00	1.00	2.00	3.00	5.00	6.40	16.0	
Veg (%)	3/2017	3/2017	1	---	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	
Bioassessment (SCI)	9/2006	9/2006	1	---	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	
Wtr Clarity Score	6/2009	12/2020	2,846	---	1.57	1.00	1.00	1.00	1.00	1.00	4.00	5.00	

Table B-12. Fanning Springs Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	10/1930	2/2021	7,114	8.3%	7.2%	7.9%	8.1%	8.4%	8.5%	8.8%	8.7%	8.5%	8.7%	8.4%	8.4%	
Wtr Elev (ft)	1/1985	2/2021	8,059	8.6%	7.6%	8.3%	8.0%	8.3%	8.3%	8.3%	8.6%	8.2%	8.8%	8.0%	9.1%	
Water Quality - Nutrients																
NOx-N (mg/L)	7/1946	2/2021	300	9.0%	7.0%	5.0%	8.3%	8.0%	8.3%	11.7%	9.3%	8.0%	10.3%	7.7%	7.3%	
TKN (mg/L)	1/1985	11/2020	263	10.3%	6.8%	4.9%	8.0%	8.0%	8.0%	11.4%	9.9%	7.6%	10.6%	7.6%	6.8%	
NH4-N (mg/L)	4/1972	11/2020	268	10.1%	6.7%	4.9%	8.2%	8.2%	7.8%	11.6%	10.1%	7.5%	10.8%	7.5%	6.7%	
TP (mg/L)	4/1972	11/2020	266	10.2%	6.8%	4.9%	8.3%	7.9%	7.9%	11.3%	9.8%	7.9%	10.9%	7.5%	6.8%	
OrthoP (mg/L)	4/1972	2/2021	247	10.5%	7.7%	4.9%	8.9%	7.7%	7.7%	11.3%	9.7%	7.3%	10.5%	7.7%	6.1%	
Water Quality - Biological																
Chl-a corr (µg/L)	6/2001	11/2020	25	4.0%	0.0%	4.0%	0.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	8.0%	12.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1956	2/2021	261	9.2%	6.9%	5.0%	8.8%	8.4%	8.0%	10.3%	10.0%	7.7%	10.7%	8.0%	6.9%	
Secchi (m)	6/1995	11/2020	238	10.5%	7.6%	5.0%	8.8%	8.0%	8.0%	11.3%	9.2%	7.1%	10.5%	7.6%	6.3%	
Turb (NTU)	4/1972	2/2021	264	8.7%	6.8%	5.3%	8.3%	8.3%	8.0%	10.6%	9.5%	8.0%	11.0%	8.3%	7.2%	
DO (mg/L)	4/1972	12/2020	295	8.8%	6.4%	5.1%	8.1%	7.8%	9.2%	11.2%	9.5%	8.1%	10.5%	7.8%	7.5%	
pH (SU)	7/1946	12/2020	304	9.2%	6.3%	4.9%	8.2%	7.9%	8.9%	11.5%	9.2%	8.2%	10.5%	7.9%	7.2%	
Wtr Temp (C)	4/1956	12/2020	303	9.2%	6.3%	5.0%	8.3%	7.9%	8.9%	11.2%	9.2%	8.3%	10.6%	7.9%	7.3%	
SpCond (umhos/cm)	7/1946	2/2021	306	9.2%	6.5%	4.9%	8.2%	7.8%	8.8%	11.4%	9.2%	8.5%	10.5%	7.8%	7.2%	
TDS (mg/L)	4/1956	2/2021	268	9.0%	7.1%	4.9%	8.6%	8.6%	7.8%	10.1%	10.1%	7.8%	10.8%	8.2%	7.1%	
Salinity (ppt)	8/1997	11/2020	185	8.1%	7.0%	5.4%	7.0%	10.8%	7.6%	9.7%	10.3%	8.6%	8.6%	9.2%	7.6%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1956	2/2021	235	6.4%	7.7%	5.5%	7.2%	9.4%	8.9%	9.4%	11.1%	9.4%	8.5%	8.9%	7.7%	
CL-T (mg/L)	7/1946	11/2020	265	9.1%	6.4%	4.9%	8.7%	8.7%	7.9%	10.6%	10.2%	7.9%	10.9%	7.9%	6.8%	
F-T (mg/L)	6/1995	2/2021	249	8.4%	7.2%	5.2%	7.6%	8.4%	8.4%	10.4%	10.0%	8.0%	10.8%	8.0%	7.2%	
SO4-T (mg/L)	6/1995	11/2020	255	9.0%	6.7%	5.1%	8.2%	8.2%	8.2%	10.6%	9.8%	7.8%	11.4%	7.8%	7.1%	
TOC (mg/L)	4/1972	11/2020	257	8.9%	7.0%	5.1%	8.6%	8.2%	8.2%	10.5%	9.7%	7.8%	11.3%	7.8%	7.0%	
Park Attendance																
Park Att	3/1997	12/2020	8,707	8.2%	7.5%	8.5%	8.3%	8.5%	8.3%	8.5%	8.5%	8.3%	8.5%	8.3%	8.5%	
Biological																
Fish (#/m2)	3/2017	3/2017	1	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Manatee (count)	12/2009	12/2020	187	26.2%	13.9%	20.9%	4.8%	0.0%	0.5%	0.5%	0.0%	0.0%	0.0%	7.5%	25.7%	
Veg (%)	3/2017	3/2017	1	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Bioassessment (SCI)	9/2006	9/2006	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	
Wtr Clarity Score	6/2009	12/2020	2,846	8.0%	7.7%	8.9%	8.0%	7.4%	8.4%	8.4%	8.1%	7.9%	8.7%	8.7%	9.7%	

Gilchrist Blue Spring

Table B-13 provides a summary of monitoring station metadata for Gilchrist Blue Spring with station locations identified in Figure B-9. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Fish and vegetation data were available from Stetson University (Kirsten Work, unpublished data) and FSI, with additional vegetation data from KES. Community metabolism and human-use activity data were also available from FSI. Ruth B. Kirby Gilchrist Blue Springs State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-13. Gilchrist Blue Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	G1NE0014	29.82980	-82.68300	W	FDEP WIN, STORET
2	21FLFSI	GILCHRIST BLUE SPRING	29.82990	-82.68285	W,Q,F,H,P	FDEP WIN, FSI, 2020
3	21FLFSI	T-1	29.82995	-82.68278	V	FSI, 2020
4	21FLFSI	T-2	29.83058	-82.68194	V	FSI, 2020
5	21FLFSI	T-3	29.83097	-82.68194	V	FSI, 2020
6	21FLFSI	T-4	29.83169	-82.68167	V	FSI, 2020
7	21FLFSI	T-5	29.83246	-82.68194	V	FSI, 2020
8	21FLGW	11459	29.82990	-82.68285	W	STORET
9	21FLGW	39964	29.82990	-82.68285	W	STORET
10	21FLGWMS	11459	29.82990	-82.68285	W,Q	FDEP WIN, STORET
11	21FLGWMS	BLU010C1P	29.83003	-82.68281	W	STORET
12	21FLSUW	127909	29.82993	-82.68283	W,S	FDEP WIN
13	21FLSUW	2322350	*29.82833*	*-82.68278*	W,Q,S	SRWMD
14	21FLSUW	BLU010C1	*29.82945*	*-82.68334*	W,Q,S	SRWMD
15	KES	Gilchrist Blue	29.82990	-82.68285	V	KES, 2020
16	Stetson	Gilchrist Blue	29.82990	-82.68285	V,F	Stetson
17	UF	Blue Spring (Gilchrist)	29.82990	-82.68285	W	Strong, 2004
18	USGS	2322350	29.82972	-82.68306	W,Q,S	USGS NWIS

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS- FDEP Ground Water Monitoring Section;21FLSUW - Suwannee River Water Management District; KES – Karst Environmental Services, Inc.; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – Fish; H – Human Use; P – primary productivity (metabolism)

A temporal data availability summary (Figure B-10), period of record statistics (Table B-14), and seasonal distribution summary (Table B-15) were developed from available data for Gilchrist Blue Spring.

Additional continuous *in-situ* water quality data are available from the SRWMD Water Data Portal[19] for water temperature, specific conductance, dissolved oxygen, pH, NOx-N, and fluorescent dissolved organic matter (fDOM) from 6/20/2019 to 3/12/2021[20]. Data are also available from FSI including an April 2018 vegetation community map and snail population densities for the Gilchrist Blue Spring pool and from the neighboring Naked Spring (water quality, fish counts, human use, metabolism). Turtle population monitoring by the Santa Fe River Turtle Project started in 2009 at Gilchrist Blue Spring and include 20 snorkel surveys. These data are not included in the SRWMD OFS database.

---

[19] http://www.mysuwanneeriver.org/data/02322350/02322350_WQ_Cont.xlsx

[20] date website was accessed; visit above link for updated period of record

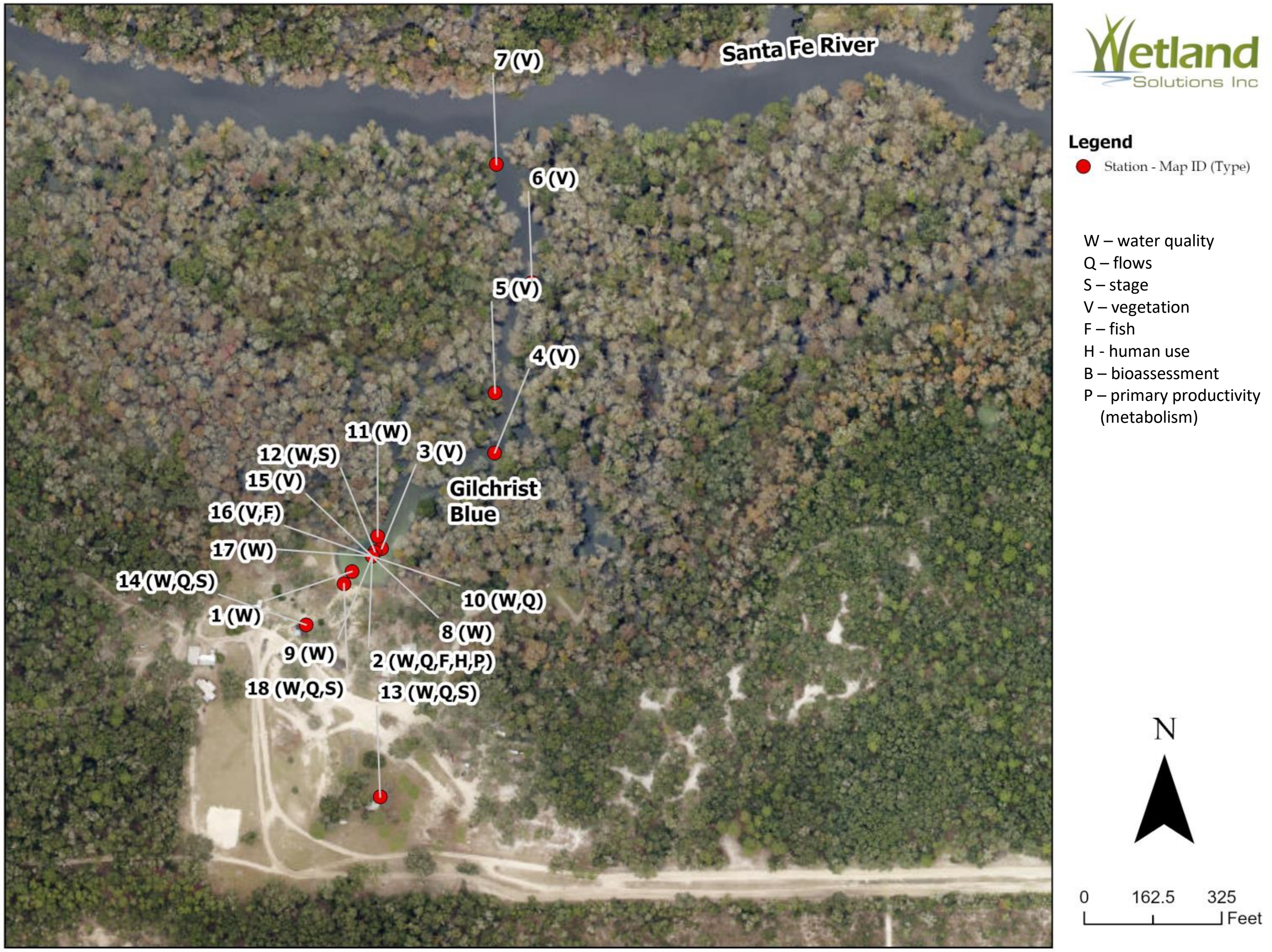


Figure B-9. Gilchrist Blue Spring Station Locations

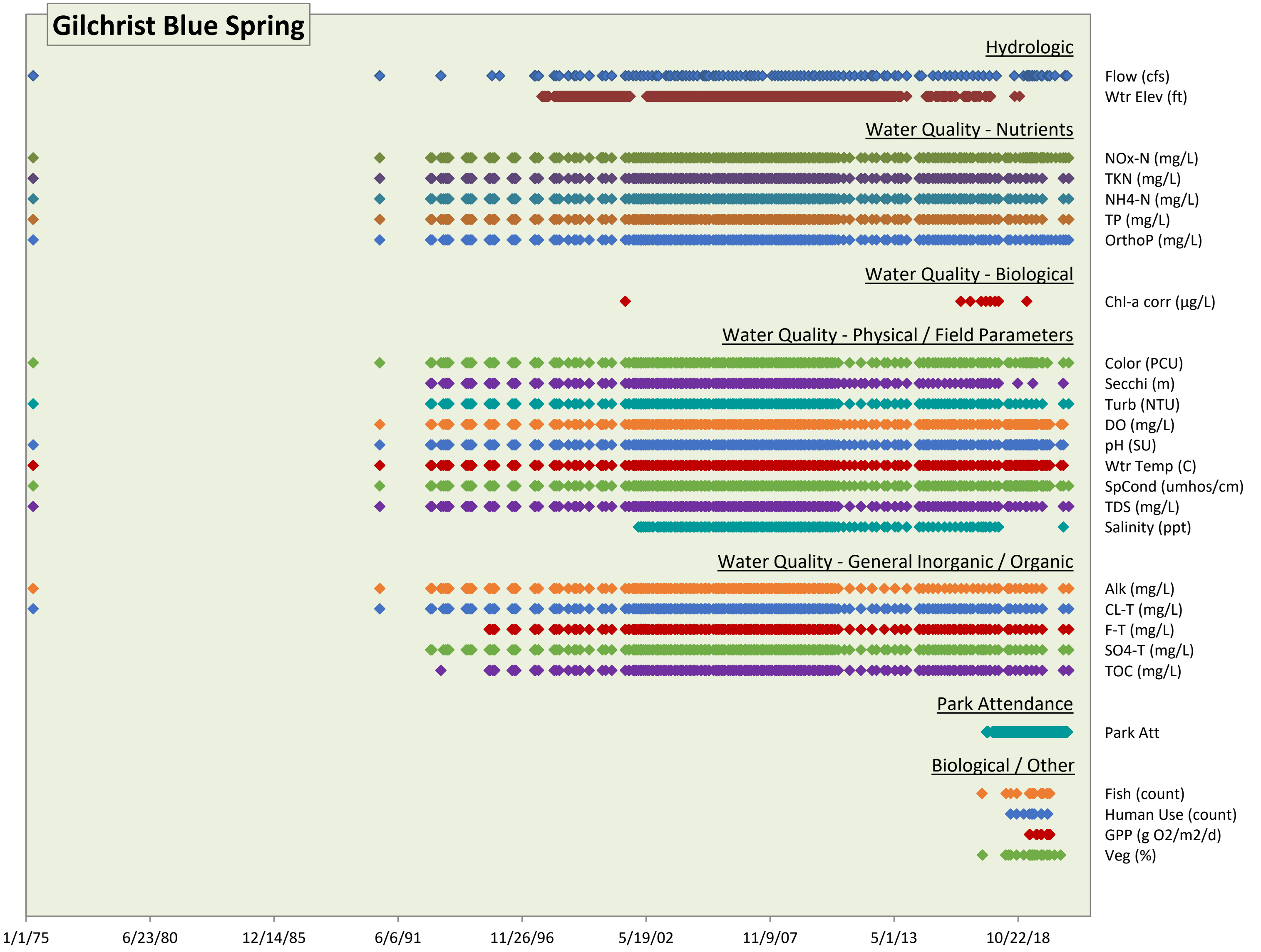


Figure B-10. Gilchrist Blue Spring Temporal Data Availability Chart

Table B-14. Gilchrist Blue Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	4/1975	12/2020	135	---	47.5	8.43	19.4	31.5	42.0	66.7	80.1	95.7	
Wtr Elev (ft)	10/1997	11/2018	5,255	---	24.9	23.3	24.0	24.2	24.7	25.5	25.9	30.1	
Water Quality - Nutrients													
NOx-N (mg/L)	4/1975	1/2021	231	0%	1.91	0.310	1.57	1.70	1.85	2.20	2.40	2.81	
TKN (mg/L)	4/1975	1/2021	203	53%	0.135	-0.015	0.040	0.080	0.100	0.180	0.250	1.60	
NH4-N (mg/L)	4/1975	1/2021	204	79%	0.027	-0.004	0.002	0.009	0.020	0.030	0.090	0.200	
TP (mg/L)	4/1975	1/2021	203	3%	0.039	0.004	0.030	0.030	0.032	0.040	0.060	0.280	
OrthoP (mg/L)	4/1975	1/2021	211	0%	0.028	0.004	0.020	0.020	0.030	0.030	0.034	0.110	
Water Quality - Biological													
Chl-a corr (µg/L)	6/2001	3/2019	9	100%	0.597	0.550	0.550	0.550	0.550	0.550	0.724	0.820	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1975	1/2021	212	75%	5.16	0.00	2.50	5.00	5.00	5.00	5.00	30.0	
Secchi (m)	11/1992	10/2020	179	12%	2.48	0.400	0.750	0.900	1.00	4.91	5.70	32.3	
Turb (NTU)	4/1975	1/2021	196	39%	0.274	0.010	0.080	0.100	0.178	0.290	0.400	8.50	
DO (mg/L)	8/1990	10/2020	246	0%	5.14	3.00	4.50	4.77	5.00	5.40	6.00	10.6	
pH (SU)	4/1975	10/2020	248	0%	7.39	5.47	7.12	7.30	7.42	7.53	7.63	8.04	
Wtr Temp (C)	4/1975	10/2020	248	0%	22.5	21.2	22.2	22.4	22.5	22.6	22.8	24.8	
SpCond (umhos/cm)	4/1975	1/2021	249	0%	363	256	336	346	362	383	391	443	
TDS (mg/L)	4/1975	1/2021	198	0%	202	20.0	185	193	203	212	221	269	
Salinity (ppt)	1/2002	10/2020	136	0%	0.549	0.100	0.100	0.100	0.100	0.180	0.200	57.3	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1975	1/2021	176	0%	162	80.0	150	156	163	170	175	196	
CL-T (mg/L)	4/1975	1/2021	199	1%	6.11	0.00	5.00	5.40	6.00	6.50	7.00	19.2	
F-T (mg/L)	6/1995	1/2021	183	3%	0.112	0.020	0.080	0.096	0.110	0.130	0.150	0.240	
SO4-T (mg/L)	11/1992	1/2021	197	0%	11.6	5.50	9.26	10.1	11.3	12.1	13.1	50.0	
TOC (mg/L)	4/1993	1/2021	187	64%	1.56	0.00	0.300	0.500	0.500	0.875	2.04	54.0	
Park Attendance													
Park Att	6/2017	12/2020	1,248	---	275	0.00	0.00	73.0	179	376	757	1,254	
Biological / Other													
Fish (count)	3/2017	3/2020	14	---	2,128	325	473	782	1,740	2,755	4,042	7,081	
Human Use (count)	6/2018	2/2020	11	---	1,422	58.0	149	301	740	1,130	3,817	6,531	
GPP (g O2/m2/d)	4/2019	3/2020	38	---	1.81	0.830	1.03	1.20	1.72	2.25	2.85	3.34	
Veg (%)	3/2017	9/2020	21	---	57.3	16.7	24.4	29.2	38.1	99.6	100	130	

Table B-15. Gilchrist Blue Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	4/1975	12/2020	135	10.4%	4.4%	8.1%	10.4%	8.9%	10.4%	11.9%	8.9%	2.2%	7.4%	9.6%	7.4%	
Wtr Elev (ft)	10/1997	11/2018	5,255	8.4%	7.1%	7.8%	7.6%	8.4%	8.7%	9.0%	9.2%	7.9%	8.5%	8.8%	8.6%	
Water Quality - Nutrients																
NOx-N (mg/L)	4/1975	1/2021	231	7.8%	6.5%	6.5%	8.2%	8.2%	12.6%	9.1%	11.7%	6.9%	7.4%	8.7%	6.5%	
TKN (mg/L)	4/1975	1/2021	203	7.9%	5.4%	6.9%	7.9%	8.4%	11.3%	9.9%	11.8%	7.4%	7.4%	9.9%	5.9%	
NH4-N (mg/L)	4/1975	1/2021	204	7.8%	5.9%	6.9%	7.8%	8.3%	11.3%	9.8%	11.8%	7.4%	7.4%	9.8%	5.9%	
TP (mg/L)	4/1975	1/2021	203	7.9%	5.4%	6.9%	7.9%	8.4%	11.3%	9.9%	11.8%	7.4%	7.4%	9.9%	5.9%	
OrthoP (mg/L)	4/1975	1/2021	211	7.6%	5.7%	6.6%	7.6%	8.1%	11.8%	9.5%	11.8%	7.6%	7.6%	9.5%	6.6%	
Water Quality - Biological																
Chl-a corr (µg/L)	6/2001	3/2019	9	0.0%	0.0%	22.2%	11.1%	11.1%	11.1%	0.0%	11.1%	11.1%	11.1%	0.0%	11.1%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1975	1/2021	212	7.5%	5.7%	7.1%	8.0%	8.5%	11.8%	9.4%	12.3%	7.1%	7.1%	9.4%	6.1%	
Secchi (m)	11/1992	10/2020	179	8.4%	6.1%	6.1%	7.8%	7.8%	11.2%	11.2%	11.2%	6.7%	7.8%	9.5%	6.1%	
Turb (NTU)	4/1975	1/2021	196	7.1%	5.1%	7.1%	7.7%	8.7%	11.7%	9.7%	11.7%	7.7%	7.1%	10.2%	6.1%	
DO (mg/L)	8/1990	10/2020	246	7.7%	5.7%	6.9%	7.7%	7.7%	12.6%	9.8%	11.8%	6.5%	8.1%	9.3%	6.1%	
pH (SU)	4/1975	10/2020	248	7.7%	5.6%	6.9%	8.5%	7.7%	12.5%	9.7%	11.7%	6.5%	8.1%	9.3%	6.0%	
Wtr Temp (C)	4/1975	10/2020	248	7.7%	5.6%	6.9%	8.5%	7.7%	12.5%	9.7%	11.7%	6.5%	8.1%	9.3%	6.0%	
SpCond (umhos/cm)	4/1975	1/2021	249	8.0%	5.6%	6.8%	8.4%	7.6%	12.4%	9.6%	11.6%	6.4%	8.0%	9.2%	6.0%	
TDS (mg/L)	4/1975	1/2021	198	7.1%	5.1%	7.1%	8.1%	8.6%	11.6%	9.6%	12.1%	7.6%	7.1%	10.1%	6.1%	
Salinity (ppt)	1/2002	10/2020	136	10.3%	7.4%	7.4%	8.8%	9.6%	7.4%	10.3%	8.8%	6.6%	8.1%	9.6%	5.9%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1975	1/2021	176	7.4%	5.7%	6.3%	8.5%	8.0%	11.4%	10.2%	11.4%	6.8%	7.4%	10.8%	6.3%	
CL-T (mg/L)	4/1975	1/2021	199	7.0%	5.5%	7.0%	7.5%	8.5%	11.6%	9.5%	12.1%	7.5%	7.5%	10.1%	6.0%	
F-T (mg/L)	6/1995	1/2021	183	7.1%	5.5%	7.7%	7.7%	9.3%	11.5%	8.7%	10.9%	7.1%	8.2%	10.4%	6.0%	
SO4-T (mg/L)	11/1992	1/2021	197	7.1%	5.6%	7.1%	7.1%	8.6%	11.7%	9.6%	11.7%	7.6%	7.6%	10.2%	6.1%	
TOC (mg/L)	4/1993	1/2021	187	7.5%	5.3%	7.5%	8.0%	9.1%	11.2%	9.1%	11.2%	7.0%	8.0%	10.2%	5.9%	
Park Attendance																
Park Att	6/2017	12/2020	1,248	7.5%	6.8%	7.5%	7.2%	7.5%	9.6%	7.5%	7.5%	9.6%	9.9%	9.6%	9.9%	
Biological / Other																
Fish (count)	3/2017	3/2020	14	0.0%	14.3%	21.4%	14.3%	7.1%	14.3%	7.1%	0.0%	0.0%	14.3%	7.1%	7.1%	
Human Use (count)	6/2018	2/2020	11	9.1%	18.2%	0.0%	9.1%	0.0%	27.3%	9.1%	0.0%	0.0%	9.1%	18.2%	0.0%	
GPP (g O2/m2/d)	4/2019	3/2020	38	0.0%	18.4%	10.5%	10.5%	15.8%	0.0%	0.0%	28.9%	0.0%	0.0%	15.8%	0.0%	
Veg (%)	3/2017	9/2020	21	4.8%	4.8%	9.5%	14.3%	9.5%	19.0%	9.5%	4.8%	4.8%	9.5%	4.8%	4.8%	

Hornsby Spring

Table B-16 provides a summary of monitoring station metadata for Hornsby Spring with station locations identified in Figure B-11. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, Alachua County, and UF. Vegetation data were available from KES, FSI, and Stetson University (Kirsten Work, unpublished data). Fish population data were also available from FSI and Stetson University. FSI also provided community metabolism estimates for the spring pool and upper spring run.

Table B-16. Hornsby Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	G1NE0017	29.85113	-82.59314	W	FDEP WIN, STORET
2	21FLACEP	HORNSBY	29.85025	-82.59329	W	STORET, Alachua Co.
3	21FLBRA	3653Z-A	29.85033	-82.59311	W	STORET
4	21FLFSI	HORNSBY SPRING	29.85033	-82.59325	W	FDEP WIN
5	21FLFSI	H-1	---	---	V,F,P	FSI, 2020
6	21FLFSI	H-2	29.85169	82.59614	V,P	FSI, 2020
7	21FLFSI	H-3	---	---	V	FSI, 2020
8	21FLFSI	H-4	---	---	V	FSI, 2020
9	21FLGW	9681	29.85036	-82.59320	W	STORET
10	21FLGW	39958	29.85002	-82.59335	W	STORET
11	21FLSUW	127934	29.85027	-82.59328	W,S	FDEP WIN
12	21FLSUW	2321970	29.85056	-82.59194	W,Q,S	SRWMD
13	21FLSUW	HOR010C1	29.85000	-82.59333	W,Q,S	SRWMD, STORET
14	21FLSUW	HOR010C1B	29.85000	-82.59333	W	STORET
15	KES	Hornsby	29.85040	-82.59320	V	KES, 2020
16	Stetson	Hornsby	29.85040	-82.59320	V,F	Stetson
17	UF	Hornsby Spring	29.85025	-82.59329	W	Strong, 2004
18	USGS	2321970	29.84972	-82.59333	W,Q,S	USGS NWIS

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLACEP - Alachua County Environmental Protection Department; 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection;21FLSUW - Suwannee River Water Management District; KES – Karst Environmental Services, Inc.; Stetson - Stetson University; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish: P – primary productivity (metabolism)

A temporal data availability summary (Figure B-12), period of record statistics (Table B-17), and seasonal distribution summary (Table B-18) were developed from available data for Hornsby Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

No park attendance data were available from Camp Kulaqua River Ranch Water Park.

Additional data are available from FSI including a September and November 2018 vegetation community map from the Hornsby Spring pool to the canoe launch area. Turtle population monitoring by the Santa Fe River Turtle Project started in 2008 at Hornsby Spring and include 39 snorkel surveys. These data are not included in the SRWMD OFS database.

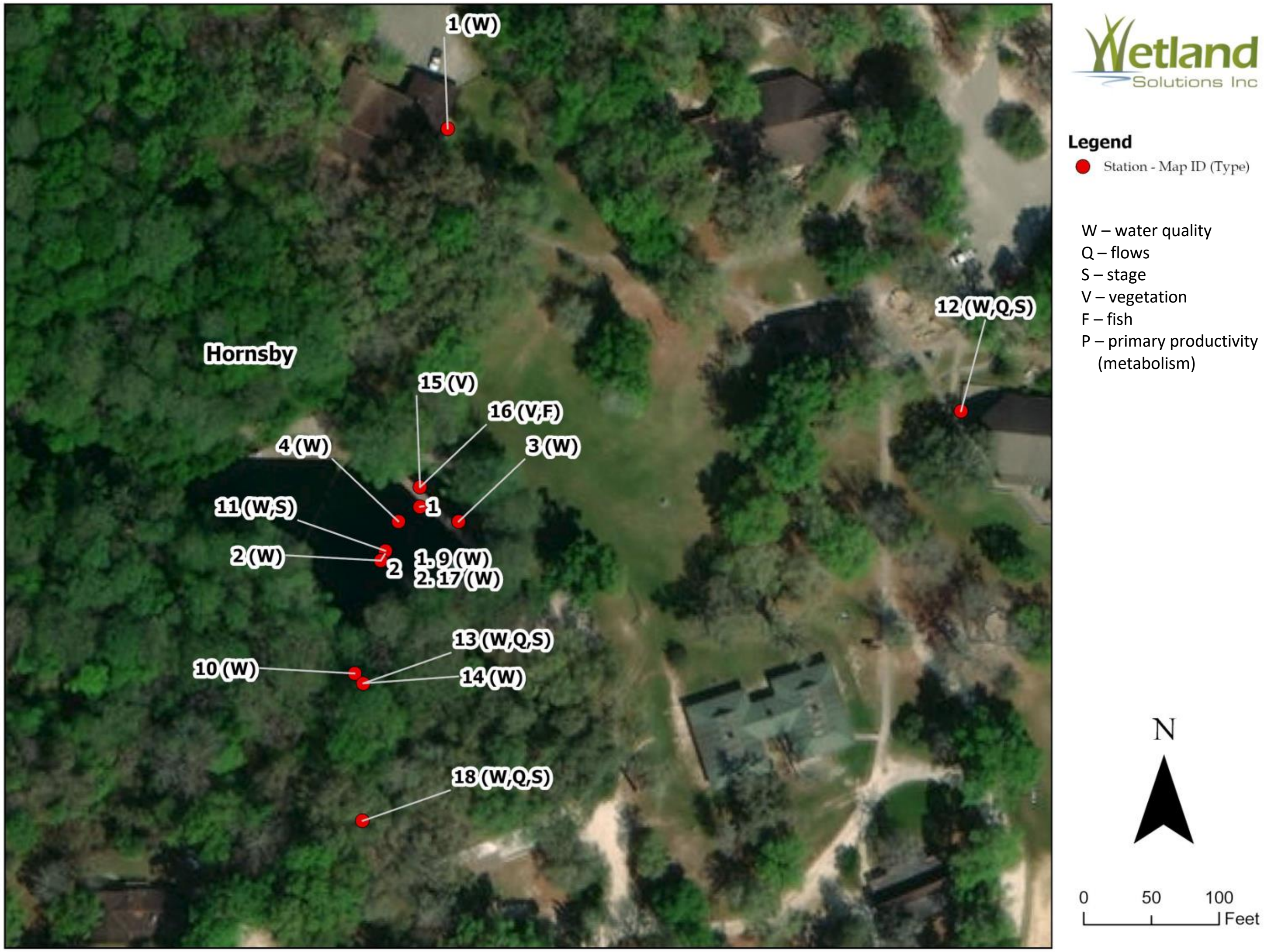


Figure B-11. Hornsby Spring Station Locations

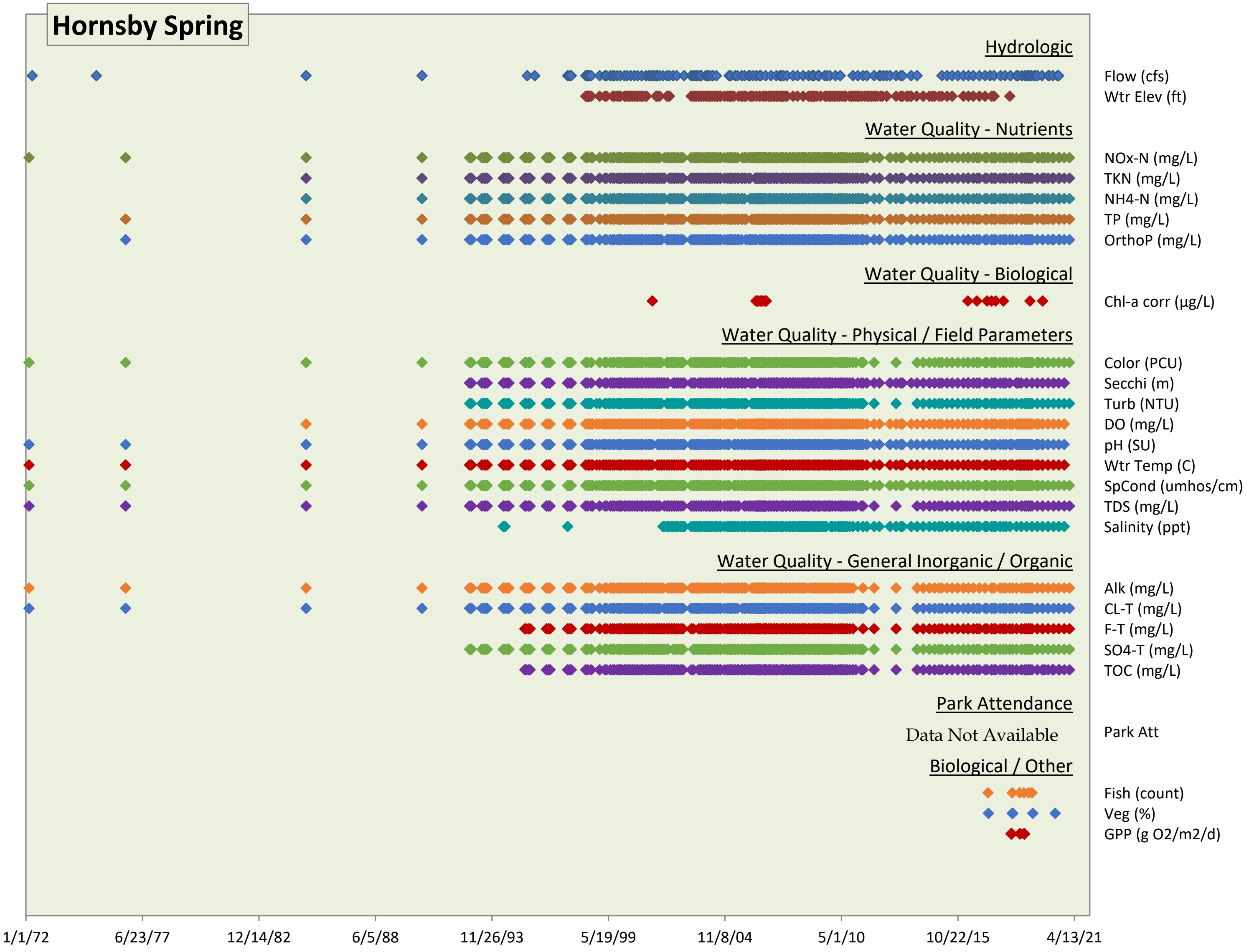


Figure B-12. Hornsby Spring Temporal Data Availability Chart

Table B-17. Hornsby Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	4/1972	7/2020	144	---	84.9	-17.5	1.91	17.8	61.5	128	204	352	
Wtr Elev (ft)	4/1998	4/2018	166	---	14.9	-1.05	0.850	1.65	3.53	32.7	33.6	35.1	
Water Quality - Nutrients													
NOx-N (mg/L)	9/1976	1/2021	256	0%	0.528	0.001	0.227	0.368	0.500	0.660	0.750	3.60	
TKN (mg/L)	3/1985	1/2021	243	22%	0.209	0.020	0.062	0.097	0.160	0.250	0.396	1.64	
NH4-N (mg/L)	3/1985	1/2021	246	84%	0.028	-0.003	0.002	0.010	0.020	0.034	0.084	0.365	
TP (mg/L)	9/1976	1/2021	245	0%	0.093	0.032	0.072	0.080	0.090	0.097	0.111	0.430	
OrthoP (mg/L)	9/1976	1/2021	236	1%	0.076	0.004	0.052	0.068	0.075	0.084	0.093	0.262	
Water Quality - Biological													
Chl-a corr (µg/L)	6/2001	10/2019	19	79%	0.908	0.550	0.550	0.550	1.00	1.00	1.10	2.10	
Water Quality - Physical / Field Parameters													
Color (PCU)	2/1972	1/2021	243	15%	16.8	1.00	5.00	5.00	10.0	15.0	30.0	400	
Secchi (m)	11/1992	10/2020	219	13%	4.95	0.250	1.00	1.60	3.60	8.25	11.2	18.3	
Turb (NTU)	11/1992	1/2021	234	25%	0.553	0.010	0.100	0.140	0.223	0.400	0.621	30.3	
DO (mg/L)	3/1985	10/2020	268	0%	0.807	0.060	0.200	0.300	0.438	0.833	1.60	8.40	
pH (SU)	2/1972	10/2020	270	0%	7.29	6.31	7.01	7.16	7.29	7.38	7.51	12.5	
Wtr Temp (C)	2/1972	10/2020	271	0%	22.5	17.1	22.1	22.3	22.5	22.6	22.9	27.4	
SpCond (umhos/cm)	2/1972	1/2021	272	0%	451	132	415	427	447	472	501	592	
TDS (mg/L)	2/1972	1/2021	238	1%	283	109	238	255	281	309	341	424	
Salinity (ppt)	6/1994	10/2020	161	0%	0.206	0.00	0.200	0.200	0.210	0.220	0.230	0.300	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	2/1972	1/2021	210	0%	158	5.00	147	154	160	167	171	187	
CL-T (mg/L)	2/1972	1/2021	239	0%	13.2	4.00	11.5	12.5	13.2	14.0	15.0	62.0	
F-T (mg/L)	6/1995	1/2021	212	2%	0.211	0.010	0.153	0.180	0.210	0.240	0.270	0.510	
SO4-T (mg/L)	11/1992	1/2021	229	0%	62.3	1.52	36.0	40.8	53.7	69.3	84.9	1,333	
TOC (mg/L)	6/1995	1/2021	223	12%	3.64	-0.420	0.741	1.47	2.20	3.86	7.68	53.3	
Biological / Other													
Fish (count)	3/2017	4/2019	5	---	1,002	154	244	380	459	810	2,248	3,206	
Veg (%)	3/2017	5/2020	5	---	96.7	83.6	90.2	100	100	100	100	100	
GPP (g O2/m2/d)	4/2018	12/2018	31	---	8.17	1.49	3.17	3.37	9.02	12.1	13.7	16.8	

Table B-18. Hornsby Spring Data Seasonal Distribution

Parameter	Period of Record		Count	Monthly Distribution												
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	4/1972	7/2020	144	8.3%	7.6%	4.9%	15.3%	6.3%	13.2%	11.1%	9.7%	2.8%	9.7%	2.8%	8.3%	
Wtr Elev (ft)	4/1998	4/2018	166	9.6%	6.0%	9.6%	8.4%	7.8%	10.8%	10.8%	7.8%	6.6%	8.4%	6.6%	7.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	9/1976	1/2021	256	9.4%	6.3%	6.3%	11.3%	6.6%	7.8%	12.5%	9.8%	7.4%	9.4%	7.4%	5.9%	
TKN (mg/L)	3/1985	1/2021	243	9.1%	5.3%	6.6%	10.7%	7.0%	8.2%	12.8%	9.5%	7.4%	9.9%	7.4%	6.2%	
NH4-N (mg/L)	3/1985	1/2021	246	8.9%	5.7%	6.5%	11.0%	6.9%	8.1%	12.6%	9.8%	7.7%	8.9%	7.3%	6.5%	
TP (mg/L)	9/1976	1/2021	245	9.0%	5.3%	6.5%	10.6%	6.9%	8.2%	13.1%	9.4%	7.8%	9.8%	7.3%	6.1%	
OrthoP (mg/L)	9/1976	1/2021	236	9.3%	5.9%	6.8%	11.0%	6.4%	8.1%	12.3%	9.7%	8.1%	8.5%	7.2%	6.8%	
Water Quality - Biological																
Chl-a corr (µg/L)	6/2001	10/2019	19	0.0%	0.0%	10.5%	10.5%	15.8%	10.5%	10.5%	10.5%	10.5%	15.8%	0.0%	5.3%	
Water Quality - Physical / Field Parameters																
Color (PCU)	2/1972	1/2021	243	9.9%	5.3%	6.2%	11.1%	7.0%	8.2%	11.9%	9.1%	7.8%	9.9%	7.4%	6.2%	
Secchi (m)	11/1992	10/2020	219	9.1%	5.5%	6.4%	11.0%	5.9%	8.7%	12.3%	10.0%	7.8%	9.1%	7.8%	6.4%	
Turb (NTU)	11/1992	1/2021	234	9.4%	4.7%	6.0%	10.7%	7.7%	9.4%	12.4%	8.5%	7.7%	9.8%	7.3%	6.4%	
DO (mg/L)	3/1985	10/2020	268	9.0%	6.3%	6.3%	10.8%	7.1%	8.6%	11.2%	9.7%	7.8%	10.1%	7.1%	6.0%	
pH (SU)	2/1972	10/2020	270	8.9%	6.7%	6.3%	10.7%	6.7%	8.5%	11.5%	9.6%	8.1%	10.0%	7.0%	5.9%	
Wtr Temp (C)	2/1972	10/2020	271	8.9%	6.6%	6.3%	10.7%	7.0%	8.5%	11.1%	9.6%	8.1%	10.0%	7.0%	6.3%	
SpCond (umhos/cm)	2/1972	1/2021	272	9.2%	6.6%	6.3%	10.7%	7.0%	8.5%	11.4%	9.6%	8.1%	9.9%	7.0%	5.9%	
TDS (mg/L)	2/1972	1/2021	238	9.2%	4.6%	6.3%	10.9%	7.1%	8.4%	12.2%	9.2%	8.4%	9.7%	7.1%	6.7%	
Salinity (ppt)	6/1994	10/2020	161	8.7%	6.2%	6.8%	10.6%	8.7%	8.1%	11.8%	8.1%	7.5%	9.3%	7.5%	6.8%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	2/1972	1/2021	210	8.1%	5.2%	6.7%	9.5%	7.6%	9.5%	12.4%	9.0%	8.6%	8.6%	7.6%	7.1%	
CL-T (mg/L)	2/1972	1/2021	239	9.2%	5.0%	6.3%	10.9%	7.1%	8.4%	12.6%	9.2%	8.4%	9.2%	7.1%	6.7%	
F-T (mg/L)	6/1995	1/2021	212	9.4%	4.7%	6.6%	10.8%	8.0%	8.5%	12.3%	8.5%	7.5%	9.9%	7.1%	6.6%	
SO4-T (mg/L)	11/1992	1/2021	229	9.6%	4.8%	6.1%	10.5%	7.4%	8.7%	12.7%	8.7%	7.9%	9.6%	7.4%	6.6%	
TOC (mg/L)	6/1995	1/2021	223	9.9%	4.5%	6.3%	11.7%	7.6%	8.1%	12.6%	8.1%	7.2%	10.3%	7.6%	6.3%	
Biological / Other																
Fish (count)	3/2017	4/2019	5	0.0%	20.0%	20.0%	20.0%	20.0%	0.0%	0.0%	0.0%	20.0%	0.0%	20.0%	0.0%	
Veg (%)	3/2017	5/2020	5	0.0%	0.0%	20.0%	20.0%	60.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
GPP (g O2/m2/d)	4/2018	12/2018	31	0.0%	0.0%	0.0%	22.6%	19.4%	0.0%	0.0%	0.0%	22.6%	0.0%	0.0%	35.5%	

Ichetucknee Headspring

Table B-19 and Table B-20 provides a summary of monitoring station metadata for the Ichetucknee Headspring and River with station locations identified in Figure B-13. The water quality and hydrological data search area focused on the head spring, while the search area for biological data expanded into the spring run due to limited biological data available from the head spring.

Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Vegetation monitoring data were provided by FDEP FPS, WSI, FSI, Stetson University, and AMEC, while faunal data (fish, macroinvertebrates, manatees, and turtles) were available from FDEP FPS, WSI, FSI, Stetson University, USGS, and AMEC. Community metabolism data were available from WSI and FSI, bioassessment data from FDEP, and human-use activity data from WSI and FSI. Ichetucknee Spring State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-19. Ichetucknee Headspring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	21030131	29.98414	-82.76184	W,Q	STORET
2	21FLA	ICHESPRING	29.98404	-82.76188	MI	FDEP
3	21FLFSI	ICHETUCKNEE HEAD SPRING	29.98419	-82.76187	W,Q,F,H	FDEP WIN, FSI, 2020
4	21FLGW	9713	29.98419	-82.76187	W	STORET
5	21FLGWMS	9713	29.98419	-82.76187	W	FDEP WIN
6	21FLSUW	127898	29.98404	-82.76188	W,S	FDEP WIN
7	21FLSUW	2322685	29.98389	-82.76194	W,Q,S	SRWMD
8	21FLSUW	ICH001C1	29.98389	-82.76194	W,Q,S	SRWMD, STORET
9	UF	ICHETUCKNEE HEAD SPRING	29.98404	-82.76188	W	Strong, 2004
10	USGS	2322685	29.98389	-82.76194	W,Q,S	USGS NWIS
11	USGS	295902082454300	29.98389	-82.76194	W,Q	USGS NWIS
12	USGS	295902082454301	29.98389	-82.76194	W,Q	USGS NWIS
13	USGS	295903082454300	29.98417	-82.76194	W	USGS NWIS
14	WSI	ICH_MAIN	29.98368	-82.76155	W,F,H	WSI, 2010; WSI, 2011

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection;21FLSUW - Suwannee River Water Management District; UF - University of Florida; USGS - U.S. Geological Survey; WSI – Wetland Solutions, Inc.
[2] W – water quality; Q – flows; S – stage; F – fish; MI – macroinvertebrates; H – Human Use

Table B-20. Ichetucknee River Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
15	21FLA	COLUM6	29.95381	-82.78856	B	FDEP
16	21FLA	T-1	29.98333	-82.76083	V	FDEP FPS
17	21FLA	T-2	29.98314	-82.76083	V	FDEP FPS
18	21FLA	T-3	29.98114	-82.75972	V	FDEP FPS
19	21FLA	T-4	29.98039	-82.75917	V	FDEP FPS
20	21FLA	T-5	29.97936	-82.75889	V	FDEP FPS
21	21FLA, WSI	PP4-1	29.98302	-82.76083	V	FDEP FPS, WSI, 2010
22	21FLA, WSI	PP4-2	29.98238	-82.76053	V	FDEP FPS, WSI, 2010
23	21FLA	PP5-0	29.96278	-82.76740	V	FDEP FPS
24	21FLA	PP5-0A	29.98143	-82.76007	V	FDEP FPS
25	21FLA, WSI	PP5-1	29.981415	-82.760031	V	FDEP FPS, WSI, 2010
26	21FLA, WSI	PP5-2	29.98095	-82.75928	V	FDEP FPS, WSI, 2010
27	21FLA	PP6-0	---	---	V	FDEP FPS
28	21FLA	PP7-1	29.98010	-82.75893	V	FDEP FPS
29	21FLA	PP8-1	29.97625	-82.75902	V	FDEP FPS
30	21FLA	PP9-1	29.96912	-82.76077	V	FDEP FPS
31	21FLA, WSI	PP10-1	29.96450	-82.76255	V	FDEP FPS; WSI, 2010
32	21FLA, WSI	PP12-1	29.964062	-82.764194	V	FDEP FPS; WSI, 2010
33	21FLA, WSI	PP12-2	29.96423	-82.76413	V,F	FDEP FPS; WSI, 2010; WSI, 2014
34	21FLA, WSI	PP13-0	29.96368	-82.76480	V,F	FDEP FPS; WSI, 2010; WSI, 2014
35	21FLA	PP14-0	---	---	V	FDEP FPS
36	21FLA, WSI	PP14-1	29.96307	-82.76655	V,F	FDEP FPS, WSI, 2010; WSI, 2014
37	21FLA, WSI	PP15-0	29.96285	-82.76745	V,F	FDEP FPS, WSI, 2010; WSI, 2014
38	21FLA, WSI	PP15-1	29.96067	-82.77008	V,F	FDEP FPS, WSI, 2010; WSI, 2014
39	21FLA, WSI	PP18-1	29.95908	-82.77305	V	FDEP FPS, WSI, 2010
40	21FLA, WSI	PP19-0	29.95942	-82.77345	V	FDEP FPS, WSI, 2010
41	21FLA, WSI	PP19-1	29.95952	-82.77397	V	FDEP FPS, WSI, 2010
42	21FLA, WSI	PP19-2	29.95923	-82.77453	V	FDEP FPS, WSI, 2010
43	21FLA, WSI	PP20-0	29.95862	-82.77670	V	FDEP FPS, WSI, 2010
44	21FLA, WSI	PP20-1	29.95863	-82.77690	V	FDEP FPS, WSI, 2010
45	21FLA, WSI	PP20-2	29.95587	-82.78262	V	FDEP FPS, WSI, 2010
46	21FLFSI	T-1	29.98333	-82.76083	V,P	FSI, 2020
47	21FLFSI	T-2	29.98314	-82.76083	V,P	FSI, 2020
48	21FLFSI	T-3	29.98114	-82.75972	V,P	FSI, 2020
49	21FLFSI	T-4	29.98039	-82.75917	V	FSI, 2020
50	21FLFSI	T-5	29.97936	-82.75889	V	FSI, 2020
51	21FLGW	Z2LR10016	29.96335	-82.76620	B	FDEP

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
52	AMEC	ICH 1	29.97990	-82.75890	V,MI	AMEC, 2016
53	Stetson	Ichetucknee	29.98420	-82.76190	V,F	Stetson
54	USGS	Ichetucknee	---	---	F,MI	Walsh & Williams, 2003
55	WSI	North Launch	29.98368	-82.76155	H	WSI, 2011
56	WSI	Dampier's	29.96037	-82.77093	H	WSI, 2011
57	WSI	ICH_UP	29.97974	-82.75880	W,P	WSI, 2010
58	WSI	Seg1	29.98284	-82.76041	F,T,P	WSI, 2010
59	WSI	Seg2	*29.98059*	*-82.75844*	F,T,P	WSI, 2010
60	WSI	Seg3	29.97624	-82.75834	F,T,P	WSI, 2010
61	WSI	Seg4	29.97365	-82.76000	F,T,P	WSI, 2010
62	WSI	Seg5	29.96626	-82.76062	F,T,P	WSI, 2010
63	WSI	Seg6	29.96414	-82.76363	F,T,P	WSI, 2010
64	WSI	Seg7	29.96042	-82.77112	F,T,P	WSI, 2010

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; AMEC – Amec Foster Wheeler Environment & Infrastructure, Inc.; Stetson - Stetson University; USGS - U.S. Geological Survey; WSI – Wetland Solutions, Inc.

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish; T – turtles; M – manatees; MI – macroinvertebrates; B – bioassessment; P – primary productivity (metabolism)

A temporal data availability summary (Figure B-14), period of record statistics (Table B-21), and seasonal distribution summary (Table B-22) were developed from available data for Ichetucknee Headspring and River. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Vegetation transects are monitored twice annually by FDEP FPS using the vertical line-intercept method. Fall monitoring is conducted immediately after the summer tubing season (September – early October) and Spring monitoring at the beginning of the tubing season (late April – May).

Manatee observation data on the Ichetucknee River were supplied by the FDEP FPS, including date, counts, and location description. Location zones along the Ichetucknee River were added to the SRWMD OFS database based on these descriptions (outlined below). If no location details were reported UIR (Upper Ichetucknee River) was used for 'general park' and IR (Ichetucknee River) for 'general river'.

- LIR (Lower Ichetucknee River below Highway 27)
- UIR – Zone 1 (Upper Ichetucknee River above Midpoint dock)
- UIR – Zone 2 (Upper Ichetucknee River from Midpoint dock to above Dampier's Landing)
- UIR – Zone 3 (Upper Ichetucknee River from Dampier's Landing to US 27)

Additional continuous *in-situ* water quality data are available for the Ichetucknee Head Spring from the SRWMD Water Data Portal[21] beginning on 4/3/2015 for water temperature, specific conductance, dissolved oxygen, pH, and fDOM and beginning on 6/18/15 for NOx-N. All parameters continue through 3/12/2021[22].

Continuous *in-situ* water quality data are also available for the Ichetucknee River at Highway 27 from the USGS NWIS[23] beginning on 11/16/2016 for NOx-N and beginning on 1/19/2017 for water temperature and specific conductance. All parameters continue through 2/10/2021[24].

Data are also available from FSI including snail population densities for transects T-1 through T-5 and human use data from Blue Hole Spring. Annual turtle population monitoring by the Santa Fe River Turtle Project occurred from 2014 to 2019 on the Ichetucknee River between at the Head Spring and South tubing take out (5.16 km length). These data are not included in the SRWMD OFS database.

---

[21] http://www.mysuwanneeriver.org/data/02322685/02322685_WQ_Cont.xlsx

[22] date website was accessed; visit above link for updated period of record

[23] http:// waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02322700

[24] date website was accessed; visit above link for updated period of record

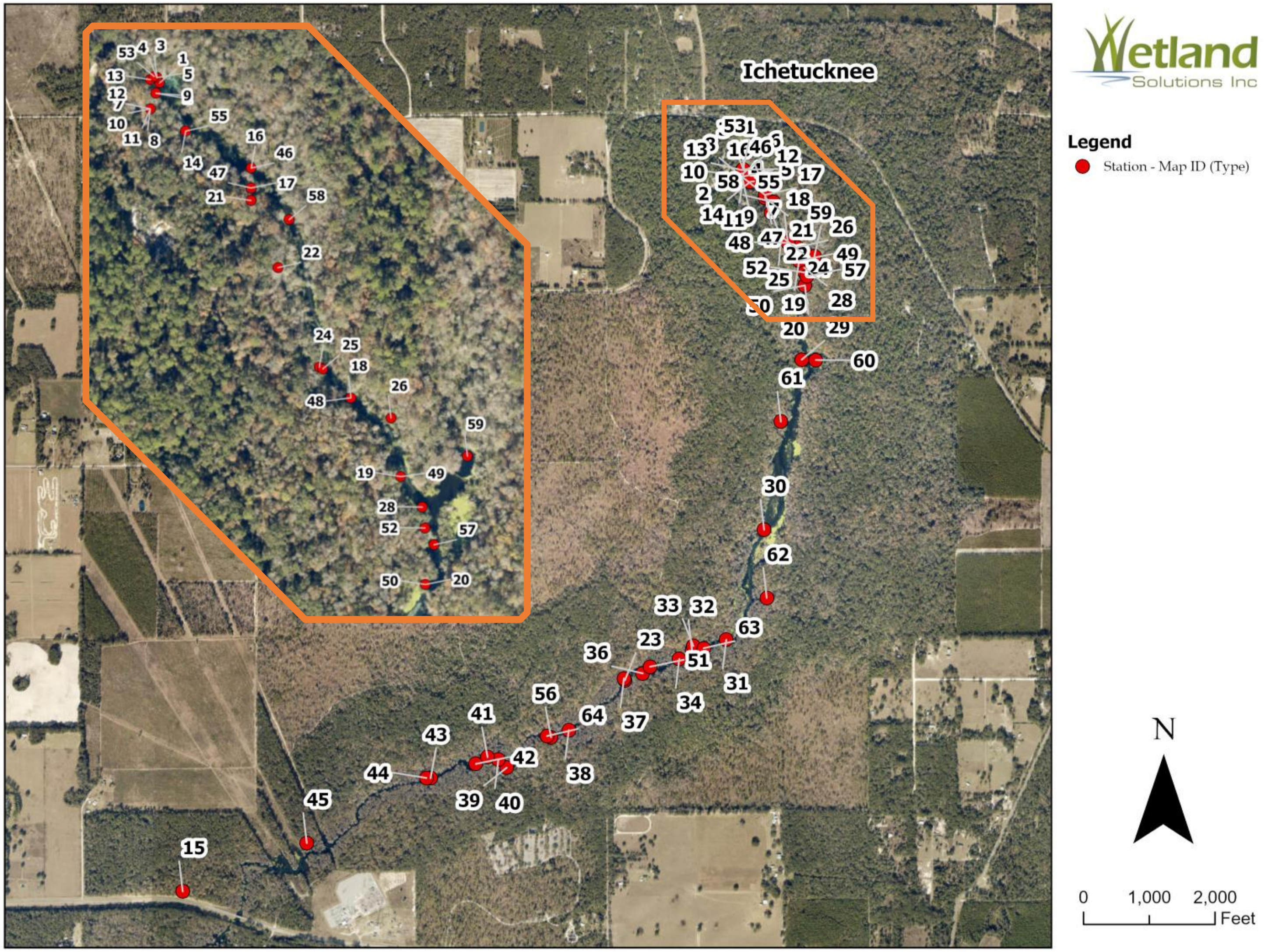


Figure B-13. Ichetucknee Headspring Station Locations

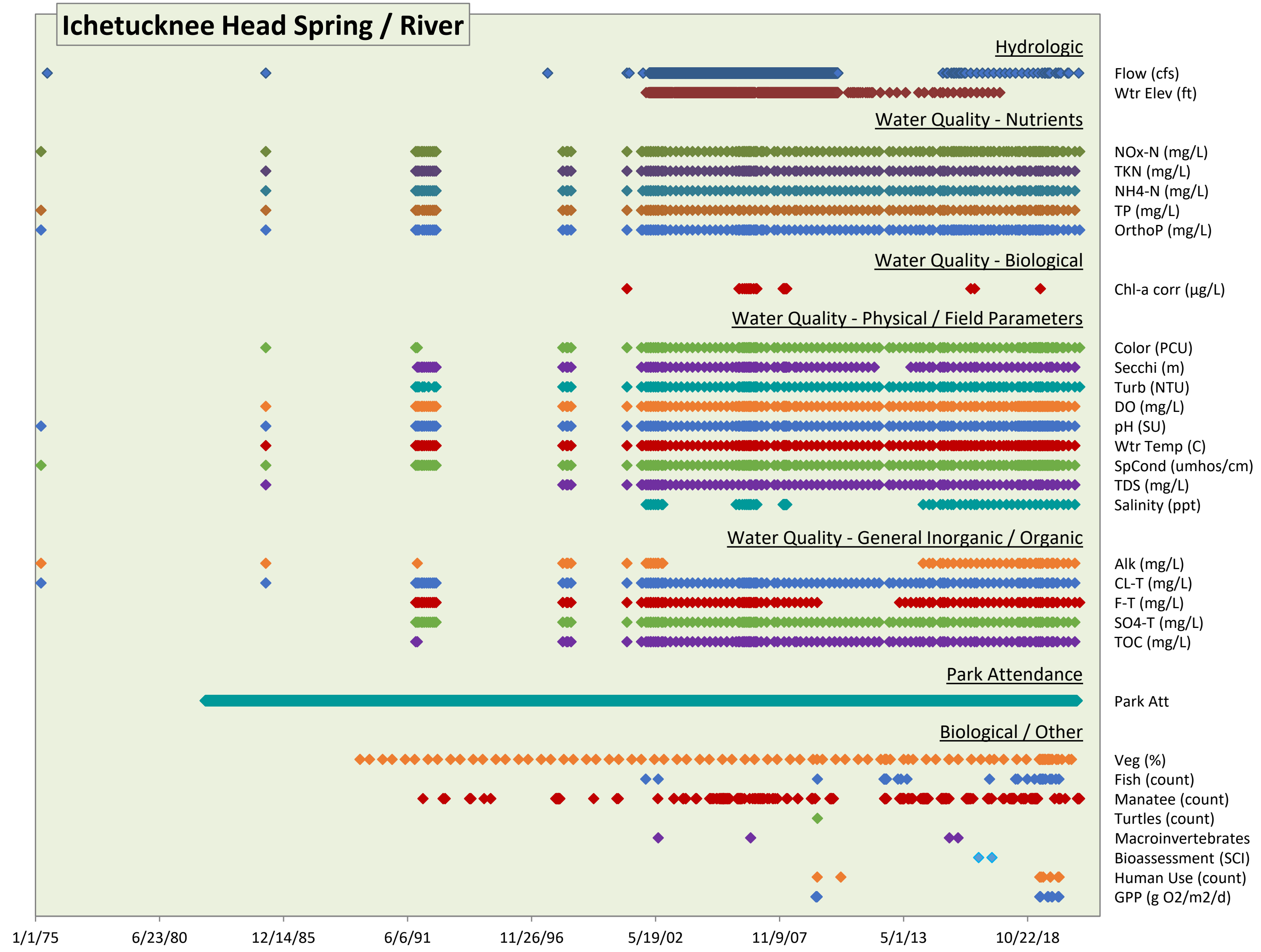


Figure B-14. Ichetucknee Headspring Temporal Data Availability Chart

Table B-21. Ichetucknee Headspring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	7/1975	1/2021	3,091	---	47.4	5.89	22.8	40.2	45.7	58.4	67.0	86.4	
Wtr Elev (ft)	12/2001	7/2017	3,002	---	1.62	0.540	0.740	0.950	1.45	1.87	2.32	24.0	
Water Quality - Nutrients													
NOx-N (mg/L)	4/1975	2/2021	182	0%	0.791	0.360	0.718	0.750	0.790	0.840	0.880	1.11	
TKN (mg/L)	3/1985	11/2020	134	68%	0.085	0.001	0.038	0.060	0.080	0.100	0.130	0.780	
NH4-N (mg/L)	3/1985	11/2020	123	86%	0.009	-0.001	0.002	0.002	0.010	0.010	0.020	0.052	
TP (mg/L)	4/1975	11/2020	124	1%	0.028	0.015	0.021	0.023	0.025	0.030	0.037	0.057	
OrthoP (mg/L)	4/1975	2/2021	164	0%	0.023	0.008	0.019	0.020	0.022	0.024	0.028	0.053	
Water Quality - Biological													
Chl-a corr (µg/L)	2/2001	5/2019	23	91%	0.712	0.500	0.550	0.550	0.820	0.850	0.850	0.960	
Water Quality - Physical / Field Parameters													
Color (PCU)	3/1985	2/2021	137	81%	4.56	0.00	1.00	2.50	5.00	5.00	8.95	27.2	
Secchi (m)	11/1991	11/2020	123	24%	3.30	0.650	1.00	1.00	1.80	5.20	6.08	24.7	
Turb (NTU)	10/1991	2/2021	132	20%	0.261	-1.30	0.100	0.150	0.200	0.300	0.449	2.70	
DO (mg/L)	3/1985	11/2020	181	0%	4.05	1.80	3.34	3.53	3.92	4.30	5.00	10.2	
pH (SU)	5/1946	11/2020	184	0%	7.48	6.67	7.23	7.36	7.47	7.55	7.65	13.4	
Wtr Temp (C)	3/1985	11/2020	197	0%	21.8	20.1	21.5	21.7	21.8	21.9	22.1	24.9	
SpCond (umhos/cm)	5/1946	11/2020	184	0%	328	46.0	310	319	329	339	348	575	
TDS (mg/L)	3/1985	11/2020	114	0%	179	109	166	172	177	185	190	210	
Salinity (ppt)	12/2001	11/2020	61	0%	0.163	0.070	0.100	0.160	0.160	0.200	0.200	0.200	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1975	11/2020	58	0%	155	48.0	143	151	160	163	165	167	
CL-T (mg/L)	5/1946	11/2020	135	0%	4.45	3.43	3.84	4.20	4.40	4.50	5.10	6.69	
F-T (mg/L)	10/1991	2/2021	118	7%	0.104	0.040	0.092	0.099	0.102	0.110	0.120	0.170	
SO4-T (mg/L)	10/1991	11/2020	130	2%	8.57	0.00	7.79	8.20	8.60	8.89	9.48	14.9	
TOC (mg/L)	10/1991	11/2020	122	82%	0.954	-0.780	0.300	0.500	1.00	1.00	1.31	11.3	
Park Attendance													
Park Att	7/1982	12/2020	14,064	---	575	0.00	12.0	36.0	140	772	1,694	11,675	
Biological / Other													
Veg (%)	5/1989	10/2020	64	---	46.6	16.8	28.7	35.5	43.6	55.3	67.4	122	
Fish (count)	12/2001	3/2020	24	---	1,553	129	225	557	881	1,560	2,048	12,343	
Manatee (count)	2/1992	2/2021	406	---	3.33	1.00	1.00	1.00	2.00	5.00	7.00	19.0	
Turtles (count)	7/2009	7/2009	1	---	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	
Macroinvertebrates	7/2002	9/2015	4	---	---	---	---	---	---	---	---	---	
Bioassessment (SCI)	8/2016	3/2017	2	---	71.5	69.0	69.5	70.3	71.5	72.8	73.5	74.0	
Human Use (count)	7/2009	3/2020	9	---	571	71.0	93.4	145	340	604	1,064	2,442	
GPP (g O2/m2/d)	6/2009	3/2020	56	---	9.81	2.71	3.90	7.98	9.54	10.9	15.8	18.6	

* Veg (%) statistics from transect PP4-1

Table B-22. Ichetucknee Headspring Data Seasonal Distribution

Parameter	Period of Record		Count	Monthly Distribution												
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	7/1975	1/2021	3,091	8.3%	8.1%	9.2%	8.9%	9.0%	8.1%	8.3%	8.2%	7.9%	8.3%	7.8%	8.0%	
Wtr Elev (ft)	12/2001	7/2017	3,002	8.3%	8.0%	8.8%	9.2%	9.3%	8.2%	8.4%	8.3%	8.1%	7.7%	7.4%	8.3%	
Water Quality - Nutrients																
NOx-N (mg/L)	4/1975	2/2021	182	13.2%	7.1%	4.9%	13.2%	7.1%	6.6%	11.5%	7.1%	7.1%	9.9%	6.6%	5.5%	
TKN (mg/L)	3/1985	11/2020	134	12.7%	7.5%	4.5%	14.2%	6.0%	6.7%	11.9%	8.2%	5.2%	11.2%	6.0%	6.0%	
NH4-N (mg/L)	3/1985	11/2020	123	13.8%	7.3%	4.1%	14.6%	5.7%	6.5%	12.2%	8.1%	4.9%	11.4%	5.7%	5.7%	
TP (mg/L)	4/1975	11/2020	124	12.1%	8.1%	4.0%	15.3%	5.6%	6.5%	12.9%	8.1%	4.8%	11.3%	5.6%	5.6%	
OrthoP (mg/L)	4/1975	2/2021	164	12.2%	7.3%	5.5%	14.0%	6.1%	6.7%	12.2%	6.7%	6.1%	11.0%	6.7%	5.5%	
Water Quality - Biological																
Chl-a corr (µg/L)	2/2001	5/2019	23	21.7%	21.7%	8.7%	8.7%	8.7%	8.7%	4.3%	4.3%	4.3%	4.3%	4.3%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	3/1985	2/2021	137	13.1%	8.0%	3.6%	13.9%	7.3%	6.6%	10.9%	7.3%	6.6%	10.9%	6.6%	5.1%	
Secchi (m)	11/1991	11/2020	123	17.1%	8.1%	4.1%	13.8%	4.9%	5.7%	12.2%	8.9%	2.4%	12.2%	6.5%	4.1%	
Turb (NTU)	10/1991	2/2021	132	11.4%	8.3%	4.5%	13.6%	6.8%	6.8%	12.1%	7.6%	5.3%	12.1%	6.1%	5.3%	
DO (mg/L)	3/1985	11/2020	181	14.4%	8.3%	5.0%	11.6%	7.7%	6.6%	12.7%	7.2%	5.0%	10.5%	6.1%	5.0%	
pH (SU)	5/1946	11/2020	184	14.1%	8.2%	4.9%	12.0%	8.2%	6.5%	12.5%	7.1%	4.9%	10.9%	6.0%	4.9%	
Wtr Temp (C)	3/1985	11/2020	197	14.2%	7.6%	5.1%	12.2%	7.1%	6.1%	12.7%	7.1%	5.6%	10.7%	6.6%	5.1%	
SpCond (umhos/cm)	5/1946	11/2020	184	14.1%	8.2%	4.9%	12.0%	8.2%	6.5%	12.5%	7.1%	4.9%	10.9%	6.0%	4.9%	
TDS (mg/L)	3/1985	11/2020	114	14.0%	7.0%	3.5%	14.9%	5.3%	6.1%	12.3%	7.9%	4.4%	13.2%	6.1%	5.3%	
Salinity (ppt)	12/2001	11/2020	61	14.8%	13.1%	6.6%	9.8%	8.2%	8.2%	8.2%	9.8%	3.3%	4.9%	8.2%	4.9%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1975	11/2020	58	6.9%	10.3%	6.9%	12.1%	8.6%	8.6%	8.6%	10.3%	6.9%	3.4%	8.6%	8.6%	
CL-T (mg/L)	5/1946	11/2020	135	12.6%	7.4%	4.4%	14.8%	6.7%	6.7%	11.9%	7.4%	5.2%	11.9%	5.9%	5.2%	
F-T (mg/L)	10/1991	2/2021	118	11.0%	9.3%	4.2%	13.6%	6.8%	7.6%	11.9%	8.5%	5.1%	10.2%	5.9%	5.9%	
SO4-T (mg/L)	10/1991	11/2020	130	12.3%	7.7%	3.8%	14.6%	6.2%	6.9%	12.3%	7.7%	5.4%	11.5%	6.2%	5.4%	
TOC (mg/L)	10/1991	11/2020	122	12.3%	7.4%	3.3%	14.8%	5.7%	6.6%	12.3%	8.2%	4.9%	12.3%	6.6%	5.7%	
Park Attendance																
Park Att	7/1982	12/2020	14,064	8.4%	7.6%	8.4%	8.1%	8.4%	8.1%	8.6%	8.6%	8.3%	8.6%	8.3%	8.6%	
Biological / Other																
Veg (%)	5/1989	10/2020	64	1.6%	3.1%	0.0%	0.0%	54.7%	1.6%	12.5%	3.1%	4.7%	51.6%	3.1%	0.0%	
Fish (count)	12/2001	3/2020	24	8.3%	8.3%	8.3%	4.2%	12.5%	16.7%	25.0%	4.2%	0.0%	8.3%	4.2%	4.2%	
Manatee (count)	2/1992	2/2021	406	13.1%	19.7%	23.9%	11.8%	7.4%	2.5%	7.1%	4.4%	4.7%	1.7%	0.5%	3.2%	
Turtles (count)	7/2009	7/2009	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Macroinvertebrates	7/2002	9/2015	4	0.0%	0.0%	0.0%	0.0%	25.0%	0.0%	50.0%	0.0%	25.0%	0.0%	0.0%	0.0%	
Bioassessment (SCI)	8/2016	3/2017	2	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
Human Use (count)	7/2009	3/2020	9	0.0%	11.1%	11.1%	0.0%	11.1%	11.1%	33.3%	0.0%	0.0%	22.2%	0.0%	0.0%	
GPP (g O2/m2/d)	6/2009	3/2020	56	0.0%	1.8%	17.9%	0.0%	19.6%	19.6%	12.5%	0.0%	16.1%	0.0%	12.5%	0.0%	

Lafayette Blue Spring

Table B-23 provides a summary of monitoring station metadata for Lafayette Blue Spring with station locations identified in Figure B-15. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Fish and vegetation data were available from Stetson University (Kirsten Work, unpublished data), bioassessment data from FDEP, and water clarity data from the FDEP FPS. Lafayette Blue Spring State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-23. Lafayette Blue Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	22051011	30.12583	-83.22597	W,Q	STORET
2	21FLA	LAFBLUESP	30.12583	-83.22597	B	FDEP
3	21FLBRA	3528Z-A	30.12589	-83.22597	W	STORET
4	21FLFSI	SUW1-S3	30.12590	-83.22609	W,F	FDEP WIN; FSI, 2020
5	21FLGW	9671	30.12583	-83.22613	W	STORET
6	21FLGW	Lafayette Blue Spring	30.12590	-83.22609	W,S	FDEP FPS
7	21FLSUW	127874	30.12594	-83.22627	W,S	FDEP WIN
8	21FLSUW	2319950	*30.12556*	*-83.22583*	W,Q,S	SRWMD
9	21FLSUW	LBS010C1	*30.12528*	*-83.22556*	W,Q,S	SRWMD, STORET
10	Stetson	Lafayette Blue	*30.12570*	*-83.22590*	V,F	Stetson
11	UF	Blue Spring (Lafayette)	30.12590	-83.22609	W	Strong, 2004
12	USGS	2319950	30.12583	-83.22611	W,Q,S	USGS NWIS

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection;21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF – University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish; B - bioassessment

A temporal data availability summary (Figure B-16), period of record statistics (Table B-24), and seasonal distribution summary (Table B-25) were developed from available data for Lafayette Blue Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Additional continuous *in-situ* water quality data are available for the Lafayette Blue Spring from the USGS NWIS[25] beginning on 5/12/2015 for NOx-N and beginning on 6/18/15 for water temperature, specific conductance, dissolved oxygen, and pH. All parameters continue through 2/10/2021[26].

Cave fauna data may also be available from Kelly Jessup, Director of the North Florida Springs Alliance (https://northfloridaspringsalliance.org/).

---

[25] http:// waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02319950

[26] date website was accessed; visit above link for updated period of record

Legend

● Station - Map ID (Type)

W – water quality
Q – flows
S – stage
V – vegetation
F – fish
B – bioassessment

Figure B-15. Lafayette Blue Spring Station Locations

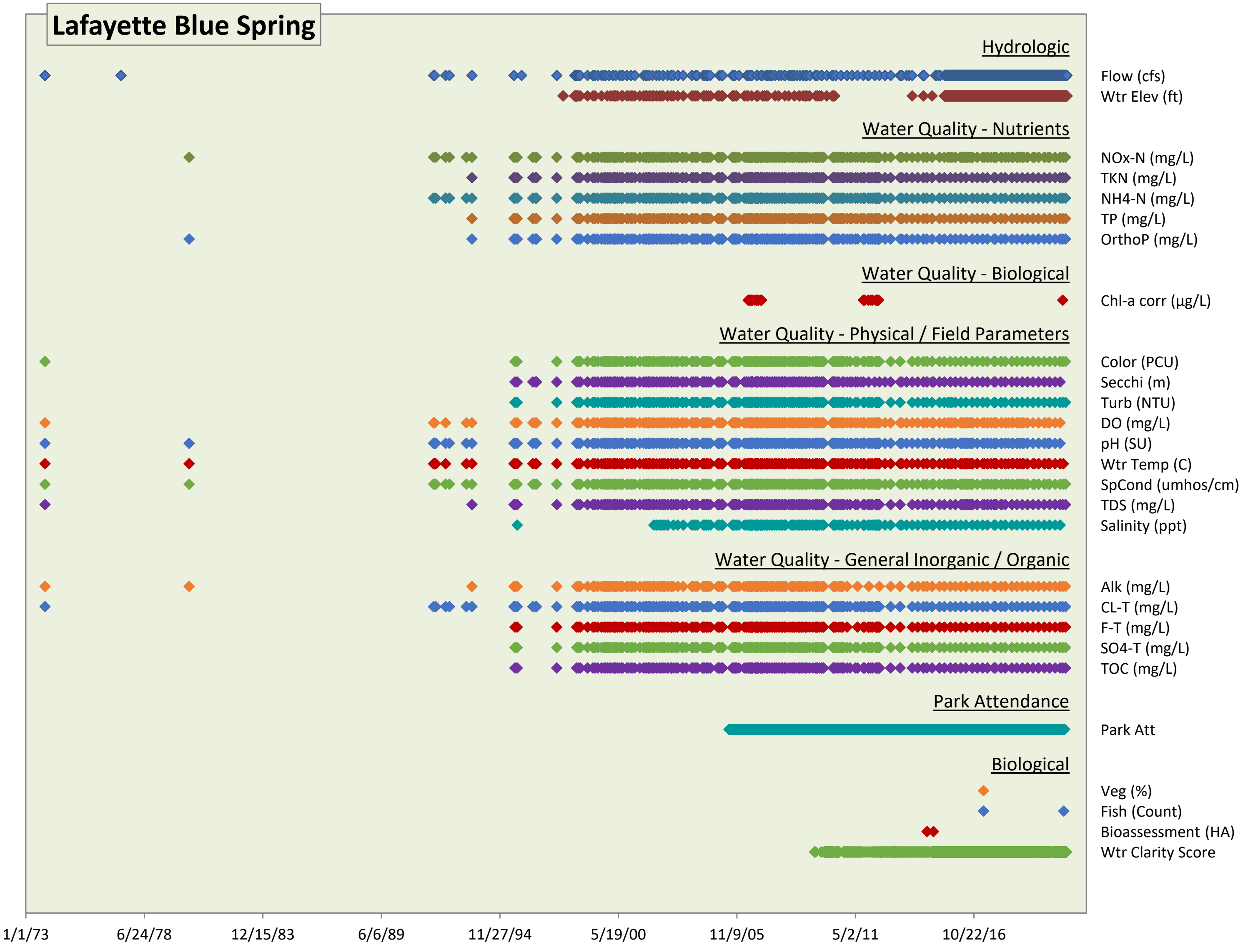


Figure B-16. Lafayette Blue Spring Temporal Data Availability Chart

Table B-24. Lafayette Blue Spring Database Inventory and Statistics

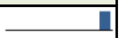
				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	11/1973	2/2021	2,190	---	52.2	-328	-15.9	46.3	70.1	87.1	101	257	
Wtr Elev (ft)	10/1997	2/2021	2,142	---	21.9	-0.54	20.3	20.5	21.3	23.7	27.5	40.3	
Water Quality - Nutrients													
NOx-N (mg/L)	7/1980	1/2021	249	1%	2.13	0.00	1.17	1.50	2.11	2.60	3.24	11.9	
TKN (mg/L)	8/1993	1/2021	213	14%	0.213	0.00	0.074	0.104	0.160	0.250	0.398	1.69	
NH4-N (mg/L)	11/1991	1/2021	217	73%	0.028	0.0007	0.006	0.010	0.020	0.030	0.056	0.500	
TP (mg/L)	8/1993	1/2021	213	2%	0.052	0.009	0.040	0.042	0.048	0.055	0.070	0.202	
OrthoP (mg/L)	7/1980	1/2021	199	1%	0.039	0.002	0.023	0.032	0.040	0.044	0.051	0.134	
Water Quality - Biological													
Chl-a corr (µg/L)	5/2006	11/2020	22	95%	1.18	0.550	0.550	0.550	1.00	1.08	2.60	2.60	
Water Quality - Physical / Field Parameters													
Color (PCU)	11/1973	1/2021	202	23%	15.1	0.00	4.77	5.00	5.00	9.50	15.0	591	
Secchi (m)	8/1995	10/2020	195	11%	5.04	0.500	1.60	3.10	6.00	6.50	7.06	10.0	
Turb (NTU)	8/1995	1/2021	203	9%	0.538	0.00	0.180	0.240	0.347	0.500	0.768	10.5	
DO (mg/L)	11/1973	10/2020	246	0%	1.03	0.145	0.300	0.500	0.750	1.10	1.65	8.50	
pH (SU)	11/1973	10/2020	250	0%	7.20	5.80	6.99	7.11	7.20	7.31	7.45	8.21	
Wtr Temp (C)	11/1973	12/2020	252	0%	21.5	11.3	21.0	21.3	21.6	21.8	22.0	27.0	
SpCond (umhos/cm)	11/1973	1/2021	254	0%	425	55.0	401	421	435	455	471	507	
TDS (mg/L)	11/1973	1/2021	217	1%	249	40.0	230	240	254	265	276	356	
Salinity (ppt)	9/1995	10/2020	142	0%	0.208	0.030	0.200	0.200	0.210	0.220	0.230	0.500	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	11/1973	1/2021	166	1%	195	7.45	185	194	200	206	212	227	
CL-T (mg/L)	11/1973	1/2021	213	0%	9.71	0.261	7.90	8.70	9.70	10.8	12.0	16.8	
F-T (mg/L)	8/1995	1/2021	195	3%	0.115	0.006	0.070	0.100	0.116	0.130	0.150	0.242	
SO4-T (mg/L)	8/1995	1/2021	201	0%	14.5	0.137	11.9	13.0	14.6	16.0	17.0	44.0	
TOC (mg/L)	8/1995	1/2021	201	15%	3.94	0.500	0.800	1.33	1.70	2.53	9.53	51.7	
Park Attendance													
Park Att	7/2005	12/2020	5,663	---	73.5	0.00	5.00	15.0	35.0	86.0	185	1,250	
Biological													
Veg (%)	4/2017	4/2017	1	---	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	
Fish (Count)	4/2017	12/2020	2	---	22.1	21.3	21.4	21.7	22.1	22.6	22.8	23.0	
Bioassessment (HA)	8/2014	12/2014	2	---	36.5	33.0	33.7	34.8	36.5	38.3	39.3	40.0	
Wtr Clarity Score	6/2009	1/2021	2,742	---	2.16	1.00	1.00	1.00	1.00	4.00	5.00	5.00	

Table B-25. Lafayette Blue Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	11/1973	2/2021	2,190	8.8%	7.2%	7.4%	7.4%	7.6%	8.3%	9.1%	9.0%	8.5%	9.2%	8.5%	9.1%	
Wtr Elev (ft)	10/1997	2/2021	2,142	9.0%	7.3%	7.5%	7.5%	7.3%	8.0%	8.8%	9.0%	8.6%	9.3%	8.7%	9.0%	
Water Quality - Nutrients																
NOx-N (mg/L)	7/1980	1/2021	249	7.6%	5.2%	5.2%	9.2%	7.2%	8.8%	11.2%	9.2%	8.0%	12.0%	6.0%	10.0%	
TKN (mg/L)	8/1993	1/2021	213	8.9%	4.7%	5.6%	8.5%	6.6%	9.4%	11.3%	8.5%	8.9%	11.7%	6.6%	9.4%	
NH4-N (mg/L)	11/1991	1/2021	217	8.8%	4.6%	5.5%	8.3%	7.4%	9.2%	11.5%	8.3%	8.8%	11.1%	6.9%	9.7%	
TP (mg/L)	8/1993	1/2021	213	8.9%	4.7%	5.6%	8.5%	6.6%	9.4%	11.3%	8.5%	8.9%	11.7%	6.6%	9.4%	
OrthoP (mg/L)	7/1980	1/2021	199	9.0%	5.0%	6.0%	8.5%	7.0%	9.0%	11.6%	8.0%	8.5%	12.1%	6.0%	9.0%	
Water Quality - Biological																
Chl-a corr (µg/L)	5/2006	11/2020	22	9.1%	4.5%	0.0%	9.1%	13.6%	9.1%	4.5%	4.5%	9.1%	9.1%	13.6%	13.6%	
Water Quality - Physical / Field Parameters																
Color (PCU)	11/1973	1/2021	202	9.4%	5.0%	5.0%	8.9%	6.9%	8.9%	10.9%	7.4%	7.9%	12.4%	7.4%	9.9%	
Secchi (m)	8/1995	10/2020	195	8.7%	4.6%	6.2%	8.7%	6.2%	9.2%	11.3%	9.2%	8.2%	12.3%	6.2%	9.2%	
Turb (NTU)	8/1995	1/2021	203	9.4%	4.9%	4.9%	8.9%	6.9%	8.9%	10.8%	7.9%	7.9%	12.8%	6.9%	9.9%	
DO (mg/L)	11/1973	10/2020	246	7.3%	5.3%	5.3%	9.8%	7.3%	8.9%	10.2%	9.3%	8.1%	11.8%	6.9%	9.8%	
pH (SU)	11/1973	10/2020	250	7.2%	5.2%	5.2%	9.6%	7.2%	8.8%	11.2%	9.2%	8.0%	11.6%	6.8%	10.0%	
Wtr Temp (C)	11/1973	12/2020	252	7.1%	5.2%	5.2%	9.5%	7.1%	8.7%	10.7%	9.5%	7.9%	11.9%	6.7%	10.3%	
SpCond (umhos/cm)	11/1973	1/2021	254	7.5%	5.1%	5.1%	9.4%	7.1%	8.7%	11.0%	9.4%	7.9%	11.8%	6.7%	10.2%	
TDS (mg/L)	11/1973	1/2021	217	8.8%	5.1%	4.6%	9.2%	6.9%	9.2%	11.1%	8.3%	7.8%	12.0%	7.4%	9.7%	
Salinity (ppt)	9/1995	10/2020	142	7.7%	4.9%	7.0%	7.0%	7.7%	11.3%	8.5%	7.0%	12.0%	8.5%	6.3%	12.0%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	11/1973	1/2021	166	7.8%	4.8%	6.0%	6.0%	6.6%	10.8%	10.8%	9.0%	9.0%	9.0%	9.0%	10.8%	
CL-T (mg/L)	11/1973	1/2021	213	8.9%	4.7%	4.7%	8.5%	7.5%	8.9%	11.7%	8.5%	7.5%	11.7%	7.5%	9.9%	
F-T (mg/L)	8/1995	1/2021	195	9.7%	4.6%	5.1%	8.7%	6.7%	9.2%	10.8%	7.7%	8.2%	11.8%	7.2%	10.3%	
SO4-T (mg/L)	8/1995	1/2021	201	9.5%	5.0%	5.0%	9.0%	7.0%	9.0%	10.9%	7.5%	8.0%	12.4%	7.0%	10.0%	
TOC (mg/L)	8/1995	1/2021	201	9.5%	5.0%	5.0%	9.0%	7.0%	9.0%	10.9%	7.5%	8.0%	12.4%	7.0%	10.0%	
Park Attendance																
Park Att	7/2005	12/2020	5,663	8.2%	7.5%	8.2%	7.9%	8.2%	7.9%	8.8%	8.8%	8.5%	8.8%	8.5%	8.8%	
Biological																
Veg (%)	4/2017	4/2017	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Fish (Count)	4/2017	12/2020	2	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
Bioassessment (HA)	8/2014	12/2014	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	
Wtr Clarity Score	6/2009	1/2021	2,742	9.8%	8.5%	9.7%	8.4%	6.6%	8.5%	9.5%	7.7%	6.5%	6.9%	8.5%	9.4%	

Levy Blue Spring

Table B-26 provides a summary of monitoring station metadata for Levy Blue Spring with station locations identified in Figure B-17. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Bioassessment data were also available from FDEP

Table B-26. Levy Blue Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	LITTWACBLU	29.44638	-82.70488	B	FDEP
2	21FLA	G1NE0868	29.45071	-82.69897	W	FDEP WIN, STORET
3	21FLGW	19500	29.45075	-82.69897	W	STORET
4	21FLSUW	127853	29.45069	-82.69898	W,S	FDEP WIN
5	21FLSUW	2313450	29.45056	-82.69917	W,Q,S	SRWMD
6	21FLSUW	BSB010C1	29.45083	-82.69889	W,Q,S	SRWMD, STORET
7	UF	Blue Spring (LEVY)	29.45071	-82.69897	W	Strong, 2004
8	USGS	2313450	29.45056	-82.69917	W,Q,S	USGS NWIS
9	USGS	292702082415700	29.45056	-82.69917	Q	USGS NWIS

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; B - bioassessment

A temporal data availability summary (Figure B-18), period of record statistics (Table B-27), and seasonal distribution summary (Table B-28) were developed from available data for Levy Blue Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

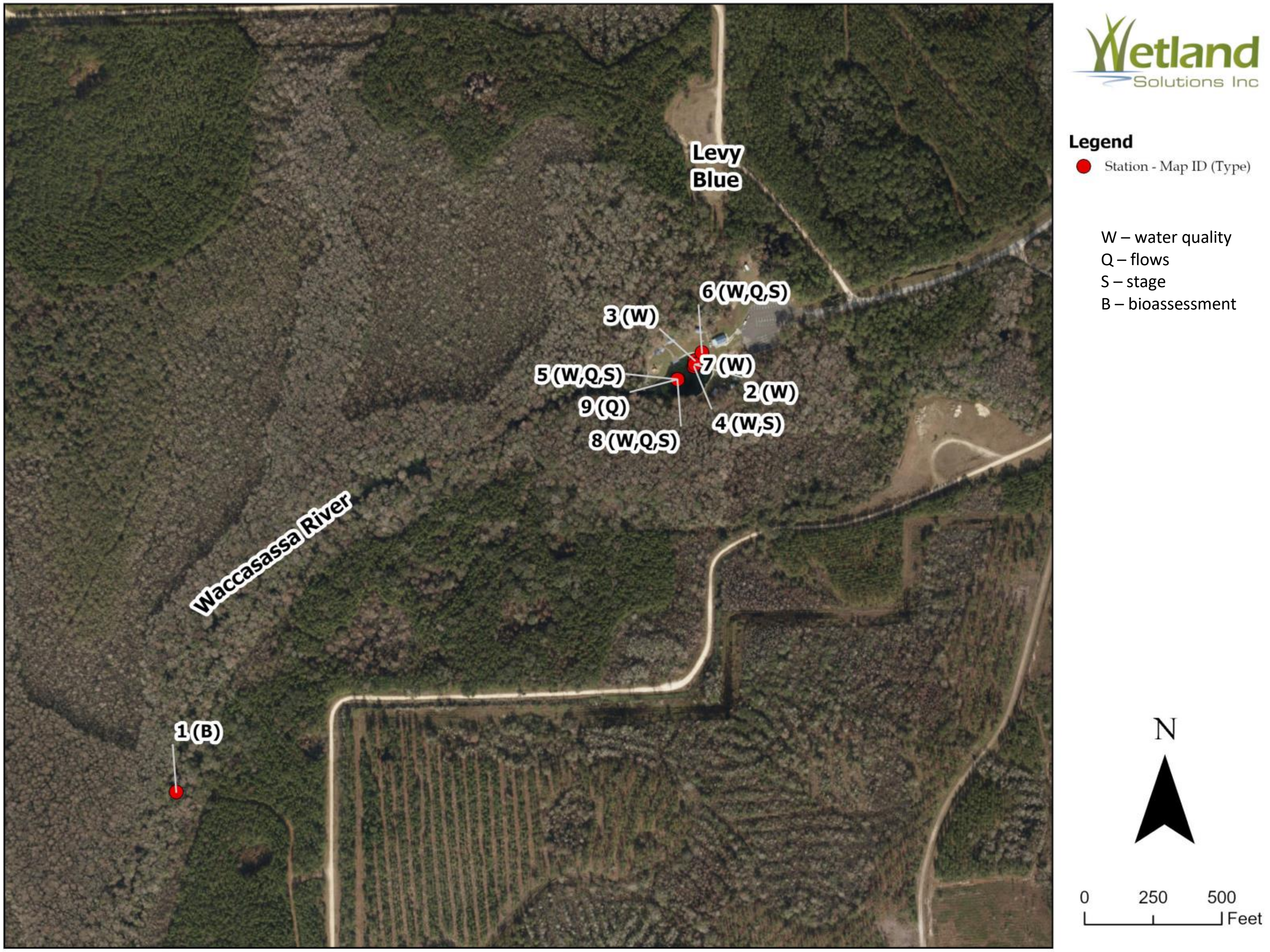


Figure B-17. Levy Blue Spring Station Locations

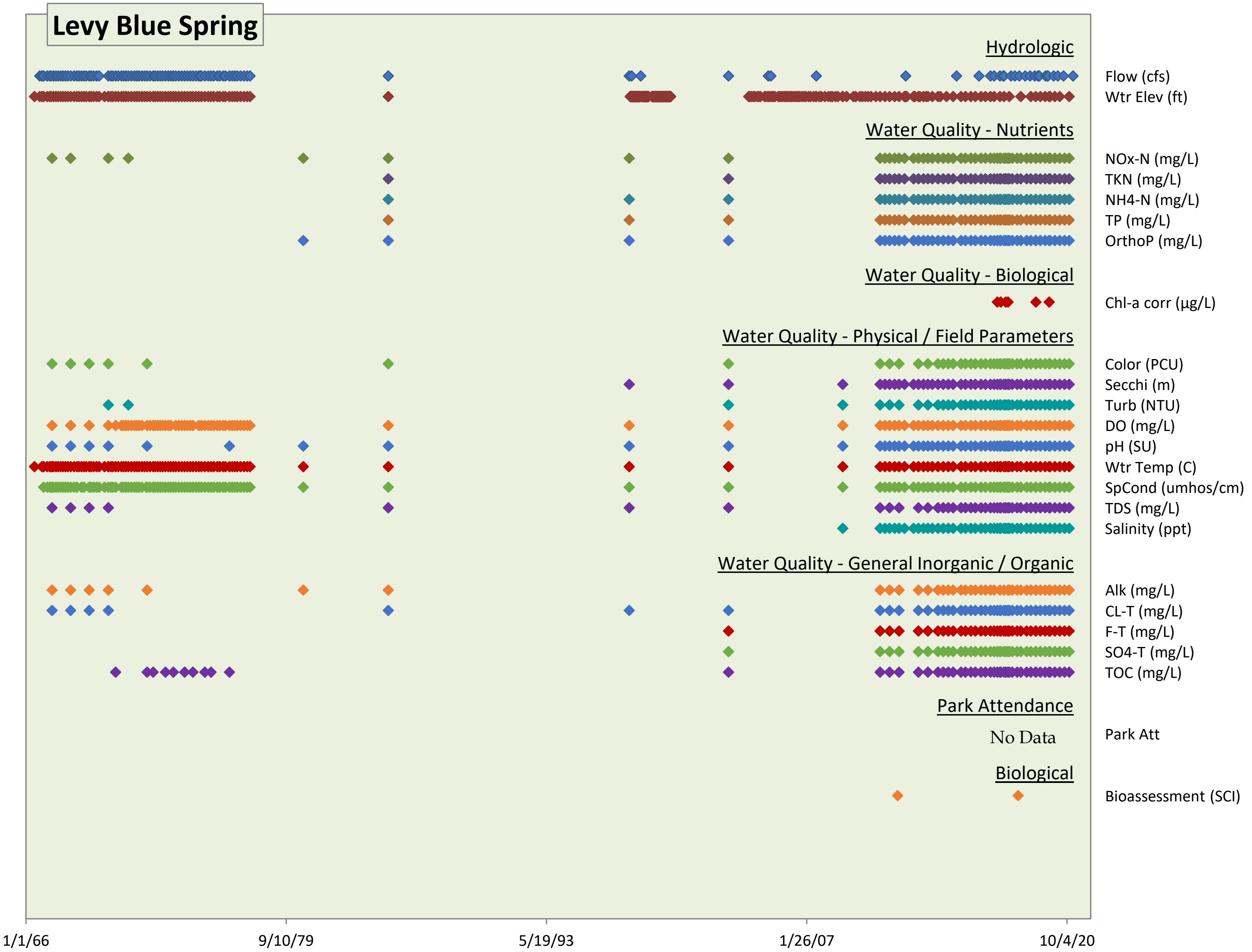


Figure B-18. Levy Blue Spring Temporal Data Availability Chart

Table B-27. Levy Blue Spring Database Inventory and Statistics

Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	3/1932	1/2021	115	---	8.77	0.00	5.43	6.50	8.17	10.3	14.5	22.3	
Wtr Elev (ft)	6/1966	11/2020	861	---	37.9	3.62	38.8	38.9	39.1	39.5	40.1	42.1	
Water Quality - Nutrients													
NOx-N (mg/L)	5/1967	11/2020	53	2%	0.668	0.136	0.323	0.470	0.650	0.800	1.15	1.31	
TKN (mg/L)	1/1985	11/2020	47	70%	0.113	0.00	0.036	0.043	0.059	0.087	0.250	1.34	
NH4-N (mg/L)	1/1985	11/2020	48	75%	0.017	-0.001	0.002	0.003	0.005	0.020	0.023	0.335	
TP (mg/L)	1/1985	11/2020	48	2%	0.036	0.020	0.025	0.032	0.034	0.036	0.040	0.140	
OrthoP (mg/L)	8/1980	11/2020	49	2%	0.029	0.003	0.022	0.024	0.029	0.031	0.036	0.120	
Water Quality - Biological													
Chl-a corr (µg/L)	2/2017	10/2019	6	83%	0.747	0.540	0.545	0.550	0.550	0.583	1.15	1.70	
Water Quality - Physical / Field Parameters													
Color (PCU)	5/1967	11/2020	46	74%	10.2	0.00	0.806	1.15	1.71	5.00	5.00	353	
Secchi (m)	9/1997	11/2020	48	67%	2.64	1.00	1.60	1.99	2.71	3.00	3.87	5.00	
Turb (NTU)	5/1970	11/2020	43	44%	0.450	0.015	0.203	0.250	0.320	0.431	0.670	4.00	
DO (mg/L)	5/1967	11/2020	98	0%	4.00	1.42	2.09	2.85	4.02	4.76	5.76	8.30	
pH (SU)	5/1967	11/2020	56	0%	7.75	6.04	7.49	7.64	7.84	7.94	8.10	8.27	
Wtr Temp (C)	6/1966	11/2020	131	0%	22.5	17.0	21.6	22.0	22.5	23.0	23.5	27.0	
SpCond (umhos/cm)	12/1966	11/2020	124	0%	202	40.0	170	176	191	234	244	363	
TDS (mg/L)	5/1967	11/2020	46	4%	269	2.00	104	122	128	135	144	6,700	
Salinity (ppt)	12/2008	11/2020	44	0%	0.110	0.100	0.100	0.110	0.110	0.110	0.120	0.140	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	5/1967	11/2020	43	2%	107	62.0	87.4	103	112	117	118	124	
CL-T (mg/L)	5/1967	11/2020	46	2%	5.24	2.56	3.91	4.43	5.05	6.38	6.72	7.85	
F-T (mg/L)	12/2002	11/2020	40	5%	0.077	0.012	0.063	0.066	0.071	0.083	0.101	0.150	
SO4-T (mg/L)	12/2002	11/2020	40	43%	2.35	0.920	1.19	1.30	2.05	2.84	3.72	6.57	
TOC (mg/L)	9/1970	11/2020	50	48%	1.70	-0.040	0.00	0.423	0.743	1.02	1.81	42.3	
Biological													
Bioassessment (SCI)	11/2011	3/2018	2	---	90.5	83.0	84.5	86.8	90.5	94.3	96.5	98.0	

Table B-28. Levy Blue Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	3/1932	1/2021	115	10.4%	5.2%	10.4%	7.8%	10.4%	5.2%	8.7%	5.2%	10.4%	7.8%	7.8%	10.4%	
Wtr Elev (ft)	6/1966	11/2020	861	8.9%	7.9%	9.5%	8.6%	5.8%	8.9%	8.6%	8.6%	9.4%	6.6%	8.8%	8.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	5/1967	11/2020	53	1.9%	9.4%	11.3%	5.7%	11.3%	9.4%	3.8%	9.4%	13.2%	3.8%	7.5%	13.2%	
TKN (mg/L)	1/1985	11/2020	47	2.1%	10.6%	12.8%	6.4%	4.3%	10.6%	4.3%	8.5%	12.8%	4.3%	8.5%	14.9%	
NH4-N (mg/L)	1/1985	11/2020	48	2.1%	10.4%	12.5%	6.3%	4.2%	10.4%	4.2%	8.3%	14.6%	4.2%	8.3%	14.6%	
TP (mg/L)	1/1985	11/2020	48	2.1%	10.4%	12.5%	6.3%	4.2%	10.4%	4.2%	8.3%	14.6%	4.2%	8.3%	14.6%	
OrthoP (mg/L)	8/1980	11/2020	49	2.0%	10.2%	12.2%	6.1%	4.1%	10.2%	4.1%	10.2%	14.3%	4.1%	8.2%	14.3%	
Water Quality - Biological																
Chl-a corr (µg/L)	2/2017	10/2019	6	0.0%	33.3%	0.0%	16.7%	0.0%	0.0%	16.7%	16.7%	0.0%	16.7%	0.0%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	5/1967	11/2020	46	2.2%	10.9%	6.5%	6.5%	15.2%	10.9%	4.3%	8.7%	6.5%	4.3%	8.7%	15.2%	
Secchi (m)	9/1997	11/2020	48	0.0%	10.4%	12.5%	6.3%	4.2%	10.4%	4.2%	8.3%	14.6%	4.2%	8.3%	16.7%	
Turb (NTU)	5/1970	11/2020	43	0.0%	11.6%	7.0%	7.0%	9.3%	11.6%	4.7%	9.3%	7.0%	4.7%	9.3%	18.6%	
DO (mg/L)	5/1967	11/2020	98	5.1%	9.2%	10.2%	5.1%	12.2%	7.1%	6.1%	8.2%	12.2%	5.1%	8.2%	11.2%	
pH (SU)	5/1967	11/2020	56	1.8%	8.9%	10.7%	5.4%	12.5%	8.9%	3.6%	8.9%	14.3%	3.6%	7.1%	14.3%	
Wtr Temp (C)	6/1966	11/2020	131	5.3%	8.4%	9.9%	4.6%	10.7%	8.4%	6.9%	7.6%	11.5%	5.3%	9.2%	12.2%	
SpCond (umhos/cm)	12/1966	11/2020	124	5.6%	8.9%	8.9%	4.8%	11.3%	8.1%	7.3%	8.1%	12.1%	4.8%	8.1%	12.1%	
TDS (mg/L)	5/1967	11/2020	46	2.2%	10.9%	6.5%	6.5%	13.0%	10.9%	4.3%	8.7%	8.7%	4.3%	8.7%	15.2%	
Salinity (ppt)	12/2008	11/2020	44	0.0%	9.1%	13.6%	6.8%	4.5%	11.4%	4.5%	9.1%	13.6%	2.3%	9.1%	15.9%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	5/1967	11/2020	43	2.3%	9.3%	7.0%	4.7%	16.3%	11.6%	2.3%	11.6%	7.0%	4.7%	9.3%	14.0%	
CL-T (mg/L)	5/1967	11/2020	46	2.2%	10.9%	6.5%	6.5%	13.0%	10.9%	4.3%	8.7%	8.7%	4.3%	8.7%	15.2%	
F-T (mg/L)	12/2002	11/2020	40	0.0%	12.5%	7.5%	7.5%	5.0%	12.5%	5.0%	10.0%	7.5%	5.0%	10.0%	17.5%	
SO4-T (mg/L)	12/2002	11/2020	40	0.0%	12.5%	7.5%	7.5%	5.0%	12.5%	5.0%	10.0%	7.5%	5.0%	10.0%	17.5%	
TOC (mg/L)	9/1970	11/2020	50	0.0%	10.0%	6.0%	6.0%	12.0%	10.0%	4.0%	8.0%	14.0%	8.0%	8.0%	14.0%	
Biological																
Bioassessment (SCI)	11/2011	3/2018	2	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	

Little Fanning Spring

Table B-29 provides a summary of monitoring station metadata for Little Fanning Spring with station locations identified in Figure B-19. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), and SRWMD. Water clarity data were also provided by the FDEP FPS. Fanning Springs State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-29. Little Fanning Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLFSI	SUW1-S9	29.58640	-82.93527	W	FDEP WIN
2	21FLGW	Little Fanning Spring	29.58583	-82.93444	W,S	FDEP FPS
3	21FLSUW	129340	29.58611	-82.93560	W,S	FDEP WIN
4	21FLSUW	2323505	29.58583	-82.93444	Q	SRWMD
5	21FLSUW	LFN010C1	29.58583	-82.93444	W,Q,S	SRWMD, STORET
6	USGS	2323505	29.58583	-82.93444	Q,S	USGS NWIS
7	USGS	293511082560700	29.58639	-82.93528	Q	USGS NWIS

[1] 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage;

A temporal data availability summary (Figure B-20), period of record statistics (Table B-30), and seasonal distribution summary (Table B-31) were developed from available data for Little Fanning Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Figure B-19. Little Fanning Spring Station Location

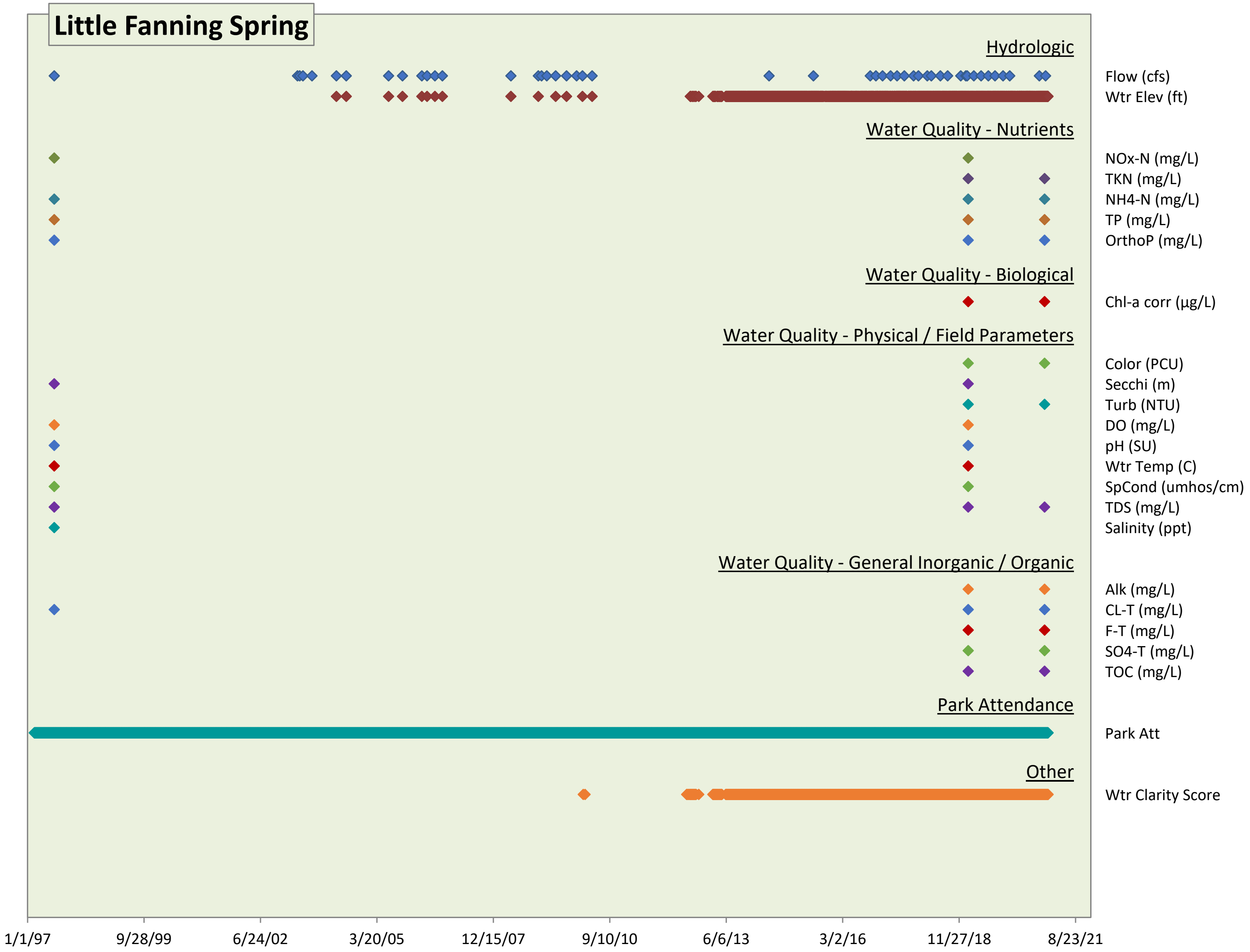


Figure B-20. Little Fanning Spring Temporal Data Availability Chart

Table B-30. Little Fanning Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	4/1972	12/2020	49	---	10.9	0.00	0.24	3.07	7.93	18.1	26.3	36.5	
Wtr Elev (ft)	4/2004	12/2020	2,547	---	12.5	0.72	11.2	11.6	12.1	12.7	14.7	17.1	
Water Quality - Nutrients													
NOx-N (mg/L)	8/1997	2/2019	2	0%	5.20	3.67	3.98	4.43	5.20	5.96	6.42	6.72	
TKN (mg/L)	2/2019	11/2020	2	0%	0.101	0.051	0.061	0.076	0.101	0.125	0.140	0.150	
NH4-N (mg/L)	8/1997	11/2020	3	100%	0.008	0.002	0.002	0.002	0.002	0.011	0.016	0.020	
TP (mg/L)	8/1997	11/2020	3	0%	0.071	0.068	0.069	0.070	0.072	0.073	0.074	0.075	
OrthoP (mg/L)	8/1997	11/2020	3	0%	0.050	0.036	0.038	0.040	0.045	0.056	0.063	0.068	
Water Quality - Biological													
Chl-a corr (µg/L)	2/2019	11/2020	2	100%	0.707	0.593	0.616	0.650	0.707	0.763	0.797	0.820	
Water Quality - Physical / Field Parameters													
Color (PCU)	2/2019	11/2020	2	50%	2.41	2.32	2.34	2.36	2.41	2.45	2.48	2.50	
Secchi (m)	8/1997	2/2019	2	50%	1.10	0.500	0.620	0.800	1.10	1.40	1.58	1.70	
Turb (NTU)	2/2019	11/2020	2	50%	0.147	0.100	0.109	0.123	0.147	0.170	0.184	0.193	
DO (mg/L)	8/1997	2/2019	2	0%	2.49	2.40	2.42	2.44	2.49	2.53	2.55	2.57	
pH (SU)	8/1997	2/2019	2	0%	7.02	6.90	6.92	6.96	7.02	7.07	7.11	7.13	
Wtr Temp (C)	8/1997	2/2019	2	0%	22.5	22.2	22.3	22.3	22.5	22.6	22.7	22.7	
SpCond (umhos/cm)	8/1997	2/2019	2	0%	482	424	435	453	482	512	529	541	
TDS (mg/L)	8/1997	11/2020	3	0%	298	284	286	288	292	306	314	319	
Salinity (ppt)	8/1997	8/1997	1	0%	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	2/2019	11/2020	2	0%	202	200	200	201	202	203	204	204	
CL-T (mg/L)	8/1997	11/2020	3	0%	12.1	8.90	9.72	11.0	13.0	13.6	14.0	14.3	
F-T (mg/L)	2/2019	11/2020	2	0%	0.100	0.097	0.098	0.098	0.100	0.101	0.102	0.102	
SO4-T (mg/L)	2/2019	11/2020	2	0%	32.0	31.0	31.2	31.5	32.0	32.5	32.8	33.0	
TOC (mg/L)	2/2019	11/2020	2	100%	0.645	0.500	0.529	0.573	0.645	0.718	0.761	0.790	
Park Attendance													
Park Att	3/1997	12/2020	8,707	---	650	0.00	101	323	514	802	1,217	17,125	
Other													
Wtr Clarity Score	1/2010	12/2020	2,729	---	1.11	1.00	1.00	1.00	1.00	1.00	1.00	5.00	

Table B-31. Little Fanning Spring Data Seasonal Distribution

Parameter	Period of Record		Count	Monthly Distribution												Chart
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hydrologic																
Flow (cfs)	4/1972	12/2020	49	8.2%	10.2%	2.0%	14.3%	8.2%	16.3%	2.0%	10.2%	4.1%	10.2%	4.1%	10.2%	
Wtr Elev (ft)	4/2004	12/2020	2,547	8.2%	7.7%	8.5%	7.3%	7.5%	8.4%	9.0%	8.9%	8.0%	8.6%	8.6%	9.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
TKN (mg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
NH4-N (mg/L)	8/1997	11/2020	3	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	
TP (mg/L)	8/1997	11/2020	3	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	
OrthoP (mg/L)	8/1997	11/2020	3	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	
Water Quality - Biological																
Chl-a corr (µg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
Secchi (m)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
Turb (NTU)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
DO (mg/L)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
pH (SU)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
Wtr Temp (C)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
SpCond (umhos/cm)	8/1997	2/2019	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	
TDS (mg/L)	8/1997	11/2020	3	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	
Salinity (ppt)	8/1997	8/1997	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
CL-T (mg/L)	8/1997	11/2020	3	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	
F-T (mg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
SO4-T (mg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
TOC (mg/L)	2/2019	11/2020	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
Park Attendance																
Park Att	3/1997	12/2020	8,707	8.2%	7.5%	8.5%	8.3%	8.5%	8.3%	8.5%	8.5%	8.3%	8.5%	8.3%	8.5%	
Other																
Wtr Clarity Score	1/2010	12/2020	2,729	7.8%	7.5%	8.4%	7.5%	7.3%	8.2%	8.9%	9.2%	8.8%	8.7%	8.6%	9.1%	

Madison Blue Spring

Table B-32 provides a summary of monitoring station metadata for Madison Blue Spring with station locations identified in Figure B-21. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Water clarity data were also provided by the FDEP FPS. Fish and vegetation data were available from WSI and Stetson University (Kirsten Work, unpublished data) while macroinvertebrate data were from Cardno. Community metabolism estimates were also available from WSI. Madison Blue Spring State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-32. Madison Blue Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLFSI	SUW1-S2	30.48054	-83.24434	W	FDEP WIN
2	21FLGW	9672	30.48044	-83.24436	W,Q	STORET
3	21FLGW	Spring Pool	30.48052	-83.24443	W,S	FDEP FPS
4	21FLGWMS	9672	30.48044	-83.24436	W,Q	STORET
5	21FLGWMS	BLM010C1	30.48028	-83.24444	W,Q,S	STORET
6	21FLGWMS	BLM010C1P	30.48048	-83.24460	W	STORET
7	21FLSUW	127851	30.48052	-83.24443	W,S	FDEP WIN
8	21FLSUW	2319302	30.48000	-83.24444	W,Q,S	SRWMD
9	21FLSUW	BLM010C1	30.48028	-83.24444	W,Q,S	SRWMD, STORET
10	Cardno	Spring Pool	30.48053	-83.24440	MI	Cardno, 2020
11	Cardno	Spring Run	30.48069	-83.24410	MI	Cardno, 2020
12	Stetson	Madison Blue	30.48040	-83.24440	V,F	Stetson
13	UF	Blue Spring (Madison)	30.48052	-83.24443	W	Strong, 2004
14	USGS	2319302	30.48028	-83.24444	W,Q,S	USGS NWIS
15	WSI	MBS-1	30.48048	-83.24443	W,S,P	WSI, 2010
16	WSI	MBS-2	30.48059	-83.24420	W,S,P	WSI, 2010
17	WSI	1	30.48055	-83.24439	V,F	WSI, 2010
18	WSI	2	30.48056	-83.24432	V,F	WSI, 2010
19	WSI	3	30.48058	-83.24424	V,F	WSI, 2010
20	WSI	4	30.4806	-83.24415	V,F	WSI, 2010
21	WSI	5	30.48065	-83.24408	V,F	WSI, 2010
22	WSI	6	30.48072	-83.24400	V,F	WSI, 2010
23	WSI	7	30.48075	-83.24390	V,F	WSI, 2010

[1] 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS – FDEP - Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey; WSI – Wetland Solutions, Inc.

[2] W – water quality; Q – flows; S – stage; V - vegetation; F – fish; MI – macroinvertebrates; P – primary productivity (metabolism)

A temporal data availability summary (Figure B-22), period of record statistics (Table B-33), and seasonal distribution summary (Table B-34) were developed from available data for Madison Blue Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Additional continuous *in-situ* water quality data are available from SRWMD Water Data Portal[27] for water temperature, specific conductance, dissolved oxygen, pH, and NOx-N from 7/9/2014 to 3/13/2021[28]. These data are not included in the SRWMD OFS database.

Cave fauna data may also be available from Kelly Jessup, Director of the North Florida Springs Alliance (https://northfloridaspringsalliance.org/).

---

[27] https://www.mysuwanneeriver.org/data/02319302/02319302_WQ_Cont.xlsx

[28] date website was accessed; visit above link for updated period of record

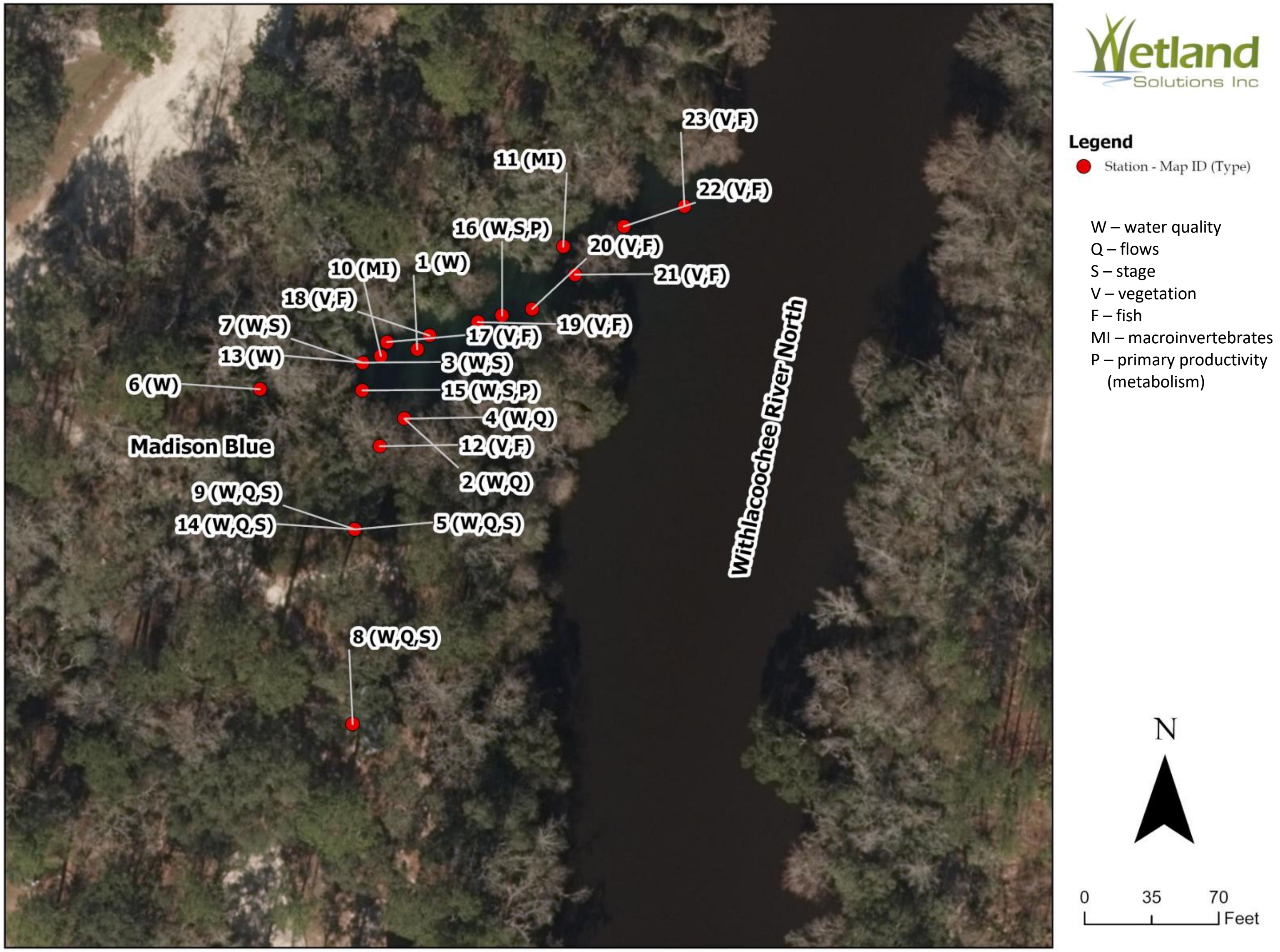


Figure B-21. Madison Blue Spring Station Location

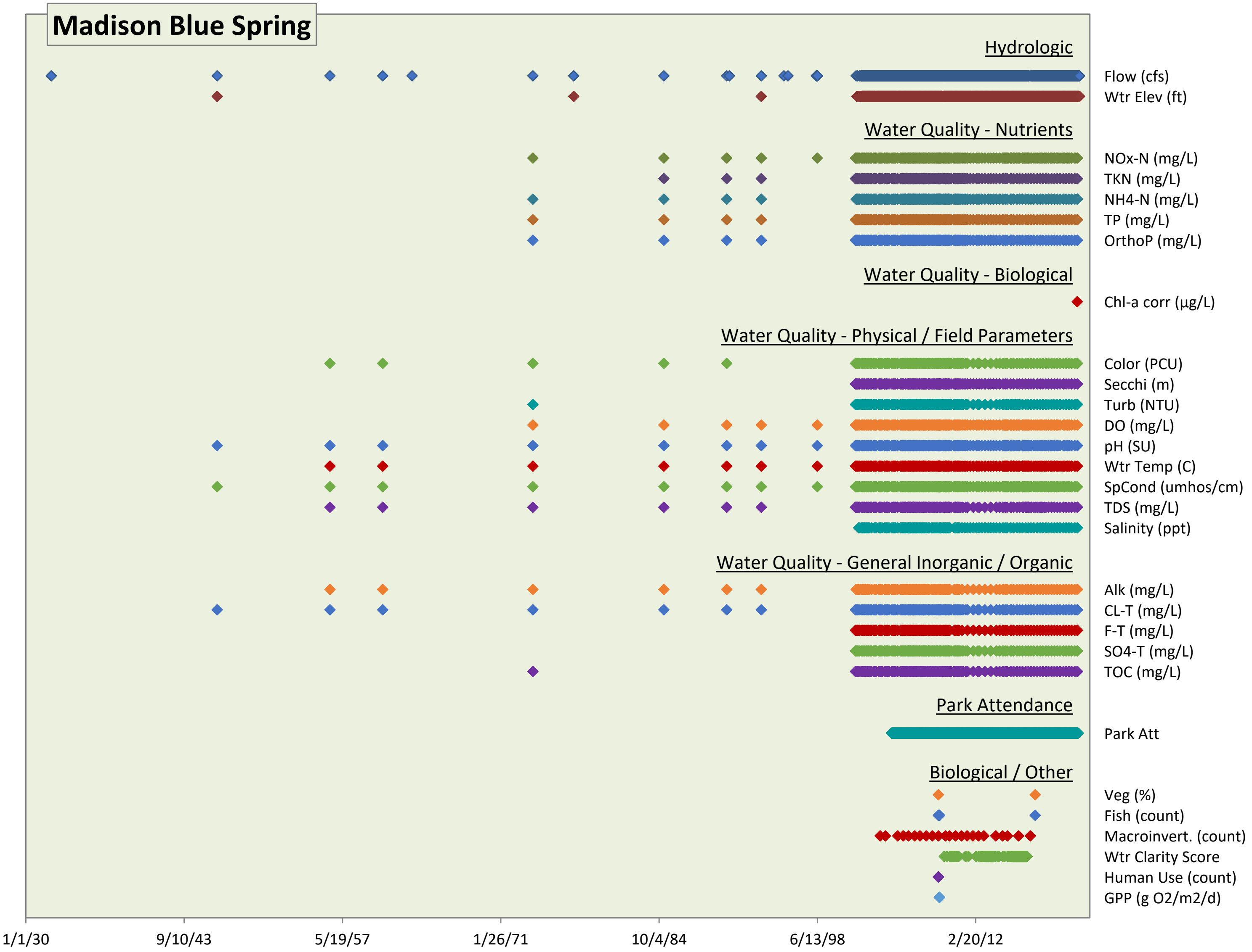


Figure B-22. Madison Blue Spring Temporal Data Availability Chart

Table B-33. Madison Blue Spring Database Inventory and Statistics

Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	3/1932	2/2021	6,603	---	98.9	-922	41.2	63.5	95.0	133	186	752	
Wtr Elev (ft)	7/1946	2/2021	6,825	---	16.1	1.89	7.87	8.62	11.5	24.6	27.1	50.3	
Water Quality - Nutrients													
NOx-N (mg/L)	11/1973	12/2020	205	0%	1.52	0.10	1.15	1.40	1.55	1.73	1.89	2.40	
TKN (mg/L)	3/1985	12/2020	165	56%	0.186	0.005	0.040	0.080	0.110	0.250	0.406	1.72	
NH4-N (mg/L)	11/1973	12/2020	165	84%	0.029	-0.009	0.004	0.010	0.020	0.040	0.095	0.233	
TP (mg/L)	11/1973	12/2020	166	1%	0.047	0.009	0.035	0.040	0.042	0.050	0.062	0.141	
OrthoP (mg/L)	11/1973	12/2020	166	0%	0.037	0.011	0.023	0.030	0.037	0.041	0.044	0.275	
Water Quality - Biological													
Chl-a corr (µg/L)	12/2020	12/2020	1	100%	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1956	12/2020	161	70%	9.82	0.00	2.00	5.00	5.00	5.00	10.0	180	
Secchi (m)	10/2001	12/2020	160	16%	5.58	0.450	1.00	2.50	7.00	7.80	8.41	18.60	
Turb (NTU)	11/1973	12/2020	166	29%	0.953	0.00	0.121	0.174	0.250	0.537	1.26	27.3	
DO (mg/L)	11/1973	12/2020	209	0%	2.07	0.800	1.20	1.54	1.83	2.15	2.62	9.61	
pH (SU)	7/1946	12/2020	212	0%	7.54	5.64	7.27	7.49	7.60	7.71	7.80	8.40	
Wtr Temp (C)	4/1956	12/2020	214	0%	20.8	11.6	20.4	20.8	20.9	21.1	21.3	45.6	
SpCond (umhos/cm)	7/1946	12/2020	215	0%	271	47.7	261	271	278	289	295	325	
TDS (mg/L)	4/1956	12/2020	171	1%	162	53.0	147	155	162	170	178	324	
Salinity (ppt)	1/2002	12/2020	127	0%	0.113	0.020	0.100	0.100	0.115	0.120	0.140	0.180	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1956	12/2020	129	0%	118	0.500	110	117	121	126	129	215	
CL-T (mg/L)	7/1946	12/2020	163	0%	5.84	2.50	4.70	5.20	5.70	6.22	7.29	13.0	
F-T (mg/L)	10/2001	12/2020	145	1%	0.153	0.033	0.110	0.140	0.152	0.170	0.200	0.272	
SO4-T (mg/L)	10/2001	12/2020	153	0%	14.0	4.44	11.3	12.0	13.0	14.6	17.1	83.6	
TOC (mg/L)	11/1973	12/2020	154	58%	1.68	-0.030	0.500	0.553	0.837	1.41	2.86	24.4	
Park Attendance													
Park Att	11/2004	12/2020	5,891	---	90.1	0.00	0.00	0.00	15.0	81.0	268	1,646	
Biological / Other													
Veg (%)	12/2008	4/2017	2	---	20.6	18.7	19.1	19.7	20.6	21.6	22.2	22.6	
Fish (count)	12/2008	4/2017	2	---	665	573	591	619	665	711	739	757	
Macroinvert. (count)	11/2003	11/2016	23	---	580	173	296	449	615	652	728	1,446	
Wtr Clarity Score	6/2009	7/2016	737	---	2.15	1.00	1.00	1.00	1.00	4.00	5.00	5.00	
Human Use (count)	12/2008	12/2008	2	---	41.0	8.00	14.6	24.5	41.0	57.5	67.4	74.0	
GPP (g O2/m2/d)	1/2009	1/2009	4	---	2.82	1.47	1.93	2.62	3.13	3.32	3.46	3.55	

Table B-34. Madison Blue Spring Data Seasonal Distribution

Parameter	Period of Record		Count	Monthly Distribution												Chart
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hydrologic																
Flow (cfs)	3/1932	2/2021	6,603	8.8%	7.5%	7.7%	7.6%	8.8%	8.5%	8.8%	9.0%	8.3%	8.3%	8.2%	8.5%	
Wtr Elev (ft)	7/1946	2/2021	6,825	8.6%	7.6%	8.2%	7.8%	8.5%	8.1%	8.6%	8.6%	8.4%	8.5%	8.4%	8.6%	
Water Quality - Nutrients																
NOx-N (mg/L)	11/1973	12/2020	205	6.8%	5.4%	9.3%	7.8%	5.9%	11.2%	8.8%	7.8%	9.8%	9.8%	6.8%	10.7%	
TKN (mg/L)	3/1985	12/2020	165	8.5%	4.2%	9.7%	7.3%	6.1%	10.9%	9.1%	6.7%	10.3%	9.1%	6.1%	12.1%	
NH4-N (mg/L)	11/1973	12/2020	165	8.5%	4.2%	9.7%	7.3%	6.1%	10.9%	9.1%	6.7%	10.3%	8.5%	6.7%	12.1%	
TP (mg/L)	11/1973	12/2020	166	8.4%	4.2%	9.6%	7.2%	6.0%	10.8%	9.0%	6.6%	10.2%	9.0%	6.6%	12.0%	
OrthoP (mg/L)	11/1973	12/2020	166	8.4%	4.2%	9.6%	7.2%	6.0%	10.8%	9.0%	6.6%	10.2%	9.0%	6.6%	12.0%	
Water Quality - Biological																
Chl-a corr (µg/L)	12/2020	12/2020	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1956	12/2020	161	8.7%	4.3%	8.1%	8.1%	6.2%	11.2%	9.3%	6.2%	8.7%	9.3%	7.5%	12.4%	
Secchi (m)	10/2001	12/2020	160	8.8%	4.4%	8.8%	7.5%	5.6%	10.6%	8.8%	6.3%	10.6%	9.4%	6.9%	12.5%	
Turb (NTU)	11/1973	12/2020	166	8.4%	4.8%	7.8%	7.2%	6.6%	10.8%	9.6%	5.4%	9.0%	9.0%	8.4%	12.7%	
DO (mg/L)	11/1973	12/2020	209	7.2%	5.3%	9.1%	7.7%	5.7%	11.0%	8.6%	7.7%	10.0%	9.1%	7.2%	11.5%	
pH (SU)	7/1946	12/2020	212	7.1%	5.2%	9.0%	8.0%	5.7%	10.8%	9.0%	7.5%	9.9%	9.0%	7.5%	11.3%	
Wtr Temp (C)	4/1956	12/2020	214	7.0%	5.1%	8.9%	7.9%	5.6%	11.2%	8.4%	7.9%	9.8%	9.3%	7.5%	11.2%	
SpCond (umhos/cm)	7/1946	12/2020	215	7.0%	5.1%	8.8%	7.9%	5.6%	11.2%	8.8%	7.9%	9.8%	9.3%	7.4%	11.2%	
TDS (mg/L)	4/1956	12/2020	171	7.6%	4.7%	7.6%	8.8%	5.8%	11.7%	9.4%	7.6%	8.8%	9.4%	7.6%	11.1%	
Salinity (ppt)	1/2002	12/2020	127	5.5%	5.5%	11.0%	3.9%	7.1%	13.4%	7.1%	6.3%	13.4%	5.5%	7.9%	13.4%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1956	12/2020	129	5.4%	5.4%	9.3%	4.7%	7.0%	13.2%	7.0%	7.8%	10.9%	6.2%	9.3%	14.0%	
CL-T (mg/L)	7/1946	12/2020	163	8.6%	4.3%	8.0%	8.0%	6.1%	11.0%	9.8%	6.7%	8.6%	9.2%	7.4%	12.3%	
F-T (mg/L)	10/2001	12/2020	145	7.6%	4.8%	8.3%	6.9%	6.2%	12.4%	9.7%	6.2%	9.7%	9.0%	6.9%	12.4%	
SO4-T (mg/L)	10/2001	12/2020	153	8.5%	4.6%	7.8%	7.8%	6.5%	11.8%	9.8%	5.9%	9.2%	9.8%	6.5%	11.8%	
TOC (mg/L)	11/1973	12/2020	154	8.4%	4.5%	7.8%	7.8%	6.5%	11.7%	9.7%	5.8%	9.1%	9.7%	7.1%	11.7%	
Park Attendance																
Park Att	11/2004	12/2020	5,891	8.4%	7.7%	8.4%	8.1%	8.4%	8.1%	8.4%	8.4%	8.1%	8.4%	8.4%	8.9%	
Biological / Other																
Veg (%)	12/2008	4/2017	2	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
Fish (count)	12/2008	4/2017	2	100.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
Macroinvert. (count)	11/2003	11/2016	23	0.0%	0.0%	0.0%	0.0%	34.8%	4.3%	4.3%	0.0%	0.0%	0.0%	52.2%	4.3%	
Wtr Clarity Score	6/2009	7/2016	737	7.3%	7.9%	7.5%	8.4%	9.2%	12.2%	14.0%	9.5%	6.0%	4.3%	4.9%	8.8%	
Human Use (count)	12/2008	12/2008	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
GPP (g O2/m2/d)	1/2009	1/2009	4	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

Manatee Spring

Table B-35 provides a summary of monitoring station metadata for Manatee Springs with station locations identified in Figure B-23. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Water clarity data and manatee count observations were provided by the FDEP FPS. Fish data were available from Stetson University (Kirsten Work, unpublished data), USGS, and WSI with vegetation data from Stetson University, WSI, and AMEC. Macroinvertebrate data were also available from USGS and AMEC. Community metabolism estimates were provided by WSI and bioassessment data from FDEP. Manatee Springs State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-35. Manatee Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLBRA	3422R-A	29.48957	-82.97674	W	STORET
2	21FLBRA	MANATEEBRA	29.48910	-82.97904	B	FDEP
3	21FLFSI	SUW1-S10	29.48945	-82.97723	W	FDEP WIN
4	21FLGW	9683	29.48950	-82.97687	W	STORET
5	21FLGW	Manatee Spring	29.48961	-82.97674	W,S,M	FDEP FPS
6	21FLGWMS	MAN010C1P	29.48924	-82.97705	W	STORET
7	21FLSUW	127860	29.48953	-82.97684	W	FDEP WIN
8	21FLSUW	2323566	29.48944	-82.97694	Q	SRWMD
9	21FLSUW	MAN010C1	29.48917	-82.97694	W,Q	SRWMD, STORET
10	AMEC	MAN 1	29.489480	-82.977980	V,MI	AMEC, 2016
11	Stetson	Manatee	29.48950	-82.97690	V,F	Stetson
12	UF	Manatee Spring	29.48961	-82.97674	W	Strong, 2004
13	USGS	2323566	29.48944	-82.97694	W,Q	USGS NWIS
14	USGS	Manatee	29.48944	-82.98056	F,MI	Walsh & Williams, 2003
15	WSI	MS-1	29.48961	-82.97674	W,S,P	WSI, 2010
16	WSI	1	29.48915	-82.98016	V,F	WSI, 2010
17	WSI	2	29.48908	-82.97982	V,F	WSI, 2010
18	WSI	3	29.48914	-82.97954	V,F	WSI, 2010
19	WSI	4	29.48914	-82.97934	V,F	WSI, 2010
20	WSI	5	29.48905	-82.97916	V,F	WSI, 2010
21	WSI	6	29.48914	-82.97898	V,F	WSI, 2010
22	WSI	7	29.48917	-82.97837	V,F	WSI, 2010
23	WSI	8	29.48934	-82.97793	V,F	WSI, 2010
24	WSI	9	29.48937	-82.97754	V,F	WSI, 2010
25	WSI	10	29.48949	-82.9773	V,F	WSI, 2010
26	WSI	11	29.48962	-82.97714	V,F	WSI, 2010

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
27	WSI	12	29.48942	-82.97697	V,F	WSI, 2010

[1] 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS - FDEP - Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; AMEC – Amec Foster Wheeler Environment & Infrastructure, Inc.; Stetson - Stetson University; USGS – UF - University of Florida; U.S. Geological Survey; WSI – Wetland Solutions, Inc.
[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish; M – manatees; MI – macroinvertebrates; B – bioassessment; P – primary productivity (metabolism)

A temporal data availability summary (Figure B-24), period of record statistics (Table B-36), and seasonal distribution summary (Table B-37) were developed from available data for Manatee Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Water clarity observations by the FDEP FPS are collected using a semi-quantitative scoring method as described above for the following zones. Manatee counts are also recorded when observed within each zone.

- Zone 1 - spring boil to swim area overlook
- Zone 2 - swim area over look to point near canoe launch
- Zone 3 - point near canoe launch to 1st overlook
- Zone 4 - area between the 1st and 2nd overlook
- Zone 5 – 2nd overlook to mouth of run
- Zone 6 - mouth of run to river pavilion
- Zone 6A - pavilion to end floating dock

Additional continuous *in-situ* water quality data are available from USGS NWIS[29] for water temperature, specific conductance, dissolved oxygen, pH, and NOx-N from 7/2/2014 to 2/10/2021[30]. These data are not included in the SRWMD OFS database.

Turtle populations have been monitored three times per year within Manatee Spring since 2010 by the Turtle Survival Alliance (TSA). The number of individuals per species that have been marked to date include the following (Eric Munscher, personal communication). A manuscript with these data is currently in peer review, following acceptance detailed data will become available.

- River cooter (*Pseudemys concinna*)– 362
- Peninsular cooter (*Pseudems floridana peninsularis*) - 71
- Florida red-bellied cooter (*Pseudemys nelsoni*) – 7
- Yellow-bellied slider (*Trachemys scripta scripta*) – 117
- Florida Chicken Turtle (*Dierochelys reticularia chrysea*) – 1

---

[29] https:// waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02323566
[30] date website was accessed; visit above link for updated period of record

- Loggerhead musk turtle (*Sternotherus minor*) – 488
- Common musk turtle (*Sternotherus odortatus*) – 11
- Common snapping turtle (*Chelydra serpentina*) – 9
- Florida softshell turtle (*Apalone ferox*) – 5
- Striped Mud Turtle (*Kinosternon baurii*) - 13
- Alligator snapping turtle (*Macrochelys temminckii*) – 1

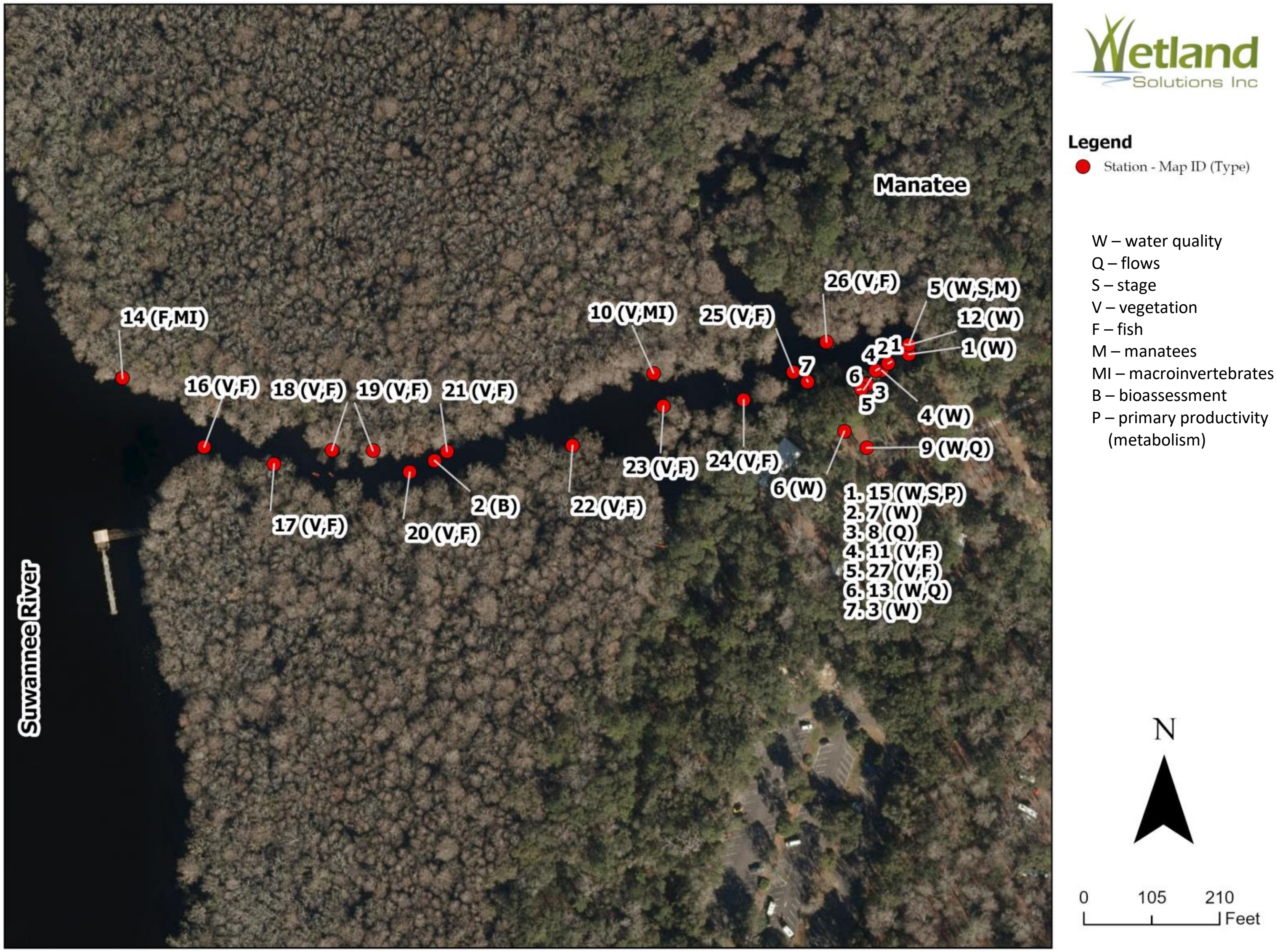


Figure B-23. Manatee Spring Station Locations

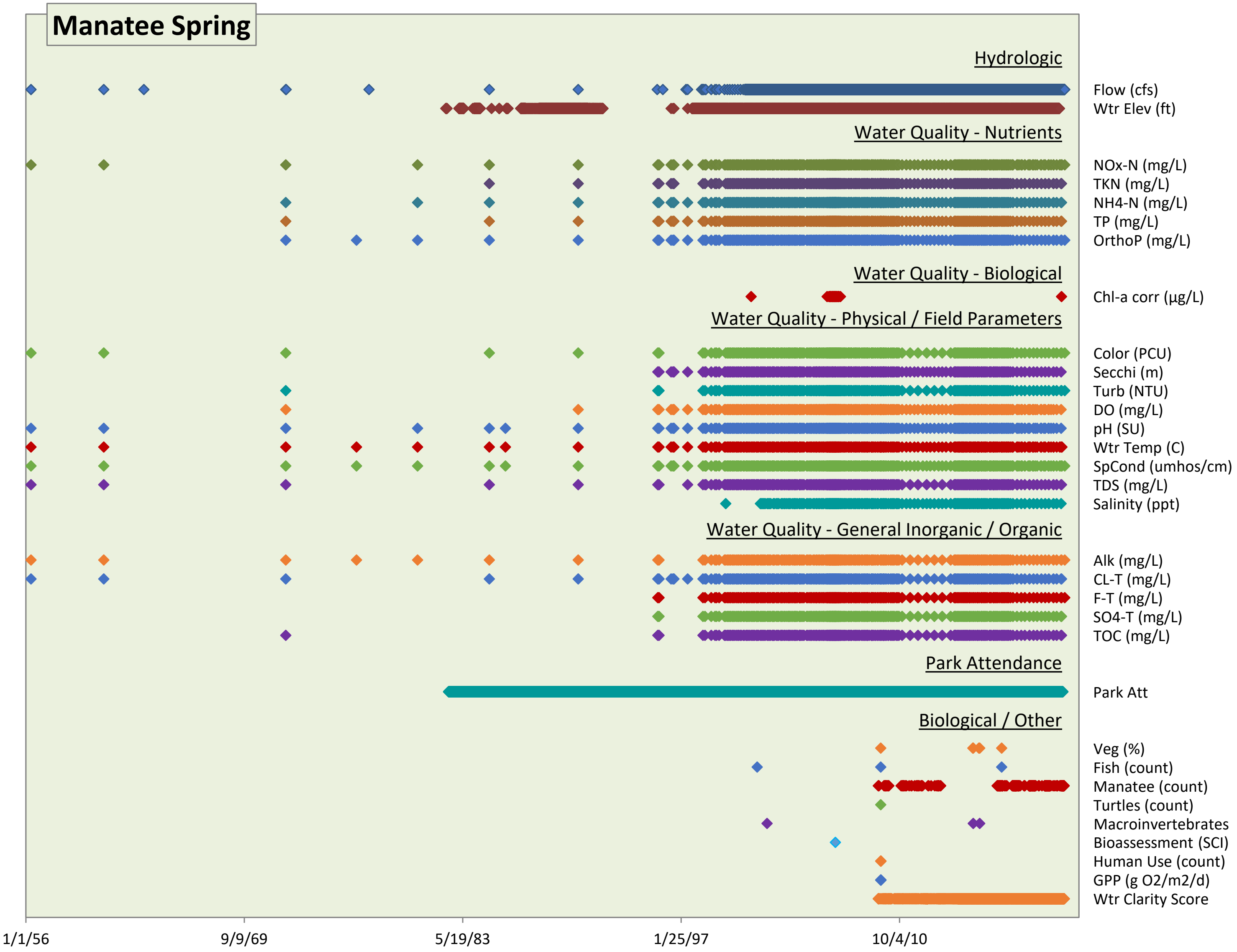


Figure B-24. Manatee Spring Temporal Data Availability Chart

Table B-36. Manatee Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	3/1932	2/2021	7,350	---	150	2.01	94.6	113	150	173	206	546	
Wtr Elev (ft)	4/1982	10/2020	9,991	---	2.72	-0.72	1.00	1.48	2.12	3.14	5.44	82.7	
Water Quality - Nutrients													
NOx-N (mg/L)	7/1946	2/2021	303	0%	2.02	0.00	1.48	1.68	1.90	2.19	2.48	18.0	
TKN (mg/L)	1/1985	11/2020	263	53%	0.188	-0.028	0.042	0.066	0.085	0.160	0.258	14.6	
NH4-N (mg/L)	4/1972	11/2020	270	88%	0.025	-0.003	0.002	0.009	0.020	0.030	0.070	0.270	
TP (mg/L)	4/1972	11/2020	266	2%	0.031	0.009	0.021	0.024	0.029	0.035	0.049	0.124	
OrthoP (mg/L)	4/1972	2/2021	249	1%	0.021	0.004	0.012	0.016	0.021	0.024	0.030	0.083	
Water Quality - Biological													
Chl-a corr (µg/L)	6/2001	11/2020	25	88%	0.996	0.700	1.00	1.00	1.00	1.00	1.06	1.10	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1956	2/2021	258	84%	5.32	0.00	1.01	5.00	5.00	5.00	5.00	231	
Secchi (m)	8/1995	11/2020	238	21%	3.46	0.600	0.985	1.30	2.00	5.81	8.00	15.0	
Turb (NTU)	4/1972	2/2021	260	20%	0.404	0.00	0.133	0.200	0.250	0.390	0.641	15.4	
DO (mg/L)	4/1972	11/2020	300	0%	1.72	0.500	1.17	1.34	1.60	1.85	2.24	8.22	
pH (SU)	7/1946	11/2020	305	0%	7.24	6.20	7.05	7.14	7.24	7.33	7.43	8.14	
Wtr Temp (C)	4/1956	12/2020	310	0%	22.4	14.8	22.0	22.2	22.3	22.5	22.6	47.9	
SpCond (umhos/cm)	7/1946	2/2021	312	0%	478	199	451	465	479	499	515	537	
TDS (mg/L)	4/1956	11/2020	264	1%	278	0.00	251	268	279	294	306	370	
Salinity (ppt)	11/1999	11/2020	194	0%	0.222	0.100	0.200	0.200	0.220	0.240	0.250	0.280	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1956	2/2021	232	0%	203	81.1	190	197	204	212	217	225	
CL-T (mg/L)	7/1946	11/2020	266	0%	8.63	1.00	7.28	8.00	8.70	9.28	10.3	14.0	
F-T (mg/L)	8/1995	2/2021	250	5%	0.104	0.010	0.063	0.090	0.100	0.120	0.150	0.390	
SO4-T (mg/L)	8/1995	11/2020	251	0%	34.8	0.00	29.0	31.7	34.7	38.1	41.8	52.4	
TOC (mg/L)	4/1972	11/2020	252	43%	2.38	0.00	0.500	0.630	1.00	1.68	6.11	43.5	
Park Attendance													
Park Att	7/1982	12/2020	14,064	---	495	0.00	133	222	407	668	986	5,149	
Biological / Other													
Veg (%)	8/2009	3/2017	6	---	51.7	14.8	14.9	23.7	58.9	70.4	81.4	91.6	
Fish (count)	11/2001	3/2017	2	---	4,129	482	1,211	2,305	4,129	5,952	7,046	7,775	
Manatee (count)	6/2009	12/2109	470	---	6.48	1.00	1.00	2.25	5.00	8.00	14.0	47.0	
Turtles (count)	8/2009	8/2009	1	---	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	
Macroinvertebrates	6/2002	10/2015	3	---	92.3	19.0	22.1	26.8	34.7	129	186	223	
Bioassessment (SCI)	9/2006	9/2006	1	---	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	
Human Use (count)	8/2009	8/2009	4	---	336	245	259	280	312	368	434	477	
GPP (g O2/m2/d)	8/2009	8/2009	4	---	21.3	17.8	18.7	20.1	22.1	23.3	23.3	23.3	
Wtr Clarity Score	6/2009	12/2109	2,757	---	1.28	1.00	1.00	1.00	1.00	1.00	2.33	5.00	

Table B-37. Manatee Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	3/1932	2/2021	7,350	8.5%	7.8%	8.5%	8.2%	8.5%	8.3%	8.5%	8.5%	8.1%	8.5%	8.2%	8.5%	
Wtr Elev (ft)	4/1982	10/2020	9,991	8.2%	8.2%	9.4%	8.7%	8.8%	8.3%	8.2%	8.1%	7.9%	8.2%	7.9%	8.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	7/1946	2/2021	303	7.6%	7.3%	7.6%	8.3%	6.9%	8.9%	10.2%	10.9%	7.9%	9.9%	6.3%	8.3%	
TKN (mg/L)	1/1985	11/2020	263	8.7%	6.1%	8.0%	7.6%	8.0%	8.7%	9.9%	9.9%	8.4%	9.1%	7.2%	8.4%	
NH4-N (mg/L)	4/1972	11/2020	270	8.5%	5.9%	7.8%	7.8%	7.8%	8.9%	10.4%	10.0%	8.1%	9.6%	7.0%	8.1%	
TP (mg/L)	4/1972	11/2020	266	8.6%	6.0%	7.9%	7.9%	7.9%	9.0%	9.8%	9.8%	8.3%	9.4%	7.1%	8.3%	
OrthoP (mg/L)	4/1972	2/2021	249	8.8%	6.8%	8.0%	8.4%	7.2%	8.8%	10.0%	9.6%	8.0%	9.2%	7.2%	7.6%	
Water Quality - Biological																
Chl-a corr (µg/L)	6/2001	11/2020	25	4.0%	0.0%	4.0%	0.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	8.0%	12.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1956	2/2021	258	8.9%	6.6%	7.0%	8.5%	8.1%	8.5%	9.7%	9.7%	7.4%	9.3%	7.8%	8.5%	
Secchi (m)	8/1995	11/2020	238	8.8%	6.7%	8.4%	8.0%	7.6%	9.2%	10.1%	8.8%	8.0%	9.2%	7.1%	8.0%	
Turb (NTU)	4/1972	2/2021	260	8.5%	6.9%	7.3%	8.1%	8.1%	8.5%	10.0%	9.2%	7.7%	9.6%	7.3%	8.8%	
DO (mg/L)	4/1972	11/2020	300	7.3%	7.0%	7.7%	8.0%	7.0%	9.3%	9.7%	11.7%	8.3%	9.7%	6.3%	8.0%	
pH (SU)	7/1946	11/2020	305	7.9%	6.6%	7.5%	8.2%	6.9%	9.2%	10.2%	11.5%	8.2%	9.8%	6.6%	7.5%	
Wtr Temp (C)	4/1956	12/2020	310	7.7%	6.8%	7.4%	8.1%	6.8%	9.4%	9.7%	11.3%	8.4%	10.0%	6.5%	8.1%	
SpCond (umhos/cm)	7/1946	2/2021	312	7.7%	7.1%	7.4%	8.0%	6.7%	9.3%	9.9%	11.2%	8.3%	9.9%	6.4%	8.0%	
TDS (mg/L)	4/1956	11/2020	264	8.7%	6.4%	6.8%	8.3%	8.0%	8.7%	9.8%	9.8%	7.2%	10.2%	7.6%	8.3%	
Salinity (ppt)	11/1999	11/2020	194	6.7%	7.2%	9.3%	5.7%	9.8%	9.3%	8.2%	9.8%	9.8%	6.7%	8.2%	9.3%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1956	2/2021	232	6.9%	7.3%	7.8%	6.9%	9.1%	9.5%	8.6%	9.9%	8.6%	7.3%	8.6%	9.5%	
CL-T (mg/L)	7/1946	11/2020	266	8.6%	6.0%	6.8%	8.3%	7.9%	9.0%	10.5%	10.2%	7.1%	9.8%	7.5%	8.3%	
F-T (mg/L)	8/1995	2/2021	250	8.4%	6.8%	7.2%	8.0%	8.4%	8.8%	10.0%	8.8%	7.6%	9.6%	7.6%	8.8%	
SO4-T (mg/L)	8/1995	11/2020	251	8.8%	6.4%	7.2%	8.0%	8.4%	8.8%	10.0%	8.8%	7.6%	10.0%	7.6%	8.8%	
TOC (mg/L)	4/1972	11/2020	252	8.7%	6.3%	7.1%	8.3%	8.3%	8.7%	9.9%	8.7%	7.5%	9.9%	7.5%	8.7%	
Park Attendance																
Park Att	7/1982	12/2020	14,064	8.4%	7.6%	8.4%	8.1%	8.4%	8.1%	8.6%	8.6%	8.3%	8.6%	8.3%	8.6%	
Biological / Other																
Veg (%)	8/2009	3/2017	6	0.0%	0.0%	16.7%	0.0%	33.3%	0.0%	0.0%	16.7%	16.7%	16.7%	0.0%	0.0%	
Fish (count)	11/2001	3/2017	2	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	50.0%	0.0%	
Manatee (count)	6/2009	12/2109	470	21.7%	12.8%	14.7%	2.3%	1.7%	1.7%	1.1%	2.1%	0.9%	1.5%	14.9%	24.7%	
Turtles (count)	8/2009	8/2009	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	
Macroinvertebrates	6/2002	10/2015	3	0.0%	0.0%	0.0%	0.0%	33.3%	33.3%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	
Bioassessment (SCI)	9/2006	9/2006	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	
Human Use (count)	8/2009	8/2009	4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	
GPP (g O2/m2/d)	8/2009	8/2009	4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	
Wtr Clarity Score	6/2009	12/2109	2,757	8.5%	7.1%	7.9%	7.8%	8.1%	9.1%	9.1%	8.6%	8.0%	8.7%	8.3%	8.7%	

Peacock Springs

Table B-38 provides a summary of monitoring station metadata for Peacock Springs with station locations identified in Figure B-25. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Water clarity data were provided by the FDEP FPS and fish data from USGS and Stetson University (Kirsten Work, unpublished data). Vegetation data were also supplied from Stetson University. Wes Skiles Peacock Springs State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-38. Peacock Springs Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLFSI	SUW1-S4	30.12283	-83.13303	W	FDEP WIN
2	21FLGW	Peacock Springs #1	30.12297	-83.13319	W,S	FDEP FPS
3	21FLGW	Peacock Springs #3	30.12213	-83.13223	W,S	FDEP FPS
4	21FLSUW	127840	30.12297	-83.13319	W,S	FDEP WIN
5	21FLSUW	2320048	30.12306	-83.13333	Q,S	SRWMD
6	21FLSUW	PEA010C1	30.12222	-83.13250	W,Q,S	SRWMD, STORET
7	Stetson	Peacock	30.12330	-83.13310	V,F	Stetson
8	UF	Peacock Spring	30.12297	-83.13319	W	Strong, 2004
9	USGS	300718083075701	30.12167	-83.13250	W,Q,S	USGS NWIS
10	USGS	23200048	30.12306	-83.13333	Q	USGS NWIS
11	USGS	Peacock	30.12255	-83.13233	F	Walsh & Williams, 2003

[1] 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V - vegetation; F - fish

A temporal data availability summary (Figure B-26), period of record statistics (Table B-39), and seasonal distribution summary (Table B-40) were developed from available data for Peacock Springs.

Additional continuous *in-situ* water quality data are available for the Peacock Springs from the SRWMD Water Data Portal[31] beginning on 12/10/2013 for specific conductance and 4/22/2015 for water temperature, dissolved oxygen, pH, NOx-N, turbidity, and fDOM beginning on 6/18/15. All parameters continue through 3/13/2021[32]. These data are not included in the SRWMD OFS database.

Turtle populations have been monitored within Peacock Springs since 2010 by the Turtle Survival Alliance (TSA). The number of individuals per species that have been marked to date include the following (Eric Munscher, personal communication). A manuscript with these data is currently in peer review, following acceptance detailed data will become available.

---

[31] http:// www.mysuwanneeriver.org/data/02320048/02320048_WQ_Cont.xlsx

[32] date website was accessed; visit above link for updated period of record

- River cooter (*Pseudemys concinna*)– 51
- Yellow-bellied slider (*Trachemys scripta scripta*) – 60
- Loggerhead musk turtle (*Sternotherus minor*) – 5
- Common snapping turtle (*Chelydra serpentina*) – 4

Cave fauna data may also be available from Kelly Jessup, Director of the North Florida Springs Alliance (https://northfloridaspringsalliance.org/).

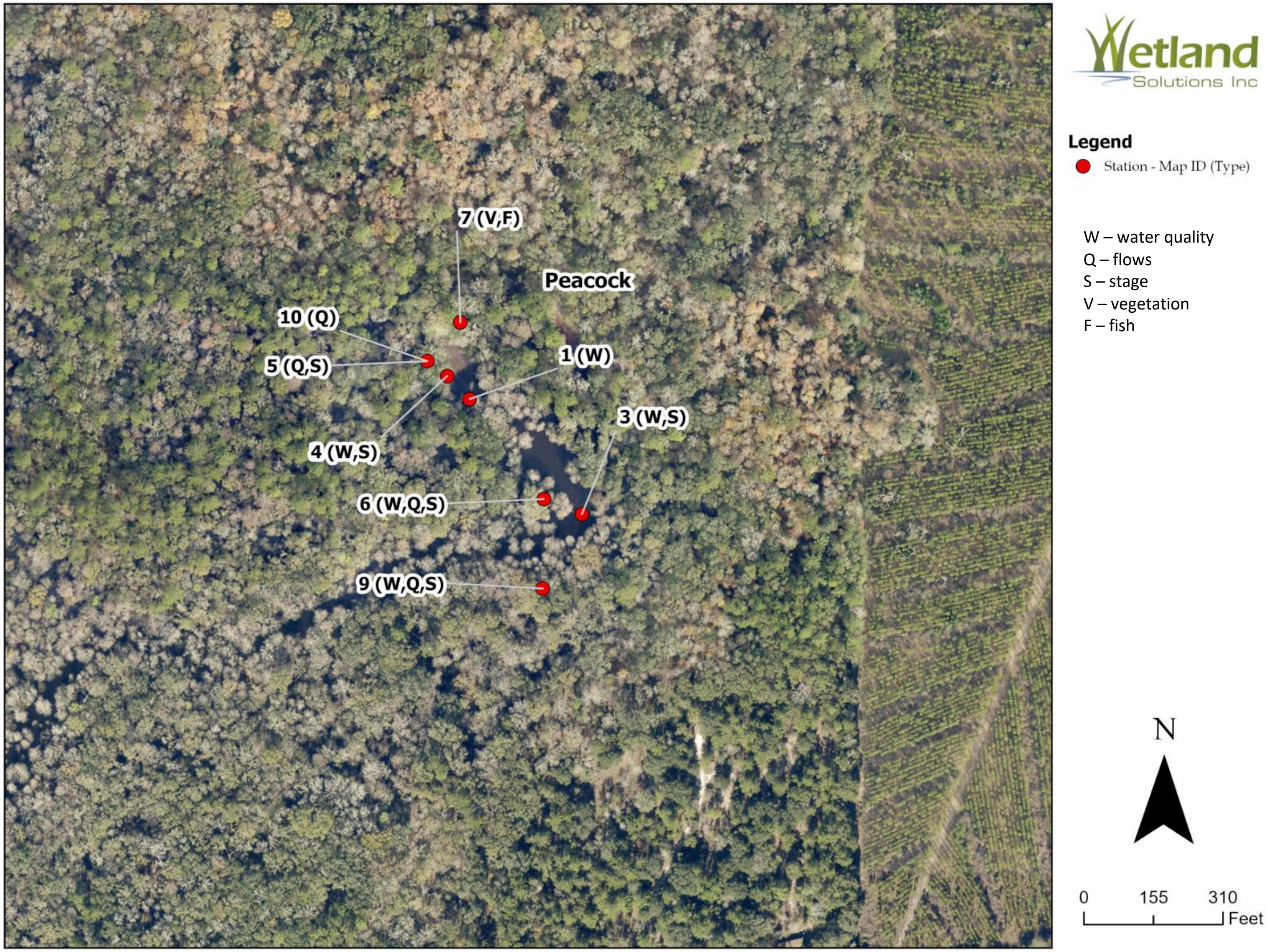


Figure B-25. Peacock Springs Station Locations

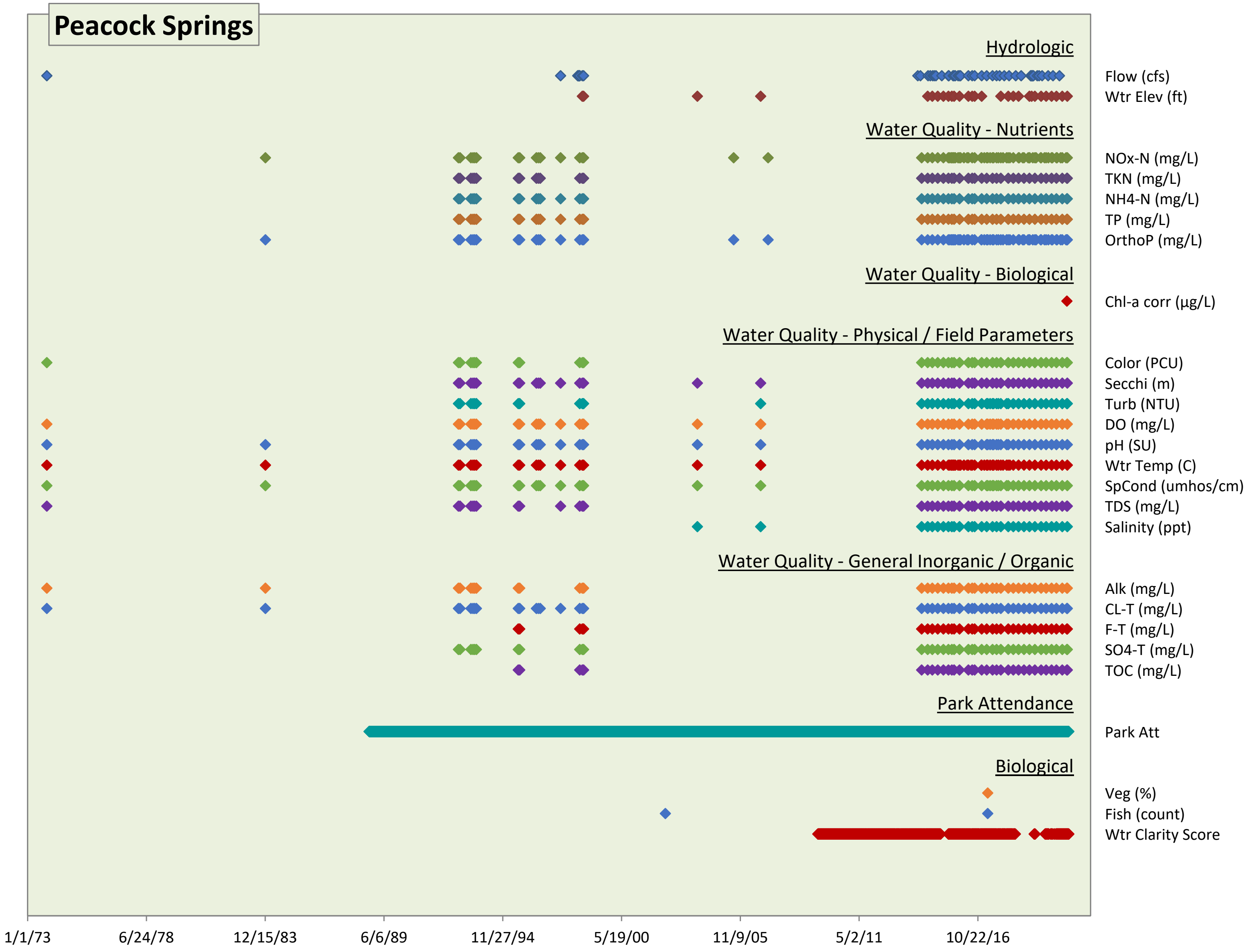
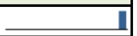


Figure B-26. Peacock Springs Temporal Data Availability Chart

Table B-39. Peacock Springs Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	11/1973	7/2020	52	---	34.2	0.49	2.50	9.17	17.1	32.4	101	201	
Wtr Elev (ft)	7/1998	12/2020	29	---	3.65	0.38	1.25	2.01	3.80	4.90	6.38	7.90	
Water Quality - Nutrients													
NOx-N (mg/L)	12/1983	12/2020	77	0%	2.75	0.056	1.87	2.32	2.85	3.36	3.73	4.99	
TKN (mg/L)	11/1992	12/2020	44	52%	0.135	0.00	0.022	0.033	0.058	0.120	0.334	0.870	
NH4-N (mg/L)	11/1992	12/2020	45	58%	0.012	-0.002	0.001	0.003	0.008	0.014	0.021	0.062	
TP (mg/L)	11/1992	12/2020	45	2%	0.052	0.026	0.038	0.043	0.045	0.053	0.063	0.144	
OrthoP (mg/L)	12/1983	12/2020	78	3%	0.042	0.004	0.027	0.036	0.041	0.045	0.054	0.189	
Water Quality - Biological													
Chl-a corr (µg/L)	12/2020	12/2020	1	100%	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	
Water Quality - Physical / Field Parameters													
Color (PCU)	11/1973	12/2020	42	52%	17.3	0.00	0.843	1.23	2.43	5.00	6.28	287	
Secchi (m)	11/1992	12/2020	46	59%	4.65	0.250	2.10	3.65	5.13	5.98	6.55	8.00	
Turb (NTU)	11/1992	12/2020	47	47%	0.939	0.110	0.152	0.226	0.370	0.523	1.50	10.4	
DO (mg/L)	11/1973	12/2020	52	0%	2.53	0.920	1.59	1.80	2.20	2.70	4.15	7.46	
pH (SU)	11/1973	12/2020	53	0%	7.27	5.34	7.03	7.21	7.33	7.47	7.54	7.70	
Wtr Temp (C)	11/1973	12/2020	66	0%	21.5	13.2	20.9	21.5	21.7	21.8	22.0	25.4	
SpCond (umhos/cm)	11/1973	12/2020	53	0%	378	58.1	347	362	404	412	420	471	
TDS (mg/L)	11/1973	12/2020	43	0%	213	73.3	185	206	223	232	238	266	
Salinity (ppt)	11/2003	12/2020	31	0%	0.188	0.030	0.190	0.200	0.200	0.200	0.200	0.250	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	11/1973	12/2020	43	2%	162	4.76	151	156	175	179	183	197	
CL-T (mg/L)	11/1973	12/2020	47	0%	6.15	1.00	4.60	5.34	6.38	7.68	7.87	8.57	
F-T (mg/L)	8/1995	12/2020	35	3%	0.178	0.066	0.131	0.160	0.179	0.204	0.217	0.275	
SO4-T (mg/L)	11/1992	12/2020	41	2%	21.4	3.00	19.6	20.9	22.2	23.4	25.0	33.0	
TOC (mg/L)	8/1995	12/2020	35	43%	2.98	0.00	0.341	0.770	1.16	1.87	2.38	31.9	
Park Attendance													
Park Att	10/1988	12/2020	11,777	---	37.0	0.00	0.00	5.00	20.0	45.0	86.0	948	
Biological / Other													
Veg (%)	4/2017	4/2017	1	---	120	120	120	120	120	120	120	120	
Fish (count)	5/2002	4/2017	1	---	283	283	283	283	283	283	283	283	
Wtr Clarity Score	6/2009	12/2020	3,467	---	1.49	1.00	1.00	1.00	1.00	1.50	2.00	5.00	

Table B-40. Peacock Springs Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	11/1973	7/2020	52	7.7%	3.8%	1.9%	13.5%	11.5%	13.5%	13.5%	7.7%	7.7%	9.6%	5.8%	3.8%	
Wtr Elev (ft)	7/1998	12/2020	29	0.0%	0.0%	13.8%	3.4%	3.4%	13.8%	10.3%	10.3%	17.2%	3.4%	6.9%	17.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	12/1983	12/2020	77	2.6%	5.2%	10.4%	5.2%	3.9%	11.7%	13.0%	10.4%	14.3%	2.6%	7.8%	13.0%	
TKN (mg/L)	11/1992	12/2020	44	0.0%	0.0%	13.6%	0.0%	2.3%	18.2%	11.4%	13.6%	18.2%	0.0%	4.5%	18.2%	
NH4-N (mg/L)	11/1992	12/2020	45	0.0%	0.0%	13.3%	0.0%	2.2%	17.8%	13.3%	13.3%	17.8%	0.0%	4.4%	17.8%	
TP (mg/L)	11/1992	12/2020	45	0.0%	0.0%	13.3%	0.0%	2.2%	17.8%	13.3%	13.3%	17.8%	0.0%	4.4%	17.8%	
OrthoP (mg/L)	12/1983	12/2020	78	2.6%	5.1%	10.3%	5.1%	3.8%	11.5%	12.8%	10.3%	14.1%	2.6%	7.7%	14.1%	
Water Quality - Biological																
Chl-a corr (µg/L)	12/2020	12/2020	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	11/1973	12/2020	42	0.0%	0.0%	14.3%	0.0%	2.4%	16.7%	9.5%	11.9%	19.0%	0.0%	7.1%	19.0%	
Secchi (m)	11/1992	12/2020	46	0.0%	0.0%	13.0%	0.0%	2.2%	17.4%	13.0%	13.0%	17.4%	2.2%	6.5%	15.2%	
Turb (NTU)	11/1992	12/2020	47	0.0%	2.1%	12.8%	2.1%	4.3%	14.9%	10.6%	10.6%	17.0%	4.3%	4.3%	17.0%	
DO (mg/L)	11/1973	12/2020	52	0.0%	1.9%	11.5%	1.9%	3.8%	15.4%	13.5%	11.5%	15.4%	3.8%	7.7%	13.5%	
pH (SU)	11/1973	12/2020	53	0.0%	1.9%	11.3%	1.9%	3.8%	15.1%	13.2%	11.3%	15.1%	3.8%	7.5%	15.1%	
Wtr Temp (C)	11/1973	12/2020	66	1.5%	3.0%	10.6%	4.5%	3.0%	13.6%	12.1%	10.6%	13.6%	4.5%	7.6%	15.2%	
SpCond (umhos/cm)	11/1973	12/2020	53	0.0%	1.9%	11.3%	1.9%	3.8%	15.1%	13.2%	11.3%	15.1%	3.8%	7.5%	15.1%	
TDS (mg/L)	11/1973	12/2020	43	0.0%	0.0%	14.0%	0.0%	2.3%	16.3%	11.6%	11.6%	18.6%	0.0%	7.0%	18.6%	
Salinity (ppt)	11/2003	12/2020	31	0.0%	0.0%	19.4%	0.0%	3.2%	16.1%	6.5%	6.5%	19.4%	3.2%	6.5%	19.4%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	11/1973	12/2020	43	0.0%	0.0%	14.0%	0.0%	2.3%	16.3%	9.3%	11.6%	18.6%	0.0%	7.0%	20.9%	
CL-T (mg/L)	11/1973	12/2020	47	0.0%	0.0%	12.8%	0.0%	2.1%	17.0%	12.8%	12.8%	17.0%	0.0%	6.4%	19.1%	
F-T (mg/L)	8/1995	12/2020	35	0.0%	0.0%	17.1%	0.0%	2.9%	17.1%	8.6%	11.4%	20.0%	0.0%	2.9%	20.0%	
SO4-T (mg/L)	11/1992	12/2020	41	0.0%	0.0%	14.6%	0.0%	2.4%	17.1%	9.8%	12.2%	19.5%	0.0%	4.9%	19.5%	
TOC (mg/L)	8/1995	12/2020	35	0.0%	0.0%	17.1%	0.0%	2.9%	17.1%	8.6%	11.4%	20.0%	0.0%	2.9%	20.0%	
Park Attendance																
Park Att	10/1988	12/2020	11,777	8.4%	7.7%	8.4%	8.2%	8.4%	8.2%	8.4%	8.4%	8.2%	8.7%	8.4%	8.7%	
Biological / Other																
Veg (%)	4/2017	4/2017	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Fish (count)	5/2002	4/2017	1	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Wtr Clarity Score	6/2009	12/2020	3,467	8.8%	6.4%	7.9%	6.9%	7.3%	9.0%	9.3%	8.9%	8.5%	8.9%	8.3%	9.8%	

Poe Spring

Table B-41 provides a summary of monitoring station metadata for Poe Spring with station locations identified in Figure B-27. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Vegetation data were available from KES, FSI, and Stetson University (Kirsten Work, unpublished data). Fish population data were also available from FSI and Stetson University. FSI also provided community metabolism estimates for the spring pool and run. Poe Springs Park attendance data were supplied by Alachua County.

Table B-41. Poe Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLACEP	POESP	29.82568	-82.64848	W,Q	STORET
2	21FLBRA	3605W-A	29.82591	-82.64905	W	STORET
3	21FLFSI	POE SPRING	29.82571	-82.64897	W,Q	FDEP WIN
4	21FLFSI	T-1	29.82579	-82.64917	V,F,P	FSI, 2020
5	21FLFSI	T-2	29.82593	-82.64917	V,F,P	FSI, 2020
6	21FLFSI	T-3	29.82604	-82.64944	V,F,P	FSI, 2020
7	21FLGW	11389	29.82572	-82.64897	W	STORET
8	21FLGW	39959	29.82566	-82.64885	W	STORET
9	21FLGW	39971	29.82572	-82.64897	W	STORET
10	21FLGWMS	39959	29.82566	-82.64885	W	STORET
11	21FLGWMS	POE010C1P	29.82583	-82.64917	W	STORET
12	21FLGWMS	POE010C2P	29.82582	-82.64910	W	STORET
13	21FLSUW	127899	29.82572	-82.64896	W,S	FDEP WIN
14	21FLSUW	2322140	*29.85694*	*-82.67944*	Q,S	SRWMD
15	21FLSUW	POE010C1	29.82583	-82.64889	W,Q.S	SRWMD, STORET
16	KES	Poe	29.82570	-82.64900	V	KES, 2020
17	Stetson	Poe	29.82570	-82.64900	V,F	Stetson
18	UF	POE SPRING	29.82571	-82.64897	W	Strong, 2004
19	USGS	2322140	29.82583	-82.64944	W,Q,S	USGS NWIS
20	USGS	294933082385800	29.82583	-82.64944	Q	USGS NWIS

[1] 21FLACEP - Alachua County Environmental Protection Department; 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS - FDEP - Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; KES – Karst Environmental Services, Inc.; Stetson - Stetson University; UF - University of Florida;USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V - vegetation; F – fish; P – primary productivity (metabolism)

A temporal data availability summary (Figure B-28), period of record statistics (Table B-42), and seasonal distribution summary (Table B-43) were developed from available data for Poe Spring.

Park attendance data for Poe Springs is primarily reported as daily totals, with the exception of the following periods. Additional screening of water elevation data will be necessary to investigate possible datum differences.

- Peak visitation by month (May 1992 – January 2008)
- Monthly totals (February 2009 - December 2010)
- Monthly vehicle totals (May 2017 - December 2020)

Additional data are also available from FSI including vegetation community maps (June 2018, September 2018, and January 2019) and snail population densities for the Poe Spring pool. Turtle population monitoring by the Santa Fe River Turtle Project occurred at Poe Spring in 2009 and 2010. These data are not included in the SRWMD OFS database.

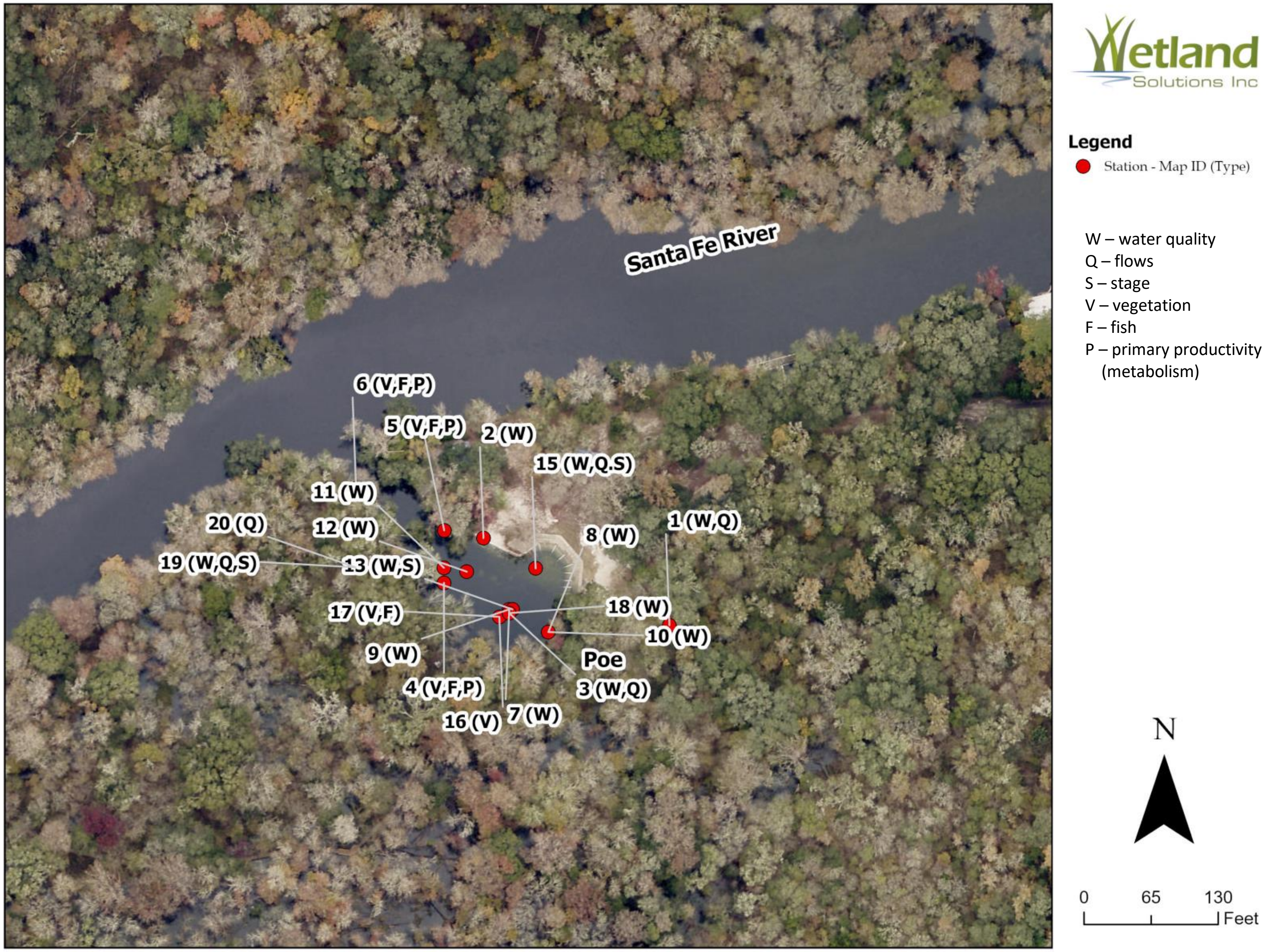


Figure B-27. Poe Spring Station Locations

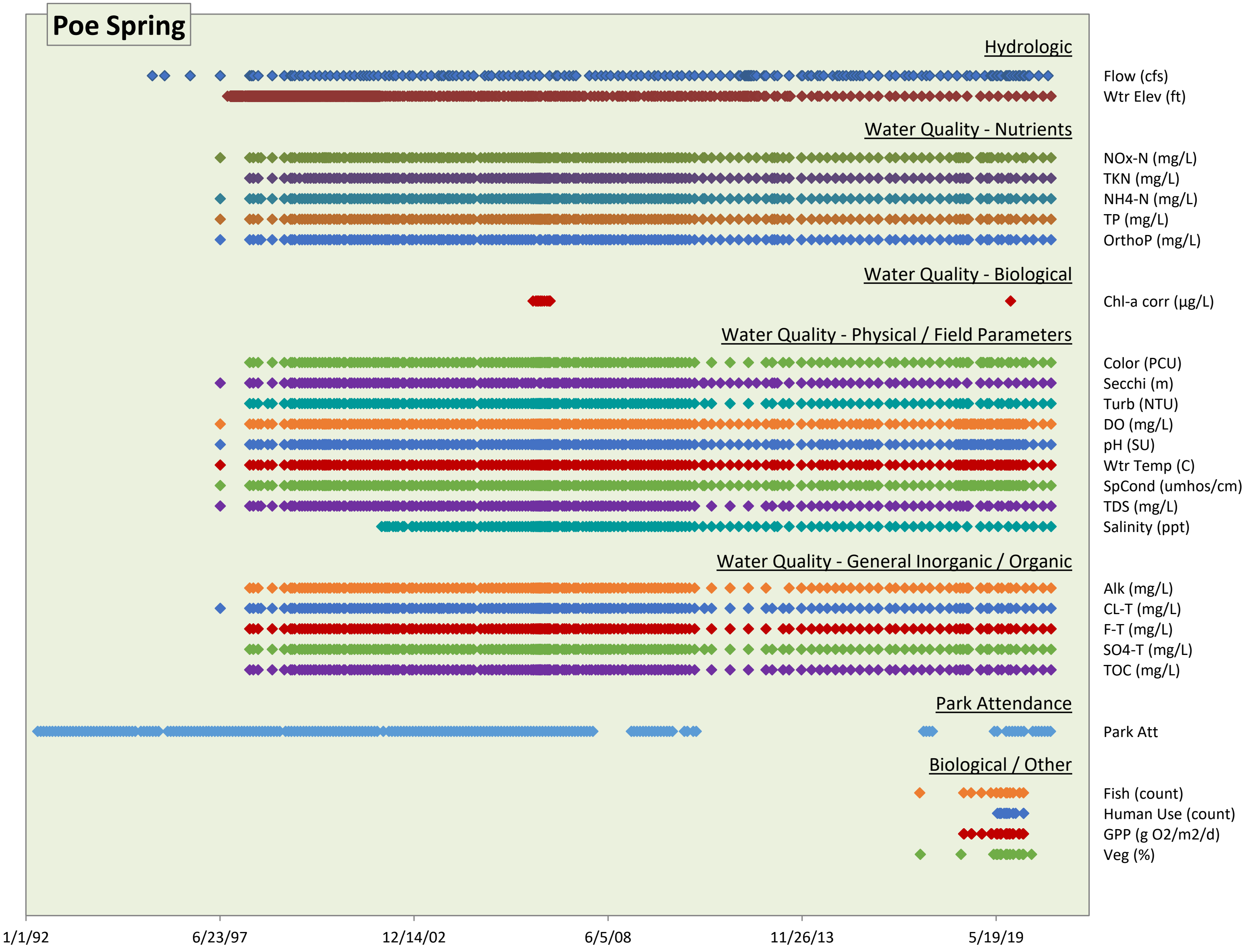


Figure B-28. Poe Spring Temporal Data Availability Chart

Table B-42. Poe Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	2/1917	11/2020	185	---	44.3	0.00	21.5	35.0	44.1	55.0	73.2	92.7	
Wtr Elev (ft)	9/1997	12/2020	1,679	---	25.1	0.19	25.5	26.4	27.0	27.7	28.4	34.6	
Water Quality - Nutrients													
NOx-N (mg/L)	5/1956	12/2020	217	0%	0.288	0.00	0.088	0.150	0.240	0.390	0.460	1.40	
TKN (mg/L)	4/1998	12/2020	198	22%	0.194	0.040	0.074	0.097	0.160	0.250	0.350	1.00	
NH4-N (mg/L)	6/1997	12/2020	206	89%	0.029	-0.004	0.002	0.010	0.020	0.034	0.095	0.200	
TP (mg/L)	6/1997	12/2020	200	0%	0.095	0.044	0.082	0.085	0.092	0.101	0.115	0.150	
OrthoP (mg/L)	6/1997	12/2020	195	0%	0.080	0.033	0.055	0.073	0.080	0.090	0.100	0.115	
Water Quality - Biological													
Chl-a corr (µg/L)	4/2006	10/2019	11	82%	1.01	0.820	1.00	1.00	1.00	1.03	1.10	1.10	
Water Quality - Physical / Field Parameters													
Color (PCU)	5/1956	12/2020	202	23%	9.85	4.00	5.00	5.00	6.71	11.2	20.0	47.1	
Secchi (m)	6/1997	12/2020	185	15%	1.53	0.305	0.830	1.00	1.10	1.30	3.24	6.70	
Turb (NTU)	4/1998	12/2020	197	26%	0.371	0.030	0.090	0.100	0.160	0.334	0.650	13.1	
DO (mg/L)	6/1997	12/2020	249	0%	0.762	0.060	0.238	0.300	0.500	0.800	1.30	7.62	
pH (SU)	5/1956	12/2020	252	0%	7.28	5.97	7.06	7.18	7.28	7.36	7.50	8.75	
Wtr Temp (C)	5/1956	12/2020	254	0%	22.4	21.4	22.1	22.3	22.3	22.4	22.5	47.9	
SpCond (umhos/cm)	5/1956	12/2020	252	0%	414	27.5	395	404	415	426	437	625	
TDS (mg/L)	5/1956	12/2020	201	1%	243	128	217	228	242	258	270	326	
Salinity (ppt)	1/2002	12/2020	154	0%	0.195	0.100	0.190	0.200	0.200	0.204	0.210	0.250	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	5/1956	12/2020	193	0%	177	140	164	169	176	186	192	200	
CL-T (mg/L)	5/1956	12/2020	202	0%	13.0	6.00	10.5	12.0	13.2	14.3	15.5	17.2	
F-T (mg/L)	4/1998	12/2020	192	1%	0.150	0.016	0.100	0.130	0.147	0.170	0.200	0.330	
SO4-T (mg/L)	4/1998	12/2020	195	0%	24.3	10.0	13.3	16.2	22.6	30.8	36.0	79.6	
TOC (mg/L)	4/1998	12/2020	193	18%	3.47	-0.390	0.720	1.40	2.07	3.30	7.94	33.1	
Park Attendance													
Park Att	5/1992	12/2020	222	---	381	0.00	55.1	96.5	271	452	790	3,874	
Biological / Other													
Fish (count)	3/2017	2/2020	13	---	661	11.0	99.2	279	399	1,003	1,399	2,087	
Human Use (count)	6/2019	2/2020	12	---	680	14.0	23.6	43.3	83.5	444	2,729	3,504	
GPP (g O2/m2/d)	6/2018	2/2020	78	---	5.70	0.130	2.74	3.57	5.22	6.82	10.2	14.2	
Veg (%)	3/2017	5/2020	16	---	55.7	5.40	12.4	31.8	55.7	79.1	100	100	

Table B-43. Poe Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	2/1917	11/2020	185	9.7%	8.1%	5.4%	9.7%	11.9%	9.7%	10.8%	7.0%	4.3%	8.6%	5.9%	8.6%	
Wtr Elev (ft)	9/1997	12/2020	1,679	8.0%	7.4%	7.0%	8.2%	7.9%	7.7%	8.1%	8.1%	7.6%	9.9%	9.9%	10.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	5/1956	12/2020	217	8.3%	8.8%	6.9%	9.2%	10.1%	9.7%	9.7%	8.3%	6.5%	6.9%	7.4%	8.3%	
TKN (mg/L)	4/1998	12/2020	198	8.1%	7.6%	7.1%	8.6%	9.6%	9.1%	10.6%	8.6%	7.1%	7.6%	8.1%	8.1%	
NH4-N (mg/L)	6/1997	12/2020	206	7.8%	8.3%	6.8%	8.7%	9.2%	9.2%	10.2%	8.7%	7.3%	7.8%	7.8%	8.3%	
TP (mg/L)	6/1997	12/2020	200	8.0%	7.5%	7.0%	8.5%	9.5%	9.5%	10.5%	8.5%	7.0%	8.0%	8.0%	8.0%	
OrthoP (mg/L)	6/1997	12/2020	195	8.2%	8.2%	7.2%	8.7%	9.2%	8.7%	9.7%	8.7%	7.2%	7.2%	8.2%	8.7%	
Water Quality - Biological																
Chl-a corr (µg/L)	4/2006	10/2019	11	0.0%	0.0%	0.0%	9.1%	9.1%	18.2%	18.2%	9.1%	9.1%	27.3%	0.0%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	5/1956	12/2020	202	8.9%	6.9%	6.9%	8.9%	10.4%	8.9%	10.4%	7.4%	6.9%	7.9%	7.9%	8.4%	
Secchi (m)	6/1997	12/2020	185	8.6%	8.1%	7.6%	8.6%	9.2%	8.6%	9.7%	8.1%	7.0%	7.6%	9.2%	7.6%	
Turb (NTU)	4/1998	12/2020	197	8.1%	6.6%	6.6%	8.6%	9.6%	9.1%	10.7%	7.6%	7.1%	9.1%	8.6%	8.1%	
DO (mg/L)	6/1997	12/2020	249	7.6%	7.6%	6.4%	8.4%	8.8%	10.4%	9.6%	8.0%	8.0%	9.2%	8.8%	6.8%	
pH (SU)	5/1956	12/2020	252	7.5%	7.9%	6.3%	8.3%	9.5%	10.3%	9.5%	7.9%	7.9%	9.1%	8.7%	6.7%	
Wtr Temp (C)	5/1956	12/2020	254	7.5%	7.9%	6.3%	8.7%	9.4%	10.2%	9.4%	7.9%	7.9%	9.1%	8.7%	7.1%	
SpCond (umhos/cm)	5/1956	12/2020	252	7.5%	7.9%	6.3%	8.3%	9.5%	10.3%	9.5%	7.9%	7.9%	9.1%	8.7%	6.7%	
TDS (mg/L)	5/1956	12/2020	201	8.0%	6.5%	6.5%	9.0%	10.4%	9.5%	10.4%	8.0%	7.5%	8.0%	8.0%	8.5%	
Salinity (ppt)	1/2002	12/2020	154	8.4%	7.8%	7.8%	8.4%	9.1%	8.4%	10.4%	8.4%	7.1%	7.8%	9.1%	7.1%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	5/1956	12/2020	193	7.8%	6.7%	6.7%	8.8%	9.8%	9.3%	10.9%	7.8%	7.3%	8.3%	8.3%	8.3%	
CL-T (mg/L)	5/1956	12/2020	202	7.9%	7.4%	6.4%	8.9%	9.9%	9.4%	10.4%	7.9%	7.4%	7.9%	7.9%	8.4%	
F-T (mg/L)	4/1998	12/2020	192	7.8%	6.3%	6.8%	8.9%	9.9%	9.4%	10.9%	7.8%	7.3%	8.3%	8.3%	8.3%	
SO4-T (mg/L)	4/1998	12/2020	195	8.2%	7.2%	6.7%	8.7%	9.7%	9.2%	10.8%	7.7%	7.2%	8.2%	8.2%	8.2%	
TOC (mg/L)	4/1998	12/2020	193	8.3%	6.2%	6.7%	8.8%	9.8%	9.3%	10.9%	7.8%	7.3%	8.3%	8.3%	8.3%	
Park Attendance																
Park Att	5/1992	12/2020	222	7.7%	8.1%	7.2%	7.2%	8.6%	9.0%	8.6%	9.0%	9.0%	8.6%	8.6%	8.6%	
Biological / Other																
Fish (count)	3/2017	2/2020	13	7.7%	7.7%	15.4%	0.0%	7.7%	7.7%	15.4%	7.7%	15.4%	7.7%	7.7%	7.7%	
Human Use (count)	6/2019	2/2020	12	0.0%	16.7%	0.0%	0.0%	0.0%	16.7%	16.7%	16.7%	8.3%	8.3%	8.3%	8.3%	
GPP (g O2/m2/d)	6/2018	2/2020	78	7.7%	6.4%	5.1%	5.1%	10.3%	10.3%	10.3%	2.6%	19.2%	10.3%	5.1%	7.7%	
Veg (%)	3/2017	5/2020	16	12.5%	12.5%	6.3%	6.3%	18.8%	6.3%	12.5%	6.3%	6.3%	6.3%	6.3%	0.0%	

Suwannee Spring

Table B-44 provides a summary of monitoring station metadata for Suwannee Spring with station locations identified in Figure B-29. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. No biological data were identified for this system.

Table B-44. Suwannee Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	21020127	30.39448	-82.93454	W,Q	STORET
2	21FLBRA	3341Y-A	30.39444	-82.93443	W	STORET
3	21FLGW	11497	30.39448	-82.93454	W	STORET
4	21FLSUW	127844	30.39441	-82.93448	W	FDEP WIN
5	21FLSUW	2315600	*30.39389*	*-82.93306*	Q	SRWMD
6	21FLSUW	SSS010C1	30.39417	-82.93444	W,Q,S	SRWMD, STORET
7	UF	Suwannee Springs	30.39448	-82.93454	W	Strong, 2004
8	USGS	2315600	30.39417	-82.93444	W,Q,S	USGS NWIS
9	USGS	302339082560400	30.39417	-82.93444	Q	USGS NWIS

[1] 21FLA -FL Dept. of Environmental Protection, Northeast District; 21FLBRA - Biological Research Associates; 21FLGW - FL Dept. of Environmental Protection; 21FLSUW - Suwannee River Water Management District; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage;

A temporal data availability summary (Figure B-30), period of record statistics (Table B-45), and seasonal distribution summary (Table B-46) were developed from available data for Suwannee Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Cave fauna data may also be available from Kelly Jessup, Director of the North Florida Springs Alliance (https://northfloridaspringsalliance.org/).

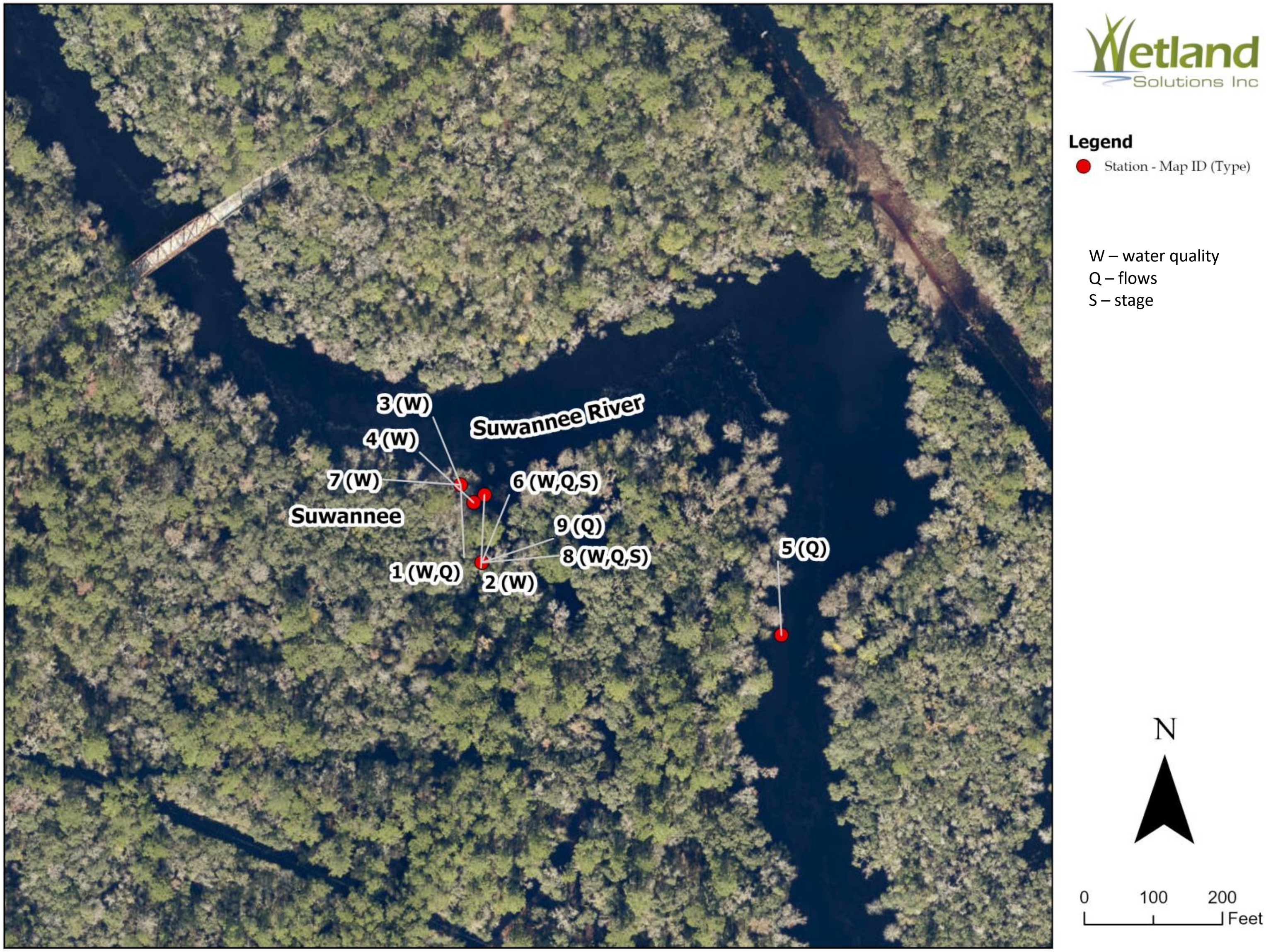


Figure B-29. Suwannee Spring Station Locations

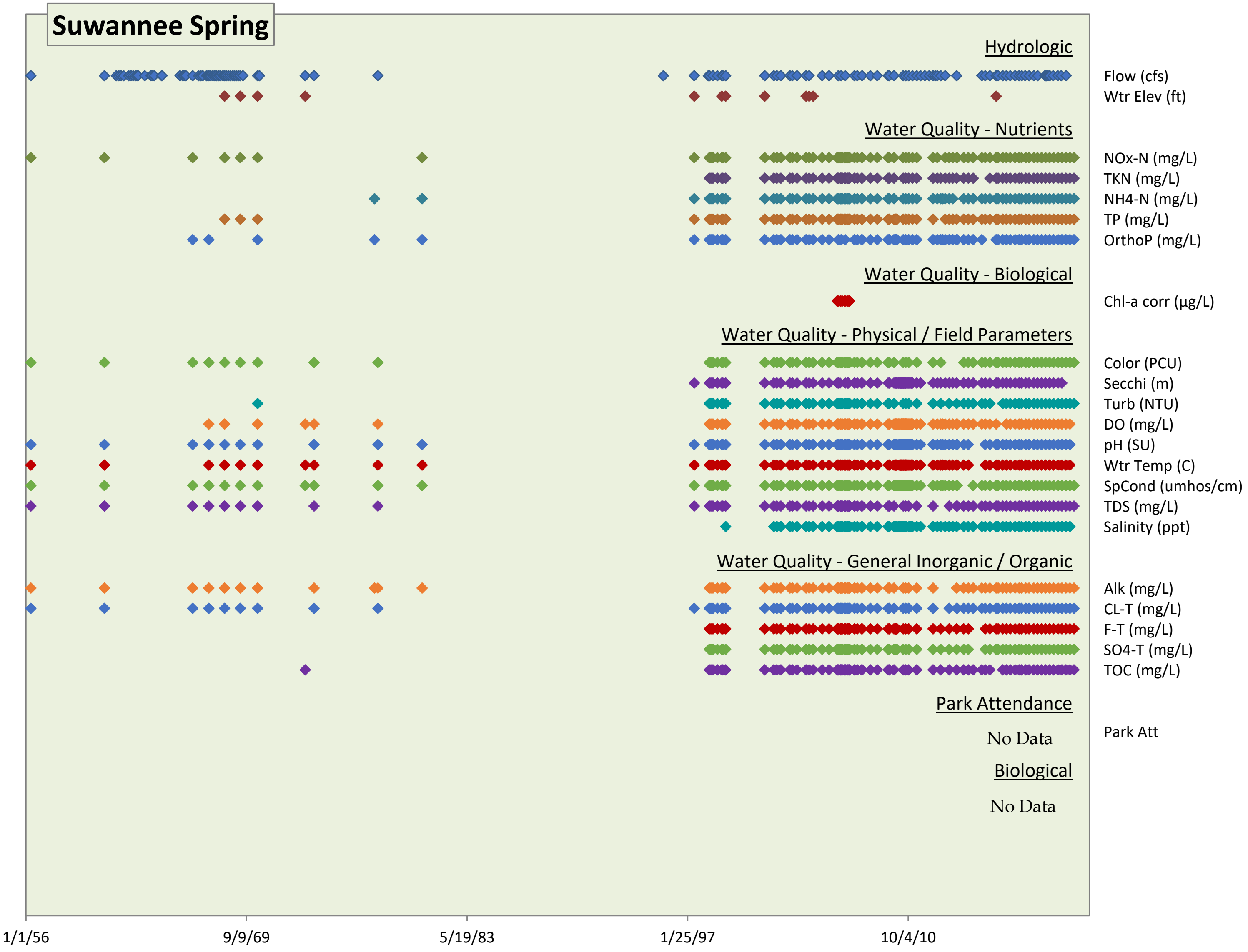


Figure B-30. Suwannee Spring Temporal Data Availability Chart

Table B-45. Suwannee Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	5/1906	7/2020	134	---	23.1	-3.10	2.59	8.35	19.1	35.6	49.5	71.5	
Wtr Elev (ft)	5/1968	3/2016	12	---	33.5	2.50	6.28	29.8	40.9	44.8	46.4	48.1	
Water Quality - Nutrients													
NOx-N (mg/L)	4/1956	1/2021	94	56%	0.017	-0.007	0.003	0.005	0.010	0.022	0.040	0.090	
TKN (mg/L)	6/1998	1/2021	84	4%	0.389	0.040	0.173	0.231	0.300	0.381	0.594	3.53	
NH4-N (mg/L)	8/1977	1/2021	89	8%	0.118	0.012	0.050	0.090	0.125	0.150	0.166	0.360	
TP (mg/L)	5/1968	1/2021	93	1%	0.158	0.004	0.110	0.117	0.130	0.148	0.188	1.62	
OrthoP (mg/L)	5/1966	1/2021	83	2%	0.120	0.002	0.090	0.102	0.117	0.137	0.151	0.264	
Water Quality - Biological													
Chl-a corr (µg/L)	5/2006	2/2007	14	93%	1.88	1.00	1.00	1.00	2.35	2.60	2.60	2.60	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1956	1/2021	89	1%	50.4	0.00	15.0	20.0	25.0	50.0	92.0	389	
Secchi (m)	6/1997	10/2020	105	20%	1.97	0.300	0.600	1.10	1.90	2.80	3.14	8.10	
Turb (NTU)	5/1970	1/2021	81	10%	1.43	0.175	0.400	0.693	1.10	1.78	2.70	6.31	
DO (mg/L)	5/1967	10/2020	122	0%	1.16	0.00	0.200	0.262	0.400	0.890	2.48	10.8	
pH (SU)	4/1956	10/2020	127	0%	7.15	4.01	6.78	7.13	7.28	7.41	7.59	8.10	
Wtr Temp (C)	4/1956	10/2020	127	0%	20.6	8.20	19.6	20.5	20.7	21.0	21.2	45.6	
SpCond (umhos/cm)	4/1956	1/2021	130	0%	287	0.00	226	284	306	322	333	369	
TDS (mg/L)	4/1956	1/2021	92	0%	182	4.00	162	174	184	195	204	244	
Salinity (ppt)	6/1999	10/2020	102	0%	0.131	0.030	0.100	0.111	0.140	0.150	0.160	0.300	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1956	1/2021	90	2%	142	0.515	130	141	149	153	158	243	
CL-T (mg/L)	4/1956	1/2021	92	1%	5.51	1.00	4.51	4.99	5.35	6.10	6.96	8.00	
F-T (mg/L)	6/1998	1/2021	85	0%	0.152	0.020	0.101	0.130	0.154	0.180	0.200	0.243	
SO4-T (mg/L)	6/1998	1/2021	85	1%	9.24	1.00	5.80	7.10	8.50	11.6	14.0	19.0	
TOC (mg/L)	5/1973	1/2021	81	1%	7.80	0.00	2.60	3.23	4.60	9.00	12.7	61.3	

Table B-46. Suwannee Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	5/1906	7/2020	134	6.0%	0.7%	4.5%	9.0%	13.4%	16.4%	10.4%	9.0%	3.0%	9.7%	12.7%	5.2%	
Wtr Elev (ft)	5/1968	3/2016	12	0.0%	0.0%	16.7%	8.3%	25.0%	25.0%	0.0%	8.3%	0.0%	0.0%	16.7%	0.0%	
Water Quality - Nutrients																
NOx-N (mg/L)	4/1956	1/2021	94	8.5%	3.2%	3.2%	9.6%	8.5%	11.7%	12.8%	12.8%	1.1%	10.6%	17.0%	1.1%	
TKN (mg/L)	6/1998	1/2021	84	9.5%	3.6%	3.6%	8.3%	6.0%	11.9%	14.3%	13.1%	1.2%	10.7%	16.7%	1.2%	
NH4-N (mg/L)	8/1977	1/2021	89	9.0%	3.4%	3.4%	7.9%	5.6%	12.4%	13.5%	14.6%	1.1%	11.2%	16.9%	1.1%	
TP (mg/L)	5/1968	1/2021	93	11.8%	3.2%	3.2%	8.6%	7.5%	11.8%	12.9%	11.8%	1.1%	9.7%	15.1%	3.2%	
OrthoP (mg/L)	5/1966	1/2021	83	10.8%	1.2%	3.6%	8.4%	7.2%	13.3%	12.0%	14.5%	0.0%	10.8%	15.7%	2.4%	
Water Quality - Biological																
Chl-a corr (µg/L)	5/2006	2/2007	14	14.3%	14.3%	0.0%	0.0%	14.3%	7.1%	14.3%	7.1%	7.1%	7.1%	14.3%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1956	1/2021	89	6.7%	3.4%	3.4%	10.1%	10.1%	11.2%	11.2%	12.4%	1.1%	10.1%	19.1%	1.1%	
Secchi (m)	6/1997	10/2020	105	9.5%	1.9%	5.7%	10.5%	7.6%	13.3%	13.3%	12.4%	1.0%	8.6%	12.4%	3.8%	
Turb (NTU)	5/1970	1/2021	81	7.4%	3.7%	3.7%	8.6%	7.4%	12.3%	12.3%	13.6%	1.2%	11.1%	17.3%	1.2%	
DO (mg/L)	5/1967	10/2020	122	8.2%	3.3%	4.9%	9.0%	10.7%	10.7%	12.3%	11.5%	1.6%	9.0%	14.8%	4.1%	
pH (SU)	4/1956	10/2020	127	7.9%	3.1%	4.7%	10.2%	10.2%	11.0%	11.8%	11.8%	1.6%	8.7%	15.0%	3.9%	
Wtr Temp (C)	4/1956	10/2020	127	7.9%	3.1%	4.7%	10.2%	10.2%	11.0%	11.8%	11.8%	1.6%	8.7%	15.0%	3.9%	
SpCond (umhos/cm)	4/1956	1/2021	130	8.5%	3.1%	4.6%	10.0%	10.8%	10.8%	11.5%	12.3%	1.5%	8.5%	14.6%	3.8%	
TDS (mg/L)	4/1956	1/2021	92	6.5%	3.3%	3.3%	9.8%	9.8%	12.0%	10.9%	12.0%	1.1%	10.9%	19.6%	1.1%	
Salinity (ppt)	6/1999	10/2020	102	9.8%	2.9%	3.9%	9.8%	8.8%	11.8%	12.7%	11.8%	2.0%	9.8%	13.7%	2.9%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1956	1/2021	90	6.7%	3.3%	3.3%	10.0%	10.0%	11.1%	11.1%	13.3%	1.1%	10.0%	18.9%	1.1%	
CL-T (mg/L)	4/1956	1/2021	92	6.5%	3.3%	3.3%	9.8%	9.8%	12.0%	10.9%	12.0%	1.1%	10.9%	19.6%	1.1%	
F-T (mg/L)	6/1998	1/2021	85	10.6%	3.5%	3.5%	8.2%	5.9%	11.8%	11.8%	12.9%	1.2%	10.6%	16.5%	3.5%	
SO4-T (mg/L)	6/1998	1/2021	85	10.6%	3.5%	3.5%	8.2%	5.9%	11.8%	11.8%	12.9%	1.2%	10.6%	16.5%	3.5%	
TOC (mg/L)	5/1973	1/2021	81	7.4%	3.7%	3.7%	8.6%	7.4%	12.3%	12.3%	13.6%	1.2%	11.1%	17.3%	1.2%	

Treehouse Spring

Table B-47 provides a summary of monitoring station metadata for Treehouse Spring with station locations identified in Figure B-31. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Vegetation data were available from KES and FSI.

Table B-47. Treehouse Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLA	G1NE0016	29.85487	-82.60290	W	FDEP WIN, STORET
2	21FLFSI	TREEHOUSE SPRING	29.85488	-82.60288	W,Q	FDEP WIN
3	21FLFSI	T-1	29.85490	-82.60290	V	FSI, 2020
4	21FLGW	9667	29.85489	-82.60288	W	STORET
5	21FLSUW	127784	29.85493	-82.60285	W	FDEP WIN
6	21FLSUW	2321971	29.85444	-82.60278	Q	SRWMD
7	21FLSUW	ALA112971	29.85473	-82.60306	W,Q,S	SRWMD
8	KES	Treehouse	29.85490	-82.60290	V	KES, 2020

[1] 21FLA – FL Dept. of Environmental Protection, Northeast District; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection;21FLSUW - Suwannee River Water Management District; KES – Karst Environmental Services, Inc.
[2] W – water quality; Q – flows; S – stage; V - vegetation

A temporal data availability summary (Figure B-32), period of record statistics (Table B-48), and seasonal distribution summary (Table B-49) were developed from available data for Treehouse Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

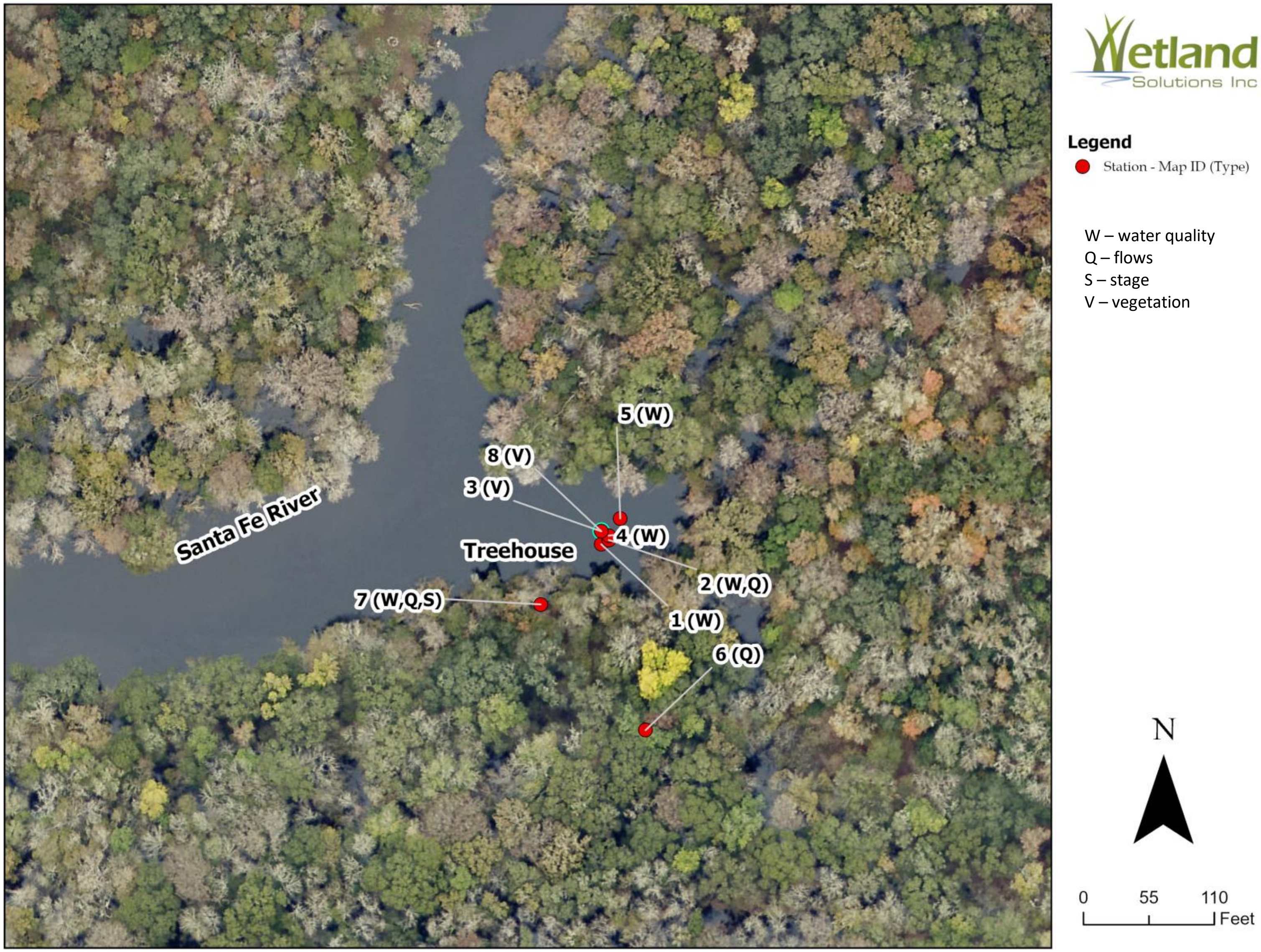


Figure B-31. Treehouse Spring Station Locations

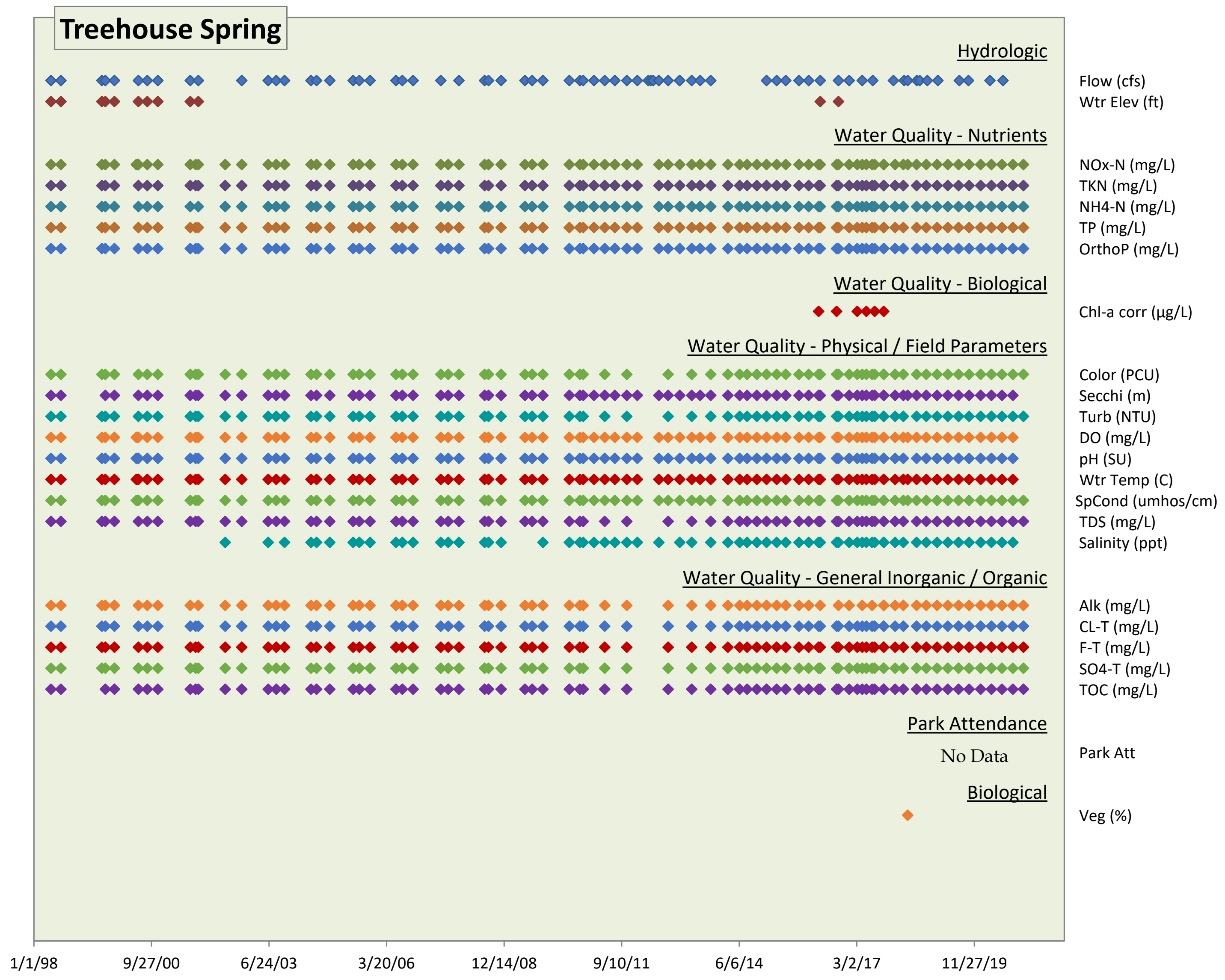


Figure B-32. Treehouse Spring Temporal Data Availability Chart

Table B-48. Treehouse Spring Database Inventory and Statistics

				Percent		Percentile							
Parameter	Period of Record		Count	BDL	Average	0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	5/1998	7/2020	70	---	253	0.00	14.9	76.5	201	378	591	794	
Wtr Elev (ft)	5/1998	9/2016	12	---	16.6	4.50	4.66	4.74	5.31	32.4	33.5	33.9	
Water Quality - Nutrients													
NOx-N (mg/L)	5/1998	1/2021	85	0%	0.329	0.016	0.076	0.191	0.340	0.464	0.538	0.800	
TKN (mg/L)	5/1998	1/2021	82	7%	0.553	0.040	0.141	0.274	0.416	0.770	1.12	1.60	
NH4-N (mg/L)	5/1998	1/2021	81	48%	0.025	0.003	0.006	0.009	0.020	0.030	0.050	0.090	
TP (mg/L)	5/1998	1/2021	82	0%	0.140	0.075	0.085	0.100	0.120	0.161	0.238	0.391	
OrthoP (mg/L)	5/1998	1/2021	82	0%	0.110	0.040	0.071	0.085	0.100	0.120	0.180	0.270	
Water Quality - Biological													
Chl-a corr (µg/L)	4/2016	10/2017	6	100%	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	
Water Quality - Physical / Field Parameters													
Color (PCU)	5/1998	1/2021	76	1%	151	5.00	15.8	31.0	100	206	400	680	
Secchi (m)	5/1998	10/2020	81	5%	2.29	0.100	0.600	1.00	1.50	2.50	5.00	10.6	
Turb (NTU)	5/1998	1/2021	76	18%	1.69	0.100	0.250	0.458	0.686	1.30	2.35	48.8	
DO (mg/L)	5/1998	10/2020	84	0%	2.45	0.300	1.00	1.70	2.25	3.14	4.13	7.62	
pH (SU)	5/1998	10/2020	83	0%	7.16	5.63	6.88	7.11	7.23	7.35	7.47	7.91	
Wtr Temp (C)	5/1998	10/2020	84	0%	22.5	14.3	20.4	21.6	22.5	23.7	24.3	26.1	
SpCond (umhos/cm)	5/1998	1/2021	85	0%	381	64.0	194	343	415	462	490	619	
TDS (mg/L)	5/1998	1/2021	76	0%	266	96.0	183	234	272	305	330	399	
Salinity (ppt)	6/2002	10/2020	64	0%	0.171	0.030	0.100	0.130	0.200	0.200	0.210	0.260	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	5/1998	1/2021	70	0%	122	6.86	60.1	109	133	149	163	180	
CL-T (mg/L)	5/1998	1/2021	76	0%	14.8	6.40	10.9	13.4	14.9	15.6	17.6	33.2	
F-T (mg/L)	5/1998	1/2021	76	1%	0.203	0.090	0.129	0.170	0.200	0.250	0.270	0.321	
SO4-T (mg/L)	5/1998	1/2021	76	1%	52.5	1.95	16.9	39.2	53.2	68.8	81.3	98.1	
TOC (mg/L)	5/1998	1/2021	75	3%	15.5	0.500	2.84	5.48	11.2	21.1	39.1	45.6	
Biological													
Veg (%)	5/2018	5/2018	1	---	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	

Table B-49. Treehouse Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	5/1998	7/2020	70	11.4%	0.0%	0.0%	11.4%	4.3%	12.9%	12.9%	15.7%	4.3%	10.0%	15.7%	1.4%	
Wtr Elev (ft)	5/1998	9/2016	12	0.0%	0.0%	0.0%	8.3%	8.3%	8.3%	0.0%	33.3%	16.7%	0.0%	25.0%	0.0%	
Water Quality - Nutrients																
NOx-N (mg/L)	5/1998	1/2021	85	10.6%	0.0%	2.4%	10.6%	4.7%	12.9%	10.6%	15.3%	4.7%	12.9%	14.1%	1.2%	
TKN (mg/L)	5/1998	1/2021	82	11.0%	0.0%	2.4%	11.0%	2.4%	12.2%	11.0%	15.9%	4.9%	13.4%	14.6%	1.2%	
NH4-N (mg/L)	5/1998	1/2021	81	11.1%	0.0%	2.5%	11.1%	2.5%	12.3%	11.1%	16.0%	4.9%	12.3%	14.8%	1.2%	
TP (mg/L)	5/1998	1/2021	82	11.0%	0.0%	2.4%	11.0%	2.4%	12.2%	11.0%	15.9%	4.9%	13.4%	14.6%	1.2%	
OrthoP (mg/L)	5/1998	1/2021	82	11.0%	0.0%	2.4%	11.0%	2.4%	12.2%	11.0%	15.9%	4.9%	13.4%	14.6%	1.2%	
Water Quality - Biological																
Chl-a corr (µg/L)	4/2016	10/2017	6	0.0%	0.0%	16.7%	16.7%	16.7%	0.0%	0.0%	16.7%	16.7%	16.7%	0.0%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
Secchi (m)	5/1998	10/2020	81	9.9%	0.0%	2.5%	11.1%	3.7%	12.3%	11.1%	14.8%	4.9%	13.6%	14.8%	1.2%	
Turb (NTU)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
DO (mg/L)	5/1998	10/2020	84	9.5%	0.0%	2.4%	10.7%	4.8%	13.1%	10.7%	15.5%	4.8%	13.1%	14.3%	1.2%	
pH (SU)	5/1998	10/2020	83	9.6%	0.0%	2.4%	10.8%	3.6%	13.3%	10.8%	15.7%	4.8%	13.3%	14.5%	1.2%	
Wtr Temp (C)	5/1998	10/2020	84	9.5%	0.0%	2.4%	10.7%	4.8%	13.1%	10.7%	15.5%	4.8%	13.1%	14.3%	1.2%	
SpCond (umhos/cm)	5/1998	1/2021	85	10.6%	0.0%	2.4%	10.6%	4.7%	12.9%	10.6%	15.3%	4.7%	12.9%	14.1%	1.2%	
TDS (mg/L)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
Salinity (ppt)	6/2002	10/2020	64	12.5%	0.0%	3.1%	14.1%	1.6%	12.5%	12.5%	10.9%	4.7%	14.1%	12.5%	1.6%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	5/1998	1/2021	70	8.6%	0.0%	1.4%	11.4%	1.4%	14.3%	8.6%	17.1%	4.3%	14.3%	17.1%	1.4%	
CL-T (mg/L)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
F-T (mg/L)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
SO4-T (mg/L)	5/1998	1/2021	76	7.9%	0.0%	2.6%	11.8%	2.6%	13.2%	7.9%	17.1%	5.3%	14.5%	15.8%	1.3%	
TOC (mg/L)	5/1998	1/2021	75	8.0%	0.0%	2.7%	12.0%	2.7%	13.3%	8.0%	16.0%	5.3%	14.7%	16.0%	1.3%	
Biological																
Veg (%)	5/2018	5/2018	1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

Troy Spring

Table B-50 provides a summary of monitoring station metadata for Troy Spring with station locations identified in Figure B-33. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Water clarity and manatee data were provided by the FDEP FPS and fish data from USGS and Stetson University (Kirsten Work, unpublished data). Vegetation data were also supplied from Stetson University. Troy Spring State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-50. Troy Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLBRA	3422T-A	30.00595	-82.99755	W	STORET
2	21FLFSI	SUW1-S5	30.00585	-82.99751	W,F	FDEP WIN, FSI
3	21FLGW	9694	30.00603	-82.99750	W,Q	STORET
4	21FLGW	Troy Spring	30.00610	-82.99720	W,Q,M	FDEP FPS
5	21FLGWMS	TRY010C1	30.00583	-82.99750	W,Q	STORET
6	21FLSUW	127915	30.00600	-82.99748	W,S	FDEP WIN
7	21FLSUW	2320250	*30.00917*	*-83.00500*	Q,S	SRWMD
8	21FLSUW	TRY010C1	30.00583	-82.99750	W,Q,S	SRWMD, STORET
9	Stetson	Troy	30.00610	-82.99720	V,F	Stetson
10	UF	Troy Spring	30.00585	-82.99751	W	Strong, 2004
11	USGS	2320250	30.00583	-82.99750	W,Q,S	USGS NWIS
12	USGS	Troy	*29.16623*	*-82.15000*	F, MI	Walsh & Williams, 2003

[1] 21FLBRA - Biological Research Associates; 21FLFSI - Howard T Odum Florida Springs Institute; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS - FDEP Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; Stetson - Stetson University; UF - University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; F – fish; M – manatees; MI - macroinvertebrates

A temporal data availability summary (Figure B-34), period of record statistics (Table B-51), and seasonal distribution summary (Table B-52) were developed from available data for Troy Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Additional continuous *in-situ* water quality data are available from USGS NWIS[33] for water temperature, specific conductance, dissolved oxygen, pH, and NOx-N from 7/2/2014 to 2/10/2021[34]. These data are not included in the SRWMD OFS database.

Turtle population monitoring started in 2019 at Troy Spring by the Turtle Survival Alliance (TSA). The number of individuals per species that have been marked to date include the following (Eric Munscher, personal communication).

---

[33] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02320250

[34] date website was accessed; visit above link for updated period of record

- River cooter (*Pseudemys concinna*)– 101
- Peninsular cooter (*Pseudems floridana peninsularis*) – 3
- Loggerhead musk turtle (*Sternotherus minor*) – 41
- Yellow-bellied slider (*Trachemys scripta scripta*) – 2
- Alligator snapping turtle (*Macrochelys temminckii*) –1

Cave fauna data may also be available from Kelly Jessup, Director of the North Florida Springs Alliance (https://northfloridaspringsalliance.org/).

Figure B-33. Troy Spring Station Locations

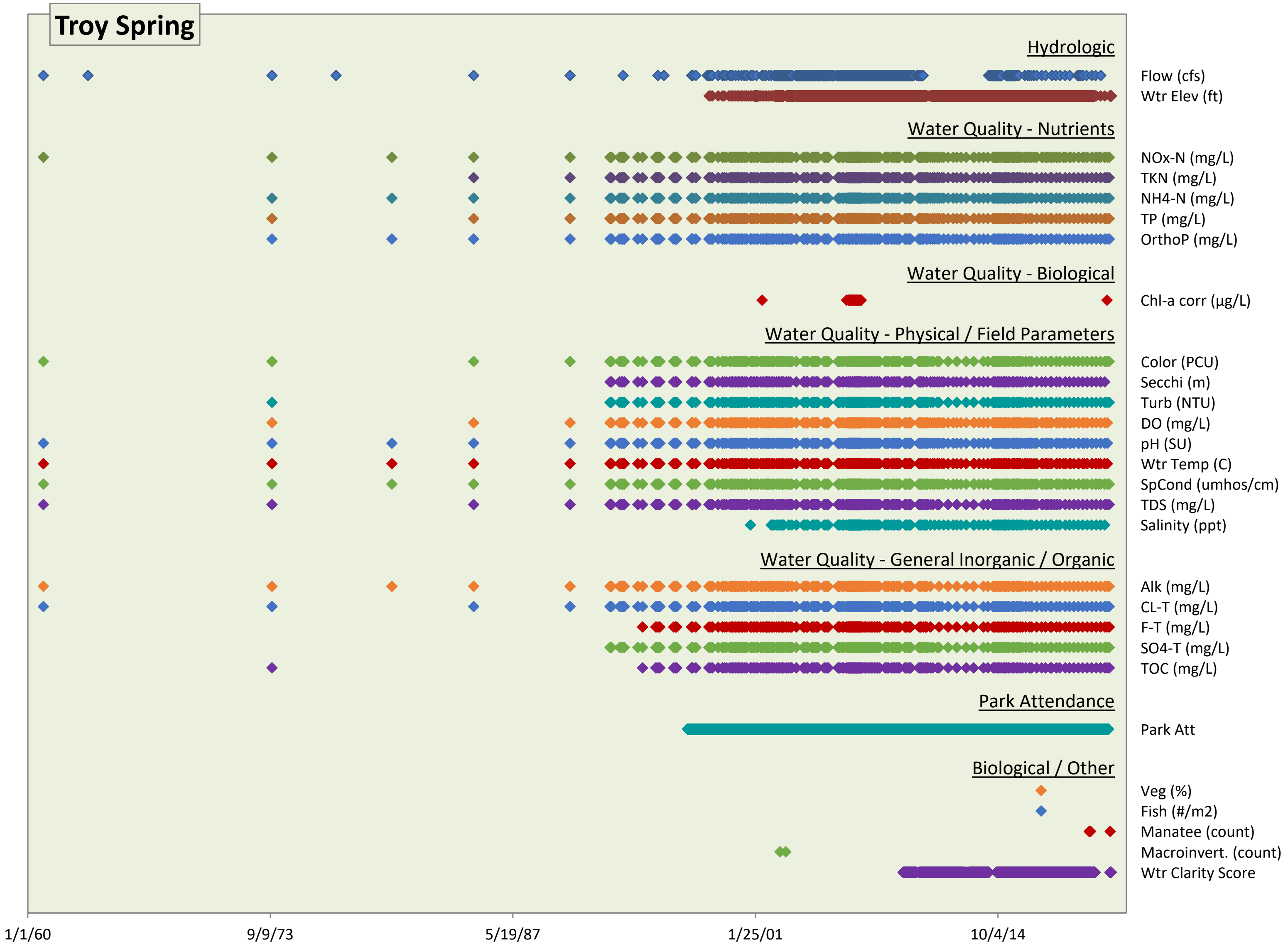


Figure B-34. Troy Spring Temporal Data Availability Chart

Table B-51. Troy Spring Database Inventory and Statistics

Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	5/1927	7/2020	3,228	---	116	-204	48.4	75.2	101	142	204	534	
Wtr Elev (ft)	6/1998	2/2021	6,504	---	13.1	-1.08	7.71	9.50	11.3	15.6	20.8	41.8	
Water Quality - Nutrients													
NOx-N (mg/L)	11/1960	1/2021	282	0%	1.97	0.070	1.22	1.60	1.95	2.43	2.71	3.20	
TKN (mg/L)	3/1985	1/2021	241	39%	0.185	0.001	0.050	0.071	0.110	0.200	0.360	1.76	
NH4-N (mg/L)	10/1973	1/2021	244	79%	0.025	-0.001	0.003	0.010	0.020	0.024	0.059	0.200	
TP (mg/L)	10/1973	1/2021	243	3%	0.039	0.013	0.025	0.030	0.032	0.040	0.061	0.210	
OrthoP (mg/L)	10/1973	1/2021	217	0%	0.030	0.002	0.020	0.023	0.030	0.032	0.040	0.168	
Water Quality - Biological													
Chl-a corr (µg/L)	6/2001	11/2020	27	96%	1.76	0.700	1.00	1.00	1.10	2.60	2.60	2.60	
Water Quality - Physical / Field Parameters													
Color (PCU)	11/1960	1/2021	233	43%	17.7	0.00	3.44	5.00	5.00	5.00	12.2	502	
Secchi (m)	11/1992	10/2020	215	15%	6.72	0.400	1.00	1.30	2.50	11.5	19.0	24.4	
Turb (NTU)	10/1973	1/2021	231	32%	0.487	0.010	0.100	0.130	0.200	0.369	0.733	8.41	
DO (mg/L)	10/1973	12/2020	267	0%	1.01	0.100	0.290	0.400	0.730	1.10	2.06	6.69	
pH (SU)	11/1960	12/2020	275	0%	7.37	5.96	7.14	7.29	7.40	7.50	7.60	7.84	
Wtr Temp (C)	11/1960	12/2020	273	0%	21.3	0.00	20.9	21.3	21.5	21.7	21.8	28.3	
SpCond (umhos/cm)	11/1960	1/2021	279	0%	351	61.0	329	344	358	375	387	767	
TDS (mg/L)	11/1960	1/2021	248	0%	206	65.0	181	198	206	217	226	700	
Salinity (ppt)	10/2000	10/2020	153	0%	0.265	0.00	0.100	0.130	0.140	0.180	0.200	18.0	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	11/1960	1/2021	212	0%	159	12.5	148	156	162	170	176	207	
CL-T (mg/L)	11/1960	1/2021	240	0%	7.22	2.00	5.00	5.40	5.96	6.40	7.28	297	
F-T (mg/L)	9/1994	1/2021	217	6%	0.101	0.00	0.058	0.080	0.100	0.120	0.140	0.310	
SO4-T (mg/L)	11/1992	1/2021	230	0%	12.9	4.65	10.3	11.5	13.0	14.0	14.8	69.5	
TOC (mg/L)	10/1973	1/2021	224	26%	3.04	0.00	0.533	0.778	1.12	2.31	7.78	42.2	
Park Attendance													
Park Att	3/1997	12/2020	8,674	---	20.3	0.00	0.00	0.00	3.00	18.0	54.0	754	
Biological													
Veg (%)	3/2017	3/2017	1	---	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3	
Fish (#/m2)	3/2017	3/2017	1	---	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	
Manatee (count)	12/2019	2/2021	5	---	2.60	1.00	1.00	1.00	3.00	4.00	4.00	4.00	
Macroinvert. (count)	6/2002	10/2002	2	---	74.5	8.00	21.3	41.3	74.5	108	128	141	
Wtr Clarity Score	6/2009	2/2021	3,684	---	1.95	1.00	1.00	1.00	1.00	4.00	4.00	5.00	

Table B-52. Troy Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	5/1927	7/2020	3,228	6.8%	6.2%	6.9%	7.0%	9.9%	10.6%	9.9%	8.9%	9.3%	8.0%	8.4%	8.0%	
Wtr Elev (ft)	6/1998	2/2021	6,504	9.0%	8.7%	9.3%	7.9%	8.2%	8.2%	8.7%	8.6%	7.9%	7.7%	7.7%	8.2%	
Water Quality - Nutrients																
NOx-N (mg/L)	11/1960	1/2021	282	8.5%	3.9%	5.3%	7.8%	5.3%	9.9%	11.7%	10.6%	8.5%	12.1%	7.1%	9.2%	
TKN (mg/L)	3/1985	1/2021	241	9.5%	4.1%	6.2%	6.6%	6.2%	10.0%	11.6%	9.5%	8.7%	11.2%	7.5%	8.7%	
NH4-N (mg/L)	10/1973	1/2021	244	9.4%	4.1%	6.1%	6.6%	6.1%	9.8%	11.9%	9.8%	9.0%	11.1%	7.4%	8.6%	
TP (mg/L)	10/1973	1/2021	243	9.5%	4.1%	6.2%	6.6%	6.2%	9.9%	11.5%	9.5%	8.6%	11.9%	7.4%	8.6%	
OrthoP (mg/L)	10/1973	1/2021	217	9.2%	4.6%	6.0%	6.9%	6.0%	9.7%	12.4%	9.2%	8.8%	12.0%	6.5%	8.8%	
Water Quality - Biological																
Chl-a corr (µg/L)	6/2001	11/2020	27	11.1%	0.0%	3.7%	3.7%	7.4%	14.8%	7.4%	11.1%	7.4%	7.4%	18.5%	7.4%	
Water Quality - Physical / Field Parameters																
Color (PCU)	11/1960	1/2021	233	9.9%	4.3%	5.6%	6.9%	6.4%	9.9%	11.6%	9.0%	7.7%	11.6%	8.2%	9.0%	
Secchi (m)	11/1992	10/2020	215	9.3%	4.2%	6.0%	7.0%	6.0%	10.7%	11.6%	8.4%	8.8%	11.6%	7.4%	8.8%	
Turb (NTU)	10/1973	1/2021	231	10.0%	4.3%	5.2%	6.9%	6.5%	10.0%	11.7%	8.7%	7.8%	12.1%	7.8%	9.1%	
DO (mg/L)	10/1973	12/2020	267	8.6%	4.1%	5.6%	7.5%	5.6%	10.1%	10.5%	10.9%	8.6%	12.0%	7.5%	9.0%	
pH (SU)	11/1960	12/2020	275	8.4%	4.0%	5.5%	7.6%	5.5%	9.8%	10.9%	10.9%	8.7%	12.0%	7.6%	9.1%	
Wtr Temp (C)	11/1960	12/2020	273	8.4%	4.0%	5.5%	7.7%	5.9%	10.3%	11.0%	10.6%	8.4%	11.7%	7.7%	8.8%	
SpCond (umhos/cm)	11/1960	1/2021	279	8.6%	3.9%	5.4%	7.9%	5.4%	10.0%	10.8%	10.8%	8.6%	12.2%	7.5%	9.0%	
TDS (mg/L)	11/1960	1/2021	248	9.3%	4.4%	5.2%	7.3%	6.0%	10.1%	11.3%	10.1%	7.7%	11.7%	7.7%	9.3%	
Salinity (ppt)	10/2000	10/2020	153	9.8%	4.6%	5.9%	5.9%	7.8%	9.8%	9.8%	7.8%	9.8%	9.8%	7.8%	11.1%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	11/1960	1/2021	212	8.5%	4.2%	6.1%	5.7%	6.6%	10.8%	11.3%	9.9%	8.5%	9.4%	9.0%	9.9%	
CL-T (mg/L)	11/1960	1/2021	240	9.6%	4.2%	5.4%	6.7%	6.3%	9.6%	11.7%	10.0%	7.9%	12.1%	7.9%	8.8%	
F-T (mg/L)	9/1994	1/2021	217	10.6%	4.1%	5.5%	6.9%	6.5%	9.7%	11.5%	8.8%	7.8%	11.5%	7.8%	9.2%	
SO4-T (mg/L)	11/1992	1/2021	230	10.0%	4.3%	5.2%	7.0%	6.5%	10.0%	11.7%	8.7%	7.8%	11.7%	7.8%	9.1%	
TOC (mg/L)	10/1973	1/2021	224	10.3%	4.5%	5.4%	7.1%	6.7%	9.4%	11.6%	8.5%	7.6%	12.5%	7.6%	8.9%	
Park Attendance																
Park Att	3/1997	12/2020	8,674	8.2%	7.5%	8.2%	8.3%	8.5%	8.3%	8.6%	8.6%	8.3%	8.6%	8.3%	8.6%	
Biological																
Veg (%)	3/2017	3/2017	1	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Fish (#/m2)	3/2017	3/2017	1	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Manatee (count)	12/2019	2/2021	5	0.0%	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	80.0%	
Macroinvert. (count)	6/2002	10/2002	2	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	
Wtr Clarity Score	6/2009	2/2021	3,684	8.6%	8.7%	8.4%	6.5%	7.6%	8.1%	8.4%	8.4%	8.8%	9.2%	8.4%	8.7%	

Wacissa Headspring

Table B-53 provides a summary of monitoring station metadata for the Wacissa Headspring and River with station locations identified in Figure B-35. The water quality and hydrological data search area focused on the head spring, while the search area for biological data expanded into the spring run due to limited biological data available from the head spring. Flow data reported below are from the USGS station approximately 2.8 miles downstream from the head spring.

Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), SRWMD, and UF. Vegetation and macroinvertebrate data were provided by AMEC, while bioassessment data were from FDEP.

Table B-53. Wacissa Headspring / Spring Run Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLBRA	3424Z-A	30.34005	-83.99143	W	STORET
2	21FLGW	9719	30.33988	-83.99148	W	STORET
3	21FLGW	SR1LR2012	30.30945	-83.98314	B	FDEP
4	21FLGW	SR1LR2023	30.27261	-83.97012	B	FDEP
5	21FLGW	Z2LR10006	30.30015	-83.98026	B	FDEP
6	21FLGW	Z2LR12012	30.22896	-83.97218	B	FDEP
7	21FLGW	Z2LR6020	30.25891	-83.97221	B	FDEP
8	21FLGW	Z2LR9006	30.32020	-83.98756	B	FDEP
9	21FLGWMS	9719	30.33966	-83.98952	W	FDEP WIN, STORET
10	21FLSUW	2326518	30.33944	-83.99083	Q,S	SRWMD
11	21FLSUW	2326526	30.30139	-83.97944	Q	SRWMD
12	21FLSUW	WAS100C1	30.34000	-83.99139	W,Q,S	SRWMD, STORET
13	21FLWQSP	WACISSAHEADS	30.34003	-83.99136	W	STORET
14	AMEC	WAC 1	30.327034	-83.987714	V,MI	AMEC, 2016
15	UF	Wacissa Spring #2	30.34005	-83.99143	W	Strong, 2004
16	USGS	2326526	30.30111	-83.97972	Q,S	USGS NWIS

[1] 21FLBRA - Biological Research Associates; 21FLGW - FL Dept. of Environmental Protection; 21FLGWMS – FDEP Ground Water Monitoring Section; 21FLSUW - Suwannee River Water Management District; 21FLWQSP - FDEP Water Quality Standards and Special Projects; AMEC – Amec Foster Wheeler Environment & Infrastructure, Inc.; UF - University of Florida;USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage; V – vegetation; B – bioassessment; MI - macroinvertebrates

A temporal data availability summary (Figure B-36), period of record statistics (Table B-54), and seasonal distribution summary (Table B-55) were developed from available data for Wacissa Spring.

Additional continuous *in-situ* water quality data are available from USGS NWIS[35] for water temperature, specific conductance, dissolved oxygen, pH, and TDS (beginning on 1/27/2016)

---

[35] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=02326526

and for NOx-N (beginning on 2/16/18). All parameters continued through 2/9/2021[36], with the exception of TDS and NOx-N which ended on 9/30/18 and 1/21/21, respectively. These data are not included in the SRWMD OFS database.

---

[36] date website was accessed; visit above link for updated period of record

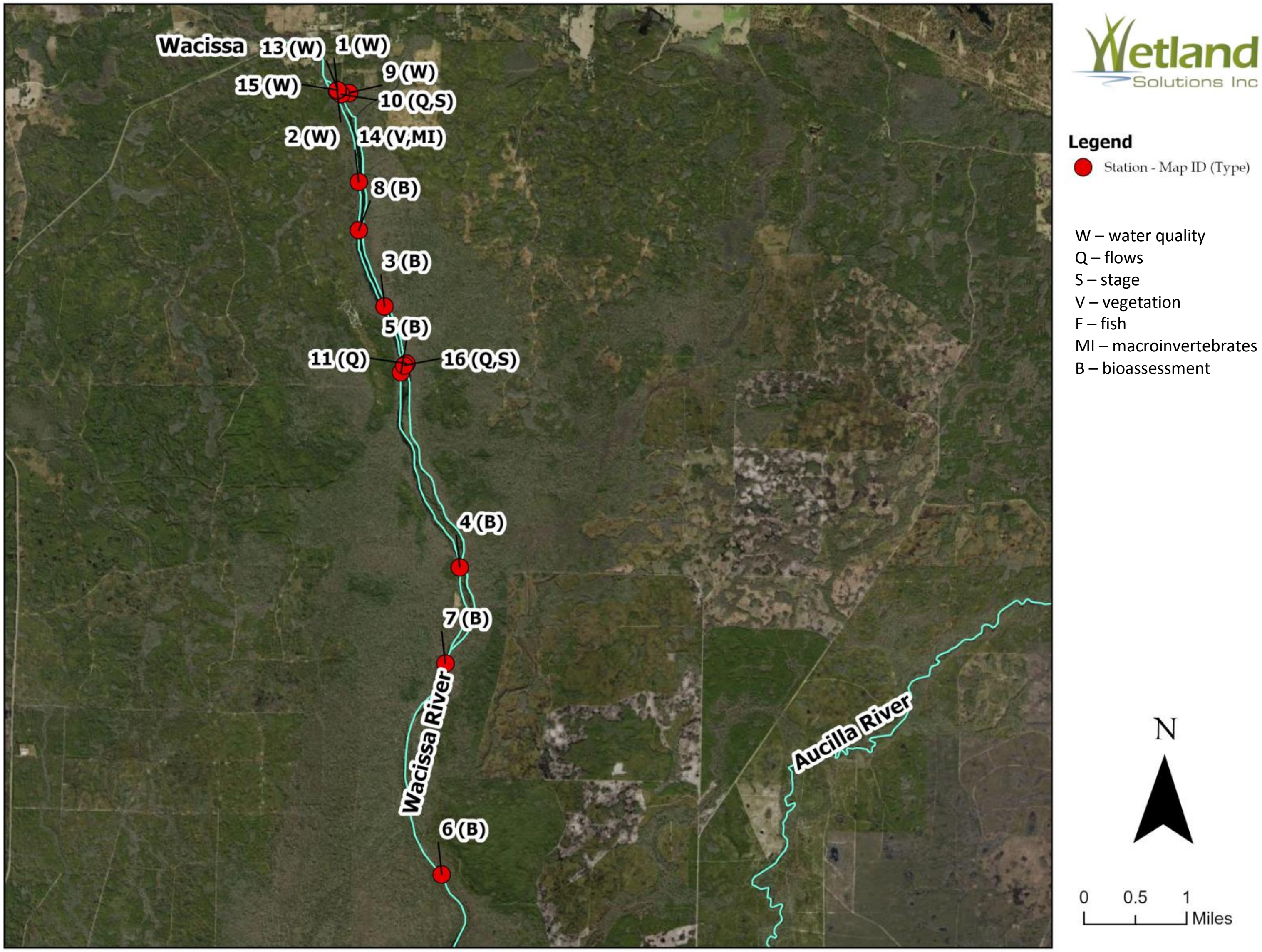


Figure B-35. Wacissa Headspring / Spring Run Station Locations

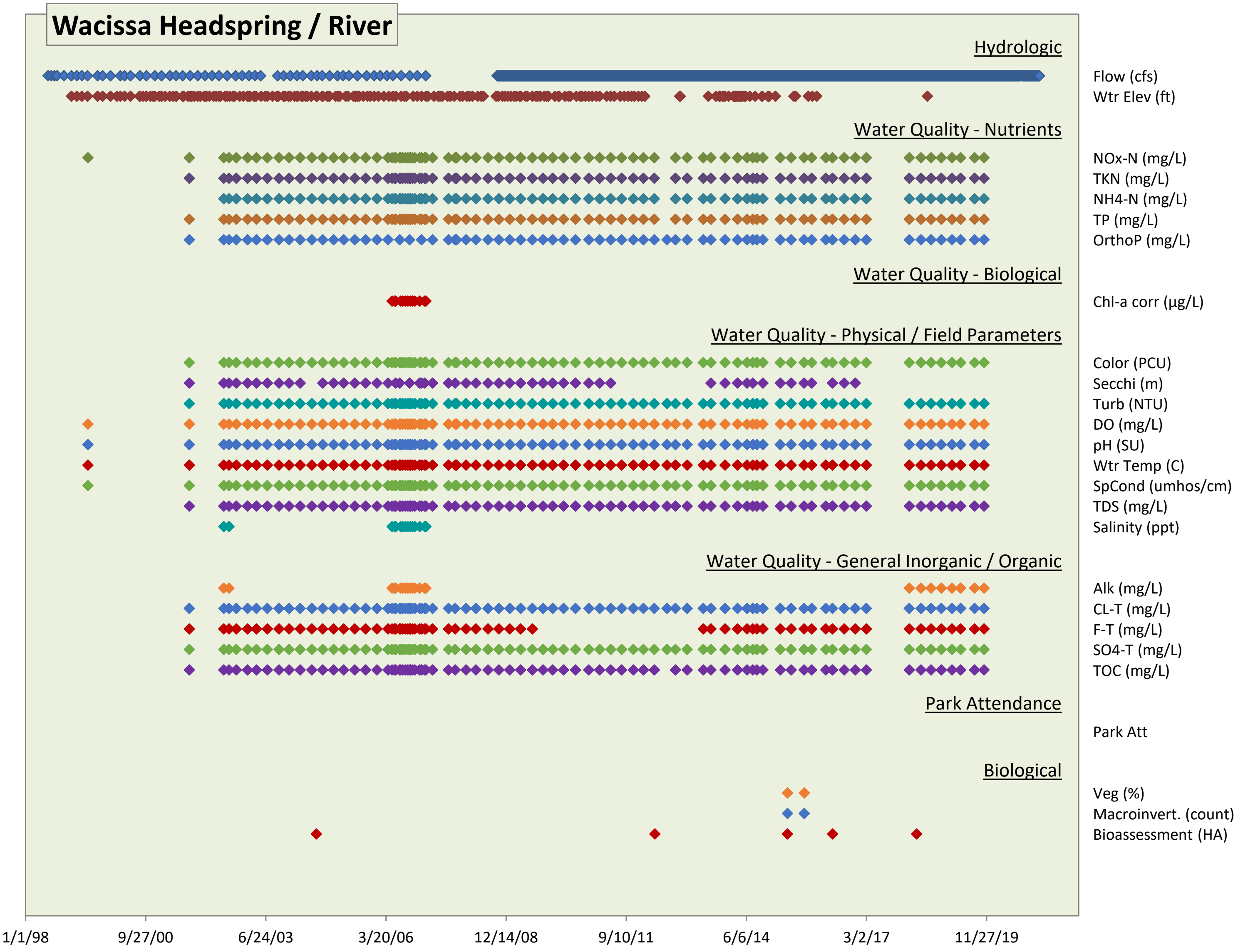


Figure B-36. Wacissa Headspring / Spring Run Temporal Data Availability Chart

Table B-54. Wacissa Headspring / Spring Run Database Inventory and Statistics

Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	6/1971	2/2021	4,564	---	377	159	265	296	350	438	529	1,200	
Wtr Elev (ft)	1/1999	7/2018	208	---	30.1	29.0	29.4	29.7	30.1	30.5	31.0	31.7	
Water Quality - Nutrients													
NOx-N (mg/L)	6/1999	11/2019	84	0%	0.415	0.240	0.343	0.380	0.420	0.455	0.474	0.520	
TKN (mg/L)	9/2001	11/2019	83	63%	0.109	0.060	0.080	0.080	0.080	0.112	0.170	0.340	
NH4-N (mg/L)	7/2002	11/2019	82	66%	0.010	0.002	0.002	0.005	0.010	0.010	0.017	0.070	
TP (mg/L)	9/2001	11/2019	83	1%	0.042	0.025	0.032	0.035	0.038	0.042	0.051	0.140	
OrthoP (mg/L)	9/2001	11/2019	71	0%	0.034	0.029	0.031	0.032	0.034	0.036	0.037	0.038	
Water Quality - Biological													
Chl-a corr (µg/L)	5/2006	2/2007	13	77%	2.09	1.00	1.00	1.05	2.60	2.60	2.68	5.30	
Water Quality - Physical / Field Parameters													
Color (PCU)	9/2001	11/2019	84	56%	7.27	2.00	2.50	3.33	5.00	5.00	15.0	40.0	
Secchi (m)	9/2001	11/2016	53	19%	2.84	0.750	1.52	2.10	2.60	3.70	4.00	9.20	
Turb (NTU)	9/2001	11/2019	84	0%	0.413	0.050	0.150	0.200	0.300	0.503	0.847	1.50	
DO (mg/L)	6/1999	11/2019	85	0%	3.29	2.01	2.43	2.70	2.97	3.41	4.62	7.42	
pH (SU)	6/1999	11/2019	85	0%	7.47	6.25	7.14	7.40	7.50	7.60	7.70	8.09	
Wtr Temp (C)	6/1999	11/2019	85	0%	20.9	19.6	20.2	20.6	20.9	21.3	21.8	23.2	
SpCond (umhos/cm)	6/1999	11/2019	85	0%	273	132	250	264	274	280	287	766	
TDS (mg/L)	9/2001	11/2019	83	0%	153	91.0	140	148	153	159	164	195	
Salinity (ppt)	7/2002	2/2007	15	0%	0.125	0.100	0.108	0.125	0.130	0.130	0.130	0.130	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	7/2002	11/2019	23	0%	129	120	121	125	130	134	136	140	
CL-T (mg/L)	9/2001	11/2019	83	0%	5.53	4.35	5.00	5.18	5.40	5.50	5.60	24.0	
F-T (mg/L)	9/2001	11/2019	69	3%	0.145	0.053	0.110	0.140	0.150	0.160	0.160	0.420	
SO4-T (mg/L)	9/2001	11/2019	83	0%	5.34	3.90	4.60	4.85	5.10	5.30	5.58	26.5	
TOC (mg/L)	9/2001	11/2019	82	41%	1.17	0.300	0.591	0.763	1.00	1.20	1.87	4.20	
Biological													
Veg (%)	5/2015	10/2015	2	---	34.5	24.3	26.4	29.4	34.5	39.6	42.7	44.8	
Macroinvert. (count)	5/2015	10/2015	2	---	2,440	1,390	1,600	1,915	2,440	2,965	3,280	3,490	
Bioassessment (HA)	8/2004	4/2018	5	---	139	125	129	136	137	145	149	151	

Table B-55. Wacissa Headspring / Spring Run Data Seasonal Distribution

Parameter	Period of Record		Count	Monthly Distribution												
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	6/1971	2/2021	4,564	8.9%	7.8%	8.3%	8.0%	8.3%	8.0%	8.3%	8.1%	7.6%	9.0%	8.6%	9.0%	
Wtr Elev (ft)	1/1999	7/2018	208	7.2%	8.7%	8.7%	8.7%	7.7%	6.3%	8.7%	8.2%	6.7%	9.6%	8.2%	11.5%	
Water Quality - Nutrients																
NOx-N (mg/L)	6/1999	11/2019	84	10.7%	7.1%	4.8%	10.7%	6.0%	7.1%	11.9%	10.7%	4.8%	15.5%	7.1%	3.6%	
TKN (mg/L)	9/2001	11/2019	83	10.8%	7.2%	4.8%	10.8%	6.0%	6.0%	12.0%	10.8%	4.8%	15.7%	7.2%	3.6%	
NH4-N (mg/L)	7/2002	11/2019	82	11.0%	7.3%	4.9%	11.0%	6.1%	6.1%	12.2%	11.0%	3.7%	15.9%	7.3%	3.7%	
TP (mg/L)	9/2001	11/2019	83	10.8%	7.2%	4.8%	10.8%	6.0%	6.0%	12.0%	10.8%	4.8%	15.7%	7.2%	3.6%	
OrthoP (mg/L)	9/2001	11/2019	71	12.7%	5.6%	5.6%	12.7%	5.6%	4.2%	12.7%	11.3%	4.2%	15.5%	7.0%	2.8%	
Water Quality - Biological																
Chl-a corr (µg/L)	5/2006	2/2007	13	0.0%	15.4%	0.0%	0.0%	7.7%	15.4%	7.7%	15.4%	7.7%	15.4%	7.7%	7.7%	
Water Quality - Physical / Field Parameters																
Color (PCU)	9/2001	11/2019	84	10.7%	7.1%	4.8%	10.7%	6.0%	6.0%	11.9%	11.9%	4.8%	15.5%	7.1%	3.6%	
Secchi (m)	9/2001	11/2016	53	15.1%	3.8%	3.8%	15.1%	3.8%	5.7%	15.1%	7.5%	3.8%	17.0%	3.8%	5.7%	
Turb (NTU)	9/2001	11/2019	84	10.7%	7.1%	4.8%	10.7%	6.0%	6.0%	11.9%	11.9%	4.8%	15.5%	7.1%	3.6%	
DO (mg/L)	6/1999	11/2019	85	10.6%	7.1%	4.7%	10.6%	5.9%	7.1%	11.8%	11.8%	4.7%	15.3%	7.1%	3.5%	
pH (SU)	6/1999	11/2019	85	10.6%	7.1%	4.7%	10.6%	5.9%	7.1%	11.8%	11.8%	4.7%	15.3%	7.1%	3.5%	
Wtr Temp (C)	6/1999	11/2019	85	10.6%	7.1%	4.7%	10.6%	5.9%	7.1%	11.8%	11.8%	4.7%	15.3%	7.1%	3.5%	
SpCond (umhos/cm)	6/1999	11/2019	85	10.6%	7.1%	4.7%	10.6%	5.9%	7.1%	11.8%	11.8%	4.7%	15.3%	7.1%	3.5%	
TDS (mg/L)	9/2001	11/2019	83	10.8%	7.2%	4.8%	10.8%	6.0%	6.0%	12.0%	12.0%	4.8%	14.5%	7.2%	3.6%	
Salinity (ppt)	7/2002	2/2007	15	0.0%	13.3%	0.0%	0.0%	6.7%	13.3%	13.3%	20.0%	6.7%	13.3%	6.7%	6.7%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	7/2002	11/2019	23	0.0%	17.4%	0.0%	4.3%	8.7%	8.7%	8.7%	21.7%	4.3%	8.7%	13.0%	4.3%	
CL-T (mg/L)	9/2001	11/2019	83	10.8%	7.2%	4.8%	10.8%	6.0%	6.0%	12.0%	12.0%	4.8%	14.5%	7.2%	3.6%	
F-T (mg/L)	9/2001	11/2019	69	10.1%	5.8%	5.8%	11.6%	4.3%	7.2%	13.0%	11.6%	5.8%	14.5%	5.8%	4.3%	
SO4-T (mg/L)	9/2001	11/2019	83	10.8%	7.2%	4.8%	10.8%	6.0%	6.0%	12.0%	12.0%	4.8%	14.5%	7.2%	3.6%	
TOC (mg/L)	9/2001	11/2019	82	11.0%	7.3%	4.9%	11.0%	6.1%	6.1%	12.2%	11.0%	4.9%	14.6%	7.3%	3.7%	
Biological																
Veg (%)	5/2015	10/2015	2	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	
Macroinvert. (count)	5/2015	10/2015	2	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	
Bioassessment (HA)	8/2004	4/2018	5	0.0%	0.0%	0.0%	20.0%	60.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%	0.0%	

White Sulphur Spring

Table B-56 provides a summary of monitoring station metadata for White Sulphur Spring with station locations identified in Figure B-37. Detailed water quality and hydrological data were available from the FDEP (Florida STORET, WIN), USGS (NWIS), and SRWMD. No biological data were identified for this system. Stephen Foster Folk Culture Center State Park attendance data were supplied by the FDEP Division of Recreation and Parks.

Table B-56. White Sulphur Spring Stations

Map ID	Organization ID[1]	Location ID	Latitude	Longitude	Type [2]	Source
1	21FLSUW	127887	30.32984	-82.76089	W,S	FDEP WIN
2	21FLSUW	WHS010C1	30.32972	-82.76111	W,Q,S	SRWMD, STORET
3	21FLSUW	2315503	*30.33306*	*-82.76083*	Q,S	SRWMD
4	UF	White Springs	30.32972	-82.76111	W	Strong, 2004
5	USGS	2315503	30.32972	-82.76111	W,Q	USGS NWIS
6	USGS	301947082454000	30.32972	-82.76111	Q	USGS NWIS

[1] 21FLSUW - Suwannee River Water Management District; UF – University of Florida; USGS - U.S. Geological Survey

[2] W – water quality; Q – flows; S – stage;

A temporal daily data availability summary (Figure B-38), period of record statistics (Table B-57), and seasonal distribution summary (Table B-58) were developed from available data for White Sulphur Spring. Additional screening of water elevation data will be necessary to investigate possible datum differences.

Additional continuous *in-situ* water quality data are available from the SRWMD Water Data Portal[37] for specific conductance from 8/1/2019 to 2/11/2021[38].

---

[37] http://www.mysuwanneeriver.org/data/CondData/02315503/02315503_Conductivity.xlsx

[38] date website was accessed; visit above link for updated period of record

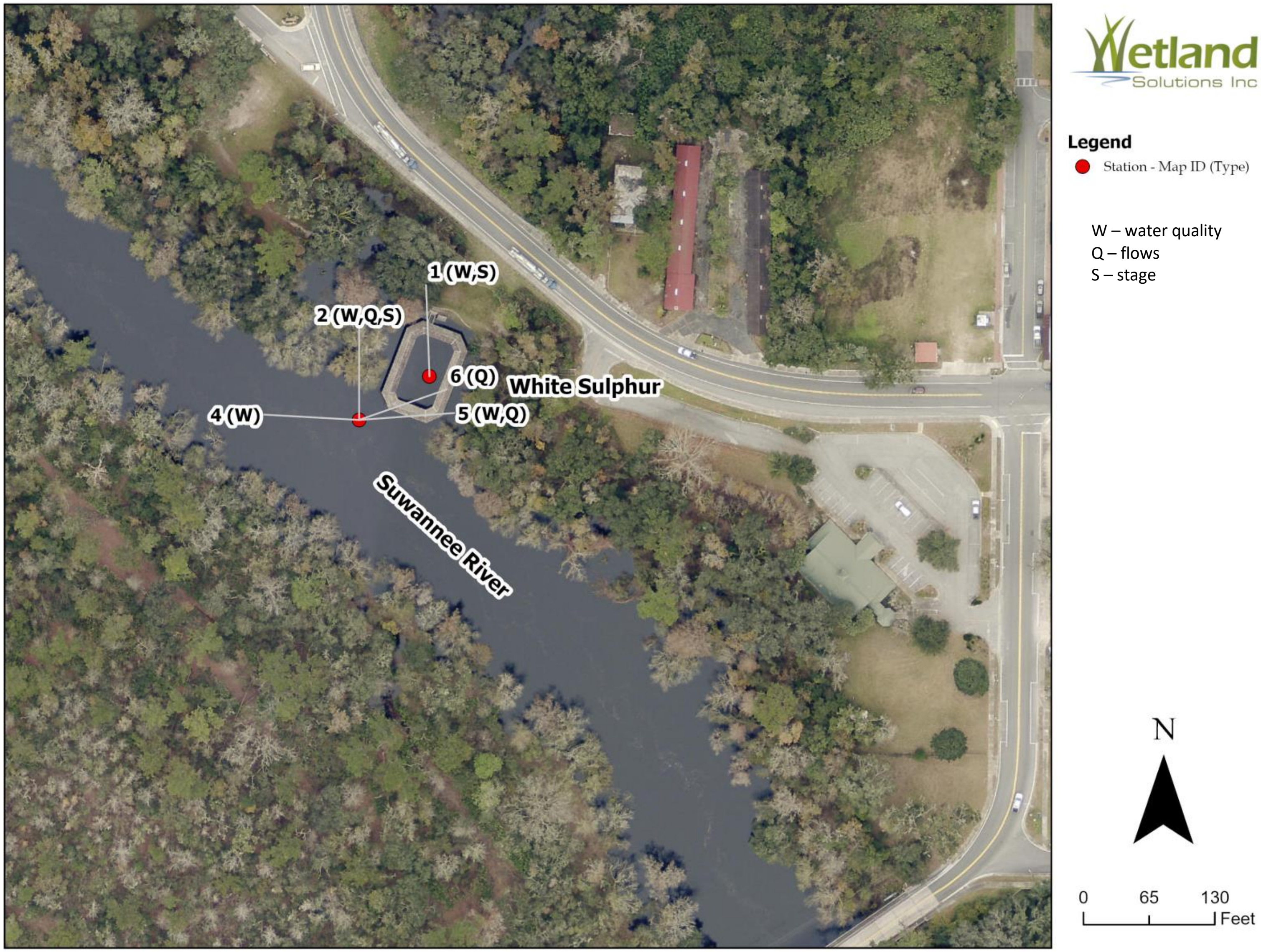


Figure B-37. White Sulphur Spring Station Locations

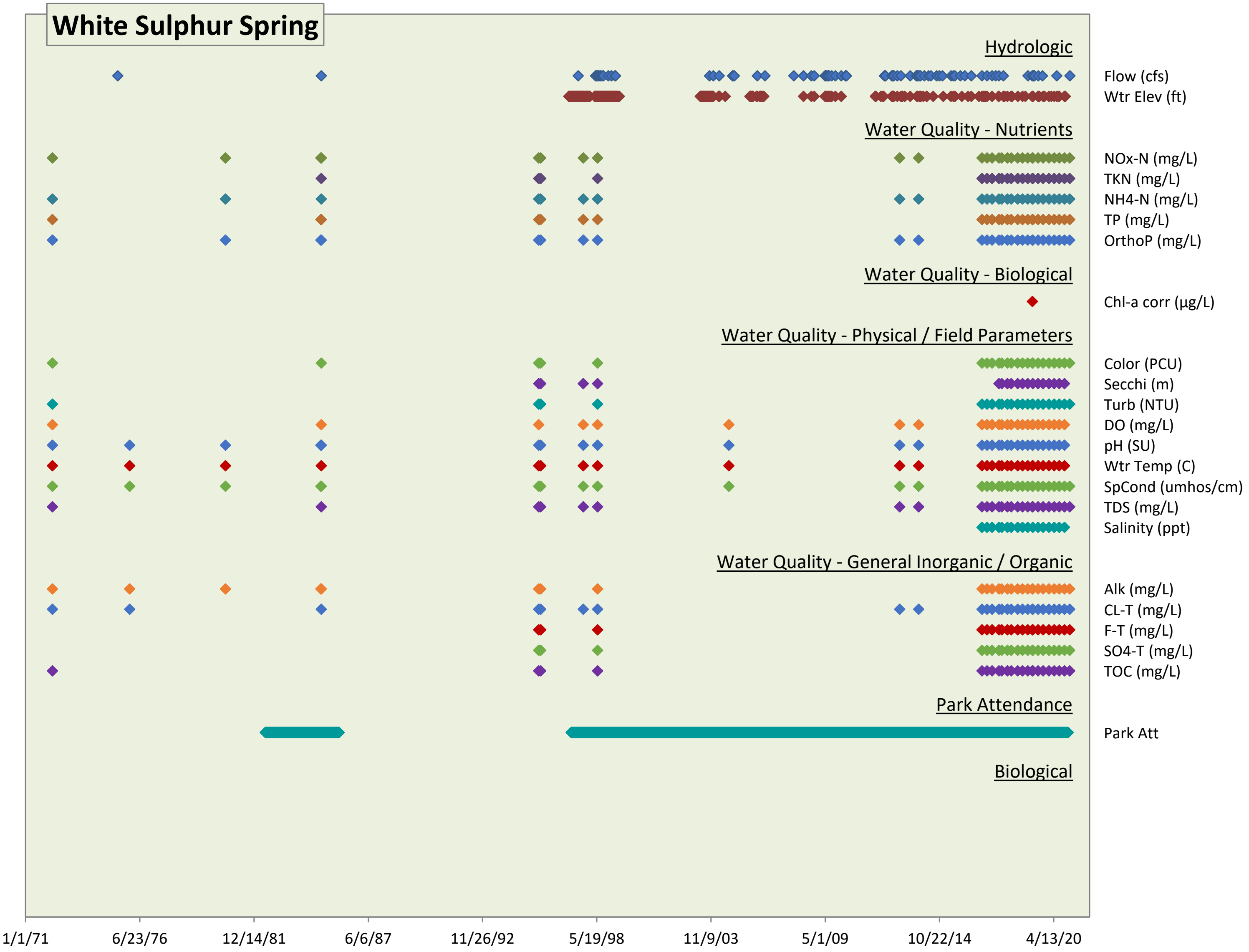


Figure B-38. White Sulphur Spring Temporal Data Availability Chart

Table B-57. White Sulphur Spring Database Inventory and Statistics

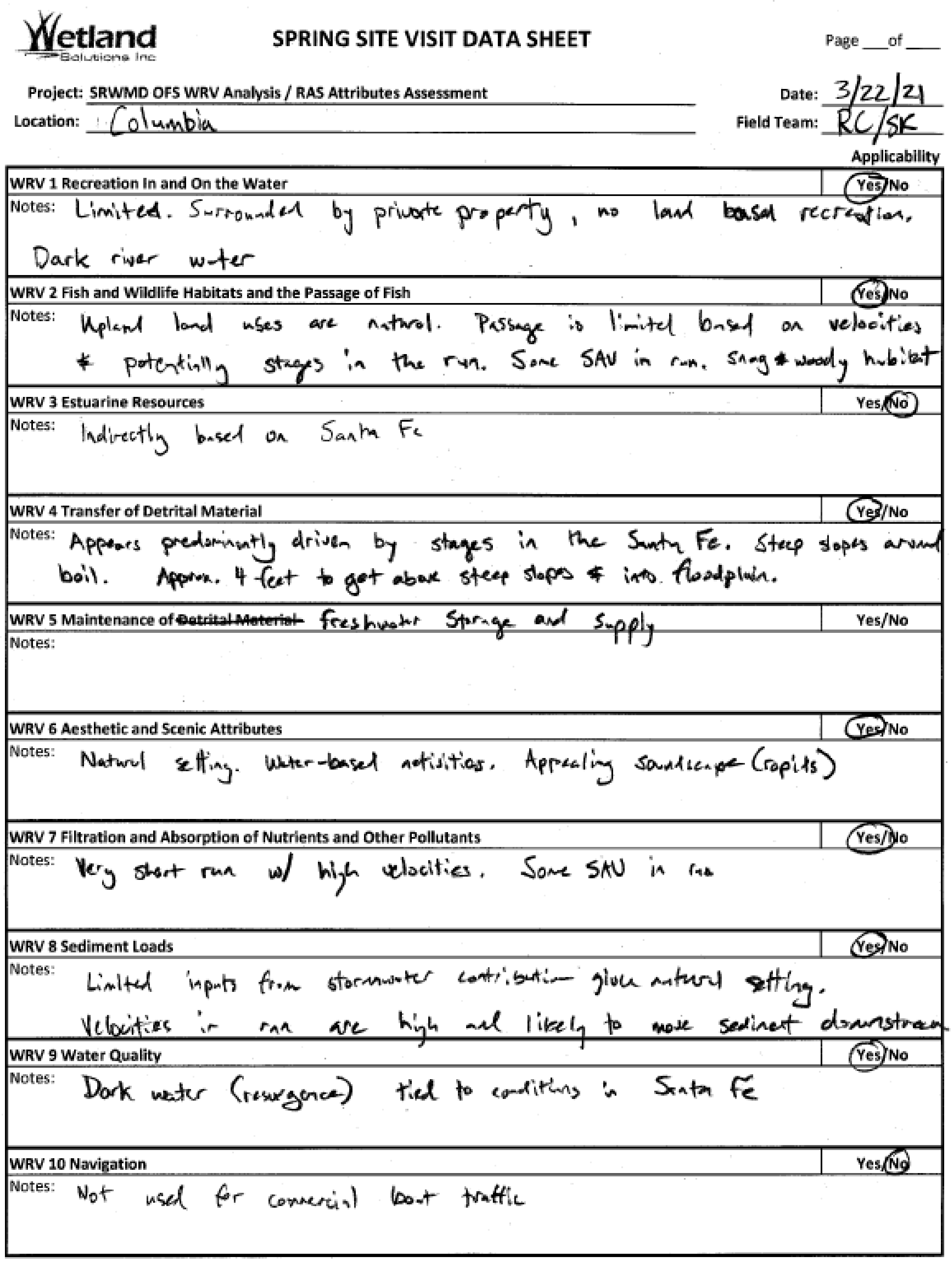
Parameter	Period of Record		Count	Percent BDL	Average	Percentile							
						0	10	25	50	75	90	100	Chart
Hydrologic													
Flow (cfs)	2/1907	1/2021	109	---	13.0	-134	-21.2	0.00	10.3	33.0	57.3	230	
Wtr Elev (ft)	1/1997	11/2020	266	---	51.4	0.850	49.7	52.8	53.6	55.0	57.8	68.3	
Water Quality - Nutrients													
NOx-N (mg/L)	4/1956	1/2021	31	29%	0.026	-0.001	0.007	0.009	0.012	0.026	0.040	0.280	
TKN (mg/L)	3/1985	1/2021	23	0%	1.43	0.140	0.195	0.232	0.363	0.923	6.00	8.82	
NH4-N (mg/L)	4/1972	1/2021	28	4%	0.779	0.004	0.010	0.036	0.103	0.125	1.83	8.34	
TP (mg/L)	4/1972	1/2021	26	0%	0.361	0.073	0.114	0.154	0.167	0.203	0.843	2.66	
OrthoP (mg/L)	4/1972	1/2021	29	0%	0.223	0.057	0.110	0.120	0.141	0.174	0.189	1.41	
Water Quality - Biological													
Chl-a corr (µg/L)	4/2019	4/2019	1	100%	0.540	0.540	0.540	0.540	0.540	0.540	0.540	0.540	
Water Quality - Physical / Field Parameters													
Color (PCU)	4/1956	1/2021	26	0%	168	10.0	34.0	55.8	110	220	429	611	
Secchi (m)	8/1995	10/2020	18	44%	1.07	0.200	0.470	0.625	0.850	1.36	1.72	3.20	
Turb (NTU)	4/1972	1/2021	23	26%	2.51	0.100	0.513	0.568	0.906	1.40	7.61	18.7	
DO (mg/L)	4/1972	10/2020	26	0%	1.72	0.100	0.175	0.250	0.400	2.14	5.89	6.85	
pH (SU)	9/1923	10/2020	34	0%	6.88	3.62	6.29	6.67	7.20	7.42	7.68	8.10	
Wtr Temp (C)	4/1956	10/2020	31	0%	21.6	12.4	19.4	19.9	21.2	21.7	23.1	46.4	
SpCond (umhos/cm)	9/1923	1/2021	35	0%	261	59.1	166	228	255	282	372	643	
TDS (mg/L)	4/1956	1/2021	29	0%	179	102	124	155	166	173	264	360	
Salinity (ppt)	11/2016	10/2020	17	0%	0.120	0.030	0.030	0.090	0.120	0.140	0.218	0.240	
Water Quality - General Inorganic / Organic													
Alk (mg/L)	4/1956	1/2021	29	7%	127	0.500	62.6	110	118	138	189	358	
CL-T (mg/L)	9/1923	1/2021	32	0%	5.71	2.00	4.14	4.85	5.35	6.45	7.30	12.0	
F-T (mg/L)	8/1995	1/2021	22	0%	0.162	0.051	0.068	0.120	0.129	0.139	0.383	0.475	
SO4-T (mg/L)	8/1995	1/2021	22	59%	2.41	0.146	0.709	1.05	2.60	3.21	3.94	4.75	
TOC (mg/L)	4/1972	1/2021	23	0%	20.2	2.90	5.17	6.48	15.3	25.8	50.9	69.3	
Park Attendance													
Park Att	7/1982	12/2020	9,990	---	257	0.00	46.0	82.0	142	233	394	11,517	

Table B-58. White Sulphur Spring Data Seasonal Distribution

				Monthly Distribution												
Parameter	Period of Record		Count	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Chart
Hydrologic																
Flow (cfs)	2/1907	1/2021	109	4.6%	3.7%	6.4%	13.8%	17.4%	8.3%	12.8%	5.5%	5.5%	9.2%	7.3%	5.5%	
Wtr Elev (ft)	1/1997	11/2020	266	7.9%	4.9%	6.8%	10.2%	9.8%	7.1%	12.0%	9.4%	7.5%	8.3%	8.3%	7.9%	
Water Quality - Nutrients																
NOx-N (mg/L)	4/1956	1/2021	31	12.9%	3.2%	6.5%	19.4%	3.2%	3.2%	9.7%	9.7%	6.5%	16.1%	9.7%	0.0%	
TKN (mg/L)	3/1985	1/2021	23	17.4%	4.3%	4.3%	17.4%	4.3%	4.3%	13.0%	8.7%	4.3%	17.4%	4.3%	0.0%	
NH4-N (mg/L)	4/1972	1/2021	28	14.3%	3.6%	3.6%	17.9%	3.6%	3.6%	10.7%	10.7%	7.1%	17.9%	7.1%	0.0%	
TP (mg/L)	4/1972	1/2021	26	15.4%	3.8%	7.7%	19.2%	3.8%	3.8%	11.5%	7.7%	7.7%	15.4%	3.8%	0.0%	
OrthoP (mg/L)	4/1972	1/2021	29	13.8%	3.4%	6.9%	17.2%	3.4%	3.4%	10.3%	10.3%	6.9%	17.2%	6.9%	0.0%	
Water Quality - Biological																
Chl-a corr (µg/L)	4/2019	4/2019	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Water Quality - Physical / Field Parameters																
Color (PCU)	4/1956	1/2021	26	15.4%	3.8%	3.8%	23.1%	3.8%	3.8%	11.5%	7.7%	3.8%	15.4%	7.7%	0.0%	
Secchi (m)	8/1995	10/2020	18	16.7%	0.0%	0.0%	16.7%	0.0%	5.6%	16.7%	11.1%	11.1%	22.2%	0.0%	0.0%	
Turb (NTU)	4/1972	1/2021	23	17.4%	4.3%	0.0%	21.7%	4.3%	4.3%	13.0%	8.7%	4.3%	17.4%	4.3%	0.0%	
DO (mg/L)	4/1972	10/2020	26	11.5%	3.8%	3.8%	19.2%	3.8%	3.8%	11.5%	7.7%	7.7%	19.2%	7.7%	0.0%	
pH (SU)	9/1923	10/2020	34	11.8%	2.9%	5.9%	17.6%	5.9%	2.9%	8.8%	8.8%	11.8%	14.7%	8.8%	0.0%	
Wtr Temp (C)	4/1956	10/2020	31	12.9%	3.2%	3.2%	19.4%	3.2%	3.2%	9.7%	9.7%	9.7%	16.1%	9.7%	0.0%	
SpCond (umhos/cm)	9/1923	1/2021	35	14.3%	2.9%	5.7%	17.1%	5.7%	2.9%	8.6%	8.6%	11.4%	14.3%	8.6%	0.0%	
TDS (mg/L)	4/1956	1/2021	29	13.8%	3.4%	3.4%	20.7%	3.4%	3.4%	10.3%	6.9%	6.9%	17.2%	10.3%	0.0%	
Salinity (ppt)	11/2016	10/2020	17	17.6%	5.9%	0.0%	17.6%	5.9%	0.0%	17.6%	5.9%	0.0%	23.5%	5.9%	0.0%	
Water Quality - General Inorganic / Organic																
Alk (mg/L)	4/1956	1/2021	29	17.2%	3.4%	6.9%	20.7%	3.4%	3.4%	10.3%	10.3%	3.4%	13.8%	6.9%	0.0%	
CL-T (mg/L)	9/1923	1/2021	32	15.6%	3.1%	3.1%	18.8%	6.3%	3.1%	9.4%	6.3%	9.4%	15.6%	9.4%	0.0%	
F-T (mg/L)	8/1995	1/2021	22	18.2%	4.5%	0.0%	18.2%	4.5%	4.5%	13.6%	9.1%	4.5%	18.2%	4.5%	0.0%	
SO4-T (mg/L)	8/1995	1/2021	22	18.2%	4.5%	0.0%	18.2%	4.5%	4.5%	13.6%	9.1%	4.5%	18.2%	4.5%	0.0%	
TOC (mg/L)	4/1972	1/2021	23	17.4%	4.3%	0.0%	21.7%	4.3%	4.3%	13.0%	8.7%	4.3%	17.4%	4.3%	0.0%	
Park Attendance																
Park Att	7/1982	12/2020	9,990	8.2%	7.4%	8.4%	8.1%	8.4%	8.1%	8.7%	8.7%	8.4%	8.7%	8.4%	8.6%	

Appendix C

Site Visit Data Sheets



SPRING SITE VISIT DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/22/21

Location: Columbia

Field Team: RC/SK

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Limited. Surrounded by private property, no land based recreation. Dark river water

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Upland land uses are natural. Passage is limited based on velocities & potentially stages in the run. Some SAV in run. Snag & woody habitat

WRV 3 Estuarine Resources Yes/[✓ No]

Notes: Indirectly based on Santa Fe

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Appears predominantly driven by stages in the Santa Fe. Steep slopes around boil. Approx. 4 feet to get above steep slopes & into floodplain.

WRV 5 Maintenance of ~~Detrital Material~~ Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Natural setting. Water-based activities. Appealing soundscape (rapids)

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Very short run w/ high velocities. Some SAV in run

WRV 8 Sediment Loads [✓ Yes]/No

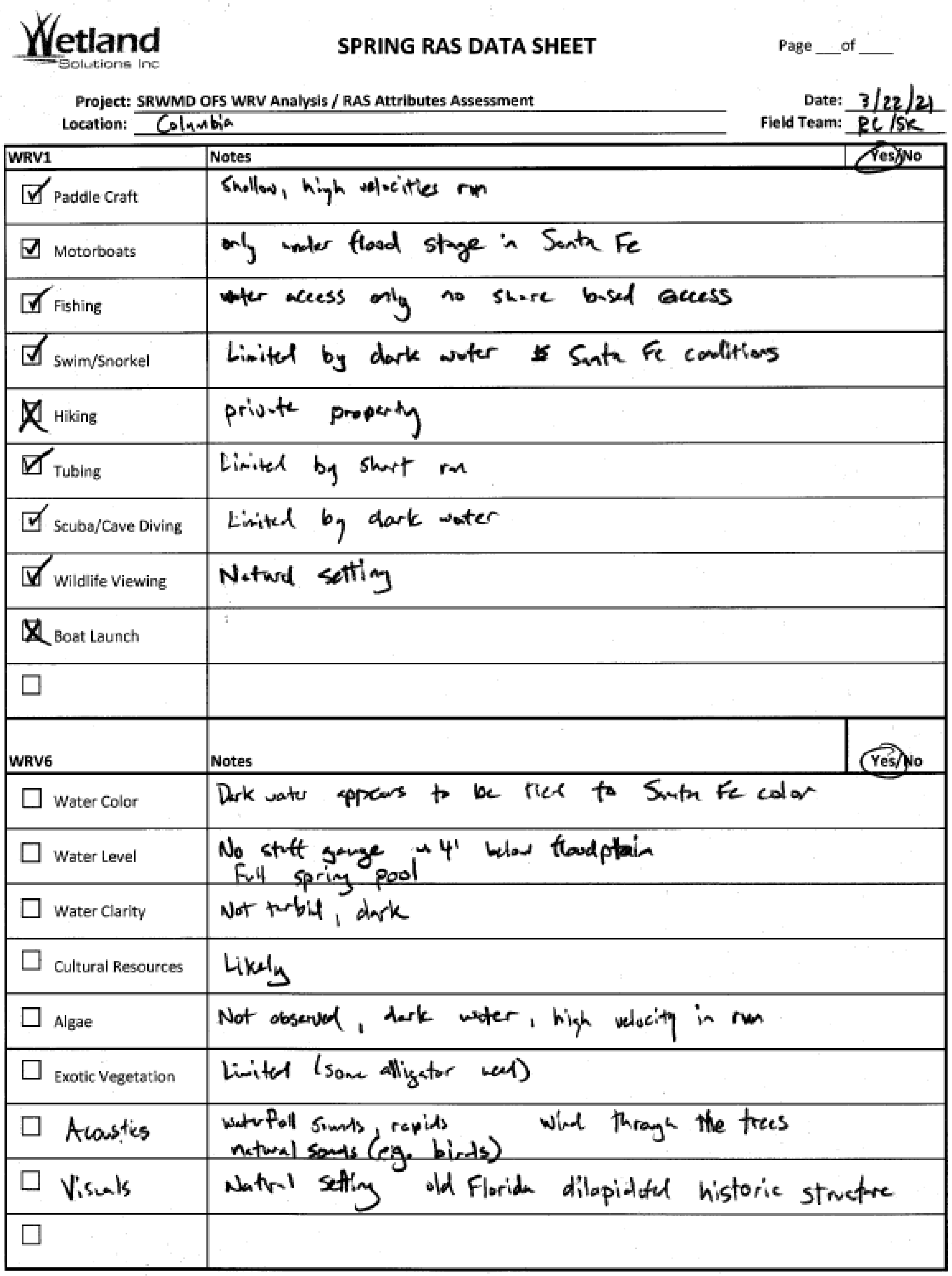
Notes: Limited inputs from stormwater contribution given natural setting. Velocities in run are high and likely to move sediment downstream

WRV 9 Water Quality [✓ Yes]/No

Notes: Dark water (resurgence) tied to conditions in Santa Fe

WRV 10 Navigation Yes/[✓ No]

Notes: Not used for commercial boat traffic



Wetland Solutions Inc

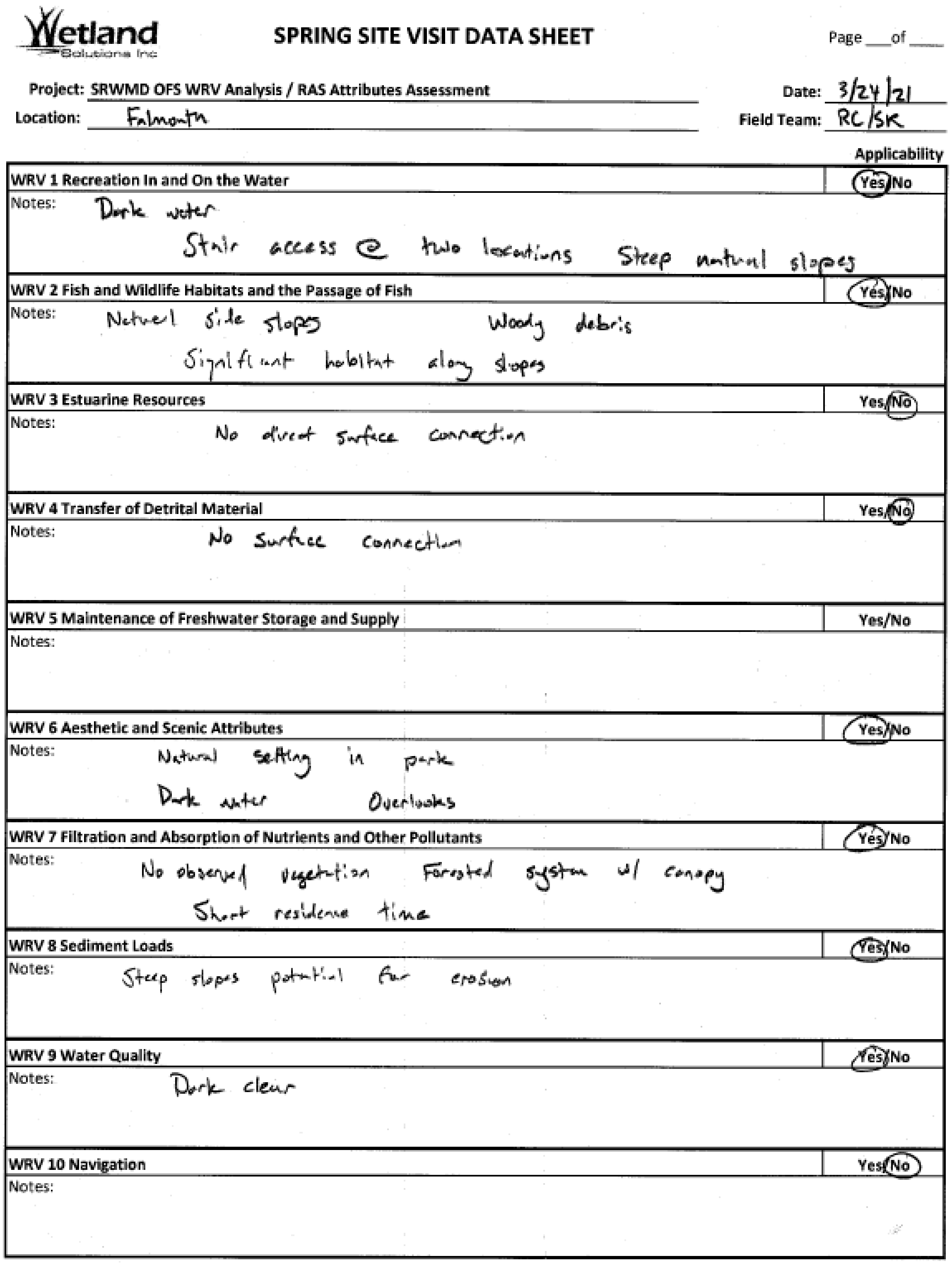
SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Location: Columbia
Date: 3/22/21
Field Team: RC/SK

WRV1	Notes	[✓ Yes]/No
☑ Paddle Craft	Shallow, high velocities run	
☑ Motorboats	only under flood stage in Santa Fe	
☑ Fishing	water access only no shore based access	
☑ Swim/Snorkel	Limited by dark water ~~&~~ Santa Fe conditions	
☒ Hiking	private property	
☑ Tubing	Limited by short run	
☑ Scuba/Cave Diving	Limited by dark water	
☑ Wildlife Viewing	Natural setting	
☒ Boat Launch		
☐		

WRV6	Notes	[✓ Yes]/No
☐ Water Color	Dark water appears to be tied to Santa Fe color	
☐ Water Level	No staff gauge ~4' below floodplain Full spring pool	
☐ Water Clarity	Not turbid, dark	
☐ Cultural Resources	Likely	
☐ Algae	Not observed, dark water, high velocity in run	
☐ Exotic Vegetation	Limited (some alligator weed)	
☐ Acoustics	waterfall sounds, rapids wind through the trees natural sounds (e.g. birds)	
☐ Visuals	Natural setting old Florida dilapidated historic structure	
☐		



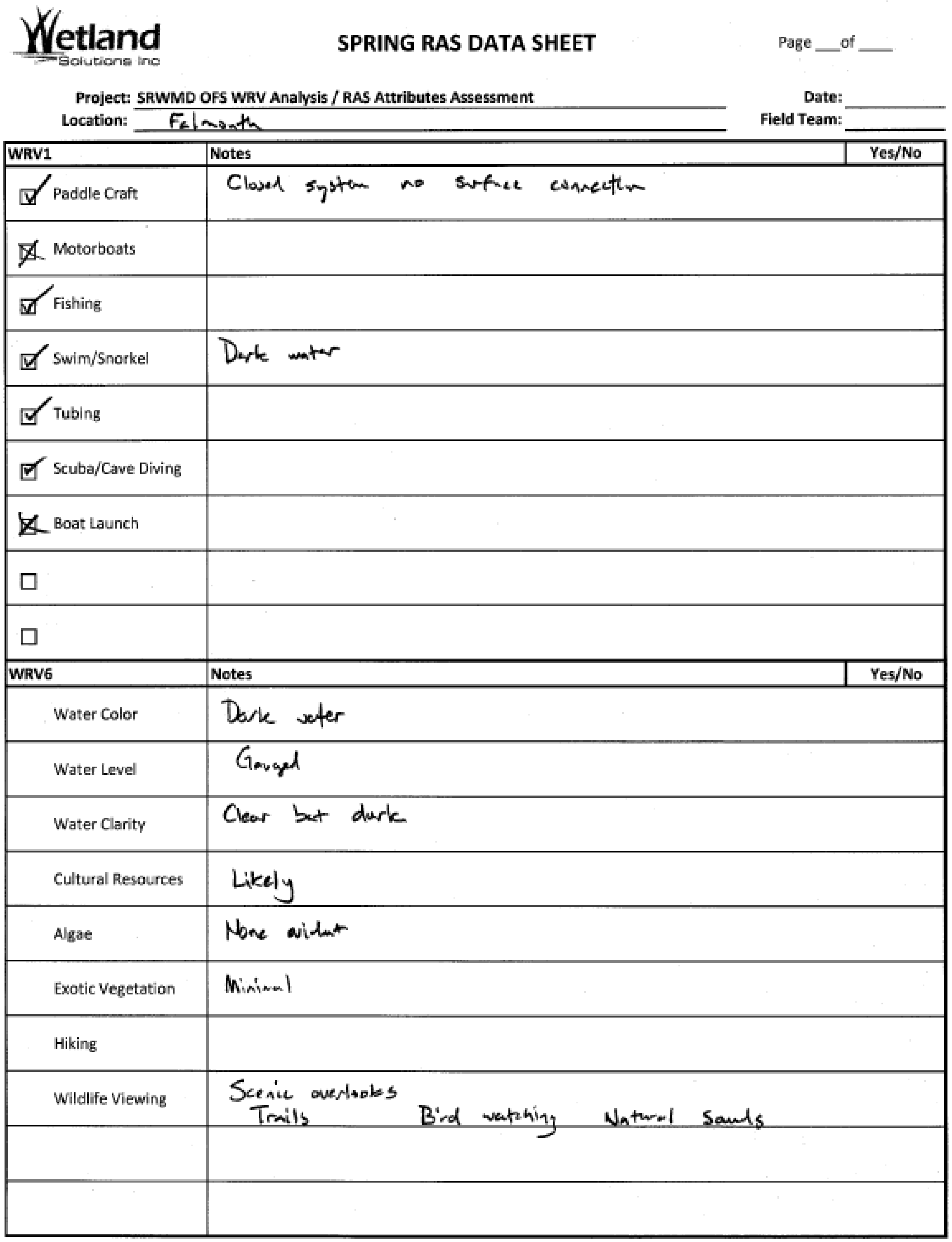
Wetland Solutions Inc

SPRING SITE VISIT DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Date: 3/24/21
Location: Falmouth
Field Team: RC/SK

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Dark water Stair access @ two locations Steep natural slopes	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Natural side slopes Woody debris Significant habitat along slopes	
WRV 3 Estuarine Resources	Yes/[✓ No]
Notes: No direct surface connection	
WRV 4 Transfer of Detrital Material	Yes/[✓ No]
Notes: No surface connection	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Natural setting in park Dark water Overlooks	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: No observed vegetation Forested system w/ canopy Short residence time	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Steep slopes potential for erosion	
WRV 9 Water Quality	[✓ Yes]/No
Notes: Dark clear	
WRV 10 Navigation	Yes/[✓ No]
Notes:	



SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

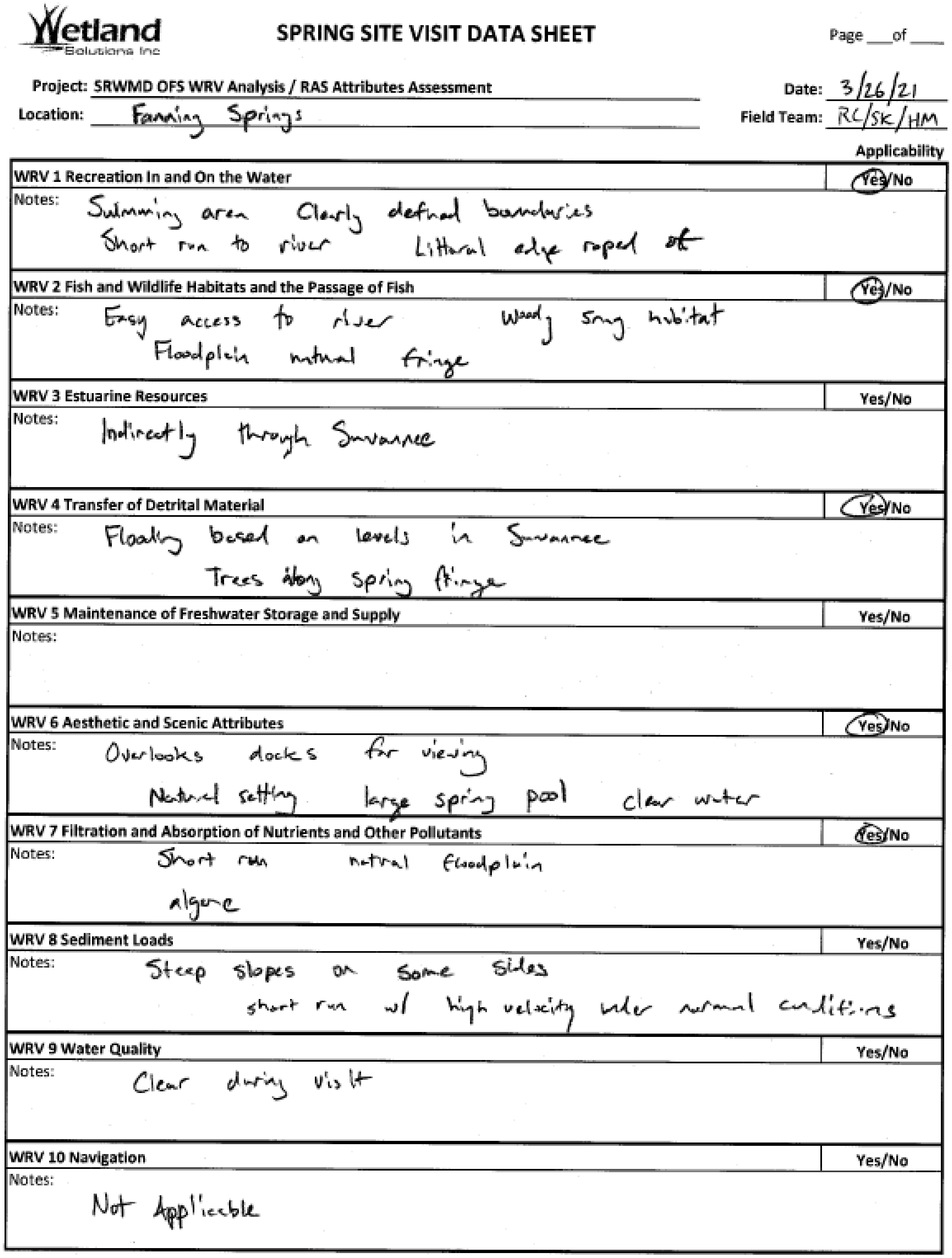
Location: Falmouth

Date: ________

Field Team: ________

WRV1	Notes	Yes/No
☑ Paddle Craft	Closed system no surface connection	
☒ Motorboats		
☑ Fishing		
☑ Swim/Snorkel	Dark water	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Dark water	
Water Level	Gauged	
Water Clarity	Clear but dark	
Cultural Resources	Likely	
Algae	None evident	
Exotic Vegetation	Minimal	
Hiking		
Wildlife Viewing	Scenic overlooks Trails Bird watching Natural Sounds	



Wetland Solutions Inc

SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/26/21

Location: Fanning Springs

Field Team: RC/SK/HM

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Swimming area Clearly defined boundaries
Short run to river Littoral edge roped off

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Easy access to river Woody snag habitat
Floodplain natural fringe

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Suwannee

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Flooding based on levels in Suwannee
Trees along spring fringe

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Overlooks docks for viewing
Natural setting large spring pool clear water

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Short run natural floodplain
algae

WRV 8 Sediment Loads Yes/No

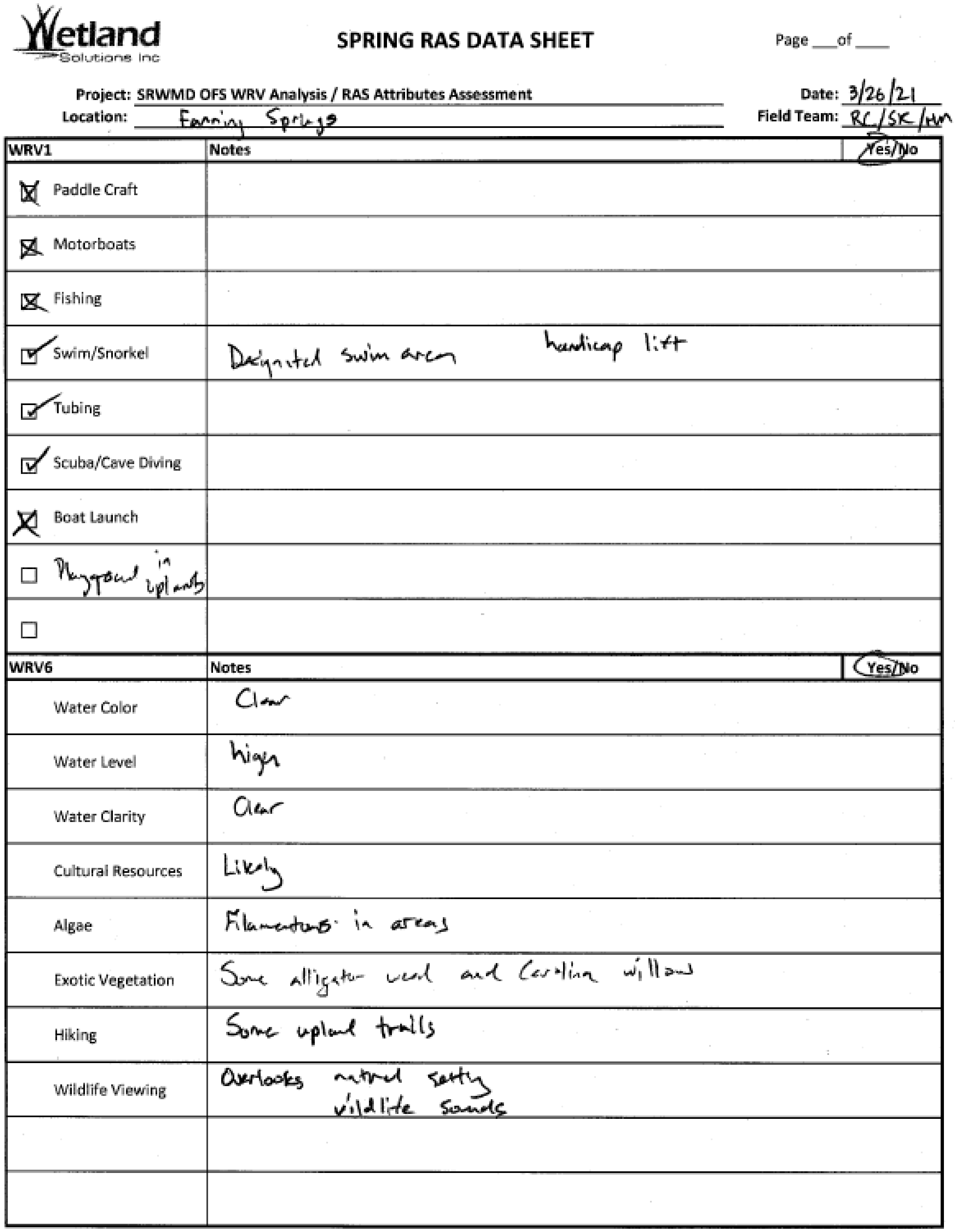
Notes: Steep slopes on some sides
short run w/ high velocity under normal conditions

WRV 9 Water Quality Yes/No

Notes: Clear during visit

WRV 10 Navigation Yes/No

Notes: Not Applicable



Wetland Solutions Inc

SPRING RAS DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

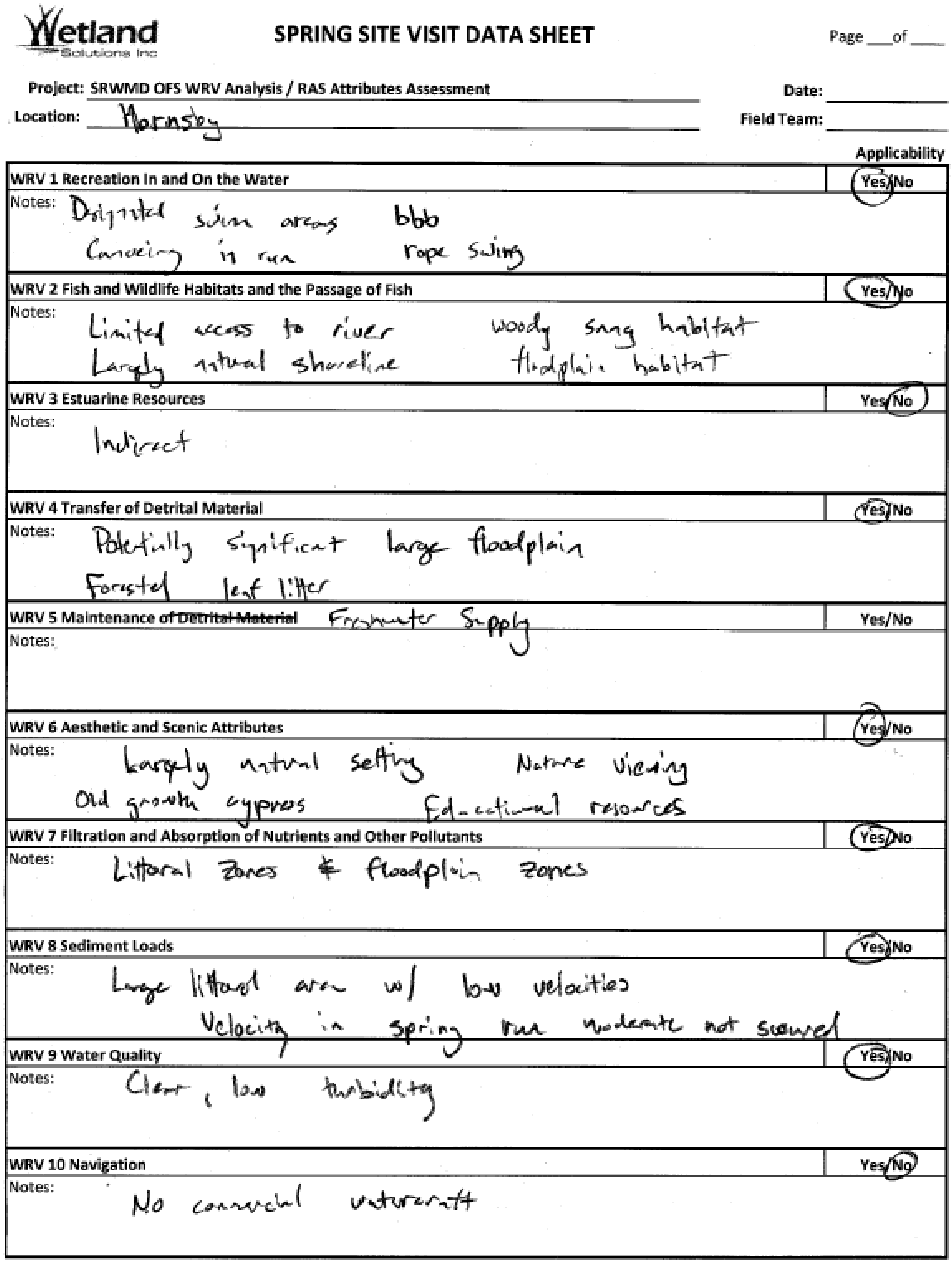
Location: Fanning Springs

Date: 3/26/21

Field Team: RC/SK/HM

WRV1	Notes	[✓ Yes]/No
☒ Paddle Craft		
☒ Motorboats		
☒ Fishing		
☑ Swim/Snorkel	Designated swim area handicap lift	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐ Playground in uplands		
☐		

WRV6	Notes	[✓ Yes]/No
Water Color	Clear	
Water Level	high	
Water Clarity	Clear	
Cultural Resources	Likely	
Algae	Filamentous in areas	
Exotic Vegetation	Some alligator weed and Carolina willow	
Hiking	Some upland trails	
Wildlife Viewing	Overlooks natural setting wildlife sounds	



SPRING SITE VISIT DATA SHEET

Page ___of ____

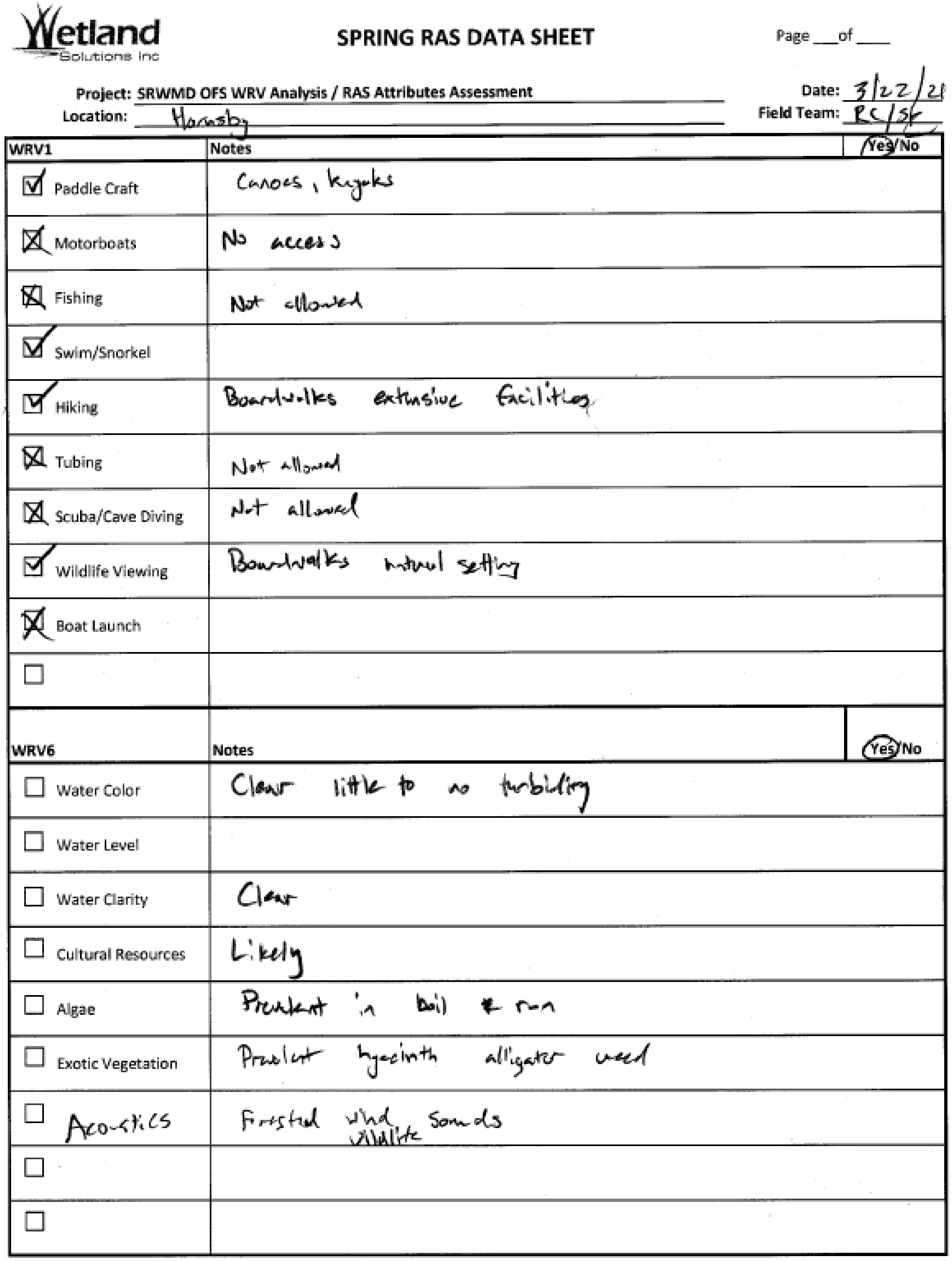
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: __________

Location: Hornsby

Field Team: __________

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Designated swim areas bbb Canoeing in run rope swing	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Limited access to river woody snag habitat Largely natural shoreline floodplain habitat	
WRV 3 Estuarine Resources	Yes/[✓ No]
Notes: Indirect	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Potentially significant large floodplain Forested leaf litter	
WRV 5 Maintenance ~~of Detrital Material~~ Freshwater Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Largely natural setting Nature viewing Old growth cypress Educational resources	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: Littoral zones & floodplain zones	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Large littoral area w/ low velocities Velocity in spring run moderate not scoured	
WRV 9 Water Quality	[✓ Yes]/No
Notes: Clear, low turbidity	
WRV 10 Navigation	Yes/[✓ No]
Notes: No commercial watercraft	



SPRING RAS DATA SHEET

Wetland Solutions Inc

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

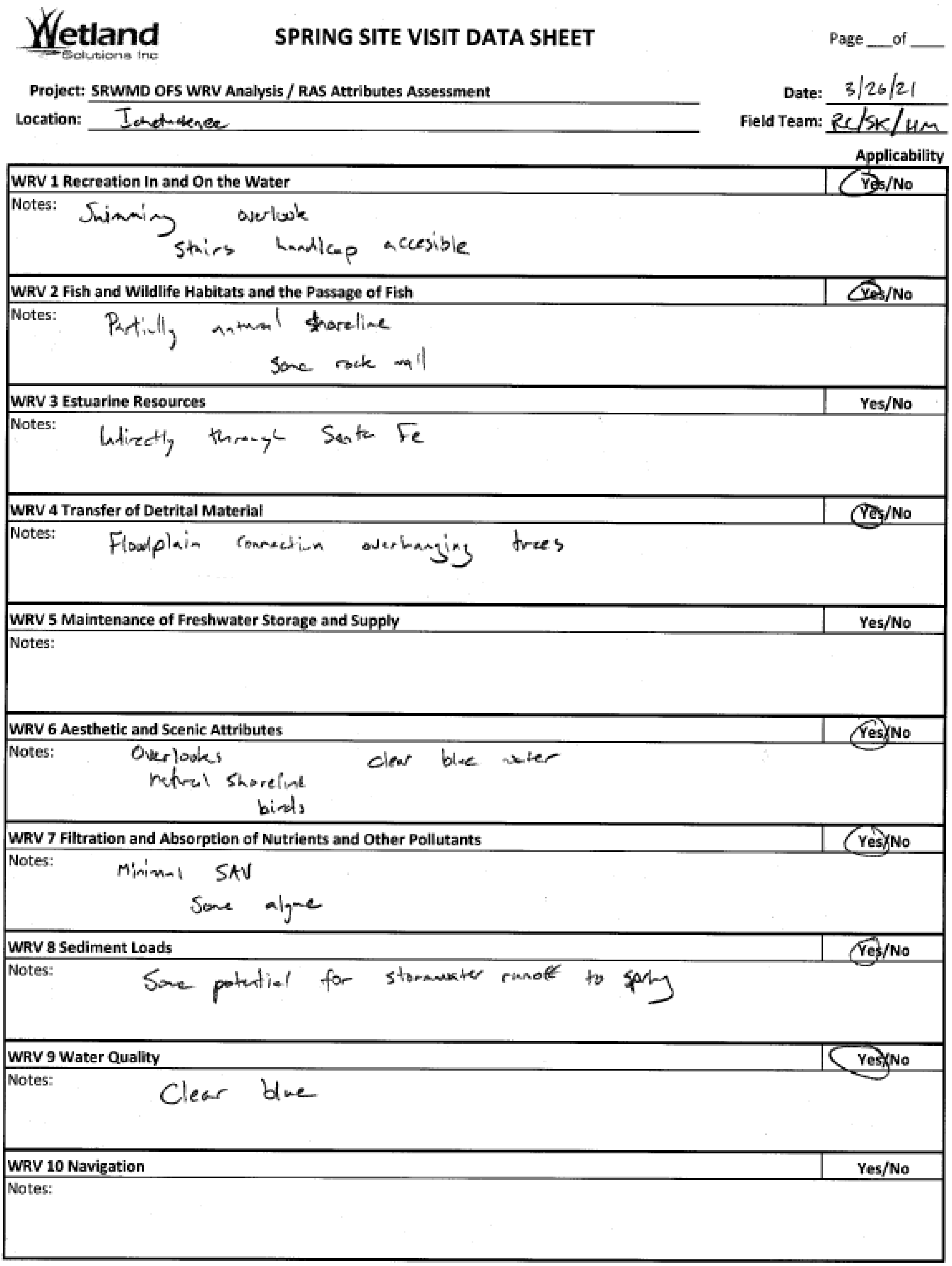
Location: Hornsby

Date: 3/22/21

Field Team: RC/SK

WRV1	Notes	[✓ Yes] / No
☑ Paddle Craft	Canoes, kayaks	
☒ Motorboats	No access	
☒ Fishing	Not allowed	
☑ Swim/Snorkel		
☑ Hiking	Boardwalks extensive facilities	
☒ Tubing	Not allowed	
☒ Scuba/Cave Diving	Not allowed	
☑ Wildlife Viewing	Boardwalks natural setting	
☒ Boat Launch		
☐		

WRV6	Notes	[✓ Yes] / No
☐ Water Color	Clear little to no turbidity	
☐ Water Level		
☐ Water Clarity	Clear	
☐ Cultural Resources	Likely	
☐ Algae	Prevalent in boil & run	
☐ Exotic Vegetation	Prevalent hyacinth alligator weed	
☐ Acoustics	Forested wind wildlife sounds	
☐		
☐		



SPRING SITE VISIT DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Ichetucknee

Date: 3/26/21

Field Team: RC/SK/HM

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Swimming overlook
stairs handicap accesible

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Partially natural shoreline
Some rock wall

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Santa Fe

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Floodplain connection overhanging trees

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Overlooks clear blue water
natural shoreline
birds

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Minimal SAV
Some algae

WRV 8 Sediment Loads [✓ Yes]/No

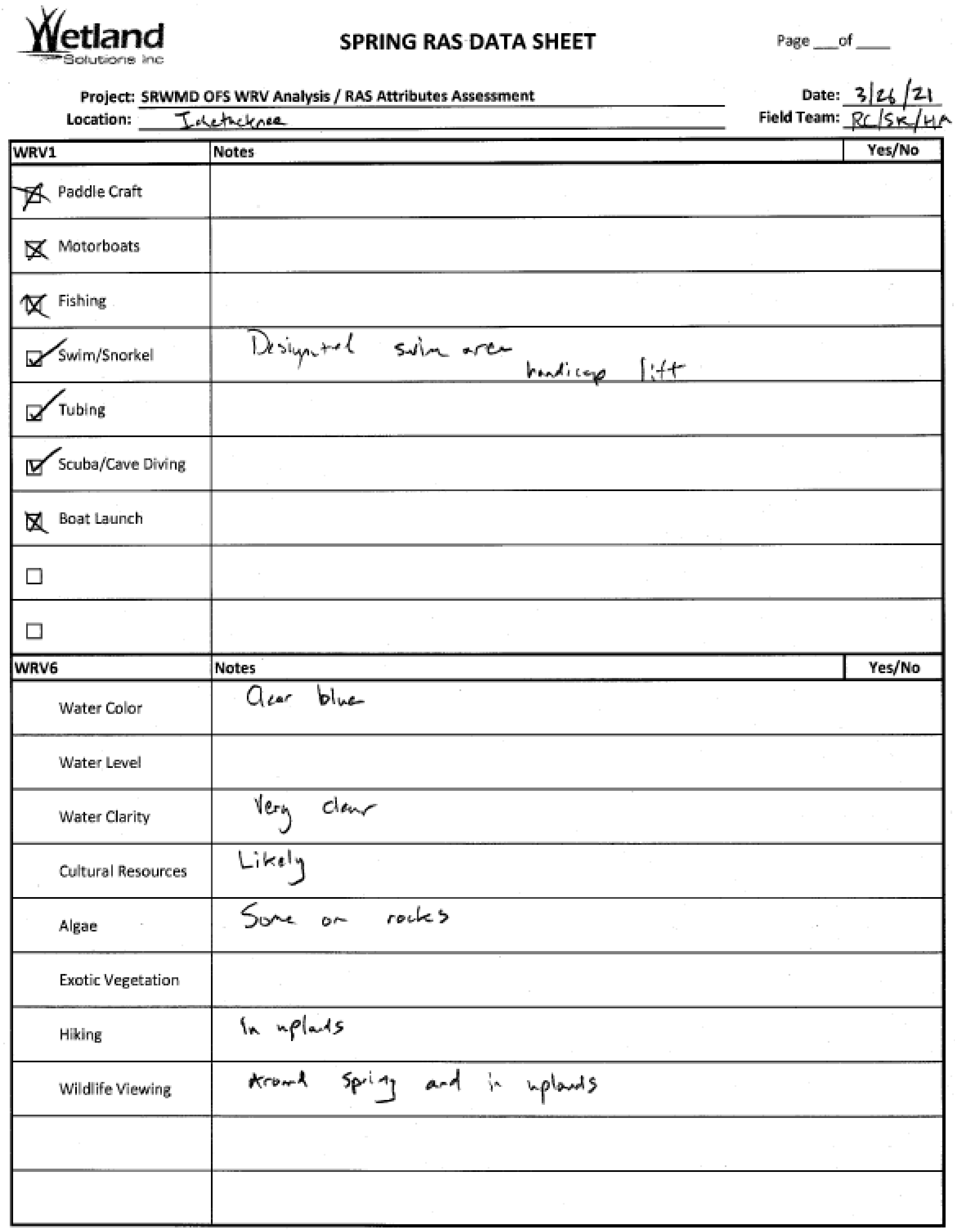
Notes: Some potential for stormwater runoff to spring

WRV 9 Water Quality [✓ Yes]/No

Notes: Clear blue

WRV 10 Navigation Yes/No

Notes:



Wetland Solutions Inc

SPRING RAS DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

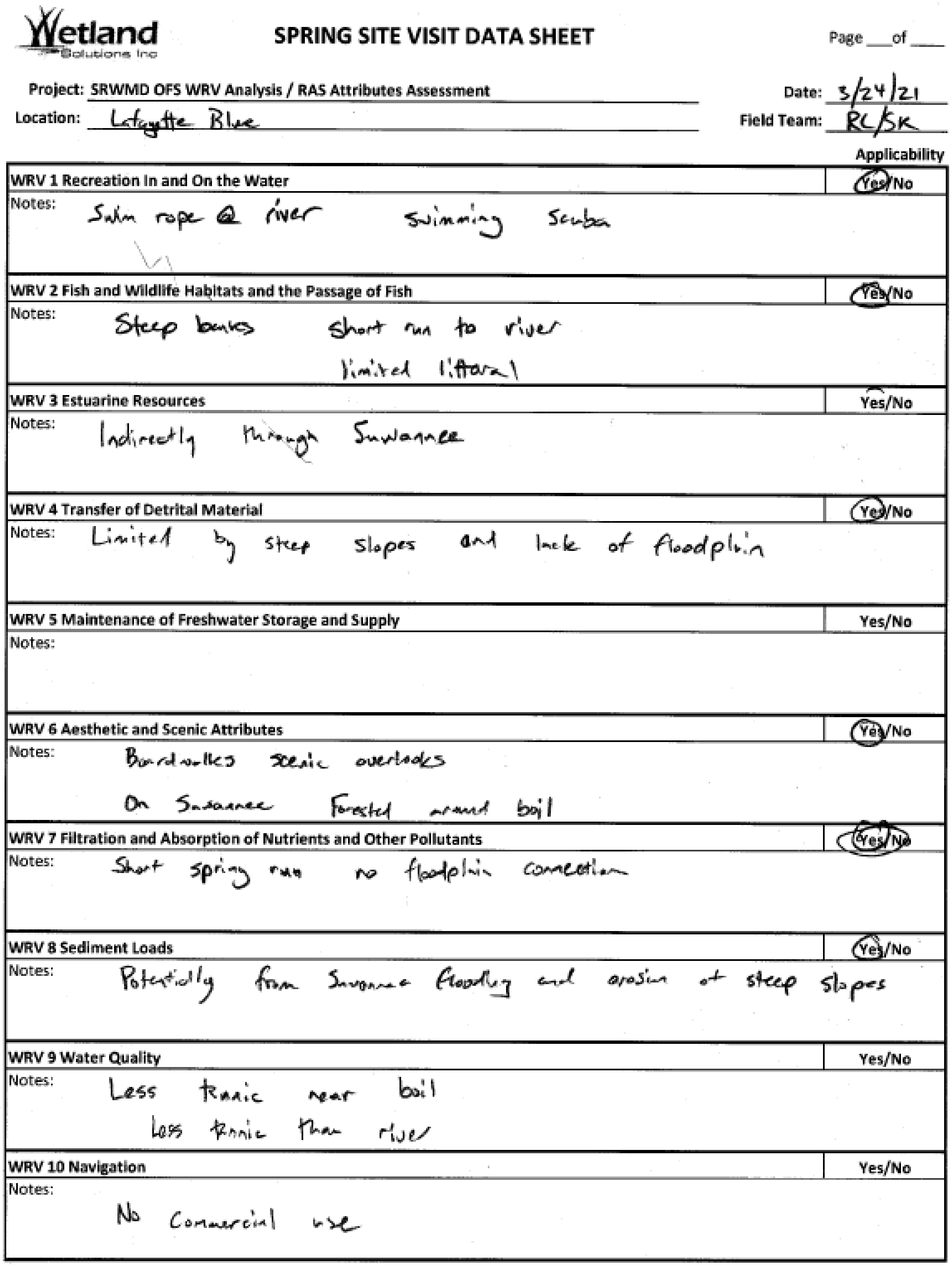
Location: Ichetucknee

Date: 3/26/21

Field Team: RC/SK/HA

WRV1	Notes	Yes/No
☒ Paddle Craft		
☒ Motorboats		
☒ Fishing		
☑ Swim/Snorkel	Designated swim area handicap lift	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Clear blue	
Water Level		
Water Clarity	Very clear	
Cultural Resources	Likely	
Algae	Some on rocks	
Exotic Vegetation		
Hiking	In uplands	
Wildlife Viewing	Around spring and in uplands	



SPRING SITE VISIT DATA SHEET

Page ___ of ___

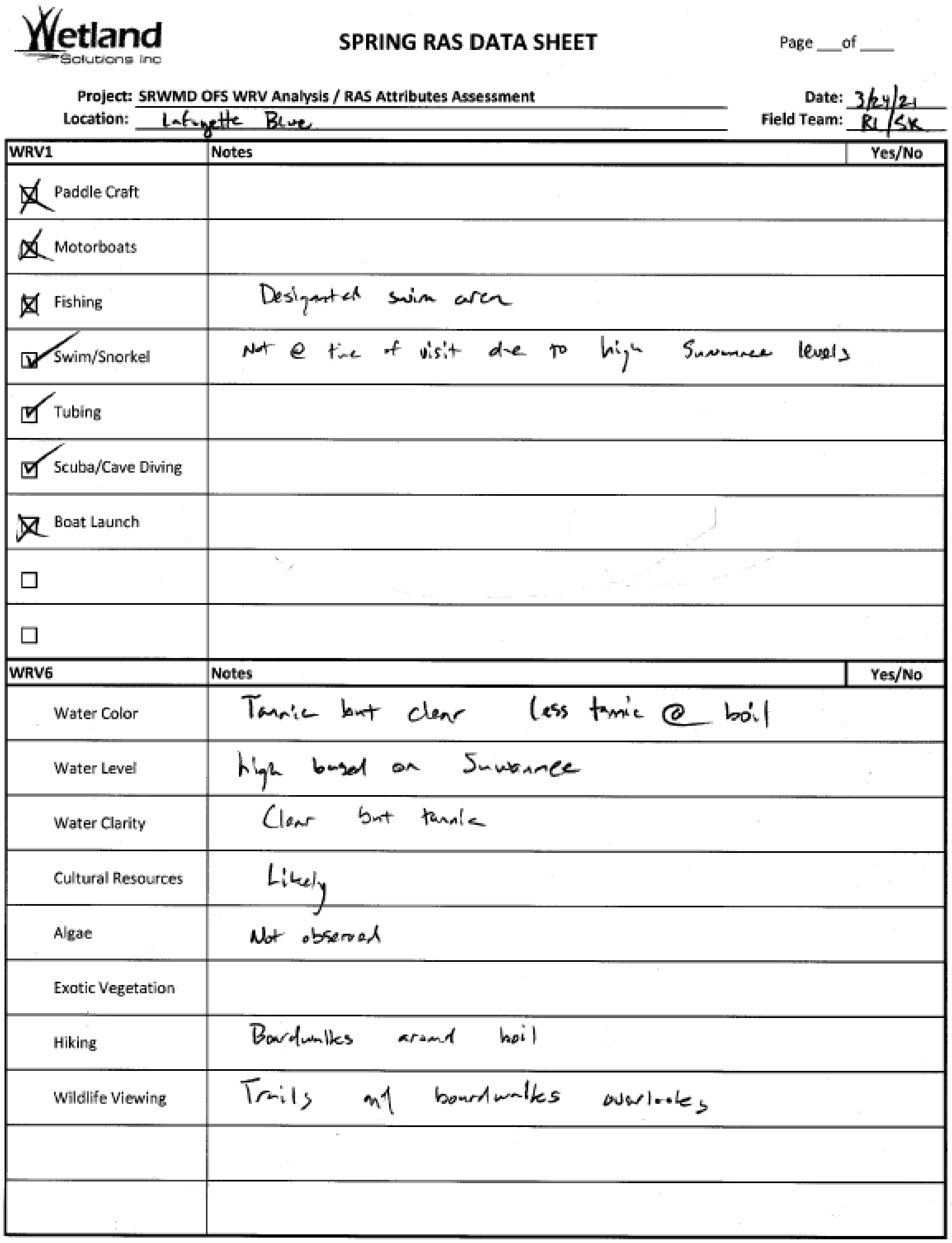
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/24/21

Location: Lafayette Blue

Field Team: RC/SK

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Swim rope @ river swimming Scuba	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Steep banks short run to river limited littoral	
WRV 3 Estuarine Resources	Yes/No
Notes: Indirectly through Suwannee	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Limited by steep slopes and lack of floodplain	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Boardwalks scenic overlooks On Suwannee Forested around boil	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: Short spring run no floodplain connection	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Potentially from Suwannee flooding and erosion of steep slopes	
WRV 9 Water Quality	Yes/No
Notes: Less tannic near boil less tannic than river	
WRV 10 Navigation	Yes/No
Notes: No Commercial use	



Wetland Solutions Inc

SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

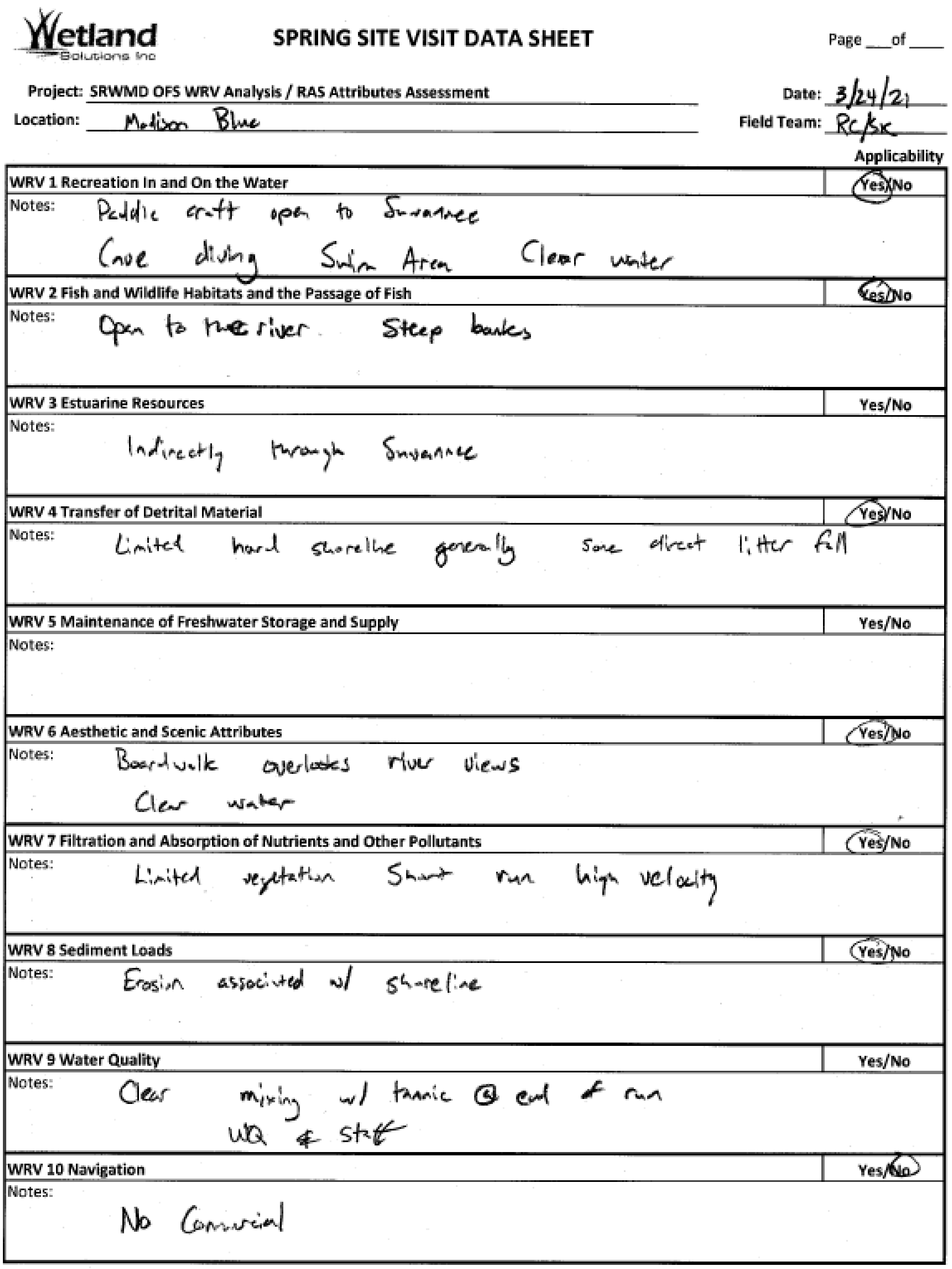
Location: Lafayette Blue

Date: 3/24/21

Field Team: RL/SK

WRV1	Notes	Yes/No
☒ Paddle Craft		
☒ Motorboats		
☒ Fishing	Designated swim area	
☑ Swim/Snorkel	Not @ time of visit due to high Suwannee levels	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Tannic but clear less tannic @ boil	
Water Level	high based on Suwannee	
Water Clarity	Clear but tannic	
Cultural Resources	Likely	
Algae	Not observed	
Exotic Vegetation		
Hiking	Boardwalks around boil	
Wildlife Viewing	Trails w/ boardwalks overlooks	



Wetland Solutions Inc

SPRING SITE VISIT DATA SHEET

Page ___ of ___

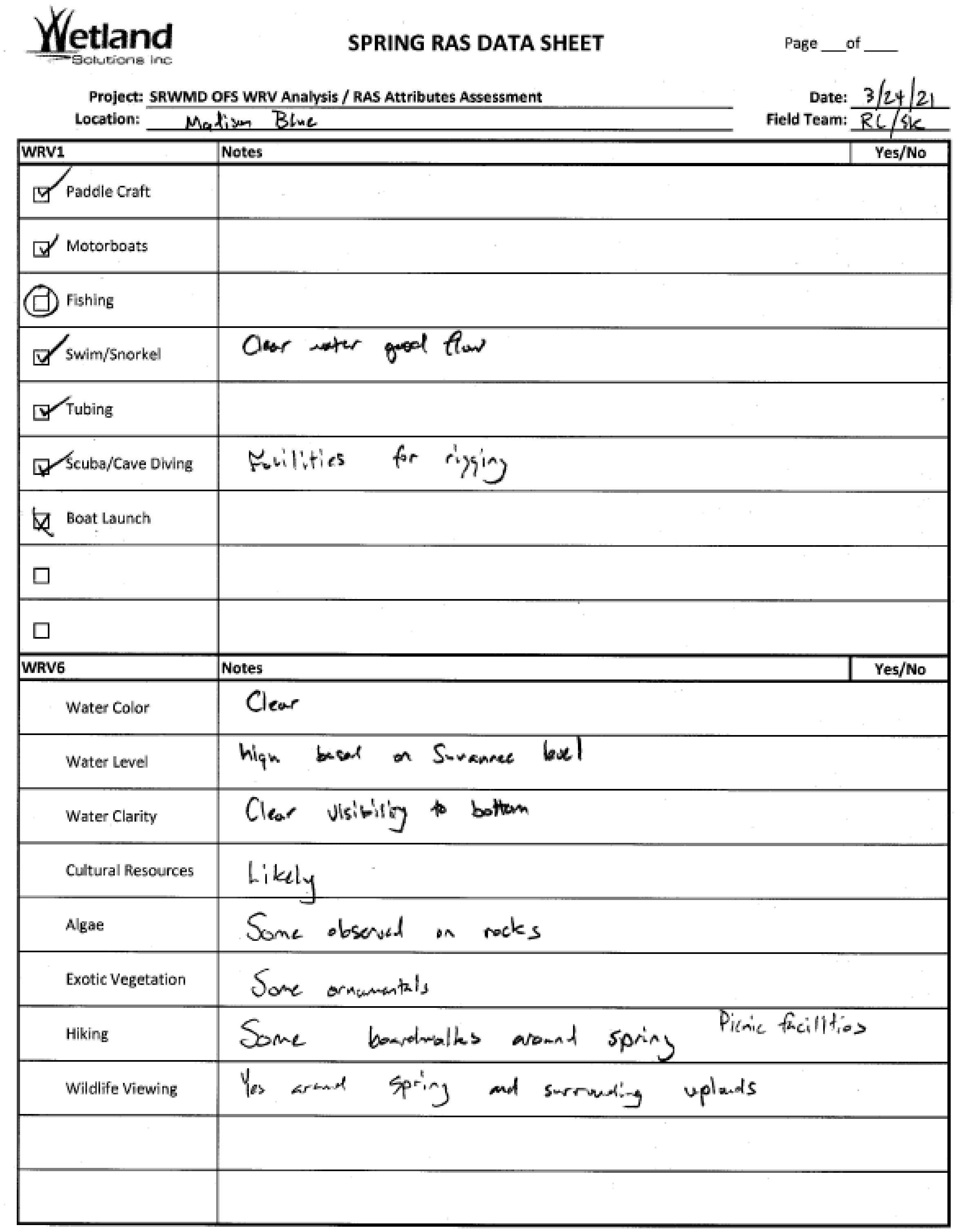
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/24/21

Location: Madison Blue

Field Team: RC/SK

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Paddle craft open to Suwannee Cave diving Swim Area Clear water	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Open to the river. Steep banks	
WRV 3 Estuarine Resources	Yes/No
Notes: Indirectly through Suwannee	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Limited hard shoreline generally Some direct litter fall	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Boardwalk overlooks river views Clear water	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: Limited vegetation Short run high velocity	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Erosion associated w/ shoreline	
WRV 9 Water Quality	Yes/No
Notes: Clear mixing w/ tannic @ end of run WQ of Staff	
WRV 10 Navigation	Yes/[✓ No]
Notes: No Commercial	



SPRING RAS DATA SHEET

Page ___ of ____

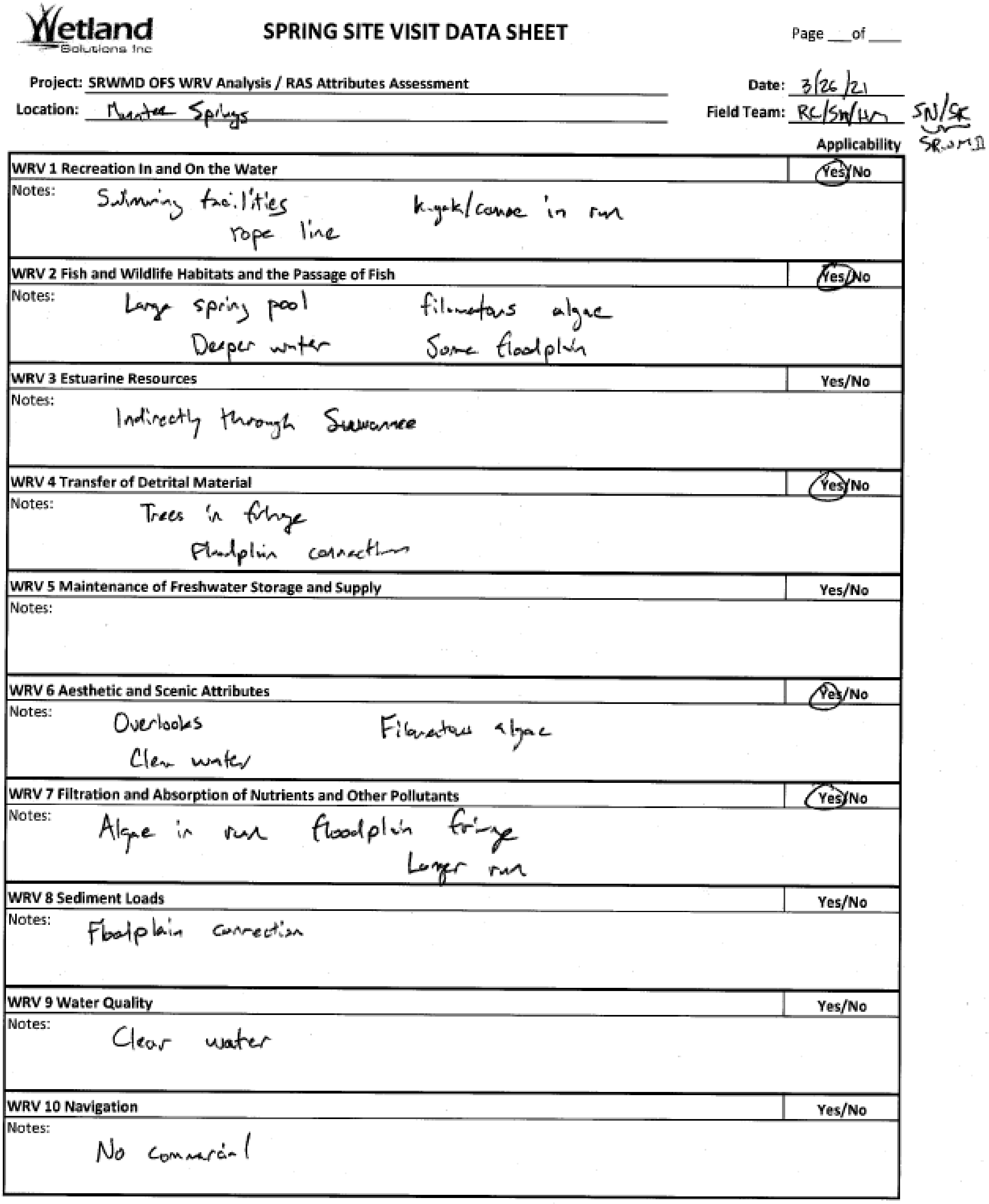
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Madison Blue

Date: 3/24/21

Field Team: RL/SK

WRV1	Notes	Yes/No
☑ Paddle Craft		
☑ Motorboats		
☐ Fishing		
☑ Swim/Snorkel	Clear water good flow	
☑ Tubing		
☑ Scuba/Cave Diving	Facilities for rigging	
☒ Boat Launch		
☐		
☐		
WRV6	**Notes**	**Yes/No**
Water Color	Clear	
Water Level	high based on Suwannee level	
Water Clarity	Clear visibility to bottom	
Cultural Resources	Likely	
Algae	Some observed on rocks	
Exotic Vegetation	Some ornamentals	
Hiking	Some boardwalks around spring Picnic facilities	
Wildlife Viewing	Yes around spring and surrounding uplands	



SPRING SITE VISIT DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Manatee Springs

Date: 3/26/21

Field Team: RC/SW/HM SN/SK SRWMD

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Swimming facilities kayak/canoe in run rope line	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Large spring pool filamentous algae Deeper water Some floodplain	
WRV 3 Estuarine Resources	Yes/No
Notes: Indirectly through Suwannee	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Trees in fringe Floodplain connection	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Overlooks Filamentous algae Clear water	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: Algae in run floodplain fringe Longer run	
WRV 8 Sediment Loads	Yes/No
Notes: Floodplain connection	
WRV 9 Water Quality	Yes/No
Notes: Clear water	
WRV 10 Navigation	Yes/No
Notes: No commercial	

SPRING RAS DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Manatee Springs

Date: 3/26/21

Field Team: RC/SK/HM

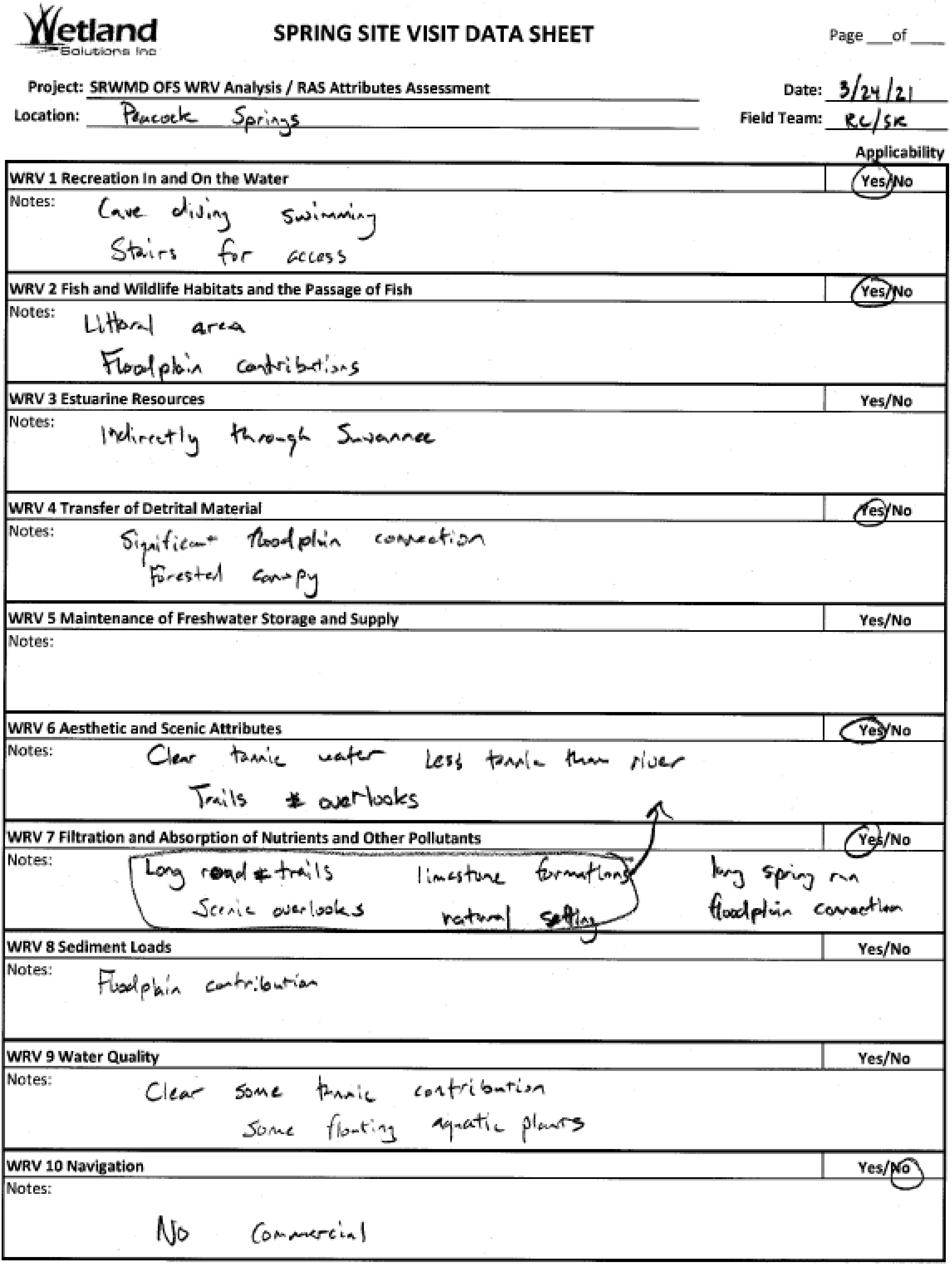
SN/SK

SRWMD

WRV1	Notes	Yes/No
☒ Paddle Craft	Swim area roped off Allowed in run	
☒ Motorboats		
☒ Fishing		
☑ Swim/Snorkel	Designated swim area	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		
WRV6	**Notes**	**Yes/No**
Water Color	Clear	
Water Level	high	
Water Clarity	Clear	
Cultural Resources	Likely	
Algae	Prevalent	
Exotic Vegetation		
Hiking	In upland	
Wildlife Viewing	Overlooks natural fringe	

Running Spring

Madison Blue MFL



SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/24/21

Location: Peacock Springs

Field Team: RC/SK

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Cave diving swimming
Stairs for access

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Littoral area
Floodplain contributions

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Suwannee

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Significant floodplain connection
Forested canopy

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Clear tannic water less tannic than river
Trails & overlooks

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Long road & trails limestone formations long spring run
Scenic overlooks natural setting floodplain connection

WRV 8 Sediment Loads Yes/No

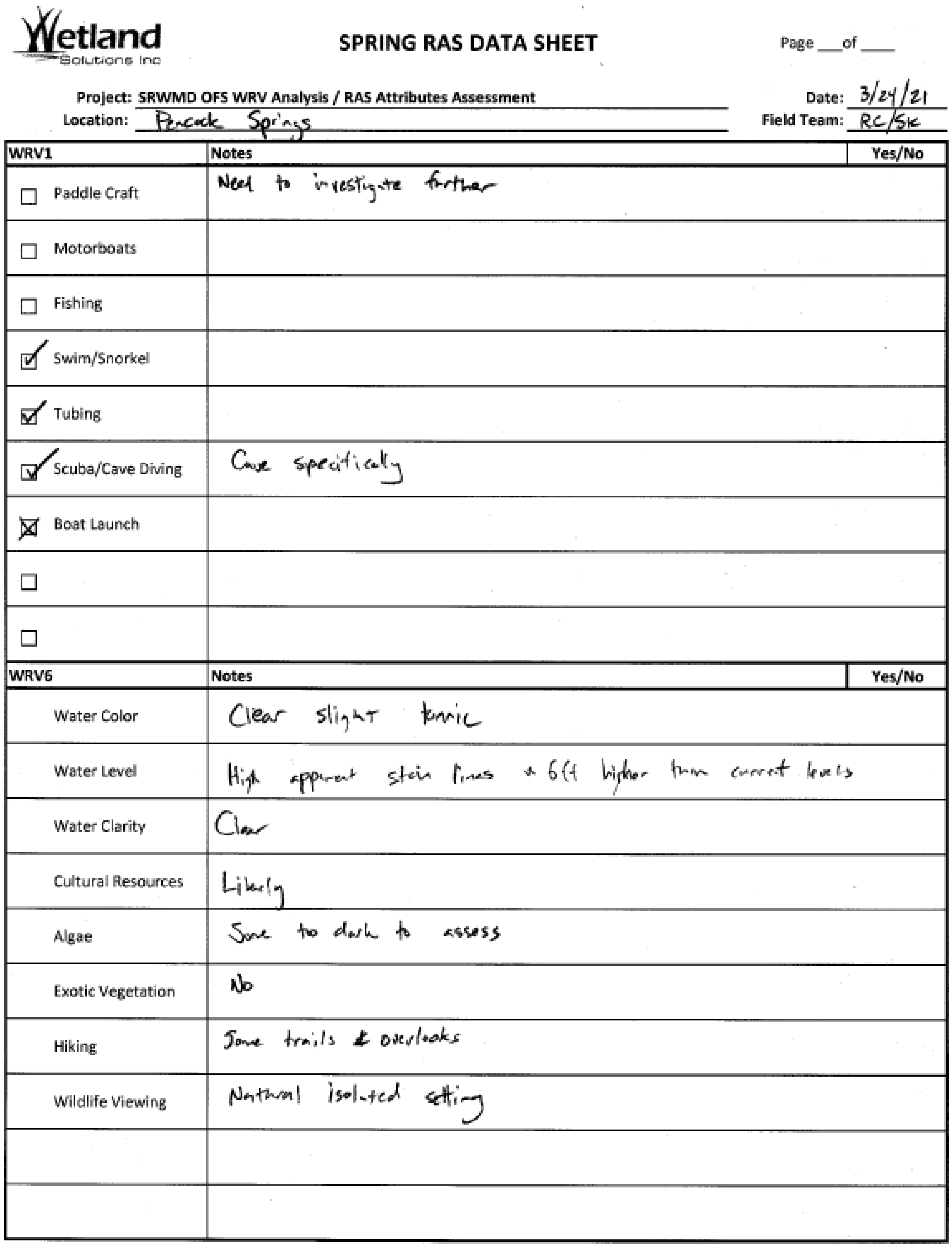
Notes: Floodplain contribution

WRV 9 Water Quality Yes/No

Notes: Clear some tannic contribution
Some floating aquatic plants

WRV 10 Navigation Yes/[✓ No]

Notes: No Commercial



SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

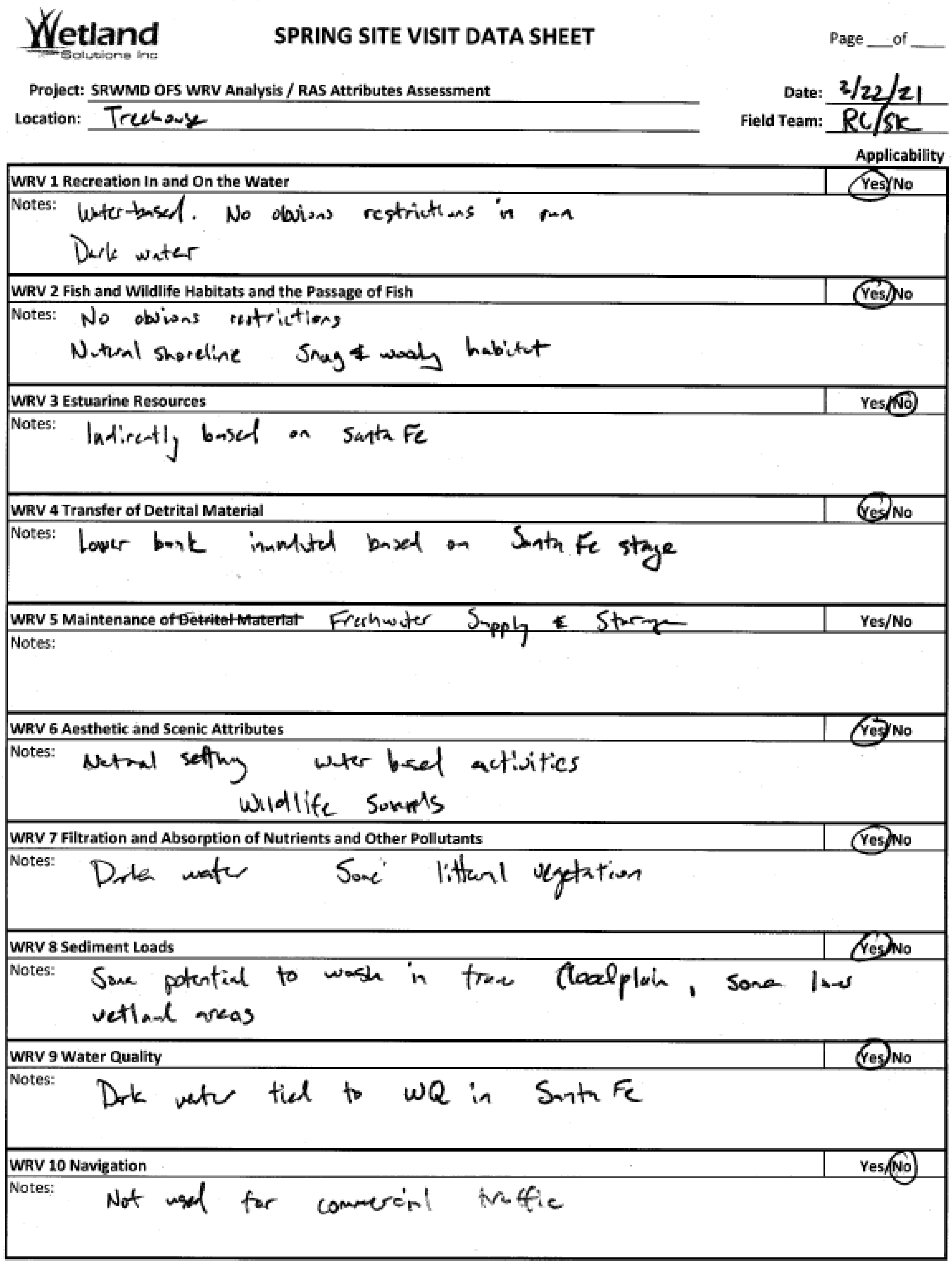
Date: 3/24/21

Location: Peacock Springs

Field Team: RC/SK

WRV1	Notes	Yes/No
☐ Paddle Craft	Need to investigate further	
☐ Motorboats		
☐ Fishing		
☑ Swim/Snorkel		
☑ Tubing		
☑ Scuba/Cave Diving	Cave specifically	
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Clear slight tannic	
Water Level	High apparent stain lines ~ 6ft higher than current levels	
Water Clarity	Clear	
Cultural Resources	Likely	
Algae	Some too dark to assess	
Exotic Vegetation	No	
Hiking	Some trails & overlooks	
Wildlife Viewing	Natural isolated setting	



SPRING SITE VISIT DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/22/21

Location: Treehouse

Field Team: RC/SK

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Water-based. No obvious restrictions in run
Dark water

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: No obvious restrictions
Natural shoreline Snag & woody habitat

WRV 3 Estuarine Resources Yes/[✓ No]

Notes: Indirectly based on Santa Fe

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Lower bank inundated based on Santa Fe stage

WRV 5 Maintenance of ~~Detrital Material~~ Freshwater Supply & Storage Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Natural setting water based activities
wildlife sounds

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Dark water Some littoral vegetation

WRV 8 Sediment Loads [✓ Yes]/No

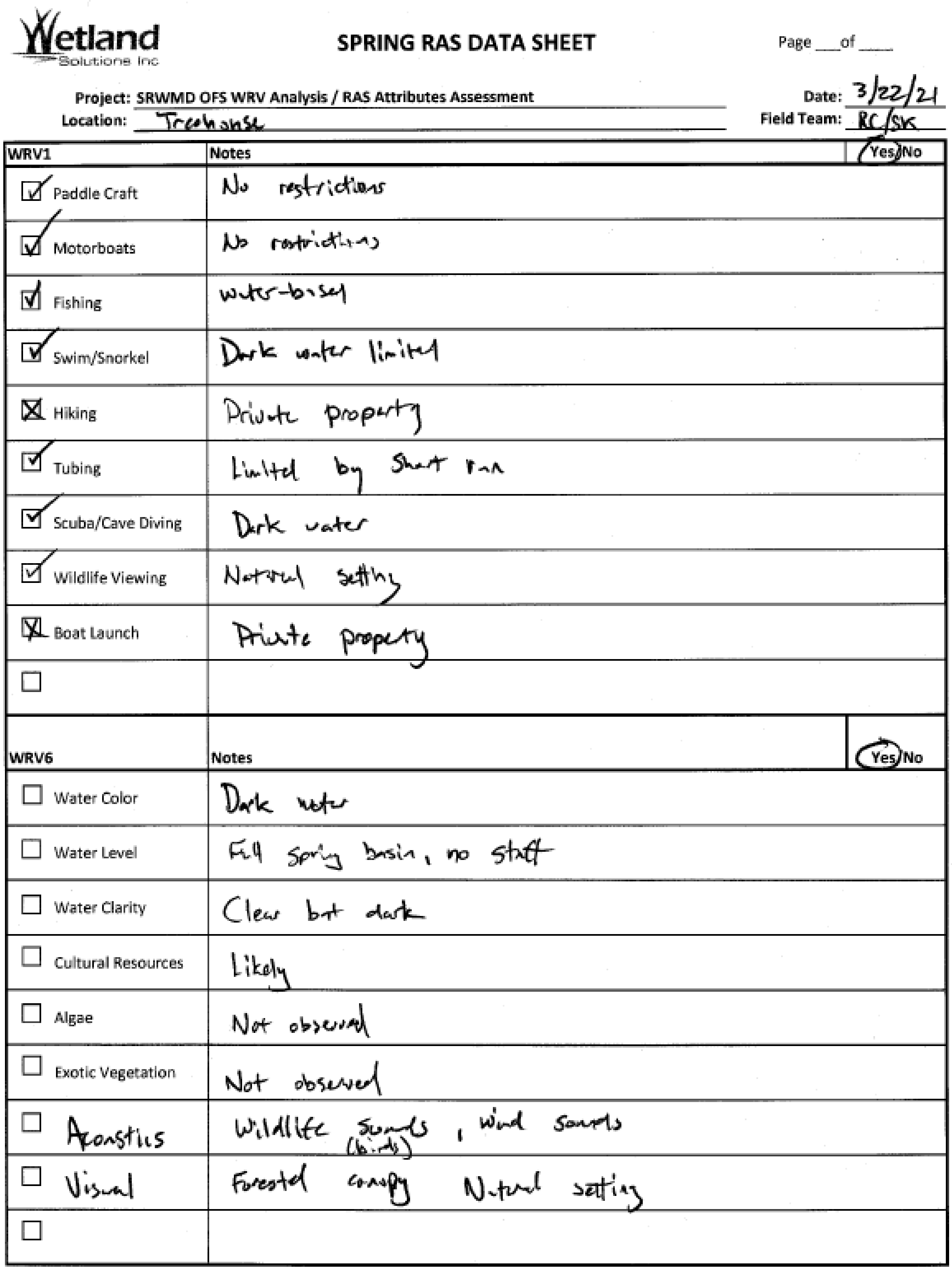
Notes: Some potential to wash in from floodplain, some low
wetland areas

WRV 9 Water Quality [✓ Yes]/No

Notes: Dark water tied to WQ in Santa Fe

WRV 10 Navigation Yes/[✓ No]

Notes: Not used for commercial traffic



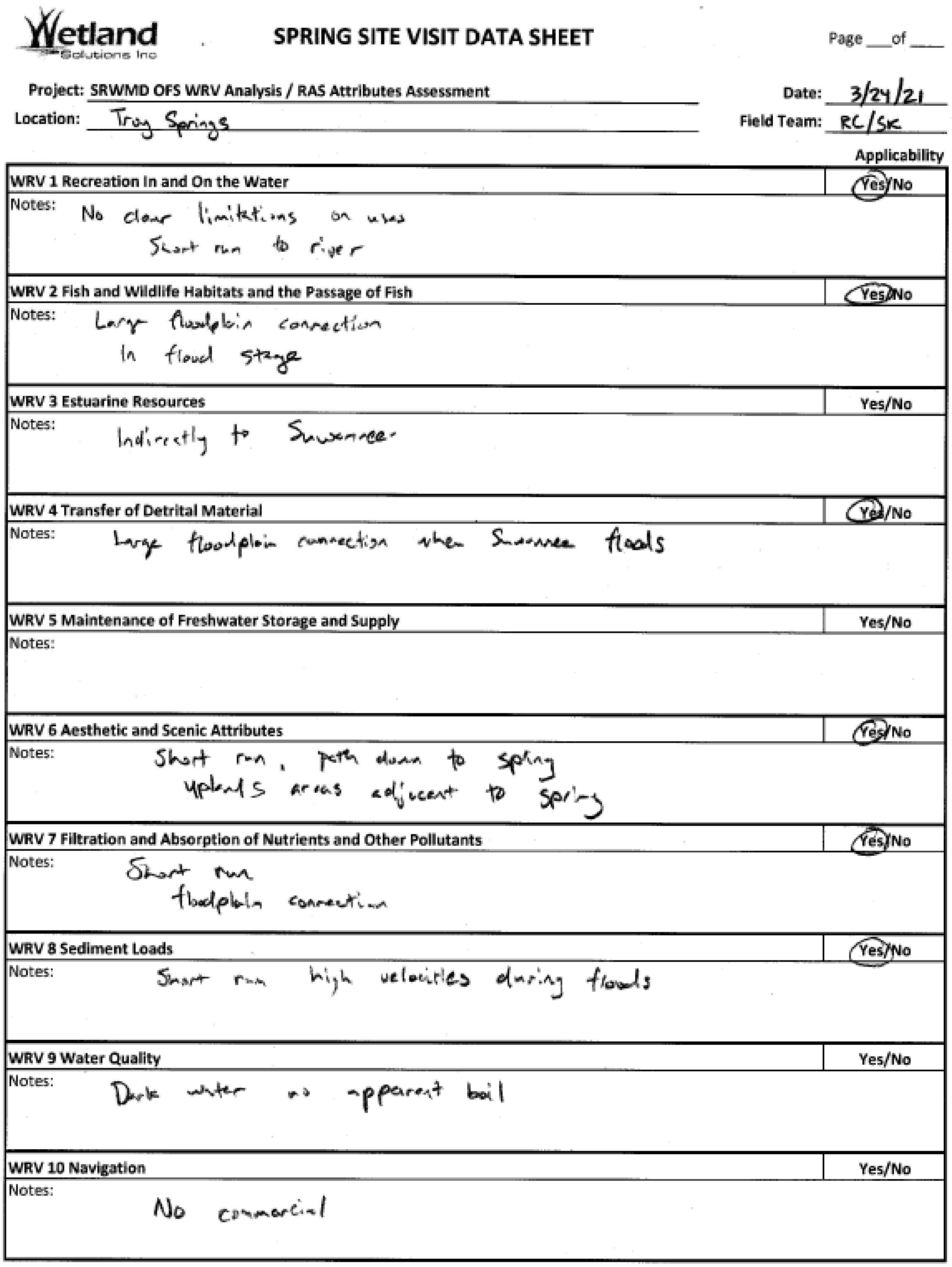
SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Date: 3/22/21
Location: Treehouse
Field Team: RC/SK

WRV1	Notes	[✓ Yes] No
☑ Paddle Craft	No restrictions	
☑ Motorboats	No restrictions	
☑ Fishing	water-based	
☑ Swim/Snorkel	Dark water limited	
☒ Hiking	Private property	
☑ Tubing	Limited by short run	
☑ Scuba/Cave Diving	Dark water	
☑ Wildlife Viewing	Natural setting	
☒ Boat Launch	Private property	
☐		

WRV6	Notes	[✓ Yes] No
☐ Water Color	Dark water	
☐ Water Level	Full spring basin, no staff	
☐ Water Clarity	Clear but dark	
☐ Cultural Resources	Likely	
☐ Algae	Not observed	
☐ Exotic Vegetation	Not observed	
☐ Acoustics	Wildlife sounds (birds), wind sounds	
☐ Visual	Forested canopy Natural setting	
☐		



SPRING SITE VISIT DATA SHEET

Page ___ of ___

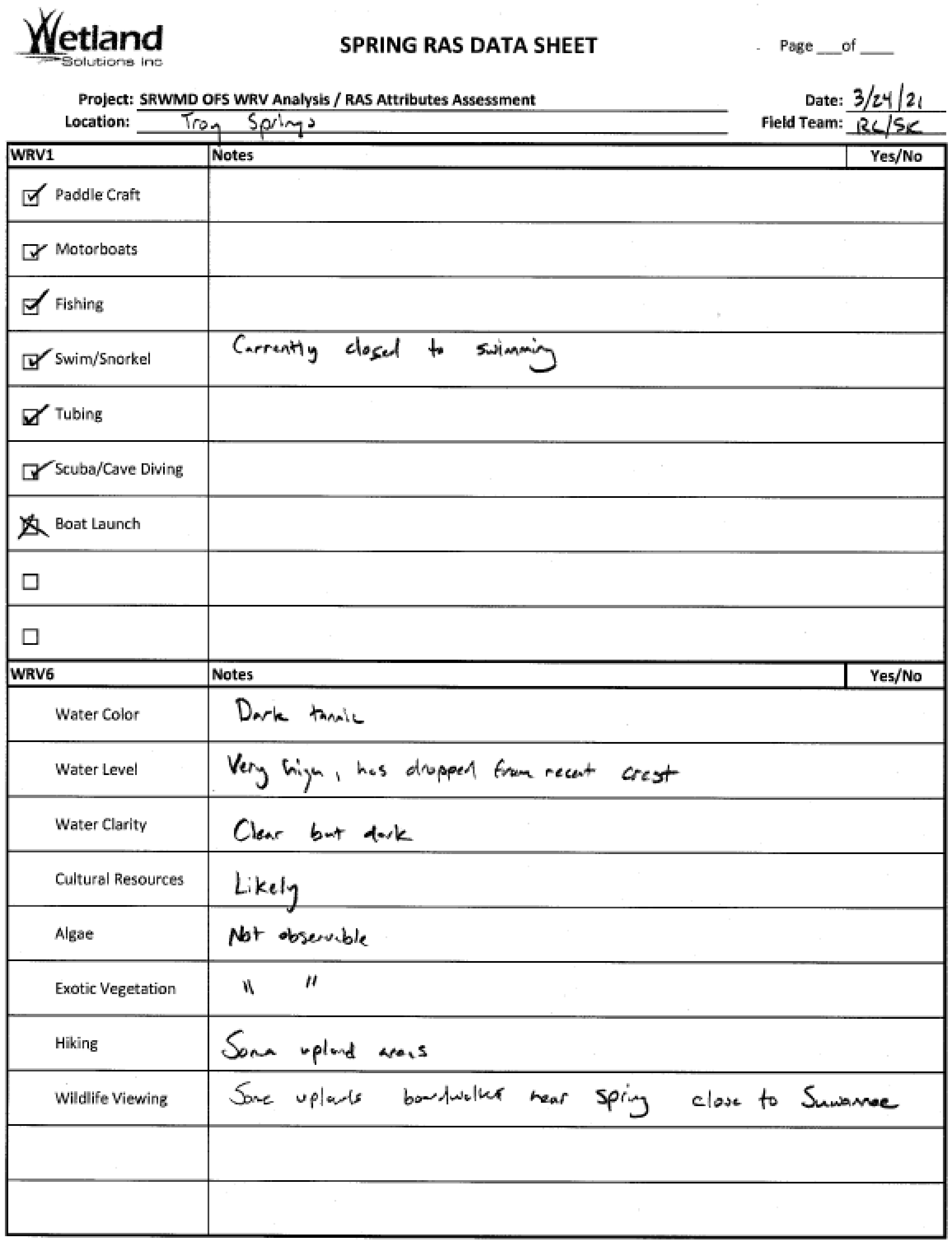
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/24/21

Location: Troy Springs

Field Team: RC/SK

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: No clear limitations on uses Short run to river	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: Large floodplain connection In flood stage	
WRV 3 Estuarine Resources	Yes/No
Notes: Indirectly to Suwannee	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Large floodplain connection when Suwannee floods	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Short run, path down to spring uplands areas adjacent to spring	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: Short run floodplain connection	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Short run high velocities during floods	
WRV 9 Water Quality	Yes/No
Notes: Dark water no apparent boil	
WRV 10 Navigation	Yes/No
Notes: No commercial	



SPRING RAS DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

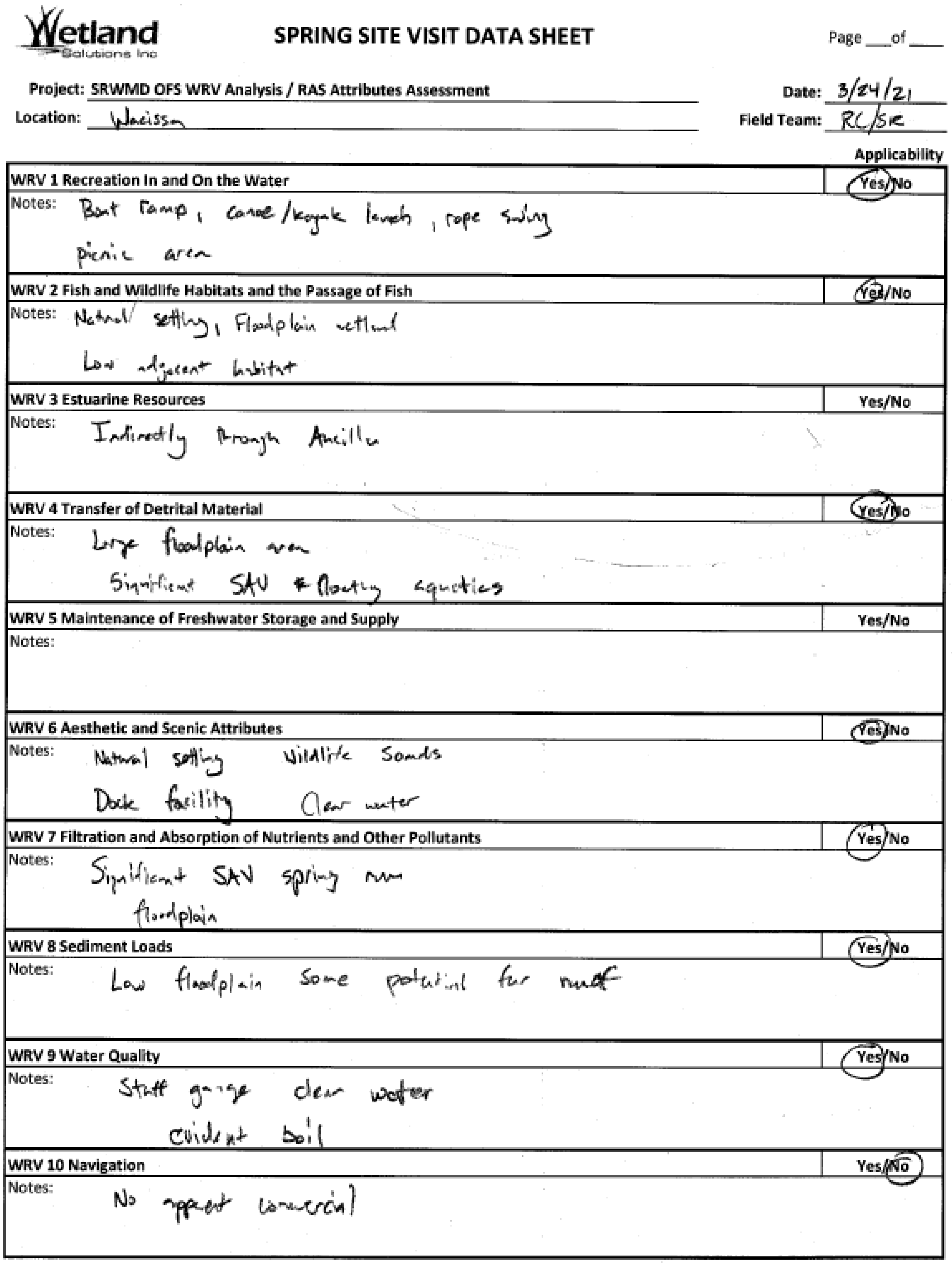
Location: Troy Springs

Date: 3/24/21

Field Team: RC/SK

WRV1	Notes	Yes/No
☑ Paddle Craft		
☑ Motorboats		
☑ Fishing		
☑ Swim/Snorkel	Currently closed to swimming	
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Dark tannic	
Water Level	Very high, has dropped from recent crest	
Water Clarity	Clear but dark	
Cultural Resources	Likely	
Algae	Not observable	
Exotic Vegetation	" "	
Hiking	Some upland areas	
Wildlife Viewing	Some uplands boardwalks near spring close to Suwannee	



SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/24/21

Location: Wacissa

Field Team: RC/SR

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Boat ramp, canoe/kayak launch, rope swing
picnic area

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Natural setting, Floodplain wetland
Low adjacent habitat

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Aucilla

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Large floodplain area
Significant SAV & floating aquatics

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Natural setting Wildlife Sounds
Dock facility Clear water

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Significant SAV spring run
floodplain

WRV 8 Sediment Loads [✓ Yes]/No

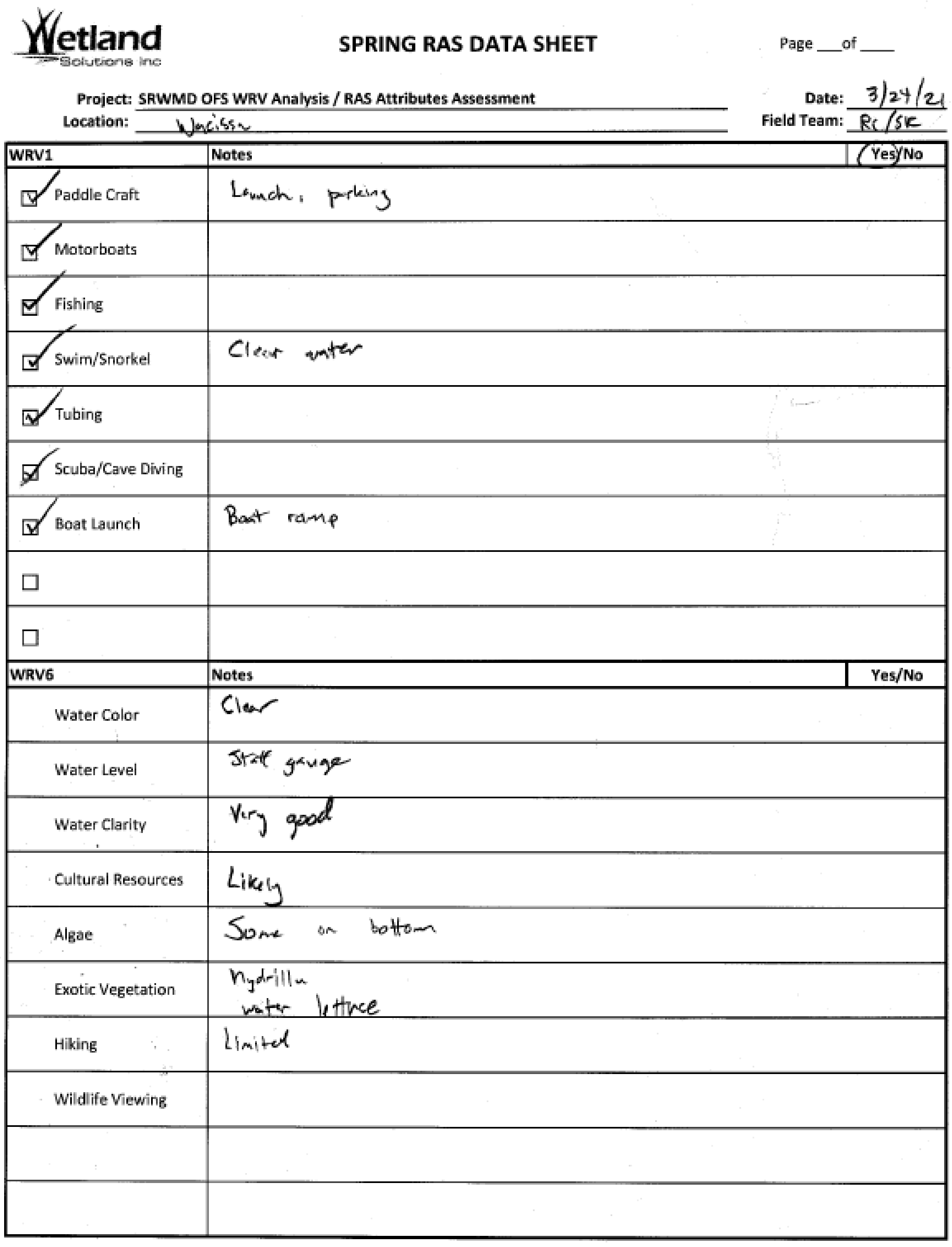
Notes: Low floodplain Some potential for runoff

WRV 9 Water Quality [✓ Yes]/No

Notes: Staff gauge clear water
evident boil

WRV 10 Navigation Yes/[✓ No]

Notes: No apparent commercial



Wetland Solutions Inc

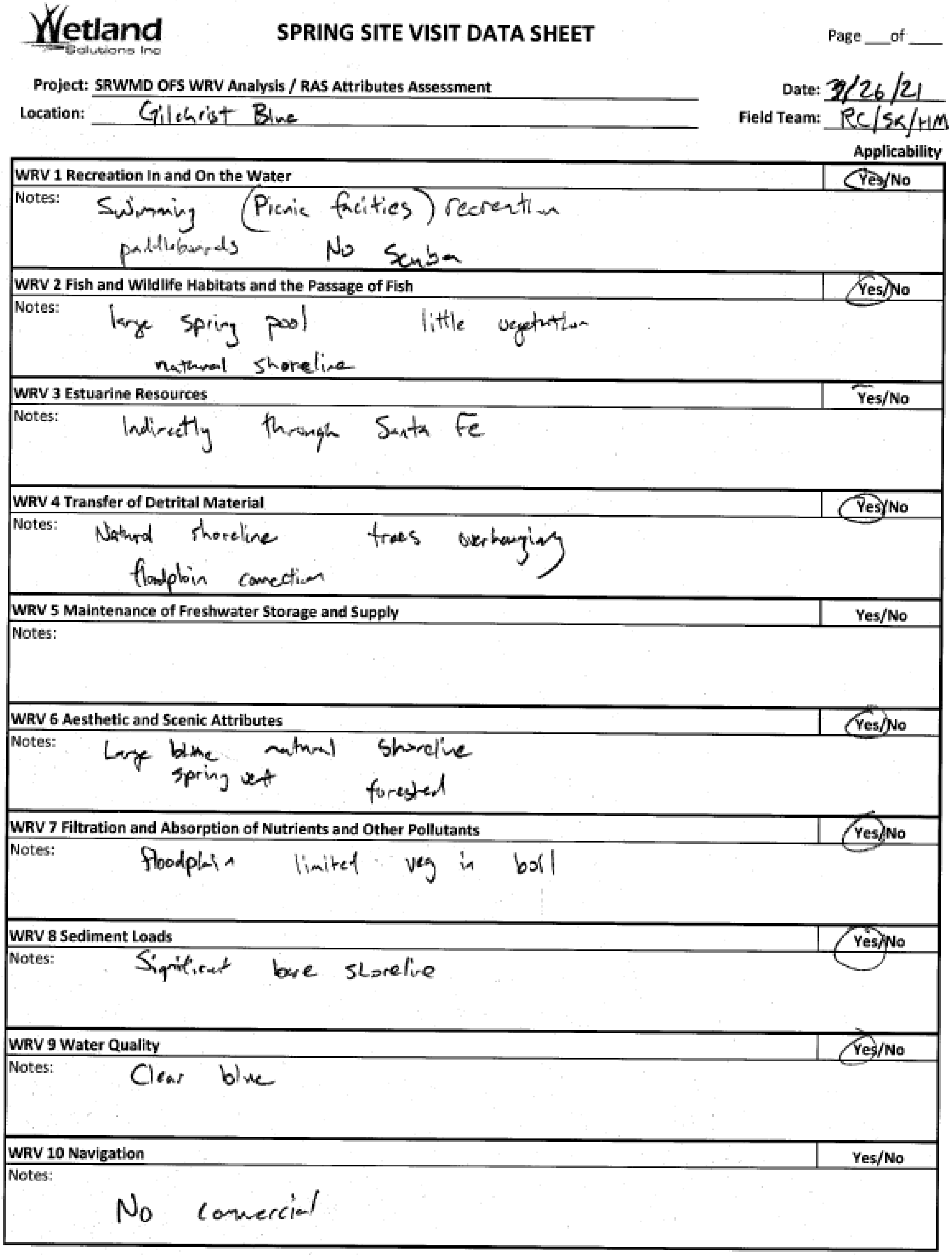
SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Location: Wacissa
Date: 3/24/21
Field Team: RC/SK

WRV1	Notes	[✓ Yes]/No
☑ Paddle Craft	Launch; parking	
☑ Motorboats		
☑ Fishing		
☑ Swim/Snorkel	Clear water	
☑ Tubing		
☑ Scuba/Cave Diving		
☑ Boat Launch	Boat ramp	
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Clear	
Water Level	Staff gauge	
Water Clarity	Very good	
Cultural Resources	Likely	
Algae	Some on bottom	
Exotic Vegetation	hydrilla water lettuce	
Hiking	Limited	
Wildlife Viewing		



SPRING SITE VISIT DATA SHEET

Page ___ of ____

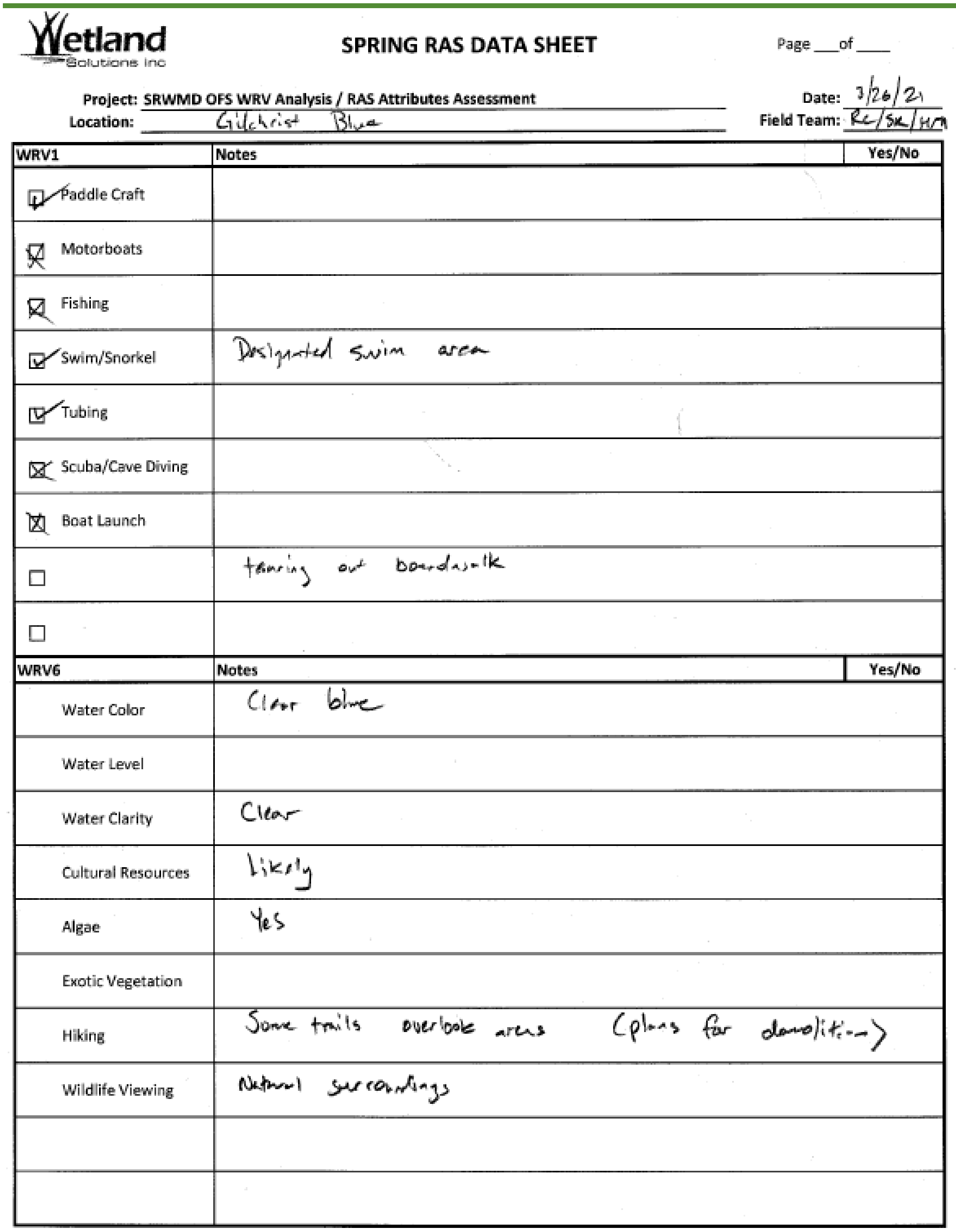
Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Gilchrist Blue

Date: 3/26/21

Field Team: RC/SK/HM

	Applicability
WRV 1 Recreation In and On the Water	[✓ Yes]/No
Notes: Swimming (Picnic facilities) recreation paddleboards No Scuba	
WRV 2 Fish and Wildlife Habitats and the Passage of Fish	[✓ Yes]/No
Notes: large spring pool little vegetation natural shoreline	
WRV 3 Estuarine Resources	Yes/No
Notes: Indirectly through Santa Fe	
WRV 4 Transfer of Detrital Material	[✓ Yes]/No
Notes: Natural shoreline trees overhanging floodplain connection	
WRV 5 Maintenance of Freshwater Storage and Supply	Yes/No
Notes:	
WRV 6 Aesthetic and Scenic Attributes	[✓ Yes]/No
Notes: Large blue natural shoreline spring vent forested	
WRV 7 Filtration and Absorption of Nutrients and Other Pollutants	[✓ Yes]/No
Notes: floodplain limited veg in bowl	
WRV 8 Sediment Loads	[✓ Yes]/No
Notes: Significant bare shoreline	
WRV 9 Water Quality	[✓ Yes]/No
Notes: Clear blue	
WRV 10 Navigation	Yes/No
Notes: No commercial	



SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

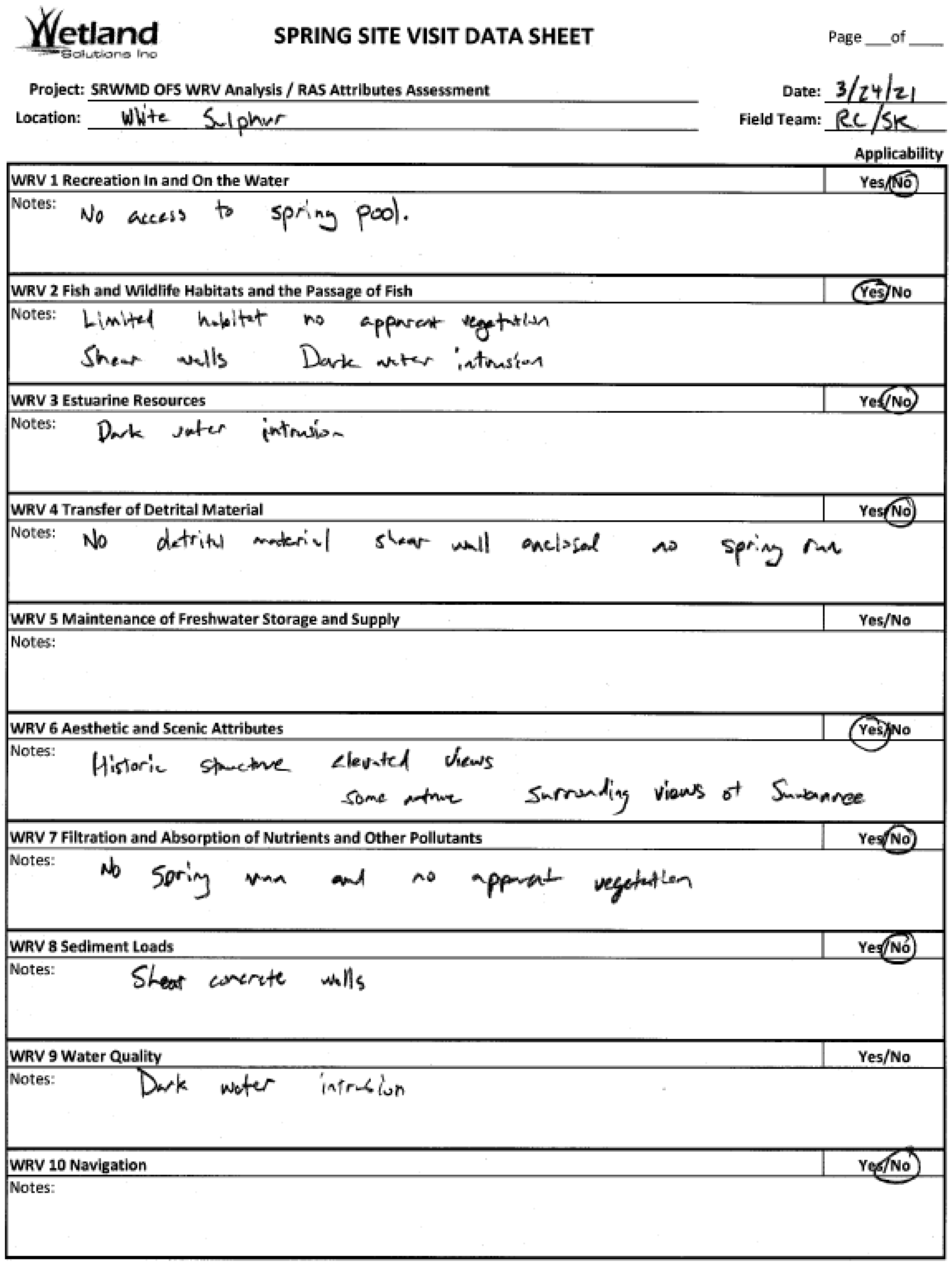
Location: Gilchrist Blue

Date: 3/26/21

Field Team: RC/SK/HM

WRV1	Notes	Yes/No
☑ Paddle Craft		
☒ Motorboats		
☒ Fishing		
☑ Swim/Snorkel	Designated swim area	
☑ Tubing		
☒ Scuba/Cave Diving		
☒ Boat Launch		
☐	tearing out boardwalk	
☐		

WRV6	Notes	Yes/No
Water Color	Clear blue	
Water Level		
Water Clarity	Clear	
Cultural Resources	likely	
Algae	Yes	
Exotic Vegetation		
Hiking	Some trails overlook areas (plans for demolition)	
Wildlife Viewing	Natural surroundings	



Wetland Solutions Inc

SPRING SITE VISIT DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Date: 3/24/21
Location: White Sulphur
Field Team: RC/SK

Applicability

WRV 1 Recreation In and On the Water — Yes/ [✓ No]
Notes: No access to spring pool.

WRV 2 Fish and Wildlife Habitats and the Passage of Fish — [✓ Yes] /No
Notes: Limited habitat no apparent vegetation
Shear walls Dark water intrusion

WRV 3 Estuarine Resources — Yes/ [✓ No]
Notes: Dark water intrusion

WRV 4 Transfer of Detrital Material — Yes/ [✓ No]
Notes: No detrital material shear wall enclosed no spring run

WRV 5 Maintenance of Freshwater Storage and Supply — Yes/No
Notes:

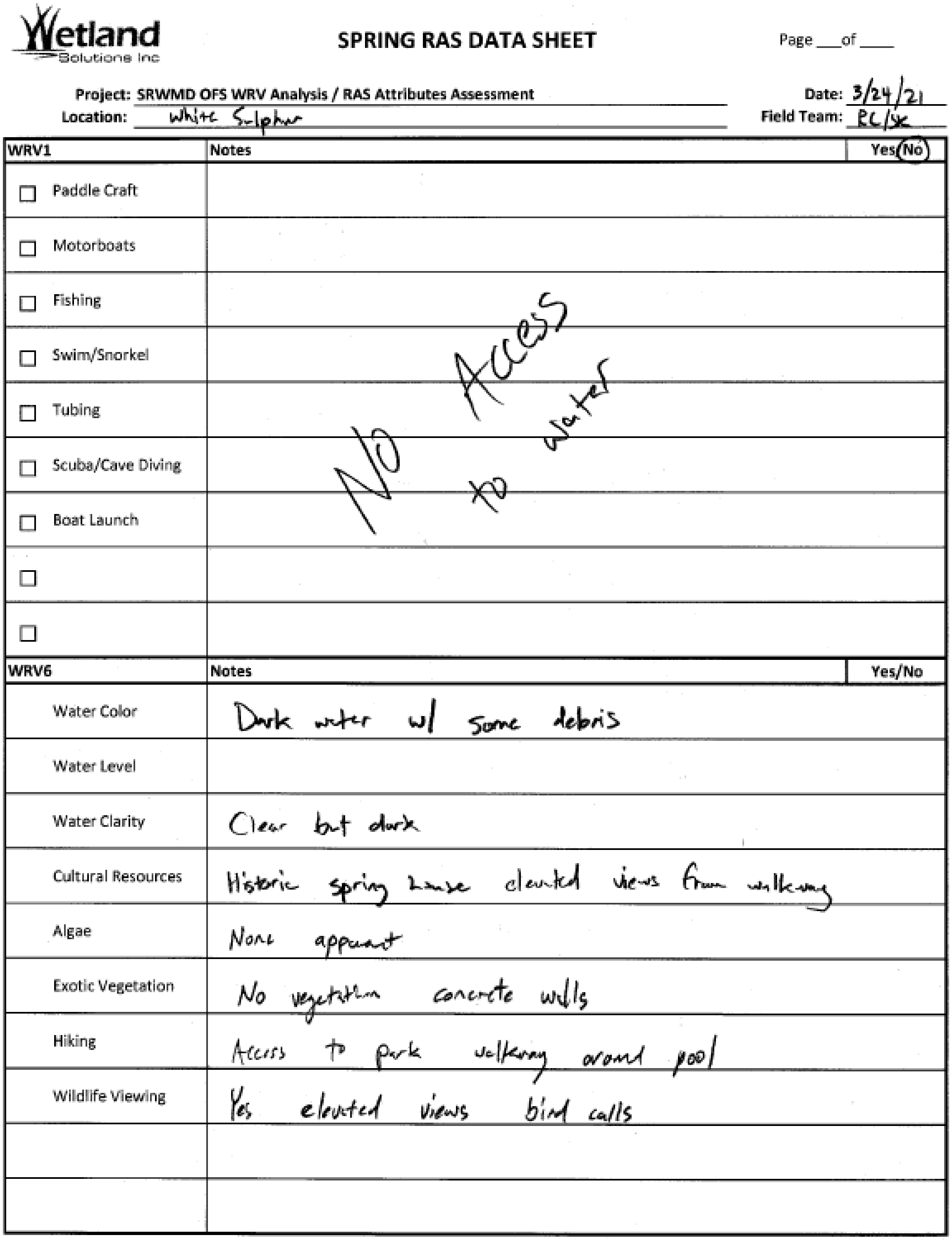
WRV 6 Aesthetic and Scenic Attributes — [✓ Yes] /No
Notes: Historic structure elevated views
some nature Surrounding views of Suwannee

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants — Yes/ [✓ No]
Notes: No spring run and no apparent vegetation

WRV 8 Sediment Loads — Yes/ [✓ No]
Notes: Sheer concrete walls

WRV 9 Water Quality — Yes/No
Notes: Dark water intrusion

WRV 10 Navigation — Yes/ [✓ No]
Notes:



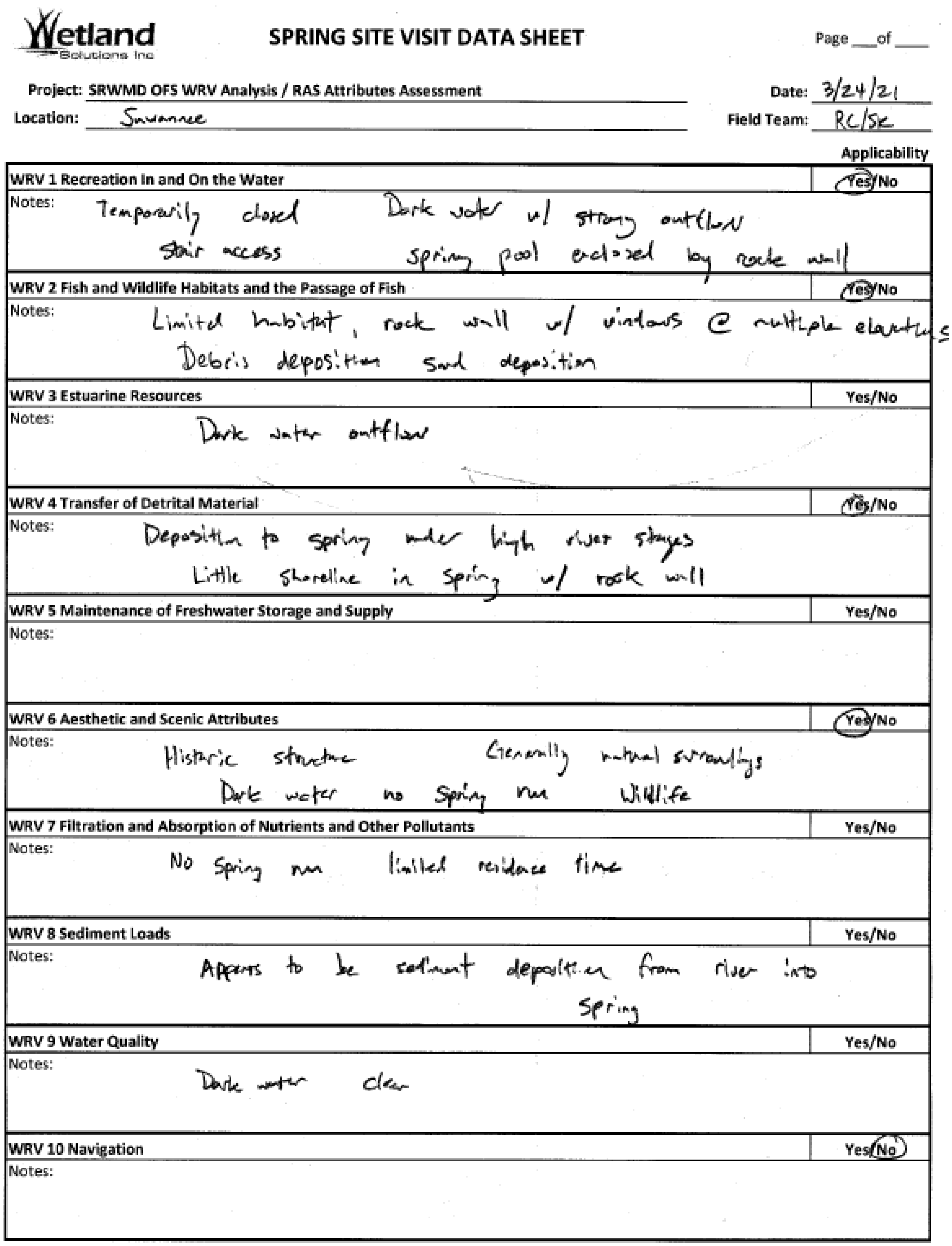
SPRING RAS DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Location: White Sulphur
Date: 3/24/21
Field Team: RC/JK

WRV1	**Notes**	**Yes [✓ No]**
☐ Paddle Craft		
☐ Motorboats		
☐ Fishing	No Access to water	
☐ Swim/Snorkel		
☐ Tubing		
☐ Scuba/Cave Diving		
☐ Boat Launch		
☐		
☐		

WRV6	**Notes**	**Yes/No**
Water Color	Dark water w/ some debris	
Water Level		
Water Clarity	Clear but dark	
Cultural Resources	Historic spring house elevated views from walkway	
Algae	None apparent	
Exotic Vegetation	No vegetation concrete walls	
Hiking	Access to park walkway around pool	
Wildlife Viewing	Yes elevated views bird calls	



SPRING SITE VISIT DATA SHEET

Page ___of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment
Date: 3/24/21
Location: Suwannee
Field Team: RC/SK

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No
Notes: Temporarily closed Dark water w/ strong outflow
Stair access spring pool enclosed by rock wall

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No
Notes: Limited habitat, rock wall w/ windows @ multiple elevations
Debris deposition sand deposition

WRV 3 Estuarine Resources Yes/No
Notes: Dark water outflow

WRV 4 Transfer of Detrital Material [✓ Yes]/No
Notes: Deposition to spring under high river stages
Little shoreline in spring w/ rock wall

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No
Notes:

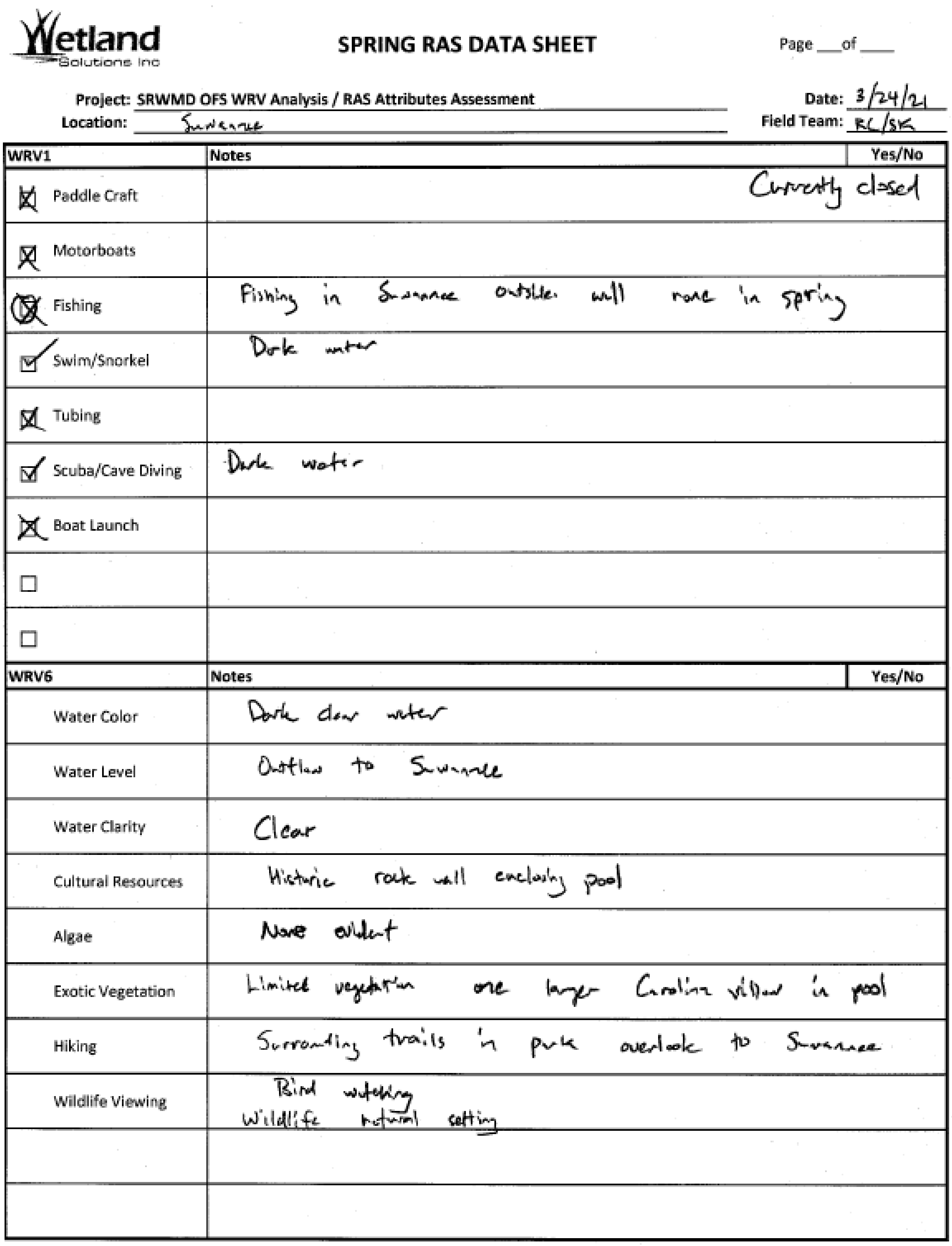
WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No
Notes: Historic structure Generally natural surroundings
Dark water no spring run Wildlife

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants Yes/No
Notes: No spring run limited residence time

WRV 8 Sediment Loads Yes/No
Notes: Appears to be sediment deposition from river into spring

WRV 9 Water Quality Yes/No
Notes: Dark water clear

WRV 10 Navigation Yes/[✓ No]
Notes:



SPRING RAS DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

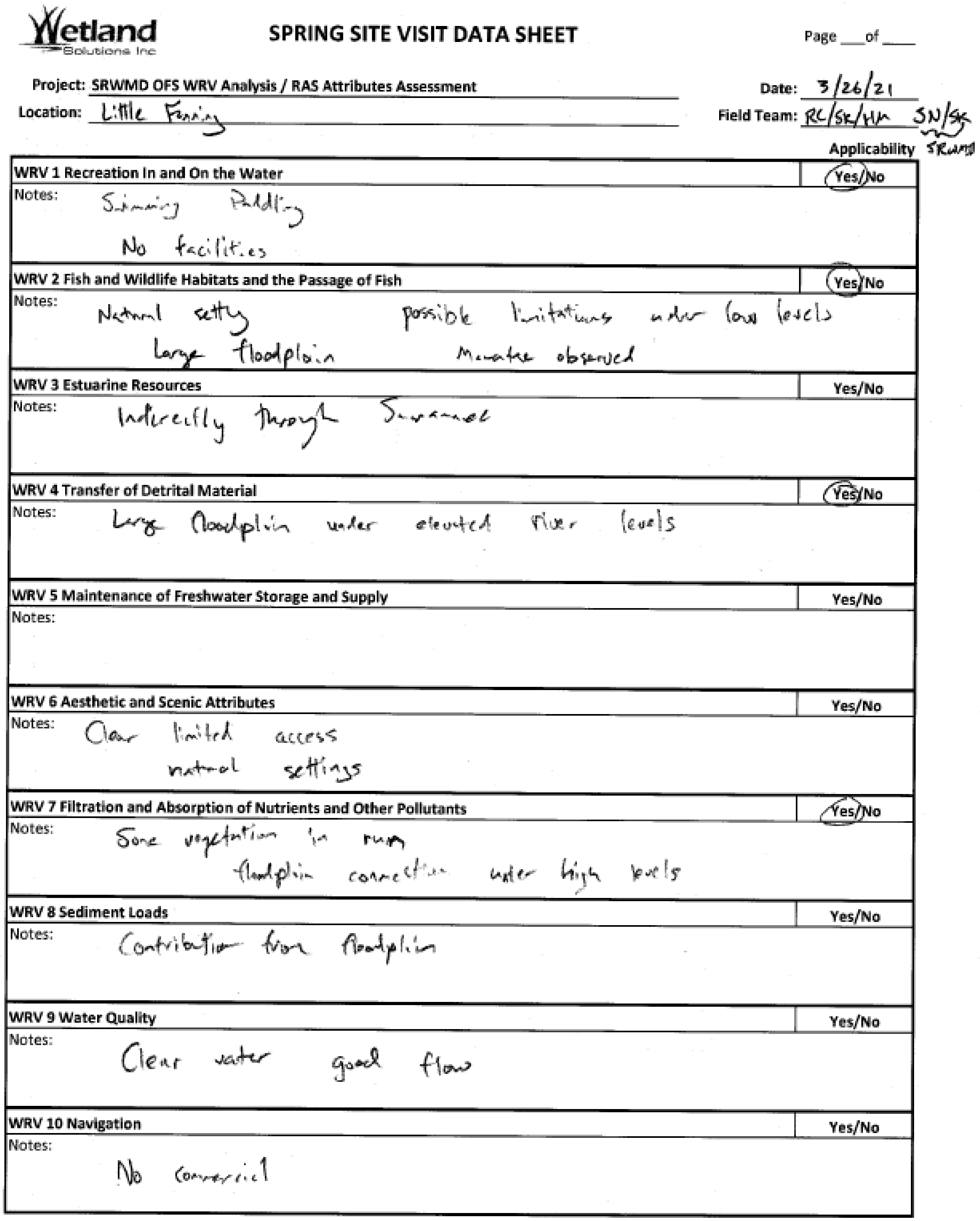
Location: Suwannee

Date: 3/24/21

Field Team: RC/SK

WRV1	Notes	Yes/No
☒ Paddle Craft	Currently closed	
☒ Motorboats		
☒ Fishing	Fishing in Suwannee outside wall none in spring	
☑ Swim/Snorkel	Dark water	
☒ Tubing		
☑ Scuba/Cave Diving	Dark water	
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Dark clear water	
Water Level	Outflow to Suwannee	
Water Clarity	Clear	
Cultural Resources	Historic rock wall enclosing pool	
Algae	None evident	
Exotic Vegetation	Limited vegetation one large Carolina willow in pool	
Hiking	Surrounding trails in park overlook to Suwannee	
Wildlife Viewing	Bird watching Wildlife natural setting	



SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/26/21

Location: Little Fanning

Field Team: RC/SK/HM SN/SK SRWMD

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Swimming Paddling
No facilities

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Natural setting possible limitations under low levels
Large floodplain Manatee observed

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Suwannee

WRV 4 Transfer of Detrital Material [✓ Yes]/No

Notes: Large floodplain under elevated river levels

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes Yes/No

Notes: Clear limited access
natural settings

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants [✓ Yes]/No

Notes: Some vegetation in run
floodplain connection under high levels

WRV 8 Sediment Loads Yes/No

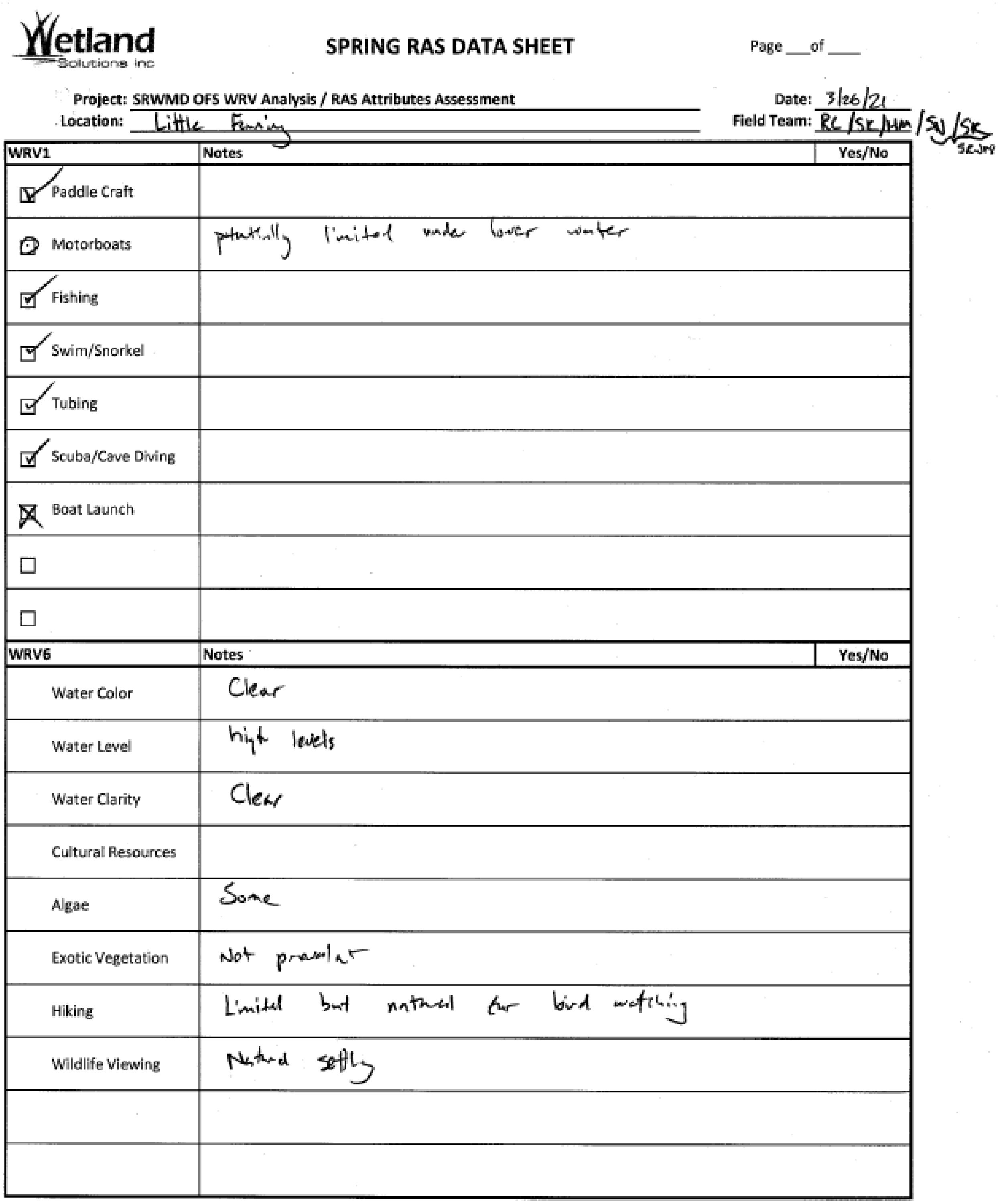
Notes: Contribution from floodplain

WRV 9 Water Quality Yes/No

Notes: Clear water good flow

WRV 10 Navigation Yes/No

Notes: No commercial



SPRING RAS DATA SHEET

Page ___ of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

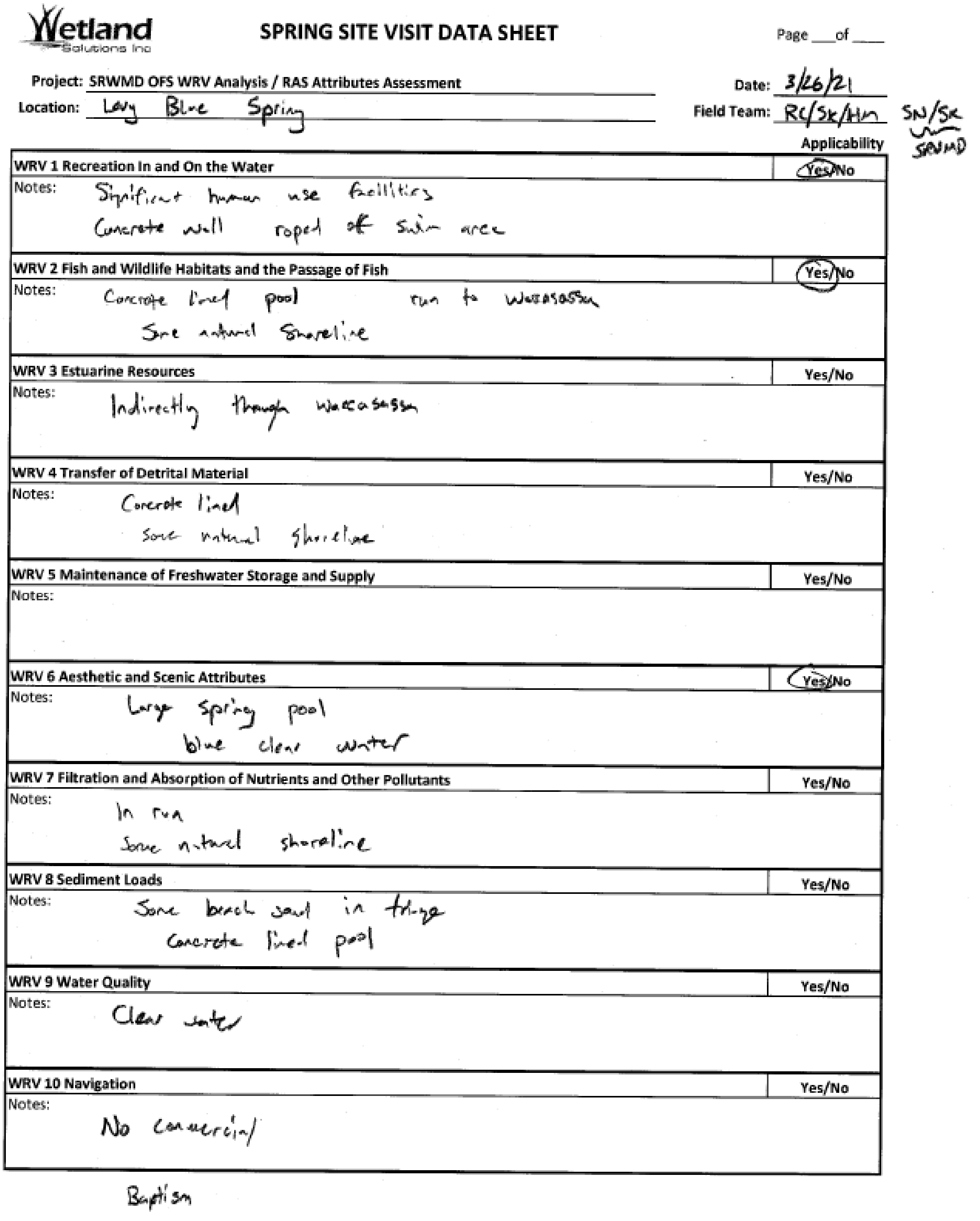
Location: Little Fanning

Date: 3/26/21

Field Team: RC/SK/HM/SJ/SK

WRV1	Notes	Yes/No
☑ Paddle Craft		
☐ Motorboats	potentially limited under lower water	
☑ Fishing		
☑ Swim/Snorkel		
☑ Tubing		
☑ Scuba/Cave Diving		
☒ Boat Launch		
☐		
☐		

WRV6	Notes	Yes/No
Water Color	Clear	
Water Level	high levels	
Water Clarity	Clear	
Cultural Resources		
Algae	Some	
Exotic Vegetation	Not prevalent	
Hiking	Limited but natural for bird watching	
Wildlife Viewing	Natural setting	



Wetland Solutions Inc

SPRING SITE VISIT DATA SHEET

Page ___of ____

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Date: 3/26/21

Location: Levy Blue Spring

Field Team: RC/SK/HM SN/SK SRWMD

Applicability

WRV 1 Recreation In and On the Water [✓ Yes]/No

Notes: Significant human use facilities
Concrete wall roped off swim area

WRV 2 Fish and Wildlife Habitats and the Passage of Fish [✓ Yes]/No

Notes: Concrete lined pool run to Waccasassa
Some natural shoreline

WRV 3 Estuarine Resources Yes/No

Notes: Indirectly through Waccasassa

WRV 4 Transfer of Detrital Material Yes/No

Notes: Concrete lined
Some natural shoreline

WRV 5 Maintenance of Freshwater Storage and Supply Yes/No

Notes:

WRV 6 Aesthetic and Scenic Attributes [✓ Yes]/No

Notes: Large spring pool
blue clear water

WRV 7 Filtration and Absorption of Nutrients and Other Pollutants Yes/No

Notes: In run
Some natural shoreline

WRV 8 Sediment Loads Yes/No

Notes: Some beach sand in fringe
Concrete lined pool

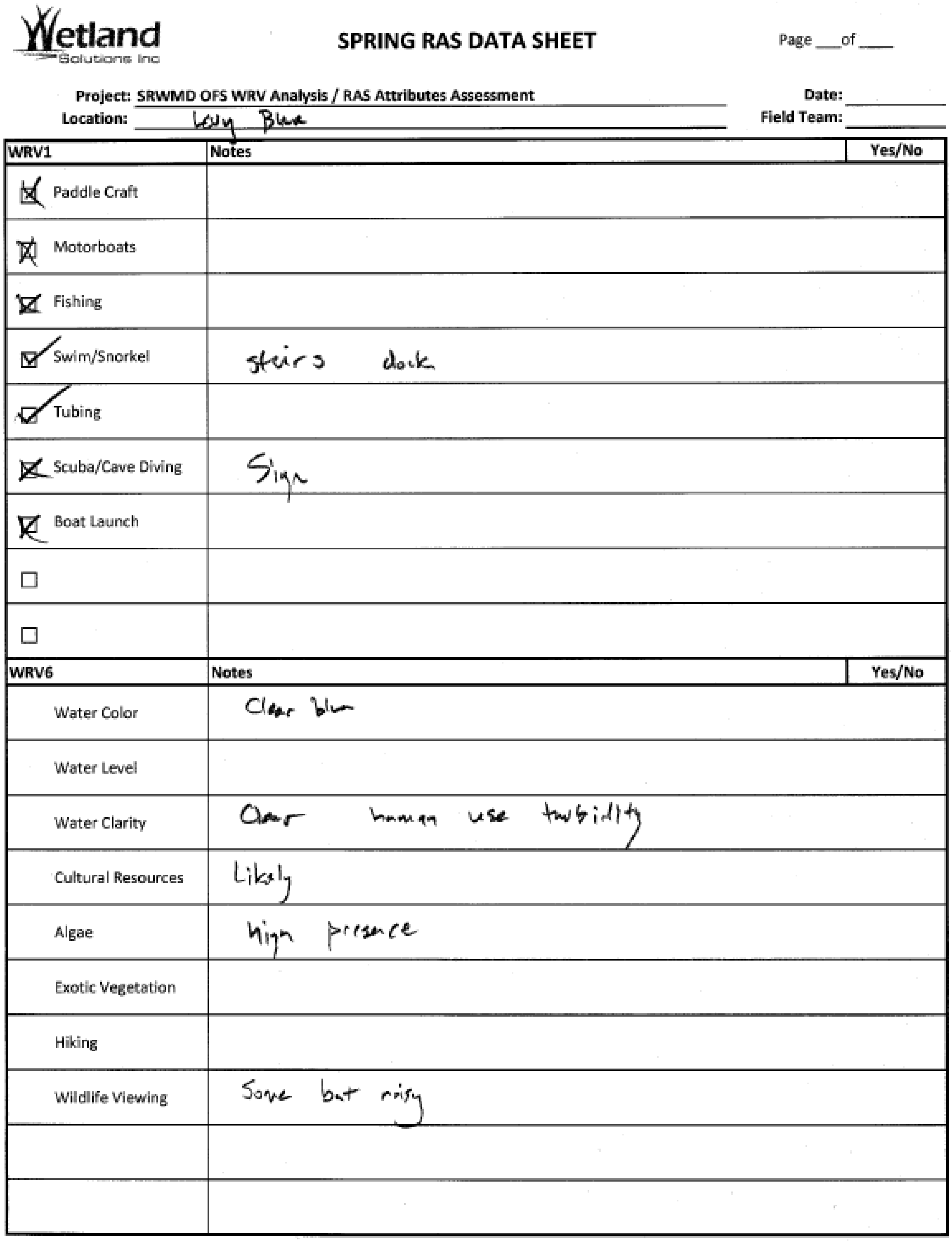
WRV 9 Water Quality Yes/No

Notes: Clear water

WRV 10 Navigation Yes/No

Notes: No commercial

Baptism



SPRING RAS DATA SHEET

Page ___ of ___

Project: SRWMD OFS WRV Analysis / RAS Attributes Assessment

Location: Levy Blue

Date: ___

Field Team: ___

WRV1	Notes	Yes/No
☒ Paddle Craft		
☒ Motorboats		
☒ Fishing		
☑ Swim/Snorkel	stairs dock	
☑ Tubing		
☒ Scuba/Cave Diving	Sign	
☒ Boat Launch		
☐		
☐		
WRV6	**Notes**	**Yes/No**
Water Color	Clear blue	
Water Level		
Water Clarity	Clear human use turbidity	
Cultural Resources	Likely	
Algae	high presence	
Exotic Vegetation		
Hiking		
Wildlife Viewing	Some but noisy	