Expanded Water Quality Monitoring for East Bay (St. Andrew Bay), Lake Wimico, Gulf County Canal, and the Intracoastal Waterway
Grant AT003

Data Collection Summary Report
Fiscal Year 2023-2024
(July 1, 2023 - June 30, 2024)

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Table of Contents

List of Figures

List of Tables

1 Introduction

In the late 1930s and early 1940s, the Gulf County Canal (GCC) and Intracoastal Waterway (ICW) were excavated by the U.S. Army Corps of Engineers (Figure 1). These waterways were created to provide a safe route for shipping agricultural products to northern markets by allowing for an inshore navigational route connecting multiple bays along the Gulf Coast from Texas to Florida. The waterways produced by these projects not only facilitated easy and safe navigation, but also hydrologically connected waterbodies which were previously isolated or minimally connected. Within Gulf, Bay, and Franklin counties, Florida, the GCC and ICW connected St. Andrew Bay, St. Joseph Bay, and Apalachicola Bay.

In recent years, potential changes in the water quality and ecology of St. Joseph Bay and Lake Wimico have been reported by residents and anecdotally attributed to freshwater flows through the GCC and ICW. Previous studies involving hydrodynamic models in East Bay (St. Andrew Bay) indicated water tends to flow from the East Bay portion of St. Andrew Bay into the Intracoastal Waterway, with reversal during some conditions (NWFWMD 1990, Blumberg and Kim 2000). Detailed data concerning discharge estimates and the timing of these historical flows is unavailable. Due to the connecting waterways, any investigation into changes in water quality of St. Joseph Bay should include investigations into the surrounding watersheds and their potential connectivity to St. Joseph Bay. As a result, understanding the connectivity between St. Andrew Bay, St. Joseph Bay, and Apalachicola Bay is imperative for understanding how flows may influence changes in the water quality and, potentially, the ecology of these multiple interconnected bay systems and Lake Wimico.

Historically, much of the land surrounding the East Bay portion of St. Andrew Bay (where St. Andrew Bay is connected to the ICW) was managed for pine silviculture. Conversion of forested lands to pasture to support cattle production began during the last decade and accelerated after October 2018 when Hurricane Michael made landfall and destroyed most of the trees in the area. These changes have the potential to affect sediment transport and water quality parameters such as nitrate levels, suspended solids, and turbidity. Adverse changes in water quality can impact aquatic ecology by promoting algal growth, reducing light availability for photosynthesis, and burying benthic habitats in sediment. Due to the hydrologic connectivity described above, water quality constituents can potentially be transported among St. Andrew Bay, St. Joseph Bay, Lake Wimico, and/or Apalachicola Bay.

In addition, stakeholders have raised concerns as to whether conditions in Lake Wimico are potentially becoming more saline, resulting in changes to the lake's ecology. Lake Wimico is connected to the Gulf of Mexico by the Intracoastal Waterway both to the northwest and southeast (Figure 1). Water quality samples collected by the Department of Environmental Protection (DEP) show that salinity in Lake Wimico becomes elevated

during periods of low rainfall. Until recently, the volume, direction, and seasonality of flows (both marine and freshwater) through Lake Wimico were largely unknown.
The Northwest Florida Water Management District (NWFWMD) was asked by the DEP to prepare a broad scope of work for assessing the hydrologic connectivity of St. Joseph Bay, Apalachicola Bay, and St. Andrew Bay and the potential of hydrologic connections to transport constituents that affect water quality. The work is funded under DEP grant AT003 which was initiated during FY 2019-2022. Previous versions of the scope of work were developed and completed to begin addressing the following questions:

1. How are Apalachicola Bay, St. Joseph Bay, and St. Andrew Bay hydrologically connected through the Intracoastal Waterway in a given year?
2. What are the water quality conditions, trends, and data gaps within East Bay (St. Andrew Bay) and its contributing watershed?
3. What are the general salinity (dissolved oxygen and temperature) characteristics of Lake Wimico throughout a year?
4. What are additional surface water inputs to St. Joseph Bay in addition to the GCC?

During FY 2023-2024, the scope of work continued data collection efforts to address the question of hydrologic connections and flows through the Intracoastal Waterway under Amendment 7 to Grant AT003. In May 2024, Amendment 8 was executed to the grant which provided additional funding to collect additional lab analyzed water quality samples at locations around St. Joseph Bay and at select second magnitude springs within District boundaries. It should be noted that data collection at the second magnitude springs is not in support of the St. Joseph Bay monitoring efforts. As part of Amendments 7 and 8 to the grant agreement, a final summary report is to be submitted to summarize the data collection efforts performed. This report summarizes the data collected as part of Amendments 7 and 8 to Grant AT003. Additional tasks and data which were collected as part of previous amendments during FY 2019-2020, FY 2020-2021, FY 2021-2022 and/or FY 2022-2023, but not during FY 2023-2024, are not included, but are described in previous annual reports. While Amendments 7 and 8 extended from 7/1/2023 through 6/30/2024, all data collection continued under these amendments are included in the analysis.

1. Introduction

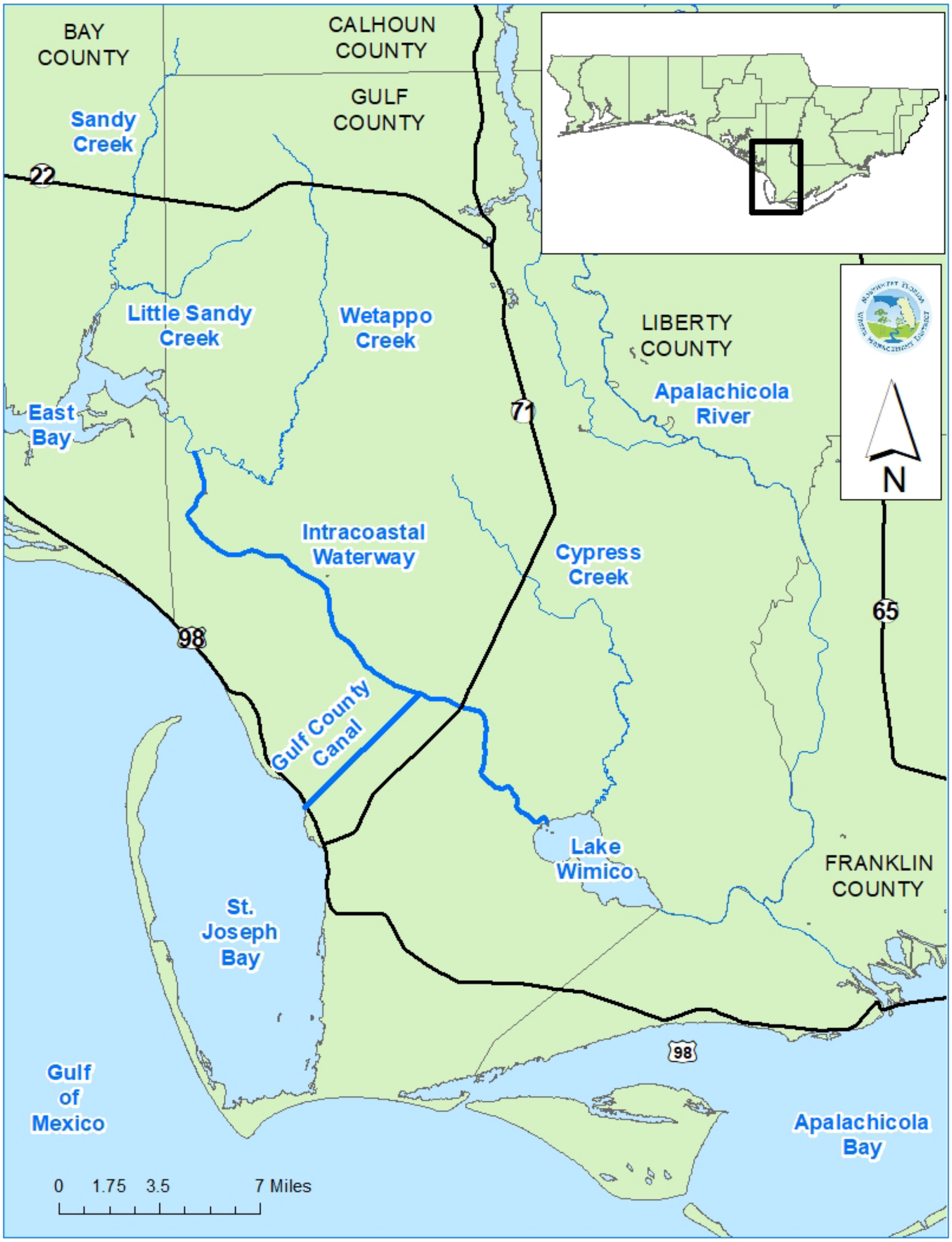


Figure 1: *General Study Area for Grant AT003*

2 Study Area

The study area for the project includes the Intracoastal Waterway and the Gulf County Canal in Gulf County, FL (Figure 1). In addition, water quality samples were collected around St. Joseph Bay and from select second magnitude springs across the Florida panhandle (not depicted in Figure 1 but described in Section 4.4).

3 Hydrology

This section provides information on existing knowledge concerning flows among Apalachicola Bay, St. Joseph Bay, and St. Andrew Bay (East Bay) (Figure 1).

3.1 Previous Studies

Three sources of available information concerning flows relevant to the ICW and GCC were identified. In 1990, Rodriguez and Wu prepared a three-dimensional hydrodynamic model to investigate contaminant flushing in St. Andrew Bay associated with wastewater treatment (Rodriguez and Wu 1990). Their investigation indicated that under some conditions, the water in East Bay remains relatively isolated from the rest of St. Andrew Bay and East Bay water may be transferred into the ICW and flow towards St. Joseph Bay and Apalachicola Bay.

Blumberg and Kim developed a subsequent three-dimensional hydrodynamic model for St. Andrew Bay which indicated that flows within the St. Andrew Bay were highly variable (Blumberg and Kim 2000). During some periods, flows entered East Bay and St. Andrew Bay from the ICW, while at other times water entering St. Andrew Bay from the Gulf of Mexico flowed into the ICW.

The United States Geological Survey produces and maintains the National Hydrography Dataset (NHD) which depicts the water drainage network of rivers, streams, canals, lakes and coastlines throughout the United States (NHD Plus, Version 2). The NHD depicts the fundamental flow network of streams, rivers, and other waterways in a series of line vectors. This dataset indicates that flows in the ICW tend to flow from East Bay towards St. Joseph Bay and Apalachicola (Figure 2).

In addition, several other studies have reported information relevant to salinity in St. Joseph Bay. In 1999, the USGS reported estimated instantaneous discharges at the mouth of St. Joseph Bay as ranging between -116,000 cubic feet per second (cfs) and 110,000 cfs during October 1997 and -132,000 cfs and 121,000 cfs during March 1998 (USGS 1999).

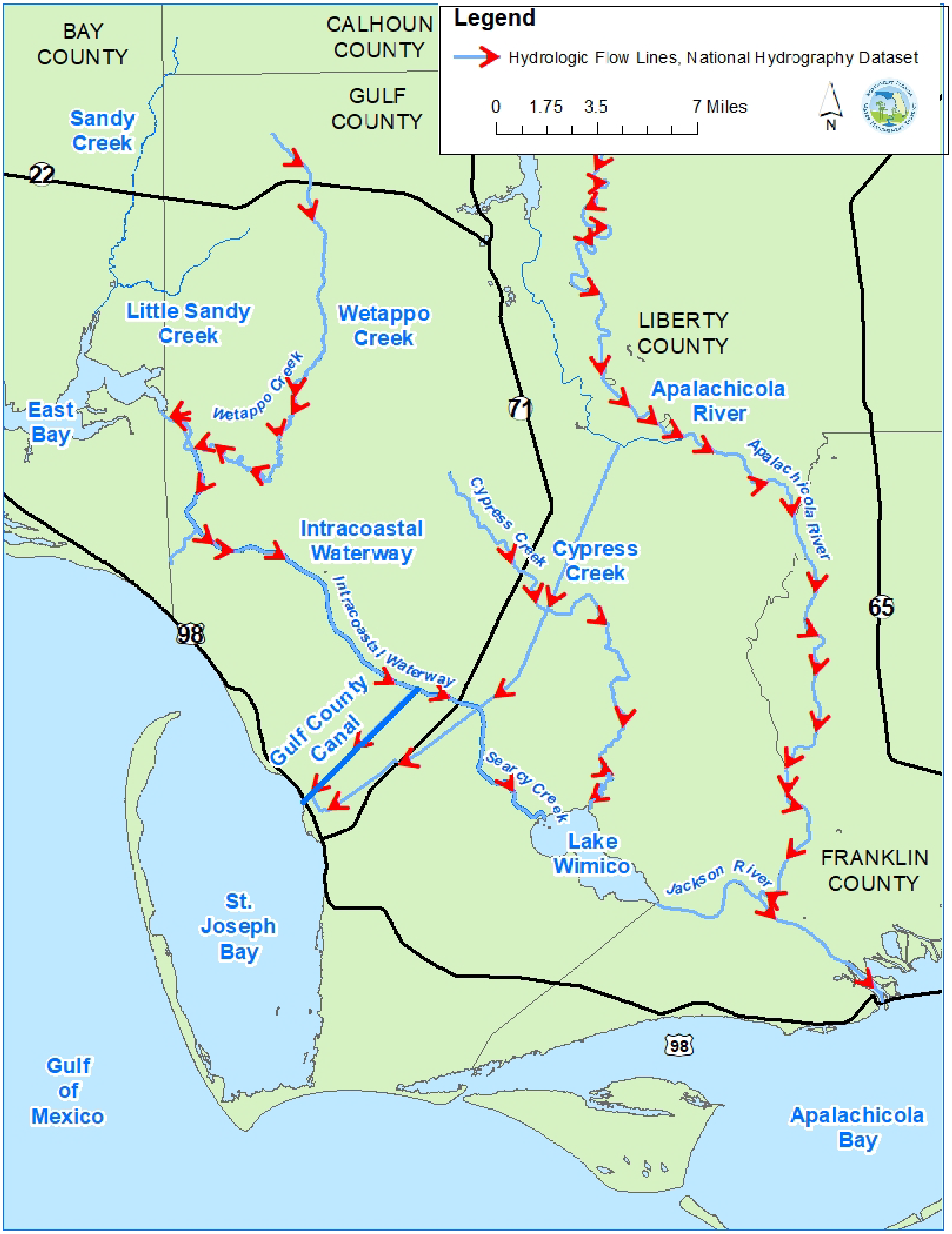


Figure 2: *Flow Directions from the National Hydrography Dataset, Version 2*

3.2 Continuous Discharge Data Collection Efforts

As part of the current study funded under DEP grant AT003, flows through the Gulf County Canal are being estimated using two continuous recording monitoring stations located along the ICW on either side of the Gulf County Canal (Figure 3).

The United States Geological Survey (USGS) was contracted to install two discharge monitoring stations to measure flows entering and leaving the Gulf County Canal at the confluence with the Intracoastal Waterway (Figure 3). During a site inspection, no suitable locations for monitoring stations were identified along the Gulf County Canal due to a large amount of boat traffic and public recreation use, poor site access, unconsolidated shoreline sediments, and a large volume of debris in the channel. Two suitable locations were identified in the Intracoastal Waterway in collaboration with the USGS. However, due to the remoteness of the site, shoreline access was not possible, and the sample locations required the construction of two platforms using pilings and boat access for maintenance.

Under a separate contract, the USGS was contracted to construct a third monitoring station located in the Box R Wildlife Management Area on the Jackson River (Figure 3). This site was originally designed to monitor flow from the main stem of the Apalachicola River/Apalachicola Bay into Lake Wimico. This station was necessary due to the possibility of additional freshwater flows being added to Lake Wimico and the Intracoastal Waterway between the Apalachicola River and GCC discharge monitoring stations. Collection of accurate discharge measurements at this site proved impossible because of the presence of dense submerged aquatic vegetation and shallow water depths. This station was maintained to collect stage and limited water quality data, and discharge data was discontinued.

All data collected at these three locations are available at the websites listed below:

1. https://waterdata.usgs.gov/fl/nwis/uv/?site_no=295323085151700&agency_cd=USGS (USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL).
2. https://nwis.waterdata.usgs.gov/fl/nwis/uv/?site_no=295308085143700&agency_cd=USGS (USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL)
3. https://waterdata.usgs.gov/fl/nwis/uv/?site_no=02359223&agency_cd=USGS (USGS Station 02359223 (JACKSON RIVER AT RANCH ROAD NR APALACHICOLA, FL)

Discharge estimates at all locations are being collected using the Index Velocity (IV) Method as described in Levesque and Oberg (2012). The IV method is required due to tidal influences which extend well into the ICW. The IV method uses calculations from two separate rating curves: 1- a stage rating curve which provides the cross-sectional area of water flowing by the sensors and 2- a velocity rating curve which relates water velocity and direction at a point in the channel to the average channel velocity. Discharge data was subsequently tidally filtered using a Godin filter and converted to daily averages by the USGS. Flows through the GCC are estimated using a mass balance approach.

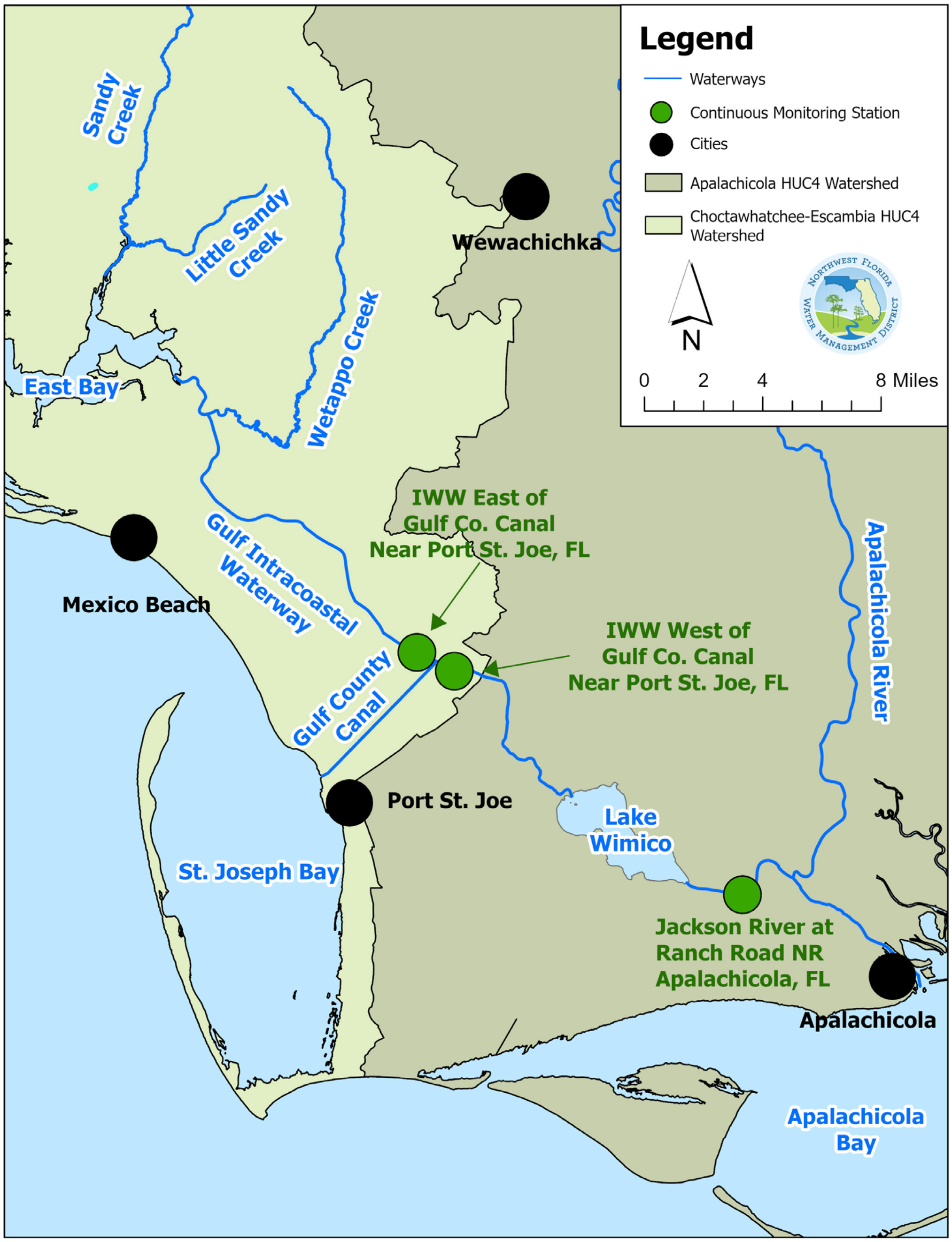


Figure 3: *Location of Monitoring Stations*

3.2.1 Continuous Station Discharge Results

Due to the complex hydrology of the system, index velocity ratings take an extraordinary amount of information and time to develop. As a result, much of the discharge data described in this report remains provisional at the time of this document's preparation. Discharge values are therefore subject to change following QA/QC efforts by the USGS. The USGS does not anticipate any major changes; however, and it is assumed that the general trends described will remain accurate even though actual values (average, median, minimum, maximum, etc.) may change.

3.2.1.1 USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL)

A total of 1,205 daily estimates of tidally filtered discharge were available at Station 295323085151700 between 10/24/2020, and 6/30/2024 (Figure 4). Several data gaps are present in the flow record which occurred as a result of sensor malfunction. During this period the average daily flow at this location was 922 cfs (median = 837 cfs) and ranged between -1,480 cfs (flowing towards the Gulf County Canal) and 4,270 cfs (flowing towards St. Andrew Bay. Negative average daily tidally filtered flows towards the Gulf County Canal/Lake Wimico occurred nearly 16 percent of the time during the period of record. Flows west of the Gulf County Canal appear to exhibit seasonality with higher flows occurring during winter/early spring months.

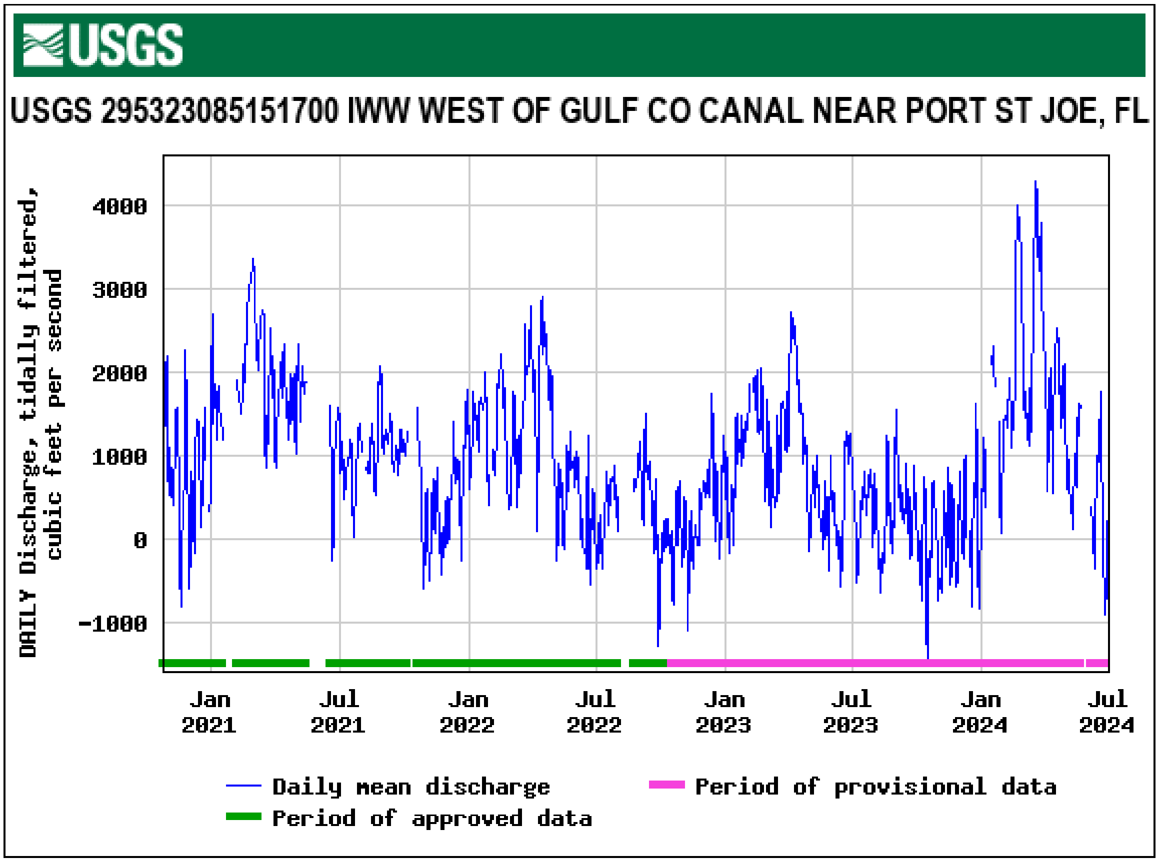


***Figure 4:** Flows Measured at USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL). Positive flows are towards St. Andrew Bay and negative flows are towards the Gulf County Canal/Lake Wimico.*

3.2.1.2 USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL)

A total of 1,098 daily estimates of tidally filtered discharge were available at Station 0298308085143700 between 9/25/2020, and 6/30/2024 (Figure 5). Several data gaps are present in the flow record which occurred as a result of sensor malfunction. In addition, a large data gap exists between 11/20/2021, and 3/21/2022, when the platform holding the sampling equipment was completely destroyed, presumably by a barge. During this period the average daily flow at this location was 3,001 cfs (median = 2,580 cfs) and ranged between -1,950 cfs (flows towards Lake Wimico) and 11,600 cfs (flows towards the Gulf County Canal/St. Andrew Bay). Net daily flows were almost always positive with water flowing towards the Gulf County Canal/St. Andrew Bay on 1089 days (>99 percent of the time) with available data.

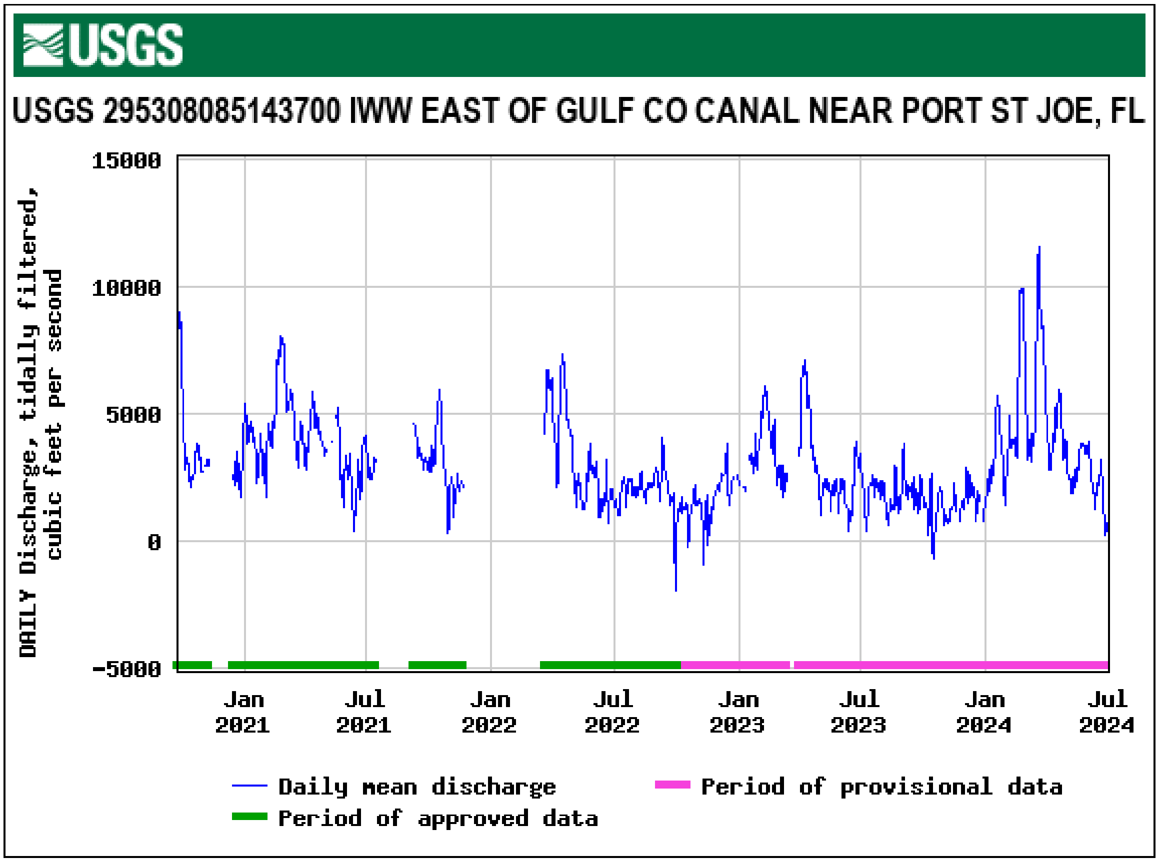


Figure 5: Flows Measured at USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL. Positive flows indicate flows towards the Gulf County Canal and St. Andrew Bay.

3.2.1.3 Flows Into the Gulf County Canal

A mass balance approach using the two stations located on the Intracoastal Waterway near the Gulf County Canal was used to calculate the net daily discharge of water flowing into or out of the Gulf County Canal. Flows into the Gulf County Canal were determined by subtracting tidally filtered flows measured at USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL) from tidally filtered flows measured at USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL). The difference in flows from these stations is estimated to represent the quantity of water diverted into the Gulf County Canal towards St. Joseph Bay.

A total of 942 concurrent daily, tidally filtered flow observations at USGS Station 295323085151700 and USGS Station 0298308085143700 were available between 10/24/2020, and 6/30/2024. Positive flows indicate water flowing into the Gulf County Canal towards St. Joseph Bay, while negative flows represent flows from the Gulf County Canal into the ICW. During this time period, the average measured discharge was 2,040 cfs (median flow = 1,780 cfs) of water flowing into the Gulf County Canal from the ICW (Figure 6). These flows ranged from -670 cfs to 7,330 cfs.

During the period of available data, there was almost always (99 percent of the time) a net daily flow of water into the Gulf County Canal from the ICW (Figure 6). The bulk of this flow is comprised of water originating from the east side of the canal; however, at times water entered the Gulf County Canal from the west. Flows into the canal from the west occurred approximately 16% of the days for which flow data into the Gulf County Canal were available. While available data indicates that flows into the Gulf County Canal may increase during the winter/early spring season, additional data collection is needed to better define long-term and seasonal trends.

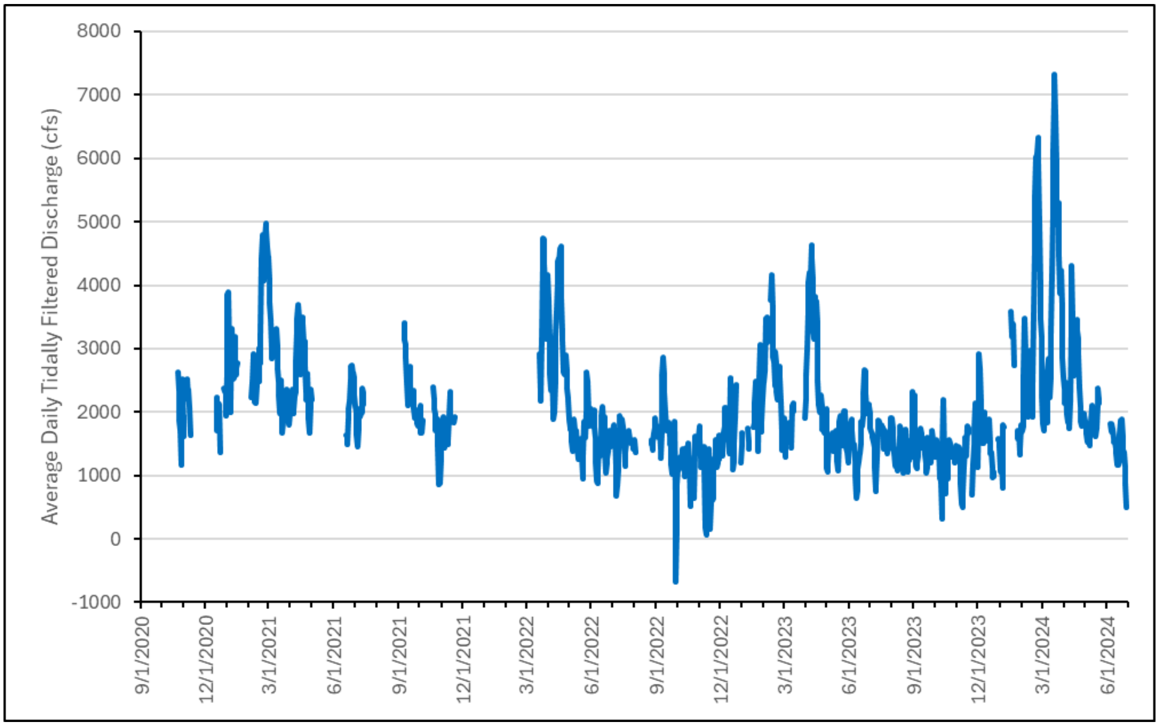


Figure 6: *Discharge Entering or Leaving the Gulf County Canal via the Gulf Intracoastal Waterway. Positive flows are entering the Gulf County Canal, with water flowing towards St. Joseph Bay.*

3.3 Flow Data Conclusions and Synthesis

Flows through the system are determined by a series of constantly changing water levels associated with coastal boundary conditions (tides, sea level, etc.) and inland boundary conditions which are also affected by river/stream flows and nearby groundwater levels. Because water levels further inland from the coast are typically higher than coastal water levels (when tidal fluctuations are removed), water tends to flow from more inland areas into coastal bays. Results indicate that if flows and/or water levels on one side of the Gulf County Canal are reduced, then those flows may be offset by increased flows from the other side of the canal.

Data collected under Grant AT003 provides considerable insight into the hydrologic connectivity between St. Joseph Bay (Gulf County Canal) and the Gulf Intracoastal Waterway. Results show that on the 942 days with available data during the study period (10/24/2020 through 6/30/2024), there was a net, positive flow into the Gulf County Canal from the Gulf Intracoastal Waterway on all but a single day (9/29/2022) when Hurricane Ian made landfall in South Florida. While there was almost always a net daily average flow of water into the Gulf County Canal, instantaneous flows were highly variable with the direction and magnitude of flows being largely affected by tides and weather conditions.

Flows from the Gulf Intracoastal Waterway can enter the Gulf County Canal from two directions: (1) from the direction of St. Andrew Bay (northwest of the canal) and/or (2) from the direction of Lake Wimico (southeast of the canal). Flows measured in the Gulf Intracoastal Waterway on the northwest side of the Gulf County Canal displayed a net daily average flow towards St. Andrew Bay on approximately 84 percent of the days with available data and with flow being towards the Gulf County Canal and/or Lake Wimico approximately 16 percent of the time. On the southeast side of the Gulf County Canal flows in the Gulf Intracoastal Waterway were almost always (99 percent of the time) flowing to the northwest.

On days when flows from both sides of the Gulf County Canal were flowing towards the Gulf County Canal, flows from both directions would be diverted into the Gulf County Canal and towards St. Joseph Bay. On the days when flows from the northwest were flowing to the southeast, it appears that most of these flows were being diverted into the Gulf County Canal with a small portion potentially flowing past the canal and towards Lake Wimico. This is supported by the flows measured on the southeast side of the Gulf County Canal almost always being greater than flows on the northwest side and nearly constant daily average flows into the Gulf County Canal.

These observations contradict data from NHD concerning flows through the system as described in Section 3.1 Previous Studies. The NHD data indicates that water flows to the southeast from St. Andrew Bay towards St. Joseph Bay and Apalachicola Bay (Figure 2)(NHD Plus, Version 2). Both Rodriguez and Wu (1990) and Blumberg and Kim (2000) reported that flows between the East Bay portion of St. Andrew Bay and the Gulf Intracoastal Waterway were highly variable changing with environmental conditions. Flows towards St. Andrew Bay occurred approximately 84% of the time. Our results indicate that during the study period, flows were nearly exclusively to the northwest and towards St. Joseph Bay from the Apalachicola Bay watershed and generally to the northwest towards St. Andrews Bay from the Apalachicola Bay watershed.

Further investigation into the flow distribution through the system reveals additional insight into the system. Flows from the IWW East and IWW West were highly correlated (Pearson's Correlation Coefficient = 0.95) indicating that flows at the IWW West Station increased in conjunction with flows at the IWW East Station (Figure 7). However, as flows from the IWW East declined to approximately 3,000 cfs, flows at the IWW West station began experiencing reversals (i.e. negative flows) with water now flowing to the southeast towards St. Joseph Bay. This indicates that if flows from the east were reduced or eliminated, flows into St. Joseph Bay from the Gulf Intracoastal Waterway System would likely continue, however this water would originate from St. Andrew Bay.

Although significant progress has been made in understanding the flows in the Gulf Intracoastal Waterway and Gulf County Canal, considerable questions remain which limit the conclusions we can make from the available data. Answers to questions such as these are critical to identifying factors affecting the bay and determining potential restoration and management activities for St. Joseph Bay. Examples of remaining questions include, but are not limited to:

1. What is the source distribution of net flows into the Gulf County Canal? It is assumed that these flows are largely comprised of fresh water; however, it is unknown what proportion of this is from the larger Apalachicola River and Bay watershed, other surface water flows from the numerous creeks and rivers located to the southeast of the Gulf County Canal, or groundwater discharge into the waterways, or some combination.
2. How are trends in sea levels affecting flows?
3. Are the flows measured during the study period representative of those occurring historically, i.e., since the construction of the Gulf County Canal and Gulf Intracoastal Waterway, or have fundamental changes occurred in the region which are affecting local water levels and flow distributions?
4. How are flows in the system affected by periods of drought and/or flooding conditions?
5. How do flows entering the Gulf County Canal and Gulf Intracoastal Waterway to the northwest of the canal change as they flow towards St. Joseph Bay and St. Andrew Bay, respectively? There is the potential for flows in the waterway to either increase or decrease as a result of interactions with both groundwater and surface water.

It is anticipated that data collection activities described in this report will continue through June 30, 2025, under a subsequent amendment to Grant AT003. During this time, the District will be in contact with the DEP to discuss future research direction and efforts into the system.

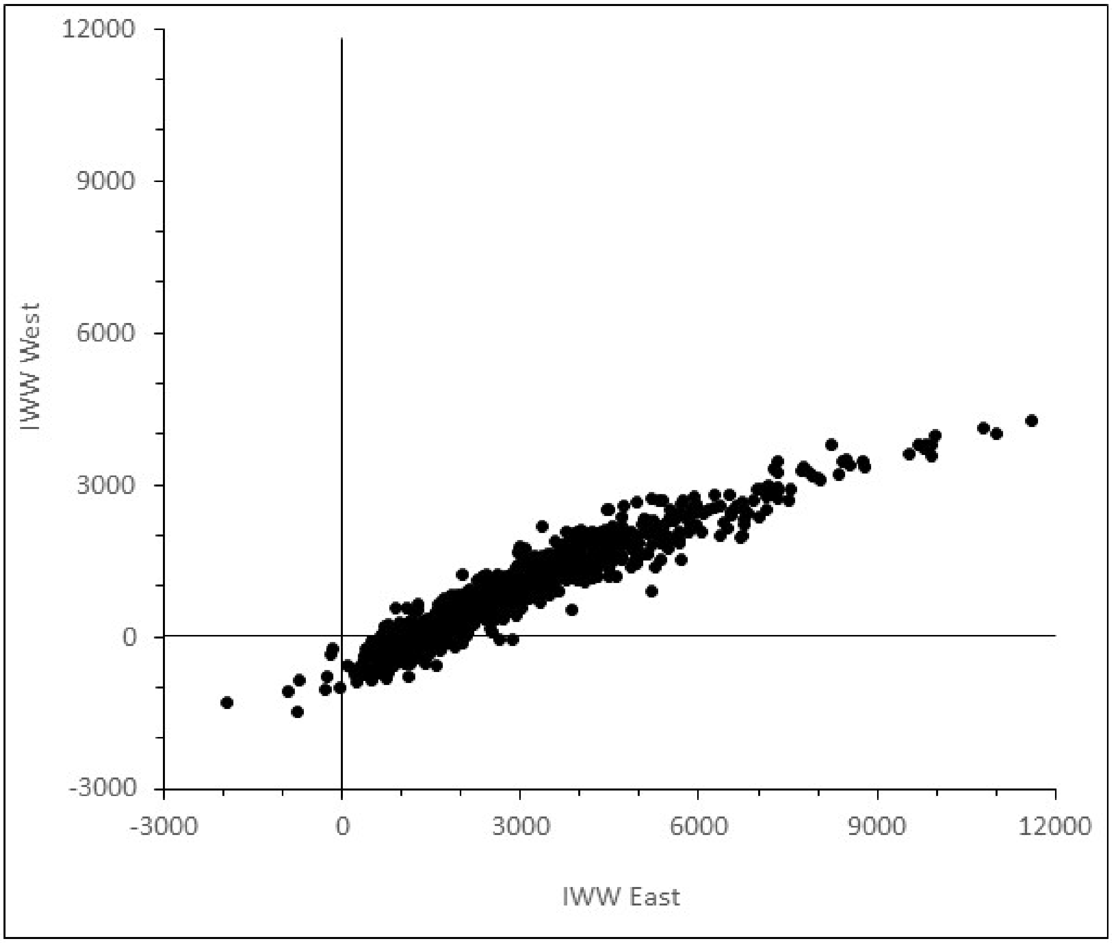


Figure 7: Scatterplot of Concurrent Flow Measurements at the IWW East and IWW West Stations. Zero (0) axis are included for reference.

4 Water Quality Data – Continuous Discharge Stations

In addition to continuous discharge data, other parameters such as water levels, pH, dissolved oxygen, temperature, specific conductivity, and nitrate plus nitrite were collected on a 15-minute basis. Summaries of these data collection results are provided below. ***Caution should be taken in using the data presented in this report as an indicator of environmental conditions at the sites. Much data from these USGS stations remains provisional at the time of this document's completion and as a result are subject to revision.***

4.1 USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL)

Stage data between 9/10/2020 and 10/18/2022 has been approved, while data collected after 10/18/2022 remains provisional and is subject to change following USGS QA/QC procedures. Water surface elevations at Station 0295323085151700 averaged 0.96 ft NAVD 88, ranging between -1.5 ft NAVD 88 and 4.27 ft NAVD 88 (Figure 8). In general, lower water surface elevations were observed during the winter months (November through March) and higher water surface elevations were observed during spring and summer months (April through October). Isolated periods of high and low water levels were regularly observed throughout the time period likely as a result of extreme tidal and/or weather conditions such as tropical systems.

Nitrate plus nitrite (Nitrate) data between 12/16/2020 and 5/17/2022 has been approved by the USGS, while data post 5/17/2022 remains provisional and is subject to change following USGS QA/QC procedures. Nitrate values collected at the surface of Station 0295323085151700 averaged 0.16 mg/L, ranging between 0 mg/L and 0.56 mg/L (Figure 9). Nitrate data was not collected at the channel bottom. In general, higher nitrate concentrations appear to be observed during winter/spring months (November through April) with lower values during the summer and fall (May through October).

Temperature data between 9/10/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. Temperature values at Station 0295323085151700 averaged 22.6°C on the surface and 23.1°C on the bottom, ranging from minimum values of 8.3°C and 8.3°C (surface and bottom, respectively) to maximum values of 34.5°C and 34.1°C (surface and bottom, respectively) (Figure 10). Higher water temperatures were observed during summer months and lower temperatures were observed during winter months, reflecting seasonal climatic variations.

The pH data collected between 9/10/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following

USGS QA/QC procedures. The pH values at Station 0295323085151700 averaged 7.2 on both the surface and bottom, ranging from minimum values of 5.1 and 5.2 (surface and bottom, respectively) to maximum values of 8.5 and 8.9 (surface and bottom, respectively) (Figure 11). Higher pH values were generally observed during winter and spring months and lower pH values were observed during summer and fall months.

Dissolved oxygen (DO) data between 9/10/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. The DO values at Station 0295323085151700 averaged 7.2 mg/L on the surface and 6.9 mg/L on the bottom, ranging from minimum values of 2.5 mg/L and 1.0 mg/L (surface and bottom, respectively) to maximum values of 11.8 mg/L and 11.4 mg/L (surface and bottom, respectively) (Figure 12). Higher DO values were generally observed during winter and spring months when water temperatures were low and lower DO values were observed during summer and fall months along with higher water temperatures.

Specific conductivity data between 9/10/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0295323085151700 averaged 3,888 microsiemens per centimeter (µS/cm) on the surface and 4,603 µS/cm on the bottom, ranging from minimum values of 51 µS/cm and 51 µS/cm (surface and bottom, respectively) to maximum values of 44,100 µS/cm and 48,600 µS/cm (surface and bottom, respectively) (Figure 13). At times, the water column at this location became considerably stratified with higher conductivity (saltier) water being found on the bottom and lower conductivity (fresh water) on the surface.

4. Water Quality Data

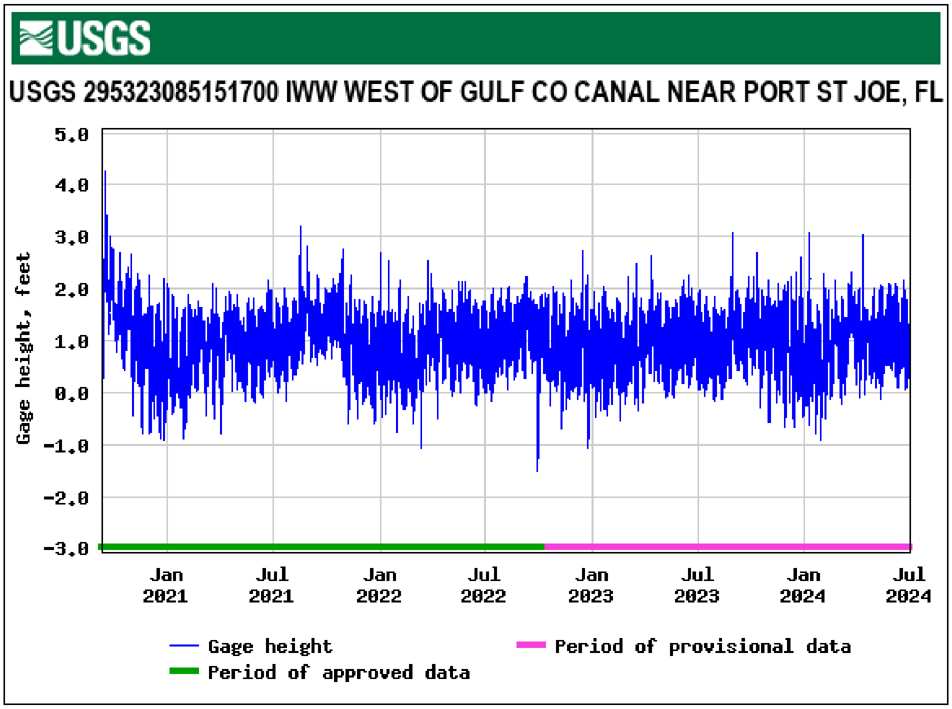


Figure 8: *Stage (ft, NAVD 88) as measured at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024. Figure provided by the USGS.*

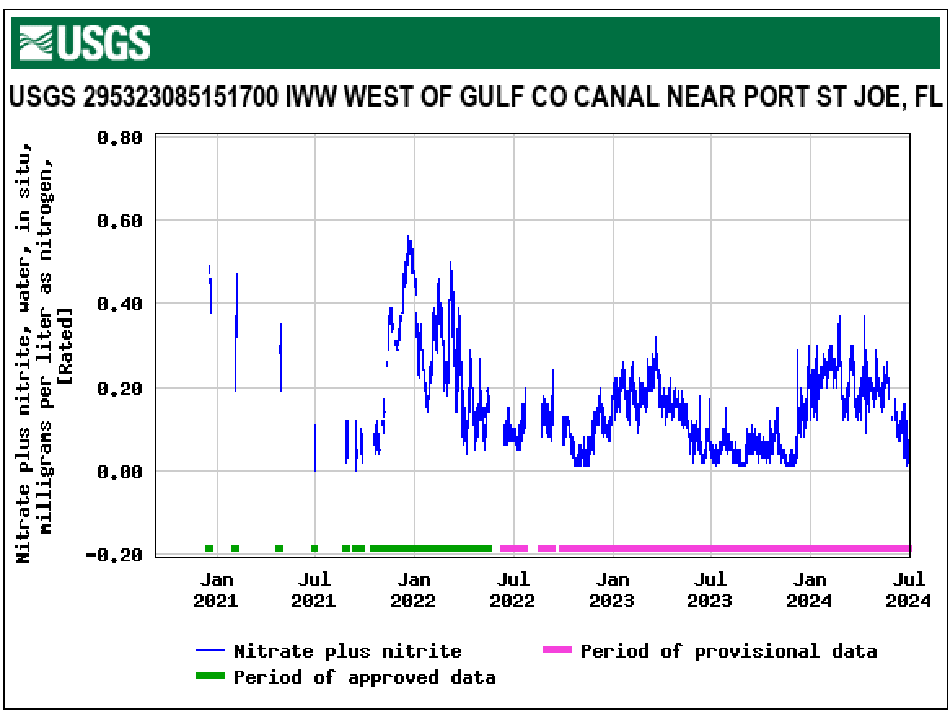
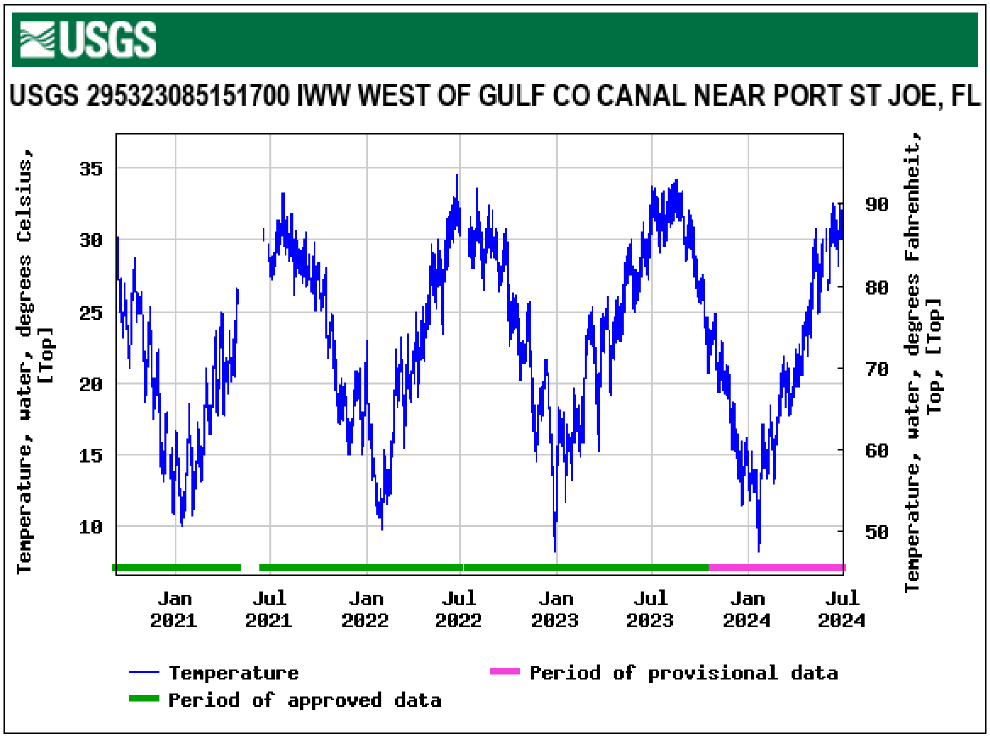


Figure 9: *Nitrate plus nitrite (mg/L) as measured at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



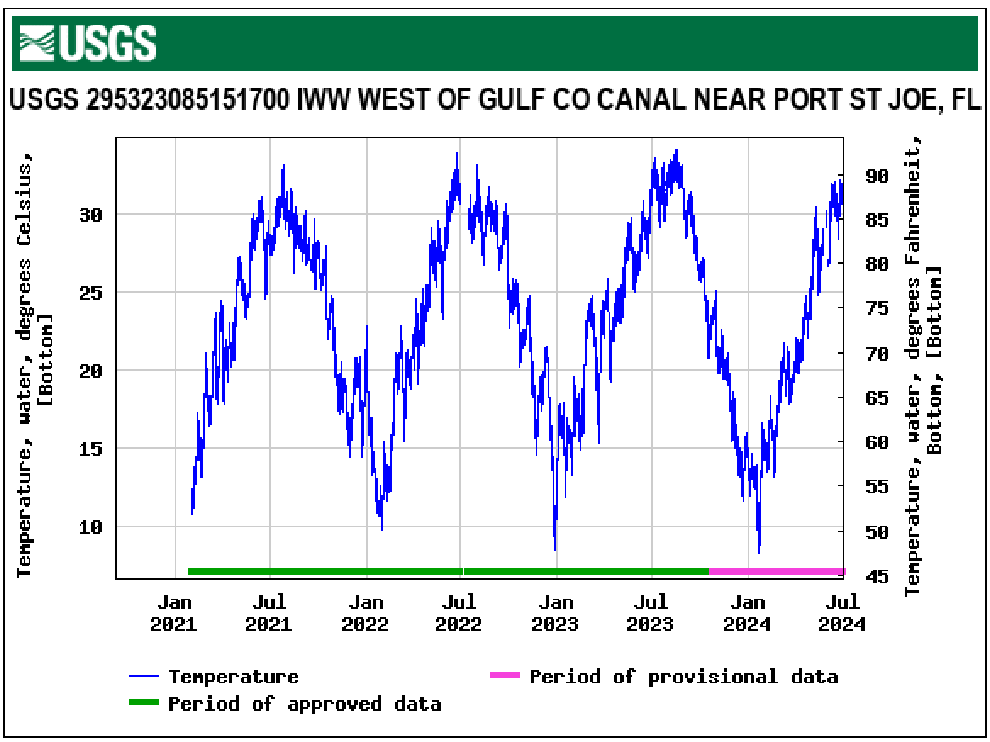
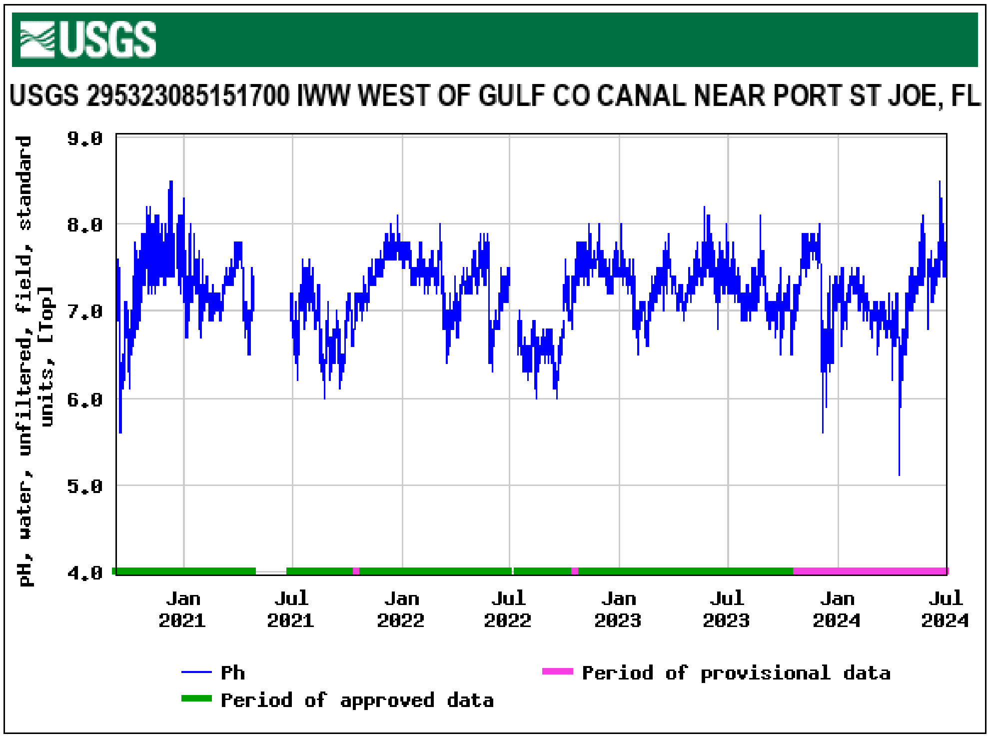


Figure 10: *Temperature (°C) as measured on both the surface (top graph) and bottom (bottom graph) at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



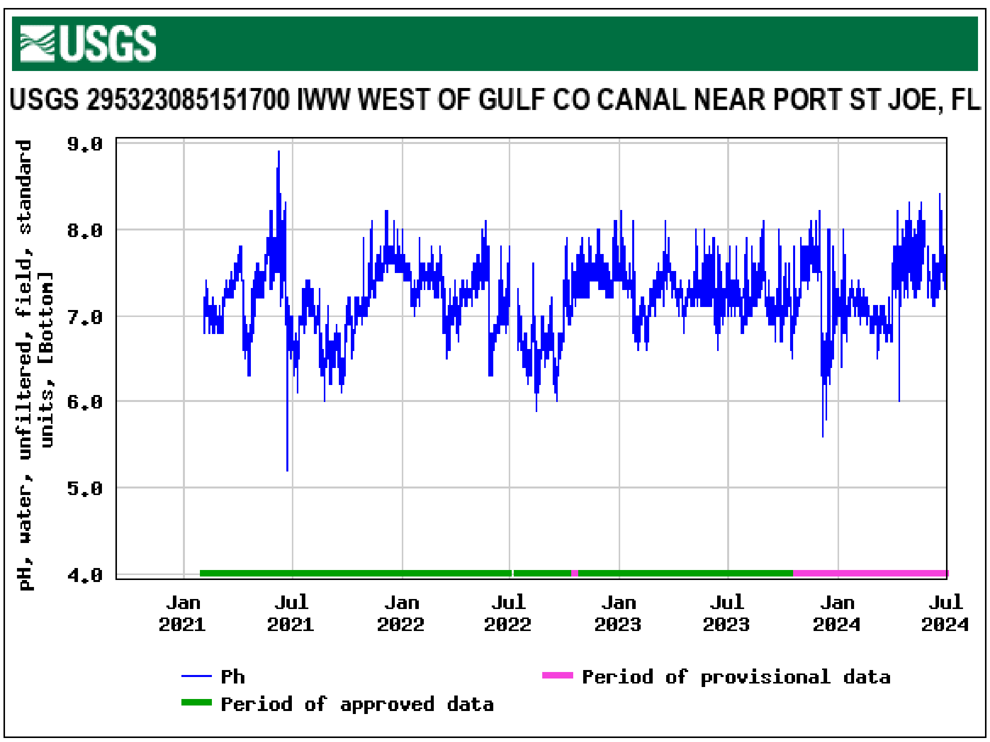
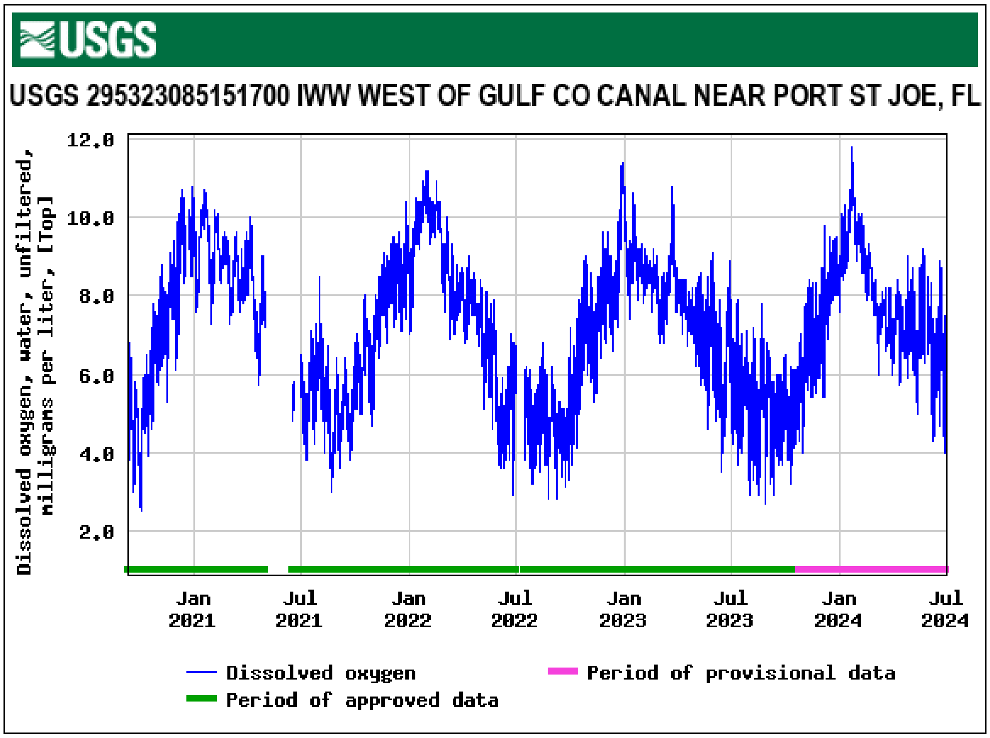


Figure 11: *pH as measured on both the surface (top graph) and bottom (bottom graph) at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



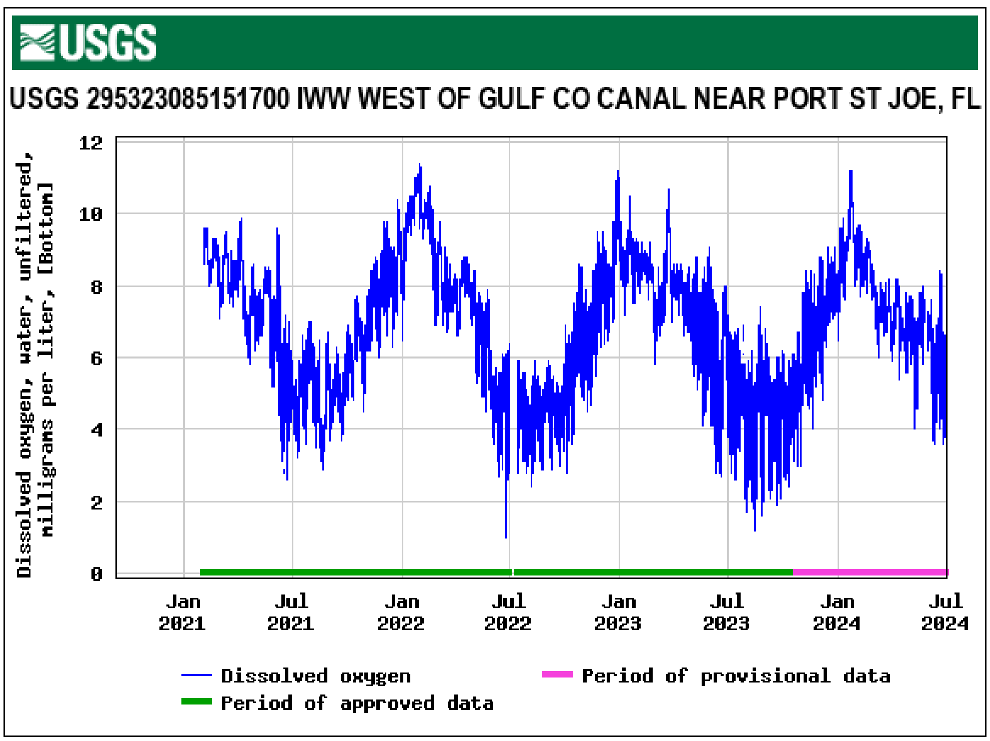
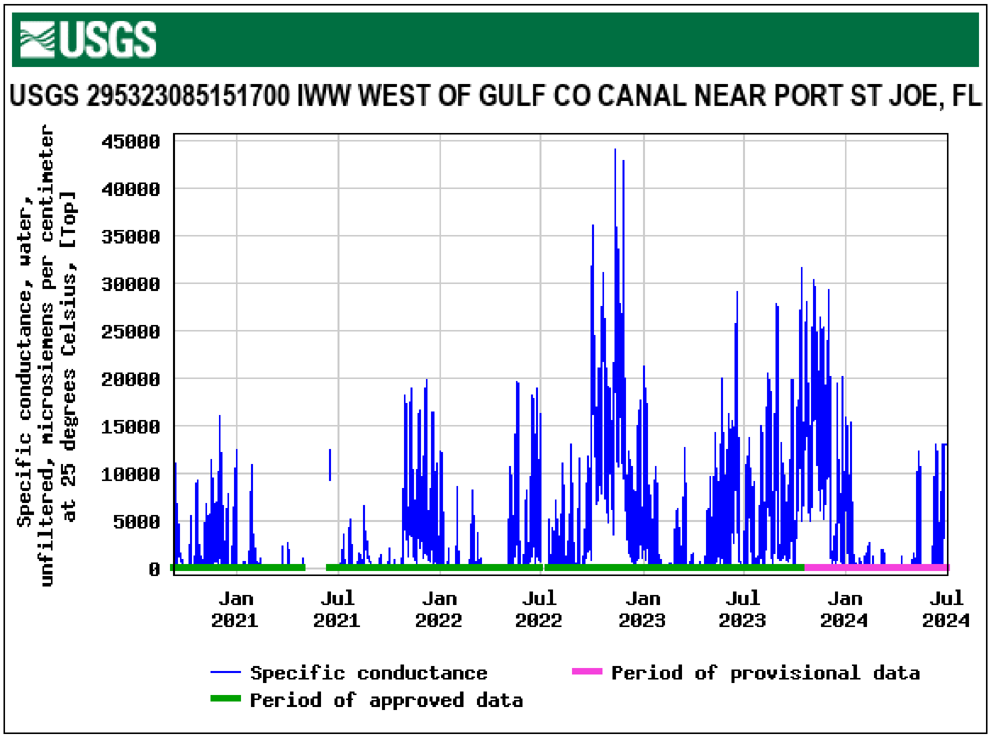


Figure 12: *Dissolved oxygen (mg/L) as measured on both the surface (top graph) and bottom (bottom graph) at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024 . Figure provided by the USGS.*

4. Water Quality Data



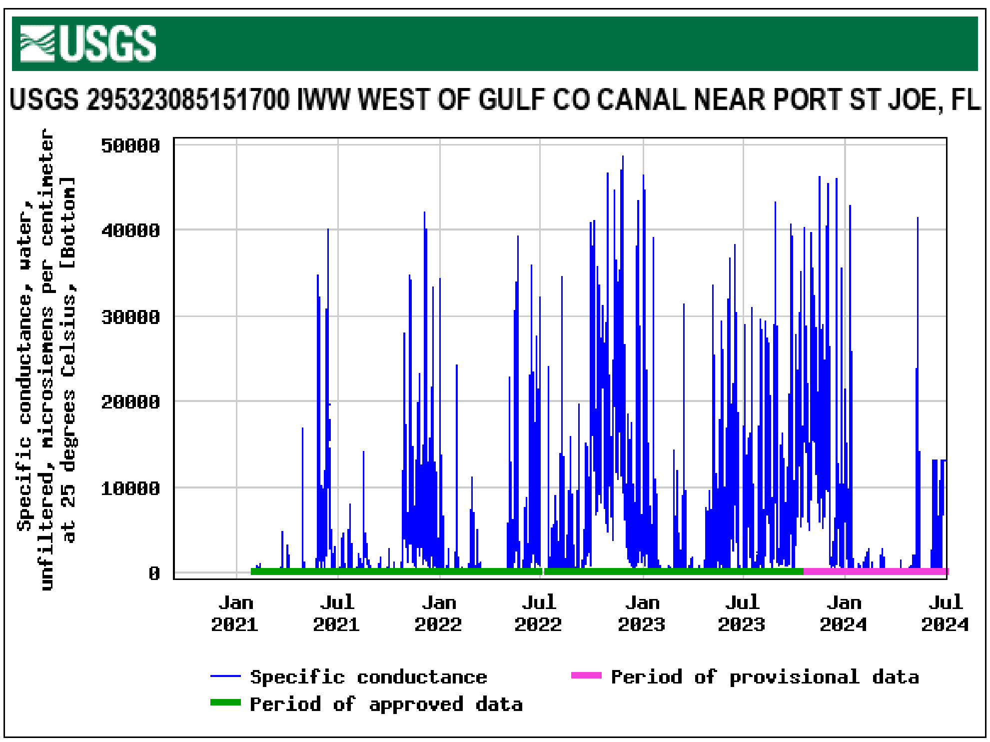


Figure 13: *Specific conductance (µS/cm) as measured on both the surface (top graph) and bottom (bottom graph) at Station 02983080851437OO (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 10, 2020, and June 30, 2024. Figure provided by the USGS.*

4.2 USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL)

Stage data between 9/4/2020 and 10/18/2022 has been approved, while data collected after 10/18/2022 remains provisional and is subject to change following USGS QA/QC procedures. Water surface elevations at Station 0298308085143700 averaged 0.87 ft NAVD 88, ranging between -1.62 ft NAVD 88 and 4.17 ft NAVD 88 (Figure 14). In general, lower water surface elevations were observed during the winter months (November through March) and higher water surface elevations were observed during spring and summer months (April through October). Isolated periods of high and low water levels were regularly observed throughout the time period likely as a result of extreme tidal conditions and weather conditions such as tropical systems.

All nitrate data remains provisional at the time of this document's preparation and is subject to change following USGS QA/QC procedures. Nitrate values collected at the surface at Station 0298308085143700 averaged 0.15 mg/L, ranging between 0 mg/L and 0.45 mg/L (Figure 15). Nitrate data was not collected at the channel bottom. In general, higher nitrate concentrations appear to be observed during winter/spring months (November through April) with lower values during the summer and fall (May through October).

Temperature data between 9/4/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. Temperature values at Station 0298308085143700 averaged 23.5°C on the surface and 23.5°C on the bottom, ranging from minimum values of 7.8°C and 8.3°C (surface and bottom, respectively) to maximum values of 34.5°C and 34.3°C (surface and bottom, respectively) (Figure 16). Higher water temperatures were observed during summer months and lower temperatures were observed during winter months, reflecting seasonal climatic variations.

The pH data between 9/4/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. The pH values at Station 0298308085143700 averaged 7.2 on surface and 7.3 on the bottom, ranging from minimum values of 6.0 and 6.1 (surface and bottom, respectively) to maximum values of 9.1 and 8.8 (surface and bottom, respectively) (Figure 17). Higher pH were generally observed during winter and spring months and lower pH were observed during summer and fall months.

Dissolved oxygen (DO) data between 9/4/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. The DO values at Station 0298308085143700 averaged 7.0 mg/L on the surface and 7.0 mg/L on the bottom, ranging from minimum values of 2.1 mg/L and 1.4 mg/L (surface and bottom, respectively) to maximum values of 11.4 mg/L and 11.6 mg/L (surface and bottom, respectively) (Figure 18). Higher DO values were generally observed during winter and spring months when water temperatures were low and lower DO values were observed during summer and fall months along with higher water temperatures.

Specific conductivity data between 9/4/2020 and 10/24/2023 has been approved, while data collected after 10/24/2023 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0298308085143700 averaged 4,057 microsiemens per centimeter (µS/cm) on the surface and 5,860 µS/cm on the bottom, ranging from minimum values of 53 µS/cm and 50 µS/cm (surface and bottom, respectively) to maximum values of 45,200 µS/cm and 49,600 µS/cm (surface and bottom, respectively) (Figure 19). At times, the water column at this location became considerably stratified with higher conductivity (saltier) water being found on the bottom and lower conductivity (fresh water) on the surface.

4. Water Quality Data

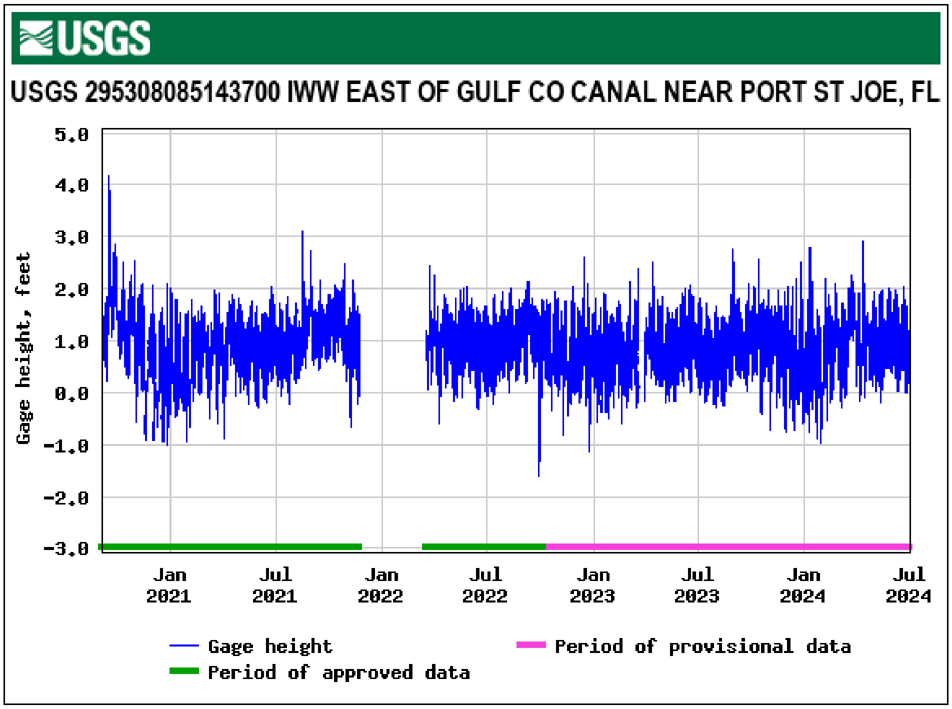


__Figure 14:__ Stage (ft, NAVD 88) as measured at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.

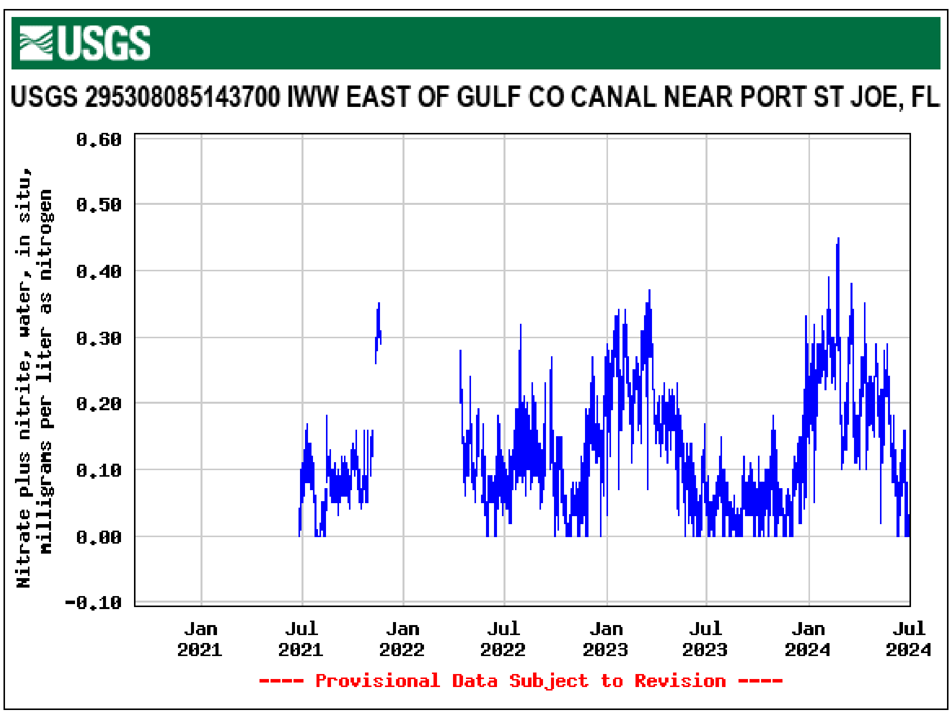
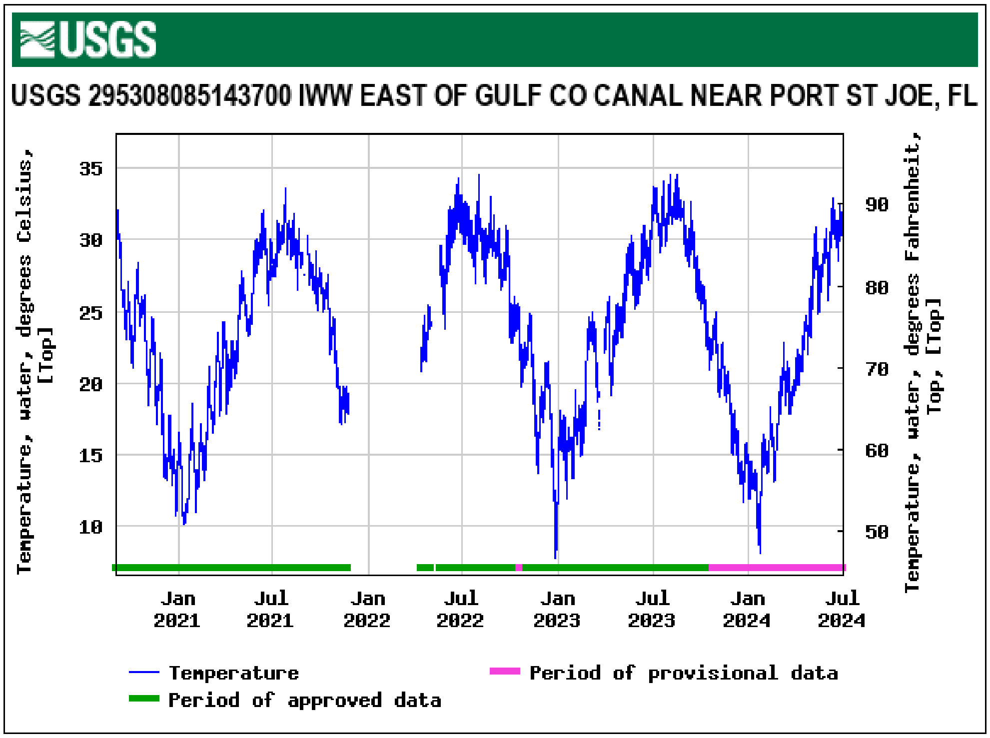


__Figure 15:__ Nitrate plus nitrite (mg/L) as measured at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.

4. Water Quality Data



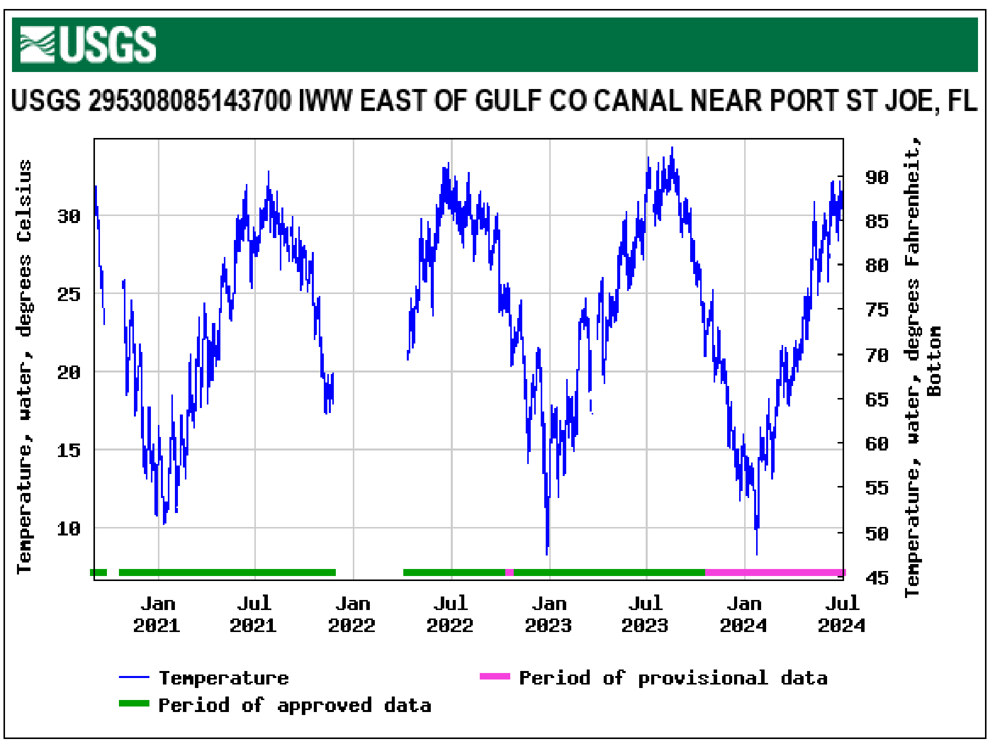
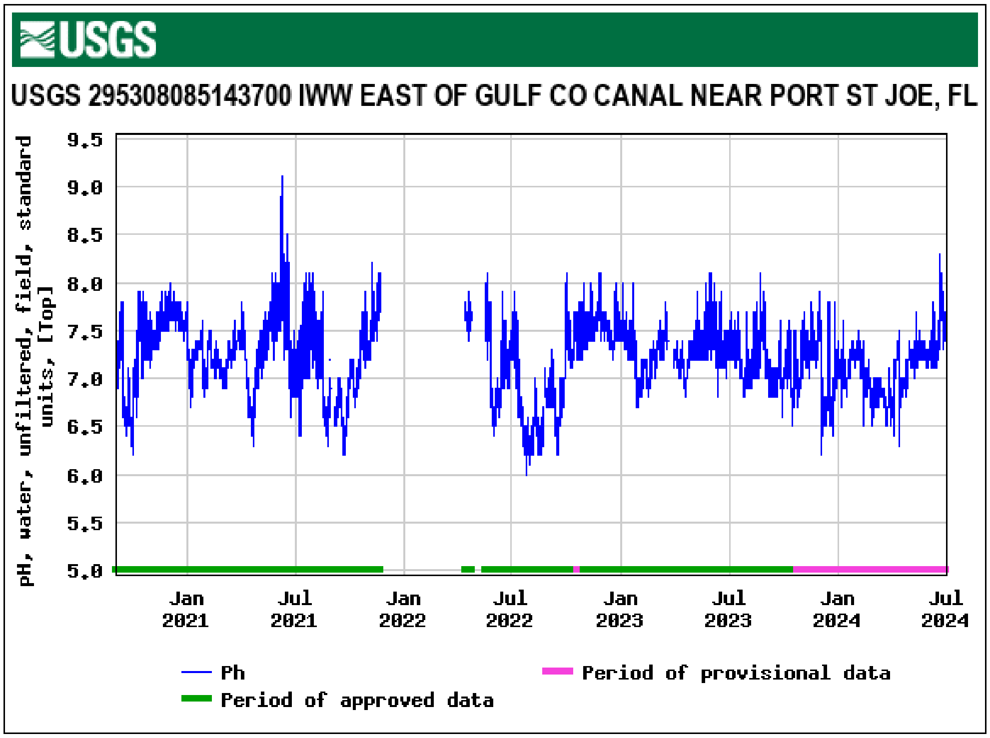


Figure 16: *Temperature (°C) as measured on both the surface (top graph) and bottom (bottom graph) at Station 02983080851437OO (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



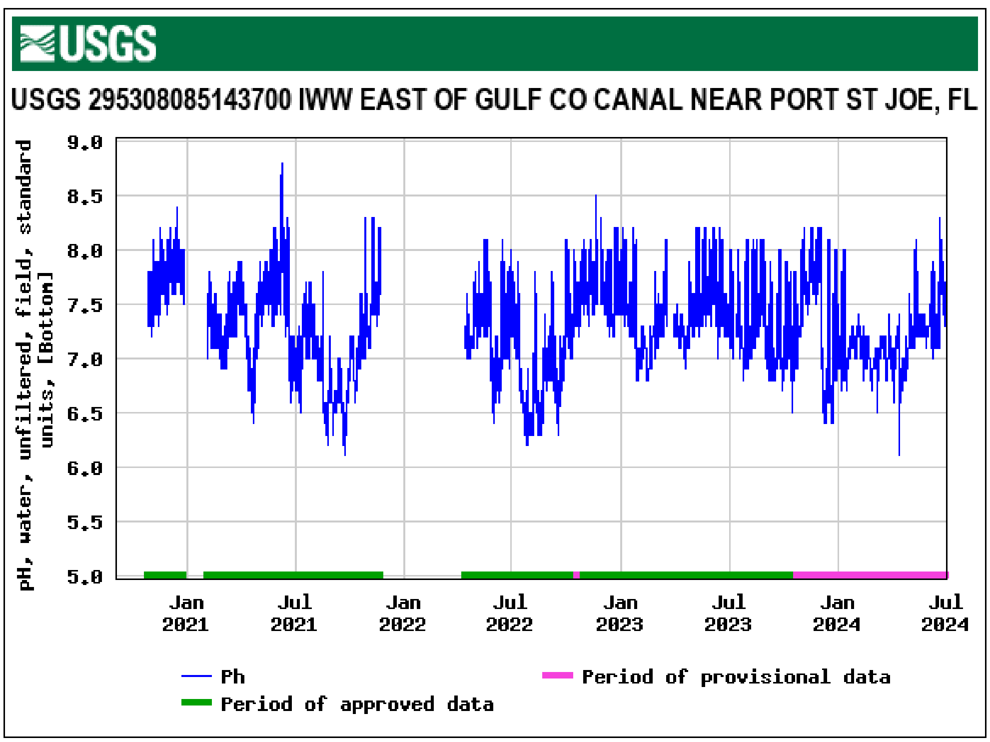
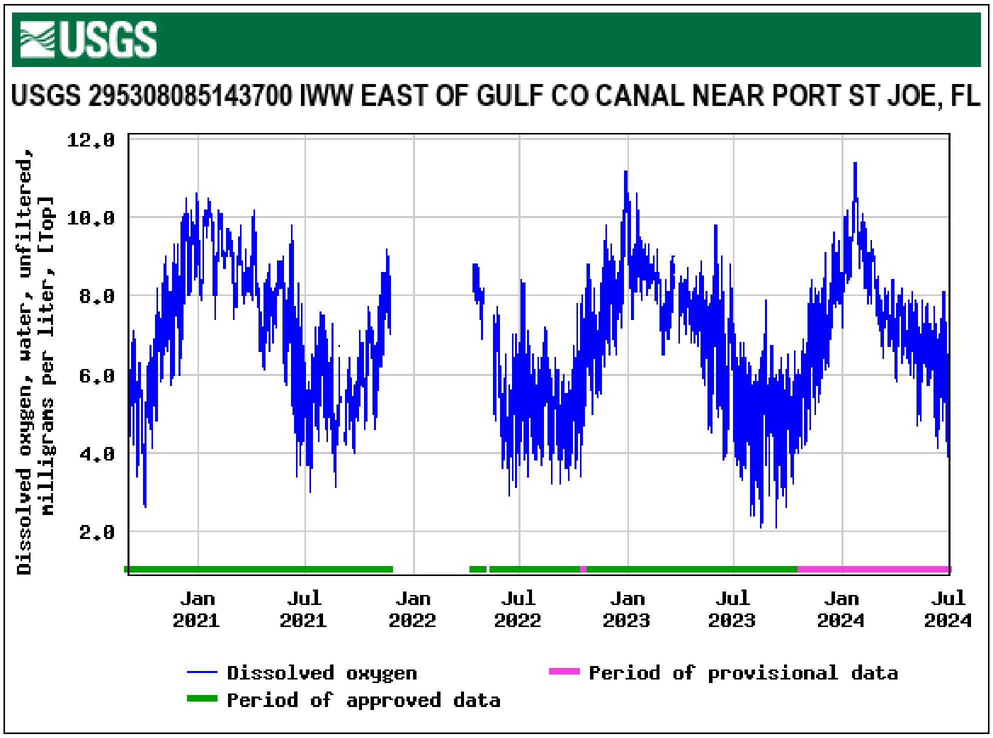


Figure 17: *pH as measured on both the surface (top graph) and bottom (bottom graph) at 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



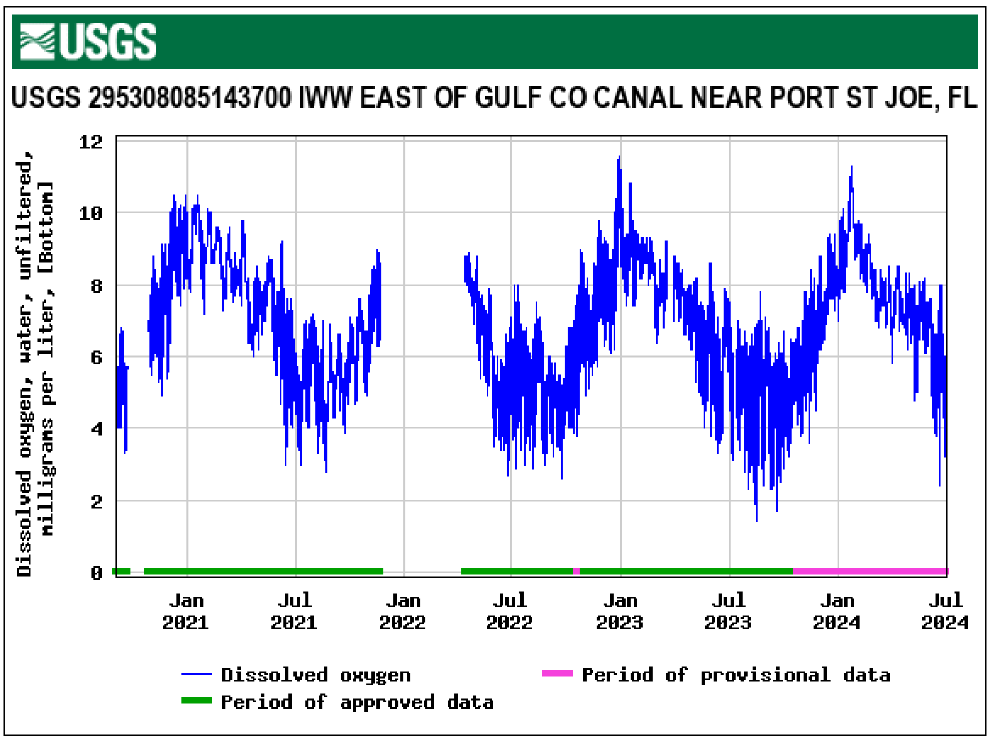
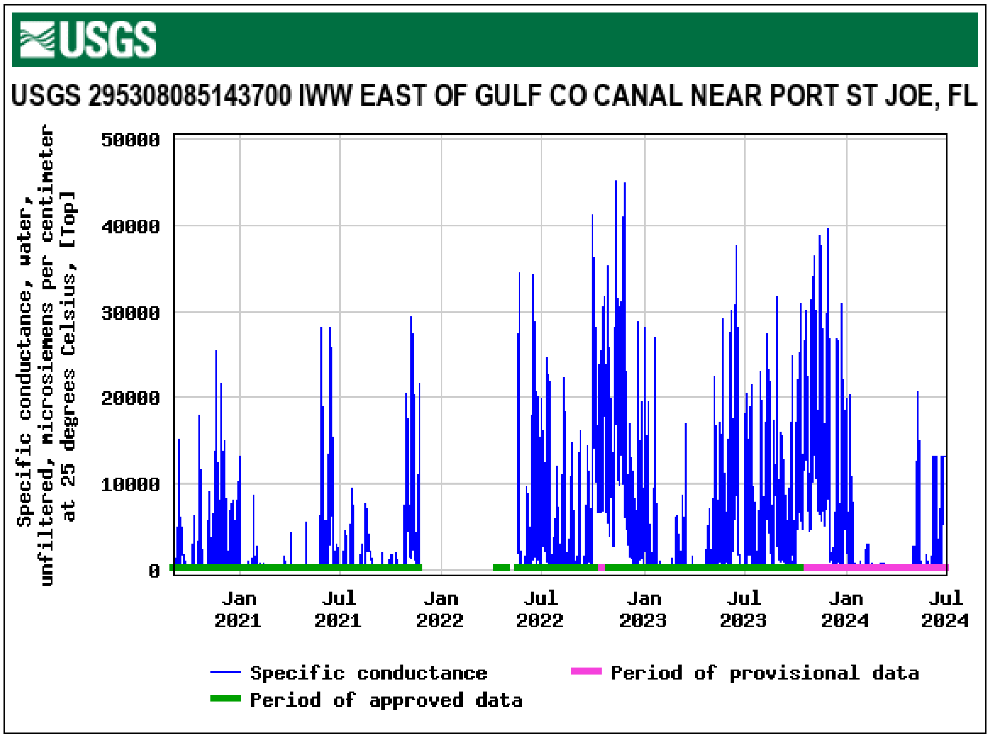


Figure 18: *Dissolved oxygen (mg/L) as measured on both the surface (top graph) and bottom (bottom graph) at Station 02983080851437OO (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data



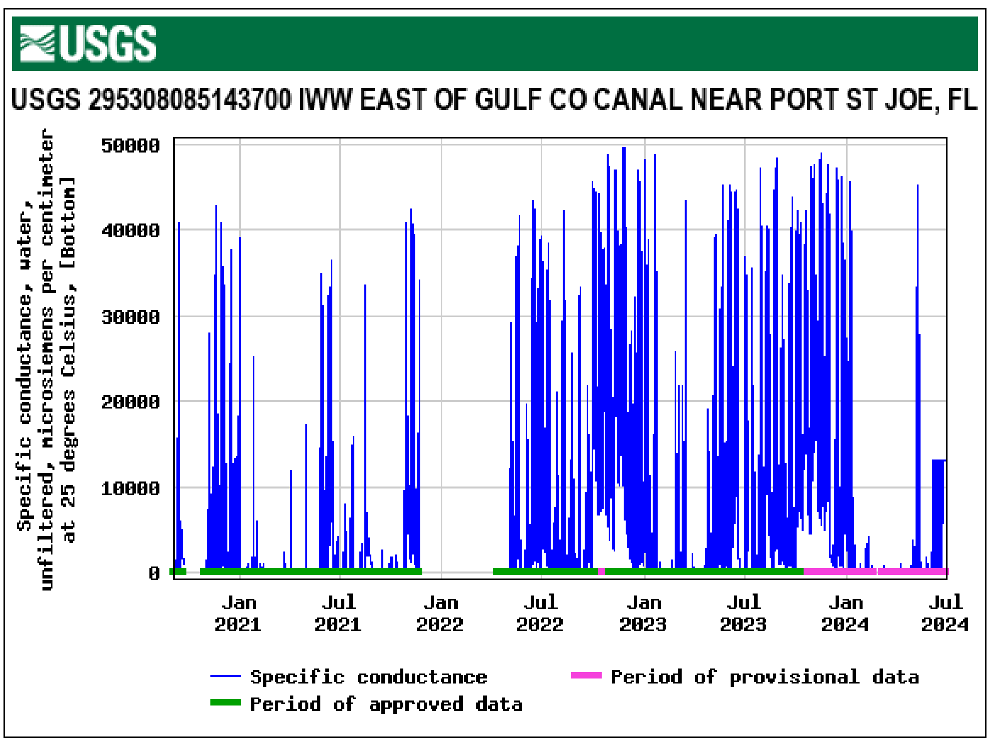


Figure 19: *Specific conductance (μS/cm) as measured on both the surface (top graph) and bottom (bottom graph) at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.) between September 4, 2020, and June 30, 2024. Figure provided by the USGS.*

4.3 USGS Station 02359223 (JACKSON RIVER AT RANCH ROAD NR APALACHICOLA, FL)

Jackson River – Stage data collected between 9/15/2020 and 10/23/2023 has been approved by the USGS, however data reported after 10/23/2023 remains provisional at the time of this document's preparation and is subject to change following USGS QA/QC procedures. Water surface elevations at Station 02329223 averaged 1.01 ft NAVD 88, ranging between -1.47 ft NAVD 88 and 3.37 ft NAVD (Figure 20). Water surface elevations at this location are highly variable throughout the year.

Temperature data between 9/15/2020 and 10/23/2023 has been approved, while data collected after 10/23/2023 remains provisional and is subject to change following USGS QA/QC procedures. Temperature values at Station 02329223 averaged 22.0°C, ranging between 6.9C and 34.4°C (Figure 21). Higher water temperatures were observed during summer months and lower temperatures were observed during winter months, responding to climatic variations.

The pH data between 9/15/2020 and 10/23/2023 has been approved, while data collected after 10/23/2023 remains provisional and is subject to change following USGS QA/QC procedures. The pH values at Station 0298308085143700 averaged 7.2, ranging between 5.4 and 9.1 (Figure 22). The pH was highly variable throughout the year at this location.

Dissolved oxygen (DO) data between 9/15/2020 and 10/23/2023 has been approved, while data collected after 10/23/2023 remains provisional and is subject to change following USGS QA/QC procedures. The DO values at Station 02359223 averaged 7.1 mg/L, ranging between 0 mg/L and 13.8 mg/L (Figure 23). Higher DO values were generally observed during winter and spring months when water temperatures were low and lower DO values were observed during summer and fall months along with higher water temperatures.

Specific conductivity data between 9/15/2020 and 10/23/2023 has been approved, while data collected after 10/23/2023 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0298308085143700 averaged 315 microsiemens per centimeter (µS/cm) with a median of 125 µS/cm. Specific conductivity ranged between 29 µS/cm and 28,700 µS/cm (Figure 24). A noticeable increase in specific conductivity occurred on 08/16/2021 (maximum 28,700 µS/cm) associated with storm surge from Tropical Storm Fred.

4. Water Quality Data

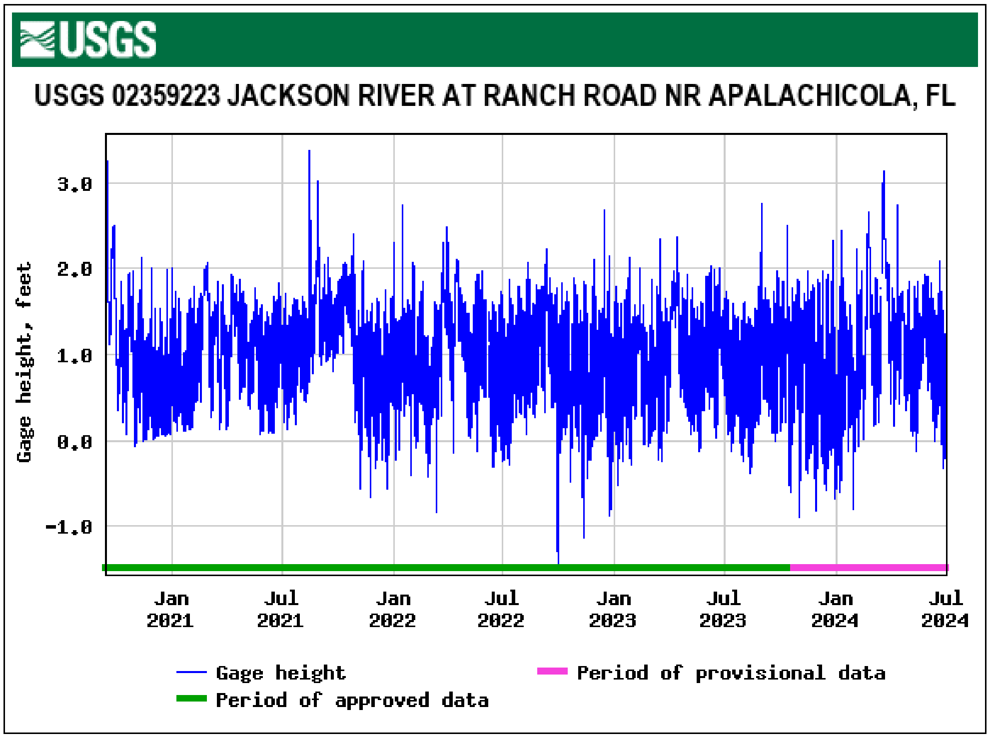


Figure 20: *Stage (ft, NAVD 88) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.) between September 15, 2020, and June 30, 2024. Figure provided by the USGS.*

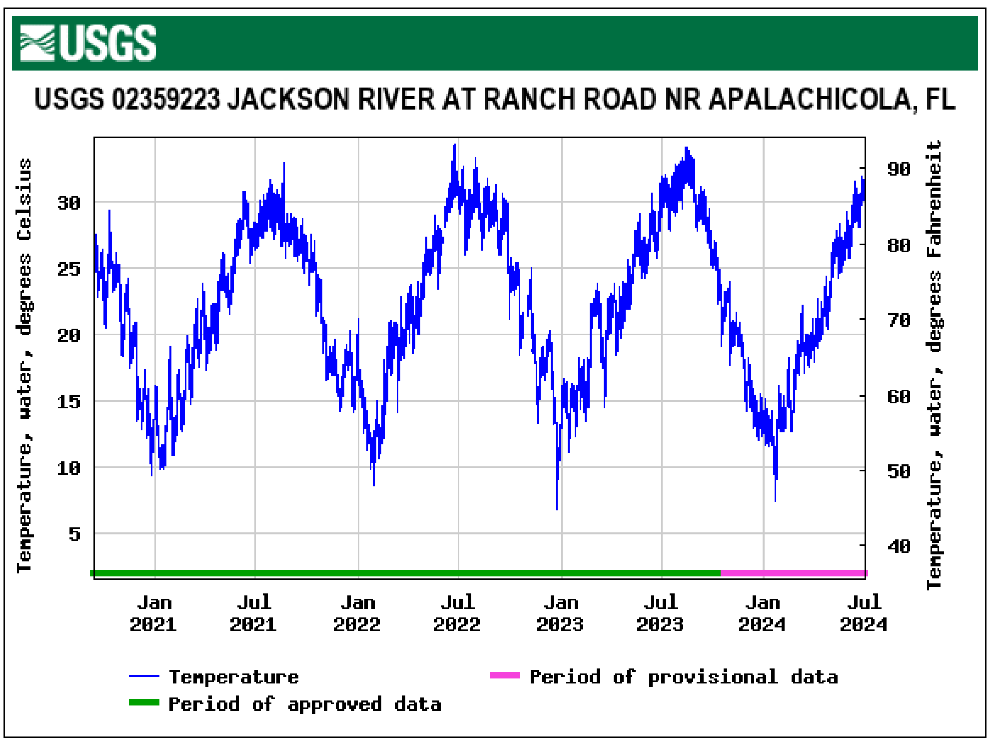


Figure 21: *Temperature (°C) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.) between September 15, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data

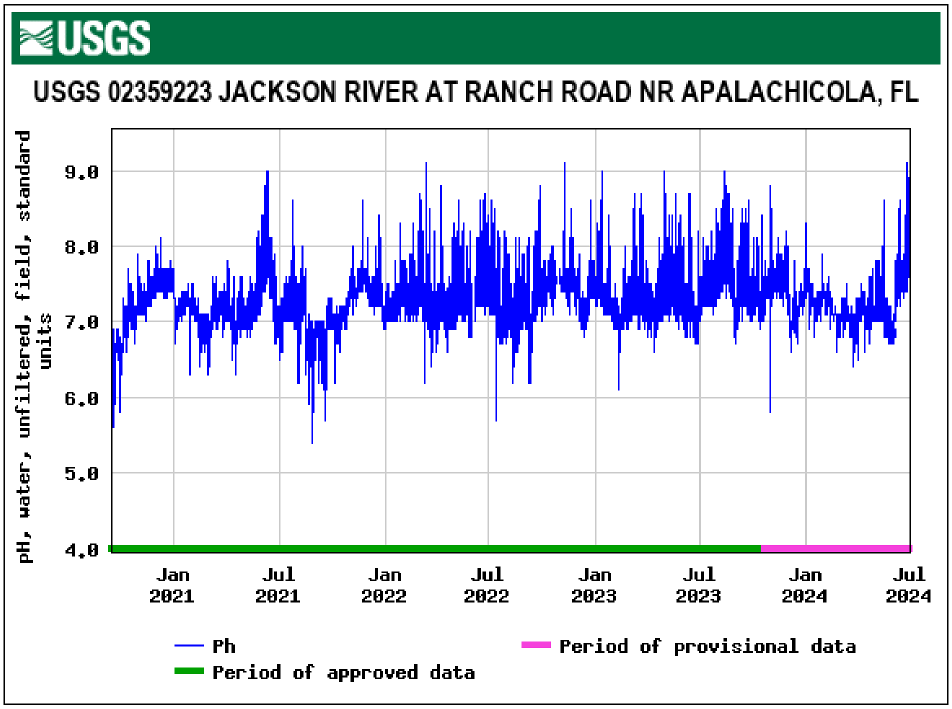


Figure 22: *pH as measured at 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.) between September 15, 2020, and June 30, 2024. Figure provided by the USGS.*

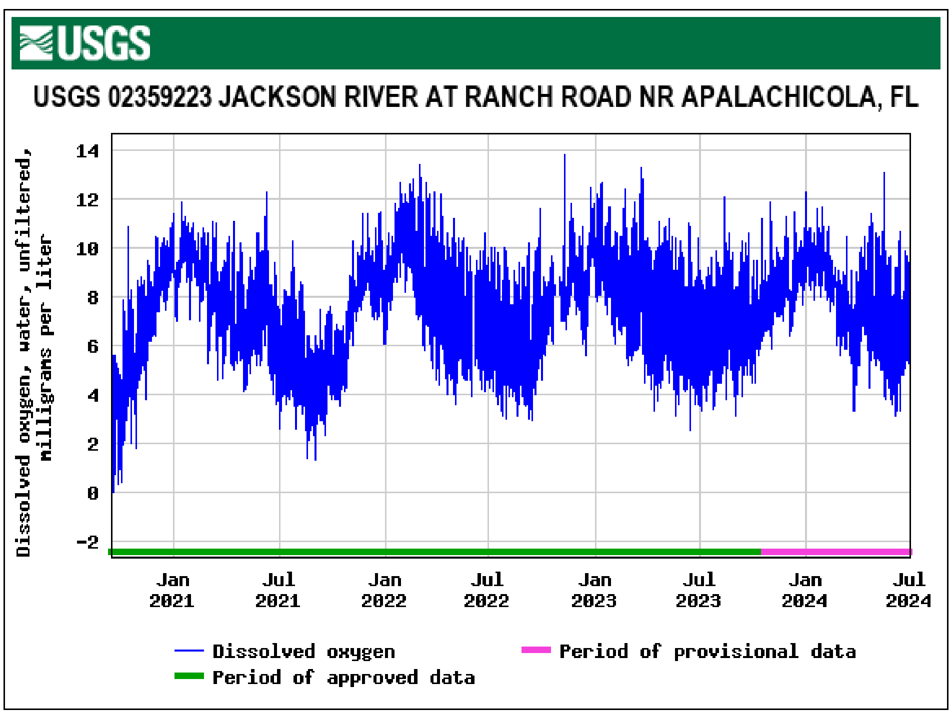


Figure 23: *Dissolved oxygen (mg/L) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.) between September 15, 2020, and June 30, 2024. Figure provided by the USGS.*

4. Water Quality Data

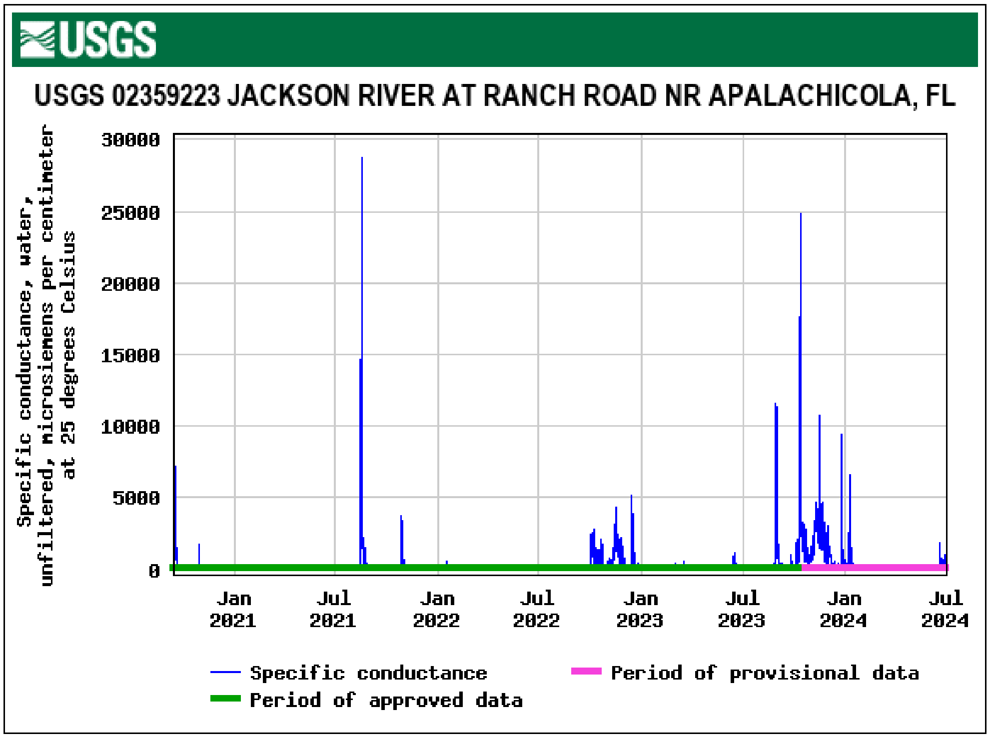


Figure 24: *Specific conductance (µS/cm) as measured at Station 02359223 ((Jackson River at Ranch Road Nr. Apalachicola, Fl.) between September 15, 2020, and June 30, 2024. Figure provided by the USGS.*

4.4 Lab Analyzed Water Quality Samples

Water quality has been identified as a primary concern for St. Joseph Bay by multiple stakeholders. Under this task, water quality samples were collected from multiple locations around St. Joseph Bay. Water quality samples were also collected from selected second magnitude springs in the Florida panhandle to provide updated information regarding these springs. Unlike water quality data previously discussed in this report, these samples consisted of water samples taken in the field and analyzed in a NELAP certified laboratory.

A contractor was hired to collect the water quality samples described in this section. All samples were collected according to DEP standard operating procedures (DEP-SOP-001/01), stored on ice as appropriate, and transported for analysis on the same day as sample collection. All samples were processed and analyzed by Advanced Environmental Laboratories, Inc. located at 2639 North Monroe Street, Suite D, Tallahassee, Florida 32303 (NELAP Accredited E811095). Multiple water quality parameters were analyzed for as displayed in Table 1. While multiple parameters were analyzed, only results from Nitrate+Nitrite and fecal coliform/*Escheria coli* are presented in this report since those are the primary water quality parameters of interest in this study. All locations were sampled once during June 2024.

Table 1: List of Lab Analyzed Water Quality Sample Parameters.

Analyte	Total (T) Dissolved (D) Other (O)
Nitrate + Nitrite (as N)	T
Ammonia (as N)	T
Total Phosphorus	T
Ortho-phosphate	D
Total Organic Carbon	T
Calcium	T
Magnesium	T
Sodium	T
Potassium	T
Chloride	T
Sulfate	T
Carbonate	T
Bicarbonate	T

Analyte	Total (T) Dissolved (D) Other (O)
Fluoride	T
Alkalinity	T
Dissolved Solids (TDS)	T
Suspended Solids (TSS)	T
Color	T
Temperature (C)	O
pH	O
Specific Conductance (µS/cm)	O
Dissolved oxygen (mg/L)	O
Field turbidity	O
Fecal coliform	O
E. coli	O

4.4.1 St. Joseph Bay

A total of 15 locations were sampled around St. Joseph Bay as part of the lab analyzed water quality sampling effort (Figure 25, Table 2). Locations were selected based upon potential surface water inputs on the east side of St. Joseph Bay and public access points along Cape San Blas and the St. Joseph Peninsula. This work expands upon similar data collection completed during FY 2020-2021, by expanding data collection sites onto Cape San Blas and the St. Joseph Peninsula. These two locations are areas of extremely high levels of development for vacation properties and include areas of potential surface water inputs around all of St. Joseph Bay. In addition, these areas surround the lower portions of St. Joseph Bay where there are areas of known seagrass impacts.

Sampling at locations around St. Joseph Bay occurred between 6/12/2024, and 6/18/2024 (Table 3). All locations were sampled once during the morning, and samples were submitted to the lab for analysis later that same day.

Table 3 displays the results of basic water quality parameters collected using a calibrated, hand-held water quality sampling meter. Temperature at the sampling locations ranged from 24.9°C at St. Joe Beach to 32.2°C at the Port St. Joe Boat Ramp. Values at most locations were between 29°C and 32°C. Salinity (Specific Conductivity) generally ranged between 9.2 ppt (17,059 µS/cm) and 10.6 ppt (20,060 µS/cm), however three locations (St. Joseph Beach, US98 at Sunset Shores, and SR30A and Country Club Road South) displayed salinity values less than 0.32 ppt (730 µS/cm). Dissolved oxygen, pH, and field turbidity ranged from 0.35 mg/L - 6.4 mg/L, 6.0 – 7.9, and 1.13 NTU – 9.1 NTU, respectively.

Nitrogen and phosphorus are two primary water quality constituents that can cause adverse effects on algae and native seagrass populations in estuaries. Combined nitrate (NO^3) and nitrite (NO^2) concentrations measured at all 15 sample locations were below the detection limit of 0.24 mg/L (Table 4). Ammonia (NH^4) concentrations were somewhat more variable ranging from 0.1 mg/L to 0.46 mg/L. Similarly, total phosphorus concentrations at all sample locations were below the detection limit of 0.15 mg/L. Ortho-phosphate concentrations were either below the detection limit or between the detection limit and the practical quantitation limit at 13 of the 15 sample locations. The two locations with detectable ortho-phosphate concentrations included locations SJB1 (St. Joe Beach, 0.089 mg/L) and SJB4 (Gulf County Canal, 0.059 mg/L). Results from additional water quality parameters analyzed for but not described in text, are provided in Table 4 and Table 5.

Most fecal coliform and *E. coli* samples were less than 86 colonies/100mL and 74 colonies/10mL of water, respectively (Table 5). However, two locations displayed bacteria counts elevated compared with other sample locations. The highest counts were collected at location SJB2 (U.S. 98 at Sunset Shores) with fecal coliform/*E. coli* samples of 400 colonies/100mL and 350 colonies/100mL, respectively. Bacteria counts at location SJB4 (Gulf County Canal) were estimated to be 234 colonies/100mL for fecal coliform bacteria and 222 colonies/100,L for *E. coli*.

4. Water Quality Data

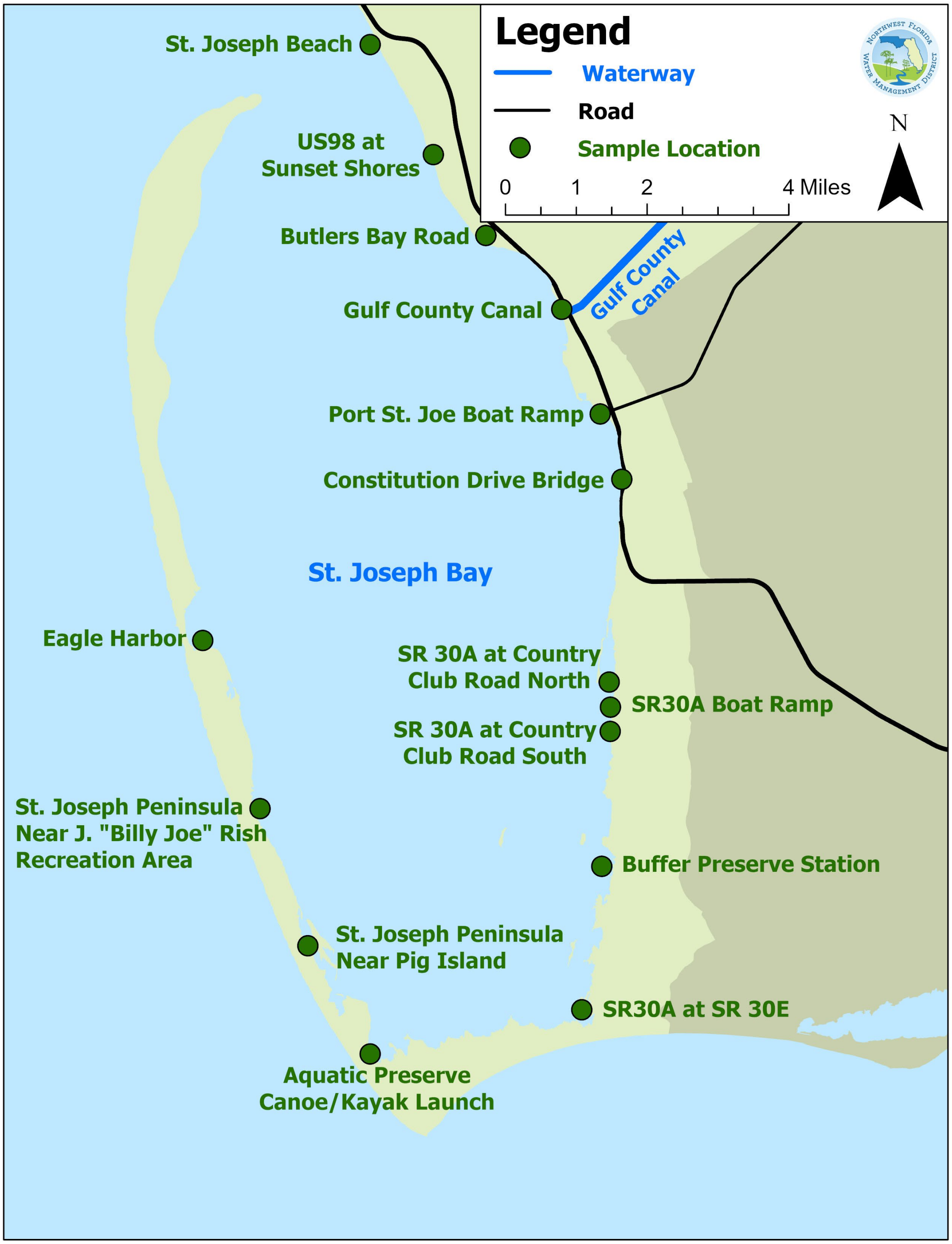


Figure 25: *Location of Lab Analyzed Water Quality Samples Collected Around St. Joseph Bay Under Amendment 8 to Grant AT003 during May/June 2024.*

4. Water Quality Data

Table 2: Location of Lab Analyzed Water Quality Samples Collected Around St. Joseph Bay Under Amendment 8 to Grant AT003 during May/June 2024.

Location Name	Monitoring Location ID	Approximate Latitude	Approximate Longitude
St. Joseph Beach	SJB1	29.896753	85.361428
US 98 at Sunset Shores	SJB2	29.880642	85.351158
Butlers Bay Road	SJB3	29.845694	85.328114
Gulf County Canal	SJB4	29.832019	85.313322
Port St. Joe Public Boat Ramp	SJB5	29.810806	85.306436
Constitution Drive Bridge	SJB6	29.798369	85.300550
SR30A at Country Club Rd North	SJB7	29.756328	85.303456
SR30A Boat Ramp	SJB8	29.747833	85.303100
SR30A at Country Club Rd South	SJB9	29.736431	85.301753
Buffer Preserve Station	SJB10	29.717878	85.304619
SR30E at Salinas Park	SJB11	29.686939	85.311886
SJB Aq. Pres. Canoe Launch	SJB12	29.679094	85.364111
St. Joe Peninsula Near Pig Island	SJB13	29.700464	85.375122
St. Joe Peninsula Near J. “Billy Joe” Rish Rec Area	SJB14	29.728264	85.387486
Eagle Harbor Boat Ramp	SJB15	29.764431	85.402419

4. Water Quality Data

Table 3. Field Parameters Collected at Sample Locations Around Port St. Joe.

Location Name	WIN ID	Sampling Date	Water Depth	Sample Depth	Temp.	Spec. Cond.	Diss. Oxygen	pH	Salinity	Field Turb.
			ft	ft	°C	µS/cm	mg/L	s.u.	ppt	NTO
St. Joseph Beach	SJB1	6/12/2024	<1.0	<1.0	24.94	415	1.28	6.97	0.2	1.13
US 98 at Sunset Shores	SJB2	6/12/2024	1.96	1.64	30.2	730	3.49	6.9	0.32	5.37
Butlers Bay Road	SJB3	6/12/2024	1.78	1.64	30.03	19,187	4.78	7.62	10.25	4.21
Gulf County Canal	SJB4	6/12/2024	7.7	1.64	31.08	19,809	4.89	7.56	10.38	2.31
			7.7	3.28	31.02	19,588	4.53	7.42	10.27	2.53
			7.7	4.92	30.92	20,034	5.07	7.29	10.55	2.49
			7.7	6.56	30.82	20,060	6.38	6.92	10.58	2.25
Port St. Joe Public Boat Ramp	SJB5	6/12/2024	4.21	1.64	32.19	19,838	3.83	6.09	10.18	3.32
			4.21	3.28	31.86	19,918	4.56	5.95	10.29	5.74
Constitution Drive Bridge	SJB6	6/13/2024	5.31	1.64	29.92	17,059	1.49	7.52	9.17	1.62
			5.31	3.28	29.75	17,553	3.14	7.77	9.35	1.35
			5.31	4.92	29.84	17,650	3.48	7.85	9.39	1.48
SR30A at Country Club Rd North	SJB7	6/13/2024	1.96	1.64	30.13	17,706	0.35	6.37	9.37	8.06
SR30A Boat Ramp	SJB8	6/13/2024	4.03	1.64	31.15	18,402	5.67	6.86	9.59	2.43
			4.03	3.28	30.39	18,461	5.72	6.28	9.76	3.48
SR30A at Country Club Rd South	SJB9	6/13/2024	1.55	0.82	29.52	421	0.95	6.17	0.19	2.97
Buffer Preserve Station	SJB10	6/13/2024	<1	<1	31.13	19,193	4.22	7.72	10.02	2.41
SR30E at Salinas Park	SJB11	6/18/2024	2.67	1.64	29.15	18,252	1.68	6.24	9.88	3.27
SJB Aq. Pres. Canoe Launch	SJB12	6/18/2024	1.09	<1	29.08	17,635	5.45	6.74	9.53	4.68
St. Joe Peninsula Near Pig Island	SJB13	6/18/2024	1.86	1.64	28.54	17,105	4.42	7.13	9.33	1.38
St. Joe Peninsula Near J. “Billy Joe” Rish Recreation Area	SJB14	6/18/2024	1.41	<1	28.39	17,003	5.49	7.82	9.29	4.12
Eagle Harbor Boat Ramp	SJB15	6/18/2024	5.45	1.64	28.42	17,545	3.68	7.53	9.61	3.97

4. Water Quality Data

Table 4: Results of Lab Analyzed Water Quality Samples Collected Around St. Joseph Bay.

Location Name	WIN ID	N	NH4	Total P	Ortho P	TOC	Ca	Mg	Na	K	Cl	SO4
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
St. Joseph Beach	SJB1	0.24 U	0.099	0.15 U	0.089	10	44	10	19	1.5 i	29	6.9 I
US 98 at Sunset Shores	SJB2	0.24 U	0.3	0.15 U	0.006 I	18	78	25	180	7.9	330	140
Butlers Bay Road	SJB3	0.24 U	0.42	0.15 U	0.0048 U	3.5	330	1000	8800	330	20 U	2700
Gulf County Canal	SJB4	0.24 U	0.29	0.15 U	0.059	2.9	350	1100	9300	350	20 U	2900
Port St. Joe Public Boat Ramp	SJB5	0.24 U	0.22	0.15 U	0.0048 U	2.8	350	1100	9300	350	20 U	2900
Constitution Drive Bridge	SJB6	0.24 U	0.42	0.15 U	0.01 I	5.2	310	950	8200	310	16000	2100
SR30A at Country Club Rd North	SJB7	0.24 U	0.50 U	0.15 U	0.006 I	9.9	330	970	8400	320	21000	2700
SR30A Boat Ramp	SJB8	0.24 U	0.46	0.15 U	0.0048 U	6.6	390	1200	10000	380	20000	2300
SR30A at Country Club Rd South	SJB9	0.24 U	0.12	0.15 U	0.006 I	17	13	6.9	32	2.7	76	5.9
Buffer Preserve Station	SJB10	0.24 U	0.21	0.15 U	0.0048 U	7.6	420	1300	11000	420	24000.0	2800
SR30E at Salinas Park	SJB11	0.24 U	0.098	0.15 U	0.0048 U	10	400	1300	10000	420	22000	3000
SJB Aq. Pres. Canoe Launch	SJB12	0.24 U	0.13	0.15 U	0.0048 U	5.7	360	1100	9000	360	22000	3000
St. Joe Peninsula Near Pig Island	SJB13	0.24 U	0.12	0.15 U	0.0048 U	4.9	370	1000	8400	340	21000	2800
St. Joe Peninsula Near J. "Billy Joe" Rish Rec Area	SJB14	0.24 U	0.18	0.15 U	0.0048 U	7.1	320	1000	8500	360	19000	2600
Eagle Harbor Boat Ramp	SJB15	0.24 U	0.4	0.15 U	0.005 I	3.6	300	950	7800	340	19000	2500

U – Analyte was not detected and the indicated value is the detection limit

I – The reported value is between the laboratory method detection limit and the practical quantitation limit

4. Water Quality Data

Table 5: Results of Lab Analyzed Water Quality Samples Collected Around St. Joseph Bay, cont.

Location Name	WIN	CO^3 mg/L	HCO^3 mg/L	F mg/L	Alk. mg/L	TDS mg/L	TSS mg/L	Color	Fecal Coliform Colonies/100mL	E. coli Colonies/100mL
St. Joseph Beach	SJB1	130	5.0 U	0.40 U	130	200	2.0 U	65	8	4
US 98 at Sunset Shores	SJB2	110	5.0 U	0.20 U	110	730	4.8	40	400	350
Butlers Bay Road	SJB3	100	5.0 U	4.0 U	110	30000	19	15	6	6
Gulf County Canal	SJB4	110	5.0 U	4.0 U	110	31000	29	5	234 B	222 B
Port St. Joe Public Boat Ramp	SJB5	110	5.0 U	4.0 U	110	30000	26	5	4	2.0 U
Constitution Drive Bridge	SJB6	100	5.0 U	0.20 U	100	29000	17	25	86	74
SR30A at Country Club Rd North	SJB7	140	5.0 U	0.20 U	140	32000	21	55	58	46
SR30A Boat Ramp	SJB8	120	5.0 U	0.20 U	120	35000	17	25	76	72
SR30A at Country Club Rd South	SJB9	43	5.0 U	0.20 U	43	200	2.0 U	25	38	24
Buffer Preserve Station	SJB10	140	5.0 U	0.20 U	140	37000	21	30	2.0 U	2.0 U
SR30E at Salinas Park	SJB11	130	5.0 U	40 U	140	39000	27	45	2.0 U	2.0 U
SJB Aq. Pres. Canoe Launch	SJB12	120	5.0 U	40 U	120	37000	35	25	22	16
St. Joe Peninsula Near Pig Island	SJB13	120	5.0 U	40 U	120	35000	55	25	8	6
St. Joe Peninsula Near J. "Billy Joe" Rish Rec Area	SJB14	120	5.0 U	40 U	120	34000	27	35	14	14
Eagle Harbor Boat Ramp	SJB15	100	5.0 U	40 U	100	31000	17	10	2.0 U	2.0 U

U – Analyte was not detected and the indicated value is the detection limit

I – The reported value is between the laboratory method detection limit and the practical quantitation limit

4.4.2 Select Second Magnitude Springs

The second magnitude springs sampled as part of this task are not related to St. Joseph Bay, however they were included as part of this grant to facilitate these data collection efforts. Detailed water quality samples at many smaller, second magnitude springs have not been collected or analyzed in more than a decade at some locations. These data are critical for assessing the current condition and health of springs throughout the Florida panhandle.

A total of 16 second magnitude springs were selected for sampling (Figure 26, Table 7). Water quality samples were collected at sample springs between 6/3/2024 and 6/11/2024 (Table 7). Samples were collected in the morning and submitted to the lab for analysis that same day.

Table 7 displays the results of basic water quality parameters collected using a calibrated, hand-held water quality sampling meter. Temperature at the sampling locations ranged from 20.2°C at Holmes Blue Spring to 26.2°C at the Hays Spring Composite Location. Temperature values at most locations were less than 22°C. As expected, salinity (specific conductivity) was low with a maximum observed salinity of 0.2 ppt (364 µS/cm) at the Baltzell Spring Composite location. Dissolved oxygen and pH ranged from 0.15 mg/L – 8.1 mg/L and 6.3 – 8.1, respectively. Field turbidity was generally low being less than 2.1 NTU at all locations except Hays Spring Composite (6.3 NTU), Mullet Spring (5.1 NTU), Beckton Spring (4.3 NTU), and Blue Hole Spring (4.0 NTU).

Nitrogen and phosphorus are two primary water quality constituents that can cause adverse effects on algae and native SAV populations. Combined nitrate (NO^3) and nitrite (NO^2) concentrations measured were highly variable ranging undetectable/below the detection limit of 0.24 mg/L at eight springs to 6.48 mg/L at the Baltzell Spring Composite location (Table 8). Ammonia (NH^4) concentrations were similarly variable ranging undetectable/below the detectable limit at nine springs to 0.66 mg/L at the Baltzell Spring Composite location. Total phosphorus concentrations at all sample locations were either below the detection limit of 0.15 mg/L or between the detection limit and the practical quantitation limit. Ortho-phosphate concentrations were either below the detection limit or between the detection limit and the practical quantitation limit at seven of the 16 sample locations. Ortho-phosphate concentrations at springs with detectable results ranged from 0.025 mg/L at Ponce de Leon spring to 0.058 mg/L at Horn Spring. Results from additional water quality parameters analyzed for but not described in text, are provided in Table 7 and Table 8. It should be noted that the sampling event took place following periods of heavy rainfall across the Florida panhandle. While efforts were made to ensure that samples taken were representative of spring flow/groundwater, excessive surface flows into the spring pool, river, etc. may have mixed with the sample water which would affect parameter concentrations. As a result, additional sampling during the dry, low flow season are required to verify any results described in this study.

Six locations had fecal coliform concentrations which were undetectable/below the detectable limit, while seven locations contained E. coli concentrations which were undetectable/below the detection limit (Table 9). Of the remaining springs, fecal coliforms and *e. coli* levels were generally low, below 20 colonies per 100 ml, at six locations. Four springs had moderate coliform levels, with the highest levels measured at Mullet Spring. Coliform levels at all springs were below the allowable singe sample limits for bathing/swimming areas (e*. coli* limit of 235 colonies per 100 ml and fecal coliform limit of 800 colonies per 100 ml, Chapter 64E-9.013, Florida Administrative Code).

4. Water Quality Data

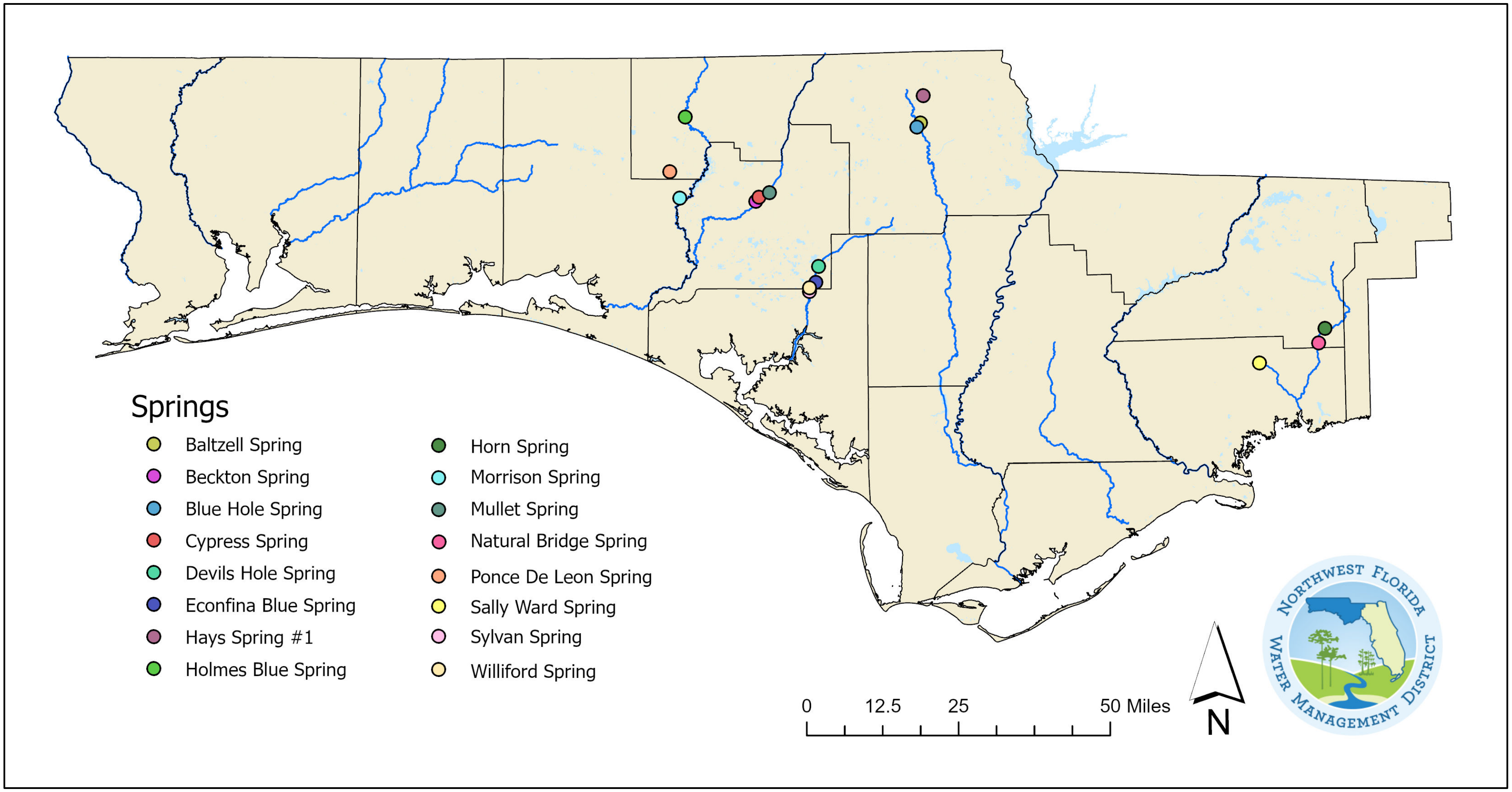


Figure 26: *Location of Lab Analyzed Water Quality Samples Collected at Second Magnitude Springs Under Amendment 8 to Grant AT003 during May/June 2024.*

4. Water Quality Data

Table 6: Location of Lab Analyzed Water Quality Samples Collected at Second Magnitude Springs Under Amendment 8 to Grant AT003 during May/June 2024.

Location Name	NWFID	Approximate Latitude	Approximate Longitude
Baltzell Spring Composite	8655	30.83003444	-85.23473917
Beckton Spring	8088	30.64859667	-85.69362361
Blue Hole Spring	7953	30.82025833	-85.24512139
Cypress Spring	8087	30.65867	-85.68423
Devils Hole Spring	8908	30.49052778	-85.52205556
Econfina Blue Spring Composite	8730	30.45156	-85.53208
Hays Spring Composite	7957	30.88161028	-85.25662417
Holmes Blue Spring	8084	30.85143	-85.88585
Horn Spring	7938	30.31926111	-84.12880833
Morrison Spring	8094	30.65792861	-85.90393167
Mullet Spring	8090	30.66842611	-85.65554
Natural Bridge Spring	9027	30.284994	-84.147296
Ponce DeLeon Spring	8085	30.72121417	-85.93078
Sally Ward Spring	774	30.2414	-84.3108
Sylvan Spring Composite	8787	30.43261	-85.5479
Williford Spring Composite	8677	30.43856222	-85.54799333

4. Water Quality Data

Table 7: Field Parameters Collected at Select Second Magnitude Springs in Northwest Florida.

Location Name	WIN	Sampling Date	Water Depth	Sample Depth	Temp.	Spec. Cond.	Diss. Oxygen	pH	Salinity	Field Turb.
			ft	ft	°C	µS/cm	mg/L	s.u.	ppt	NTO
Baltzell Spring Composite	8655	6/10/2024	24.41	22.41	21.42	364	5.39	7.41	0.19	0.35
Beckton Spring	8088	6/5/2024	21.75	19.75	22.43	188	4.3	7.08	0.09	4.33
Blue Hole Spring	7953	6/10/2024	39.28	37.28	23.87	295	4.54	7.51	0.14	3.98
Cypress Spring	8087	6/5/2024	12.41	10.41	20.55	205	5.28	7.93	0.11	0.81
Devils Hole Spring	8908	6/4/2024	UNK	1.64	23.78	104	2.2	6.59	0.05	2.06
Econfina Blue Spring Composite	8730	6/4/2024	3.91	1.64	22.64	121	4.78	7.31	0.06	1.74
Hays Spring Composite	7957	6/10/2024	3.46	1.64	26.23	353	6.11	7.63	0.16	6.34
Holmes Blue Spring	8084	6/6/2024	24.29	22.29	20.16	204	5.21	7.45	0.11	1.81
Horn Spring	7938	6/3/2024	22.11	20.11	20.72	247	0.38	7.51	0.13	1.16
Morrison Spring	8094	6/6/2024	23.64	21.64	21.36	217	2.93	7.02	0.11	1.47
Mullet Spring	8090	6/5/2024	3.96	1.64	21.50	203	3.56	6.33	0.1	5.06
Natural Bridge Spring	9027	6/3/2024	20.15	18.15	20.78	194	0.15	7.41	0.1	0.81
Ponce DeLeon Spring	8085	6/11/2024	20	18	20.55	227	8.09	7.56	0.12	0.26
Sally Ward Spring	774	6/3/2024	20.73	18.73	20.95	325	2.83	7.12	0.17	0.88
Sylvan Spring Composite	8787	6/4/2024	2.63	1.64	21.96	125	2.17	7.18	0.06	0.73
Williford Spring Composite	8677	6/4/2024	3.86	1.64	21.74	127	1.29	8.13	0.06	1.24

4. Water Quality Data

Table 8: Results of Lab-Analyzed Water Quality Samples Collected at Select Second Magnitude Springs

Location Name	WIN	N	NH4	Total P	Ortho P	TOC	Ca	Mg	Na	K	Cl	SO4
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Baltzell Spring Composite	8655	6.48	0.066	0.15 U	0.026	0.54 I	65	2.0	2.1 I	0.85 I	5.7 I	2.3 I
Beckton Spring	8088	0.24 U	0.013 I	0.17 I	0.016 I	3.4	30	4.7	7.3	0.78 I	14	2.0 U
Blue Hole Spring	7953	0.655	0.042	0.15 U	0.021	1.9 I	48	2.7	2.0 I	0.65 I	4.0 I	2.0 U
Cypress Spring	8087	0.453	0.010 U	0.15 U	0.026	0.50 U	36	4.9	3.2 I	0.50 U	5.3 I	2.0 U
Devils Hole Spring	8908	0.24 U	0.012 I	0.15 U	0.01 I	1.7 I	17	2.8	1.3 I	0.50 U	2.6 I	0.20 U
Econfina Blue Spring Composite	8730	0.24 U	0.035	0.15 U	0.008 I	0.50 U	21	2.8	1.1 I	0.50 U	2.6 I	0.20 U
Hays Spring Composite	7957	2.71	0.053	0.15 U	0.013 I	1.1 I	59	1.5	1.8 I	0.64 I	4.6 I	2.0 U
Holmes Blue Spring	8084	0.554	0.010 U	0.15 U	0.032	0.50 U	37	5.7	2.0 I	0.50 U	3.5 I	2.0 U
Horn Spring	7938	0.237 I	0.034	0.15 U	0.058	2.5	39	7.6	3.3	0.56 I	5.4	8.3
Morrison Spring	8094	0.24 U	0.023 I	0.15 U	0.027	0.50 U	35	8.3	2.1 I	0.65 I	3.4 I	3.2 I
Mullet Spring	8090	0.480	0.025 I	0.16 I	0.011 I	3.8	33	3.5	2.3 I	0.50 U	4.8 I	2.0 U
Natural Bridge Spring	9027	0.24 U	0.019 I	0.15 U	0.055	5.0	36	5.8	2.9 I	0.59 I	5.0	4.6 I
Ponce DeLeon Spring	8085	0.384 I	0.034	0.15 U	0.025	0.50 U	35	8.3	1.7 I	0.54 I	1.0 I	2.7 I
Sally Ward Spring	774	0.632	0.048	0.15 U	0.040	0.50 U	49	11	6.0	0.71 I	8.3	8.7
Sylvan Spring Composite	8787	0.24 U	0.016 I	0.15 U	0.008 I	0.50 U	22	3.3	1.8 I	0.50 U	3.8 I	2.0 U
Williford Spring Composite	8677	0.24 U	0.028 I	0.15 U	0.013 I	0.55 I	23	3.0	1.5 I	0.50 U	3.2 I	2.0 U

U – Analyte was not detected and the indicated value is the detection limit.

I – The reported value is between the laboratory method detection limit and the practical quantitation limit.

4. Water Quality Data

Table 9: Results of Lab-Analyzed Water Quality Samples Collected at Select Second Magnitude Springs, cont.

Location Name	WIN	CO^3	HCO^3	F	Alk.	TDS	TSS	Color	Fecal Coliform	E. coli
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		Colonies/100 mL	Colonies/100 mL
Baltzell Spring Composite	8655	5.0 U	150	0.40 U	150	230	2.0 U	5.0 U	2.0 U	2.0 U
Beckton Spring	8088	5.0 U	84	0.40 U	84	96	2.0 U	30	48	40
Blue Hole Spring	7953	5.0 U	120	0.40 U	130	140	2.0 U	15	8	4
Cypress Spring	8087	5.0 U	110	0.40 U	110	110	2.0 U	5.0 U	6	6
Devils Hole Spring	8908	5.0 U	50	0.20 U	51	74	2.0 U	5.0 U	4	4
Econfina Blue Spring Composite	8730	5.0 U	59	0.20 U	60	74	2.0 U	5.0 U	80	54
Hays Spring Composite	7957	5.0 U	140	0.40 U	140	190	4.9	7.5	76	60
Holmes Blue Spring	8084	5.0 U	110	0.20 U	110	110	2.0 U	5.0 U	2.0 U	2.0 U
Horn Spring	7938	5.0 U	110	0.20 U	120	140	2.0 U	20	2.0 U	2.0 U
Morrison Spring	8094	5.0 U	110	0.20 U	120	110	2.0 U	5.0 U	8	4
Mullet Spring	8090	5.0 U	88	0.40 U	89	100	2.0 U	25	114	88
Natural Bridge Spring	9027	5.0 U	100	0.20 U	100	140	2.0 U	55	2.0 U	2.0 U
Ponce DeLeon Spring	8085	5.0 U	110	0.20 U	110	130	2.0 U	5.0 U	2.0 U	2.0 U
Sally Ward Spring	774	5.0 U	150	0.20 U	150	180	2.0 U	5.0 U	2.0 U	2.0 U
Sylvan Spring Composite	8787	5.0 U	61	0.20 U	62	68	2.0 U	5.0 U	14	10
Williford Spring Composite	8677	5.0 U	64	0.20 U	64	100	2.0 U	5.0 U	4	2.0 U

U – Analyte was not detected and the indicated value is the detection limit.
B – Colony Count exceeded the ideal of 20-80 (total coliform) or 20-60 (fecal coliform).
I – The reported value is between the laboratory method detection limit and the practical quantitation limit.

4.5 Water Quality Data Conclusions and Synthesis

Water quality collected around St. Joseph Bay was generally good during June 2024. Nitrogen and total phosphorus concentrations were not detected, with results below the detection limit at all sample locations. Similarly, bacteria (fecal coliform, *E. coli*) concentrations were generally low with elevated concentrations relative to other locations around St. Joseph Bay only found at two locations. This is generally similar to results collected during the summer months during 2021 and 2022, as described in NWFWMD (2021) and NWFWMD (2022). Regular sampling is required in order to monitor long-term trends and help determine factors that may be related to any adverse water quality conditions measured in St. Joseph Bay.

Water quality sampling at second magnitude springs throughout the Florida panhandle was highly variable ranging from below the detection limit for nitrogen to 6.48 mg/L at the Baltzell Spring Composite location. In addition, Hays Spring displayed nitrogen levels (2.71 mg/L) particularly elevated compared to other sample springs. Total phosphorus concentrations were below the practical quantitation limit at all springs. Fecal coliform and E. coli concentrations at all locations met allowable limits for bathing/swimming areas and were below 114 colonies/100 mL and 88 colonies/100 mL, respectively. Water quality sampling at the second magnitude springs included in this study has been intermittent with many locations not sampled in more than a decade. This makes it difficult to describe any long-term changes in water quality at these locations. It is recommended that regular water quality sampling be performed at these springs to more accurately determine the health of the spring and potential changes in water quality.

5 Stakeholder Meetings and Long-Term Monitoring Plan

In order to help identify stakeholder concerns regarding the current conditions and trends of St. Joseph Bay, a public stakeholder meeting was held on September 25, 2023, in Port St. Joe. During this meeting, the District presented a summary of findings to date concerning flow patterns and volumes near the intersection of the Gulf County Canal and the Gulf Intracoastal Waterway including a description of potential implications for freshwater flows and their impacts into St. Joseph Bay. The District presentation was followed by an extensive discussion with stakeholders about concerns related to the health of St. Joseph Bay.

The District was asked to develop a long-term data collection plan to identify data gaps that would increase understanding of factors affecting St. Joseph Bay and facilitate the development of solutions and management options to address potential adverse changes. As part of this plan, representatives from the St. Joseph Bay Aquatic Preserve, St. Andrew Bay/St. Joseph Bay Estuary Program, and FWC were contacted for suggestions on the types of data collection activities that may be most beneficial to the management of St. Joseph Bay. The following list outlines the data collection activities proposed in the long-term monitoring plan. Additional details can be found in the monitoring plan which has been included as Appendix A.

1. Continue discharge and water quality monitoring in the Gulf Intracoastal Waterway System. The results from monitoring efforts during previous fiscal years are described in Section 2 and Section 3 of this report.
2. Develop a hydrodynamic model for St. Joseph Bay
3. Expand/enhance continuous data recording stations
4. Assess shallow groundwater inflows and water quality
5. Assess potential sediment transport into St. Joseph Bay via the Gulf County Canal and Gulf Intracoastal Waterway System
6. Develop a Citizen Science Initiative
7. Develop and evaluate satellite-based estimates of historical water quality in St. Joseph Bay.
8. Monitor surface water inputs into St. Joseph Bay for water quality
9. Evaluate changes in land use and estimated nutrient loading in the St. Joseph Bay Watershed

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Appendix A - Long-Term Research Plan for St. Joseph Bay

Long-Term Research Plan for St. Joseph Bay

Submitted in partial fulfillment of Department of Environmental Protection
Grant AT003 Amendment 8

Northwest Florida Water Management District
81 Water Management Drive
Havana, Florida 32333
850-539-5999

June 2024

Introduction

Compared to many bays in Florida St. Joseph Bay has been considered relatively healthy, however numerous challenges have been identified. Due to St. Joseph Bay's location in a more rural setting with relatively minimal historical impacts, significant data gaps exist in our understanding of the bay and any adverse impacts that may be present. Filling these data gaps is necessary for understanding current stressors and any associated adverse impacts to the system. This understanding will help focus the state's efforts and resources towards projects and restoration in order to obtain optimal results.

As part of the state's commitment to maintaining and restoring the health of aquatic ecosystems, the Northwest Florida Water Management District (District) was tasked with developing a long-term (three to five year) research plan (Plan) aimed at addressing key deficiencies in our understanding of St. Joseph Bay and surrounding waters. This Plan was developed with input from key stakeholders identified in the region currently managing, studying, or making a living off the waters of St. Joseph Bay. The goal of the Plan is to identify key data gaps and information and help identify projects required to successfully manage St. Joseph Bay into the future. The projects described in this Plan are not exhaustive and are focused on areas of State priorities and jurisdiction at the time of the Plan's development. As the system is studied and our understanding improves, it is likely that additional data gaps and projects to address them will be identified.

Multiple stakeholder meetings were held to gather input and facilitate conversations about information needed to better understand, manage, and potentially restore St. Joseph Bay. Stakeholder meetings included those for the general public and those targeted to members of the scientific/management community as part of the St. Joseph Bay Initiative. Following meetings, subsequent discussions were held with individuals from the Department of Environmental Protection (DEP) (Chief Science Officer, Office of Environmental Accountability and Transparency, St. Joseph Bay Aquatic Preserve, Division of Environmental Assessment and Restoration, Apalachicola National Estuarine Research Reserve, etc.), the Florida Fish and Wildlife Conservation Commission (FWC), and the St. Andrew/St. Joseph Bays Estuary Program to identify details related to potential projects.

This plan is organized as a series of proposed tasks that will help improve the understanding of St. Joseph Bay to facilitate management of the system. Tasks are presented as discrete activities to be completed individually; however, many are interrelated and some would be optimized if completed concurrently. As a result, the sequence of tasks completed should be determined in collaboration with the DEP and potentially other stakeholders to optimize results.

The prioritization and scheduling of individual projects will be determined in collaboration with DEP. Project descriptions and cost estimates provided in this document are for planning purposes only. Details regarding project design and actual costs are likely to fluctuate/deviate, sometimes significantly, from these descriptions based on the changes in state priorities, finalization of scopes of work, contractor availability, inflation, etc.

Task 1. Continue Discharge and Water Quality Monitoring in the Gulf Intracoastal Waterway System

This task consists of the operation and maintenance of three discharge and limited water quality (nitrate, pH, dissolved oxygen, salinity) monitoring stations. The two Intracoastal Waterway stations collect continuous discharge and water quality data and are located along the Intracoastal Waterway on either side of the Gulf County Canal in Gulf County, Florida (Figure 1). The Jackson River Discharge Station is located in the Box R Wildlife Management Area in Franklin County, Florida. At this location, continuous water quality data and discrete discharge measurements are collected. These stations were installed and operated by the United States Geological Survey (USGS) as part of previous amendments to Grant AT003 beginning in Fiscal Years 2019-20 and 2020-21, respectively. These data are important for helping to determine the volume, seasonality, and water quality of flows through the Gulf Intracoastal Waterway System.

Data previously collected under this task has demonstrated that during the available period of record, water in the Gulf Intracoastal Waterway System is flowing across watershed boundaries (i.e., from the Apalachicola Bay watershed to the St. Andrew Bay/St. Joseph Bay watershed) and that flows from the Gulf Intracoastal Waterway may be providing the largest freshwater inputs into St. Andrew Bay and St. Joseph Bay (Figure 2). Bays are typically managed on a watershed basis under the assumption that water tends to stay within a watershed; however, this study has shown that previous assumptions concerning flow inputs into St. Joseph Bay and St. Andrew Bay were incorrect.

Due to trends in precipitation during the project, flow data at the discharge monitoring stations have not yet been collected during periods of extremely high (>100,000 cfs) and low (<8,440 cfs) flows as measured at the Apalachicola River Sumatra station. These flows are critical to the understanding of the system as flow trends may change significantly during periods of drought and/or flooding.

Continuing this data collection is critical to better understanding factors affecting the salinity and water quality of St. Joseph Bay in addition to St. Andrew Bay and Apalachicola Bay. In addition, these data would likely serve as critical data input and/or calibration data for any future hydrologic modeling of flows through the system.

Under this task, the USGS will continue to be contracted for the operation and maintenance of these stations on an annual basis. Due to the nature of this data collection, it is recommended that these efforts be continued annually throughout the duration of the project. During FY 2024-25, the estimated cost for this effort is $226,250. The final cost during the current and future fiscal years is dependent on the number of locations, parameters sampled, periodicity of field verification samples, and annual increases in costs associated with inflation or other factors.

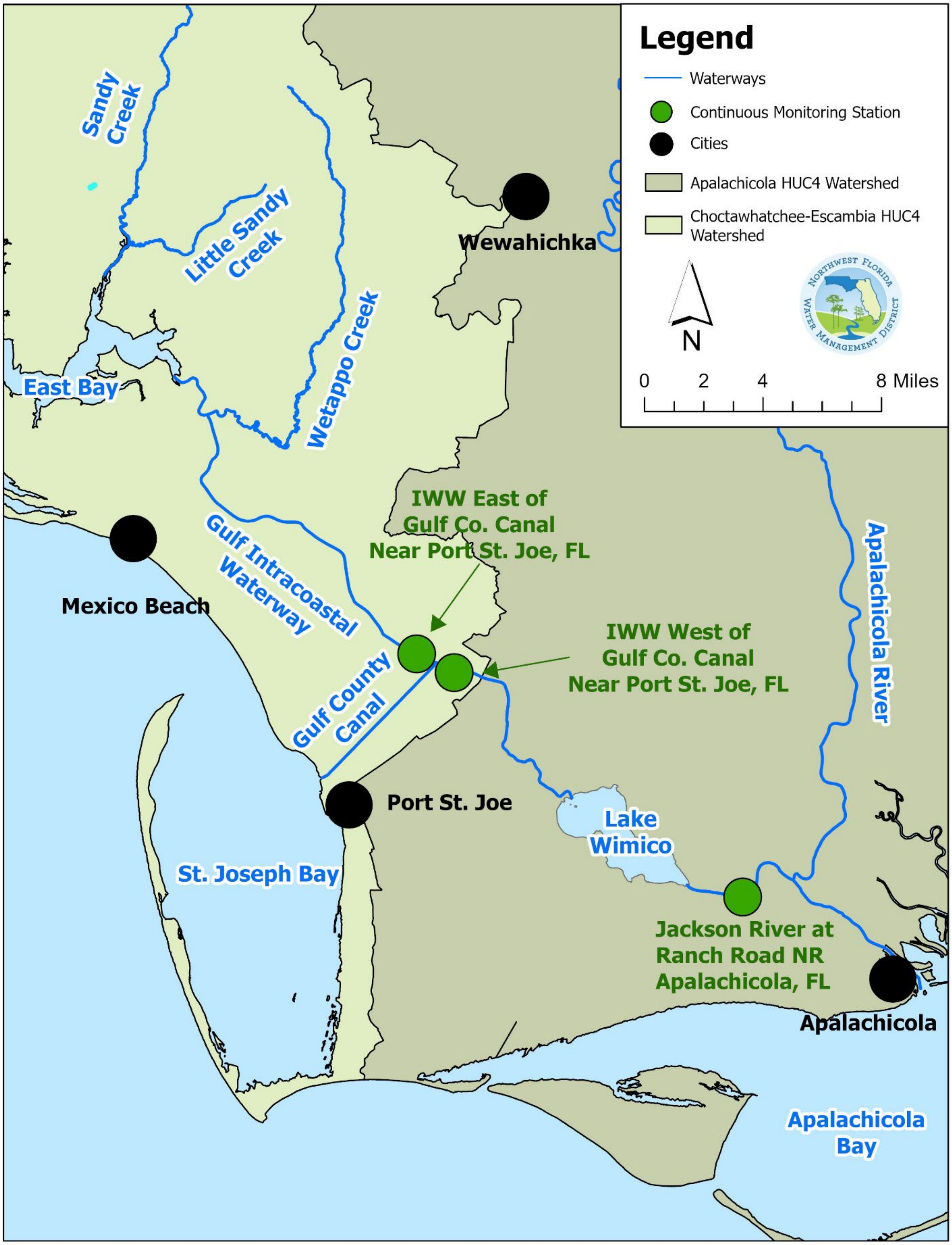

Figure 1. Location of the Continuous Discharge and Water Quality Monitoring Stations

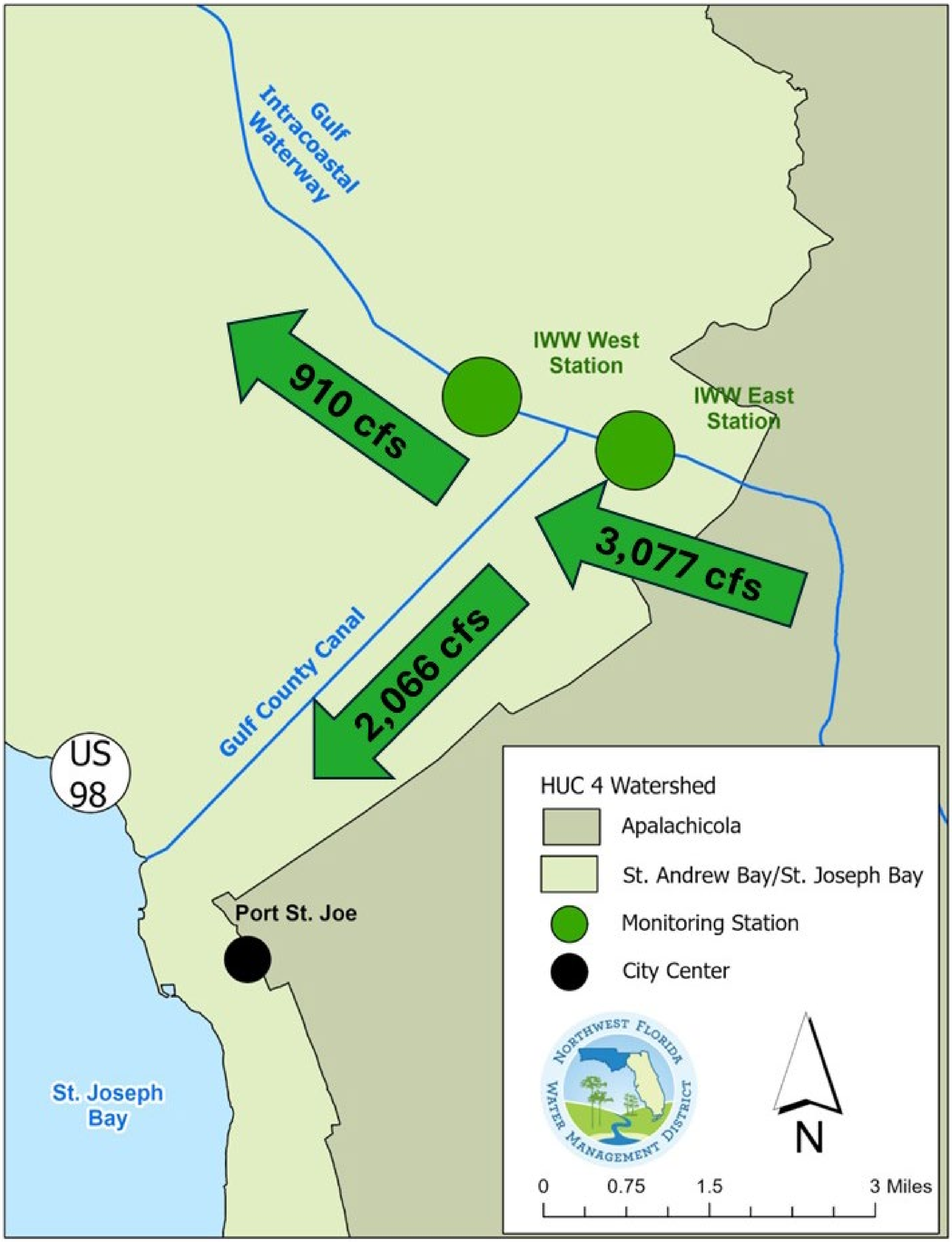

Figure 2. Net Flows Measured in the Gulf Intracoastal Waterway System between October 24, 2020 and June 30, 2023

Task 2. Develop Hydrodynamic Model for St. Joseph Bay

Significant data gaps identified by partners involved in the St. Joseph Bay Initiative are related to circulation within the bay. Historically, it was assumed that little surface water was flowing into St. Joseph Bay which was supported by measured salinity in many of the lower parts of the bay often being relatively high (i.e., >20 psu). Recent data has shown this assumption may be incorrect with the Gulf County Canal providing nearly 2,000 cfs of water into the bay and salinity near the mouth of the bay often approaching 0 psu. Currently, the fate and impact of water entering St. Joseph Bay from the Gulf County Canal are poorly understood. Reports by stakeholders suggest that circulation within the bay is counterclockwise; however, results using an uncalibrated model suggest circulation is on average clockwise. Understanding the hydrodynamics and circulation within St. Joseph Bay is of critical importance. Currently, a well calibrated hydrodynamic model capable of simulating bay circulation, salinity, etc. is not available.

A well calibrated hydrodynamic model for St. Joseph Bay can provide researchers with valuable information regarding how water circulates and affects salinity in the bay. Similar models have been used in other systems throughout Florida (Figure 3). In addition, this model may help provide insight into how changes in sea level and precipitation patterns are likely to affect salinity, circulation, and freshwater inflows into the bay which is critical to managing a resilient ecosystem facing changing boundary conditions. Currently, calibrated hydrodynamic models exist or are being constructed for adjacent systems, i.e., St. Andrew Bay and Apalachicola Bay, however, no such efforts are yet underway for St. Joseph Bay. The proposed development of a hydrodynamic model for St. Joseph Bay involves three sub-tasks as outlined below.

1- *Development of Hydrodynamic Modeling Plan*. Under this sub-task, a contractor will be hired to develop a plan for the development and calibration of the hydrodynamic model. As part of this plan, the contractor will review available data and current data collection efforts that are appropriate for model development and calibration. As part of this review, the contractor will develop, if necessary, a data collection plan detailing the location and types of data which are missing to develop a well calibrated model. The contractor will suggest the best type of hydrodynamic model to be developed for St. Joseph Bay to meet the state's needs. A schedule and formal budget will be developed for the completion of the model. The estimated cost of this sub-task is less than $100,000 and is anticipated to take up to a year to complete.

2- *Data Collection*. This sub-task involves collecting additional data needed to develop a well calibrated hydrodynamic model. Types of data collected under this effort may include high resolution, i.e., 15-minute increment water surface elevation data, bathymetry, salinity data, tidal flux, wind, temperature, and water flow. If possible, data collection is proposed to be conducted in collaboration with St. Joseph Bay Initiative partners such as the St. Joseph Bay Aquatic Preserve and the Florida Fish and Wildlife Conservation Commission. It is anticipated that these data collection efforts would occur over the period of at least one year but may span several years. The cost would depend on the number of stations and the locations at which they were installed.

3- *Model “Development and Calibration”*. This sub-task involves the actual development and calibration of the model as identified in the Hydrodynamic Modeling Plan. A contractor will be tasked with constructing the model, developing all model input files, calibrating the model, and producing multiple model runs/scenarios. It is anticipated that this task may take one year or longer to complete. The cost of this sub-task is anticipated to be less than $300,000.

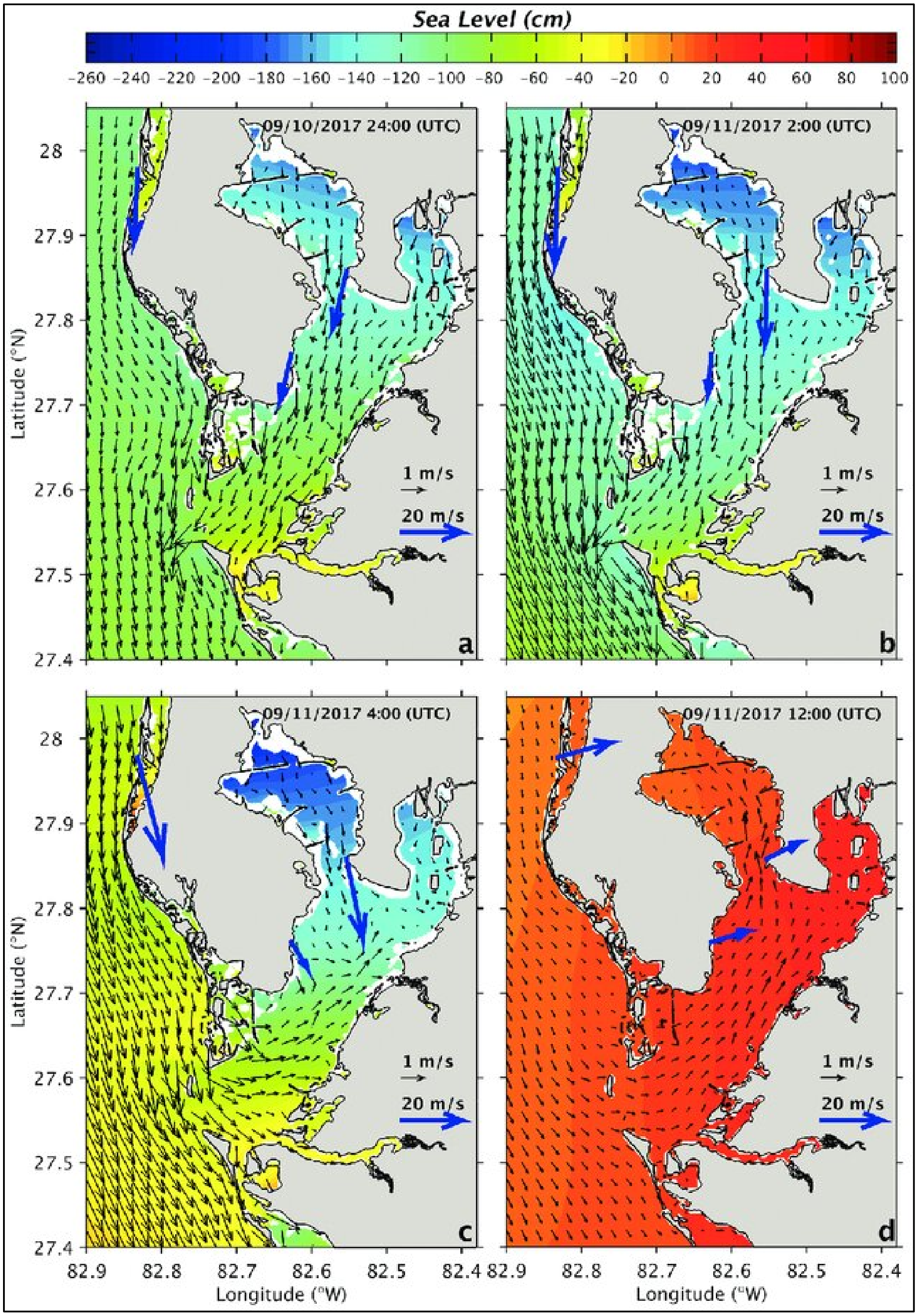

Figure 3. Example Hydrodynamic Model Results (wind and water surface elevation) from Tampa Bay, Florida (from Chen *et al.* 2018)

Task 3. Expand/Enhance Continuous Data Recording Stations

Continuous data are invaluable for understanding and monitoring changes in water quality and flow as it provides information across a range of tidal, weather, and climatic conditions.

Currently, continuous data collection within St. Joseph Bay is limited and occurs at two locations, Black's Island and in Port St. Joe near the boat ramp (Figure 4). Data collected at Black's Island is maintained by the St. Joseph Bay Aquatic Preserve and consists of conductivity, temperature, and depth data. The station in Port St. Joe[1] is maintained by the DEP through a contract with Stevens-Connect and consists of water level and weather data (air temperature, barometric pressure, relative humidity, wind direction, and wind speed). Additional continuous data may be required to increase the spatial and temporal distribution around St. Joseph Bay. Additional continuous data collection may be recommended in Task 2 "Develop Hydrodynamic Model for St. Joseph Bay." Two potential locations and data station descriptions are provided below, although other locations may be identified during future collaboration with St. Joseph Bay Initiative partners.

Eagle Harbor – Until recently, FWC operated a data collection station at Eagle Harbor on the St. Joseph Bay Peninsula (Figure 4). This station collected conductivity, temperature, and depth data using a continuous recorder and was part of a seagrass mapping project. This is the only location on the peninsula/western side of St. Joseph Bay with longer-term, historical data, and continuing data collection at this location would be especially important for improving the understanding of western bay conditions. Continuation of this data collection would be relatively cost effective and would likely only require equipment purchase and a survey, if needed, to convert water depths into water surface elevations relative to a standard elevation datum (i.e. NAVD 88). The St. Joseph Bay Aquatic Preserve has offered to install, operate, and maintain this station if the equipment can be provided. This effort could be completed within a few months, and the timing would largely depend on the time required to obtain the equipment. It is anticipated that the cost of station construction at this location would be less than $50,000 with annual maintenance less than $25,000.

Gulf County Canal at US 98 – Currently, flow data for water entering St. Joseph Bay from the Gulf Intracoastal Waterway System is estimated as the water entering the Gulf County Canal from the Gulf Intracoastal Waterway. The locations of the current sampling stations provide reliable estimates of water flowing through the Gulf Intracoastal Waterway System; however, potential exists for additional flow pickup or loss along the Gulf County Canal's five-mile length. A data collection station at this location would allow the monitoring of flows and water quality at the intersection of St. Joseph Bay and the Gulf County Canal (Figure 4). Discharge, depth, and water quality (e.g., conductivity, temperature, TSS, color) data at this site may be useful. Much of this area is privately owned and in order to collect data in this area a partnership with local landowners must be reached. It is anticipated that construction of this station would be less than $150,000 with annual operation being less than $125,000.

Other Potential Locations – Multiple other locations exist which could provide important information regarding water levels, as well as salinity and other water quality parameters. Potential locations for consideration include the T.H. Stone Memorial St. Joseph Bay Peninsula State Park, within the vicinity of the St. Joseph Bay Aquatic Preserve's Canoe and Kayak Launch, and the St. Joseph Bay State Buffer Preserve Visitor Center (Figure 4).

[1] Station ID 4026, Port St. Joe, https://stevens-connect.com/public/project/512/dashboard#station_id=4026

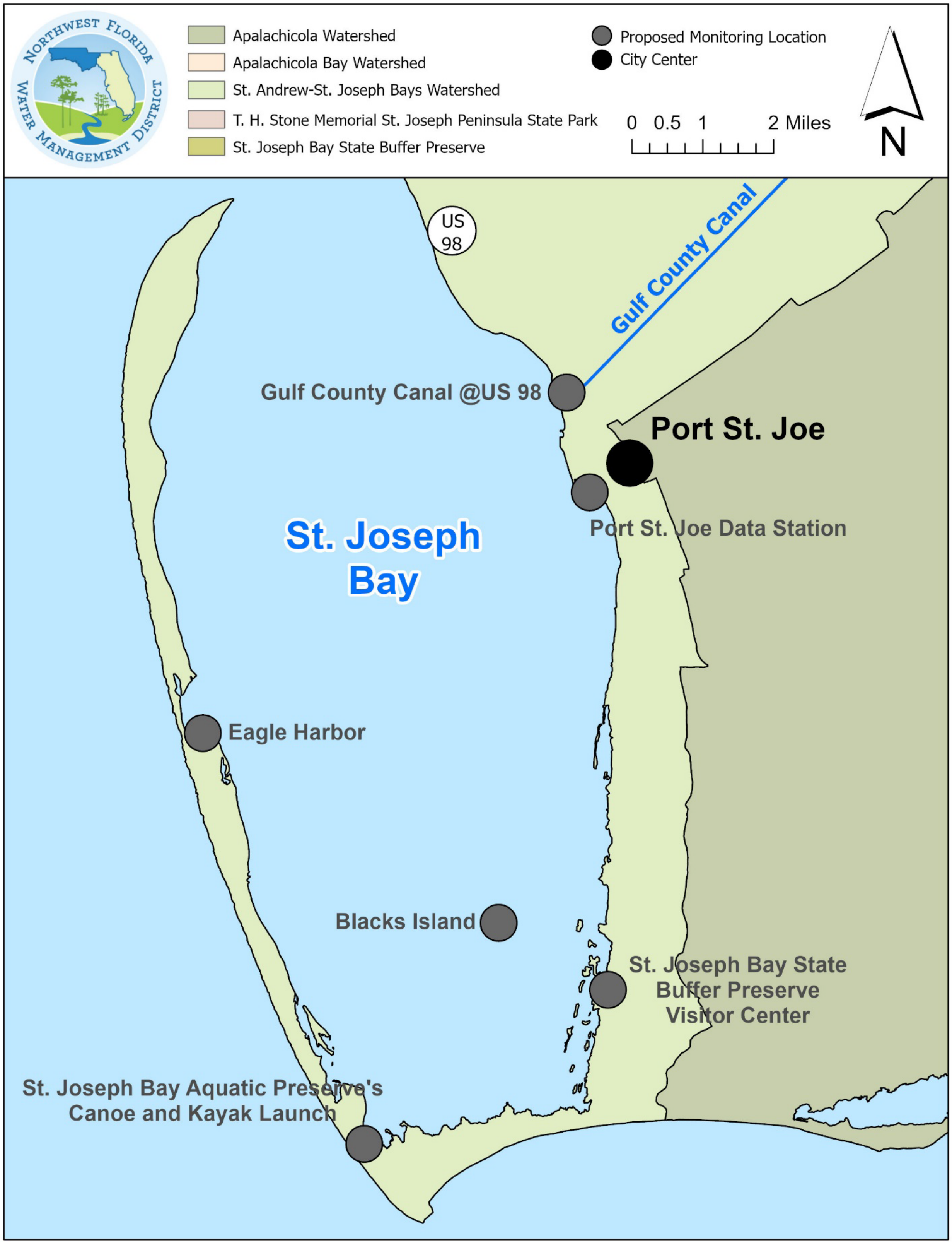

Figure 4. Location of Potential Continuous Recorder Monitoring Stations

Task 4. Assess Shallow Groundwater Inflows and Water Quality

While the focus of most salinity and eutrophication studies in aquatic systems is on surface water sources, recent research suggests that groundwater may play an important role (DeHan 2000), particularly during periods of low rainfall (Tobias et al. 2001) (Figure 5). Currently, little information exists regarding the significance of groundwater inputs on St. Joseph Bay. Specifically, it is not known if groundwater is a significant factor in determining salinity and water quality in St. Joseph Bay. Best available data suggests that the surficial aquifer near the bay is slightly above the mean sea level, indicating that groundwater seepage into St. Joseph Bay is potentially occurring. However, the volume of this groundwater seepage and the chemical characteristics of this water are currently unknown. Prior to any investigation into groundwater interactions in St. Joseph Bay, additional research partners, such as the Florida Geological Survey (FGS) and/or USGS, would be contacted to provide insight into sampling design. Following this consultation, a more formal task description can be developed. In order to help assess the significance of groundwater on St. Joseph Bay salinity and water quality, multiple subtasks may be required. These tasks are listed below.

1- *Identify Existing Surficial, Shallow Groundwater Wells Suitable for Monitoring*. Before groundwater seepage into St. Joseph Bay can be quantified, suitable locations to measure groundwater elevations and water quality near the bay must be identified. This sub-task would identify existing shallow, groundwater wells that may be suitable for use in the study. This task is anticipated to cost less than $50,000.
2- *Construct Additional Surficial, Shallow Groundwater Wells*. If the number and/or distribution of existing shallow groundwater wells capable of being sampled is determined to be insufficient for addressing groundwater inflows, additional well construction may be required. This sub-task would identify well locations and contract for their construction. This sub-task is anticipated to cost less than $150,000. Wells would be instrumented with continuous recording CTD sensors.
3- *Water Quality Data Collection*. Once a suitable number of shallow groundwater wells have been identified and/or constructed, these wells should be sampled for water levels and water quality parameters. Wells should ideally be equipped with continuous water level recorders while water quality sampling should include lab analyzed grab samples similar to those described elsewhere in this Plan. Samples should be collected at a minimum of quarterly intervals and taken to a NELAC certified laboratory for processing. It is anticipated that this sub-task would cost less than $50,000 for one year of quarterly monitoring depending on the number of sites.
4- *Measure Groundwater Seepage into St. Joseph Bay*. In this sub-task, groundwater experts, i.e., FGS, USGS, etc., would be contracted to help develop a methodology to investigate ground water seepage volumes on St. Joseph Bay and its effects on water quality and salinity. Currently the cost of this sub-task is unknown.

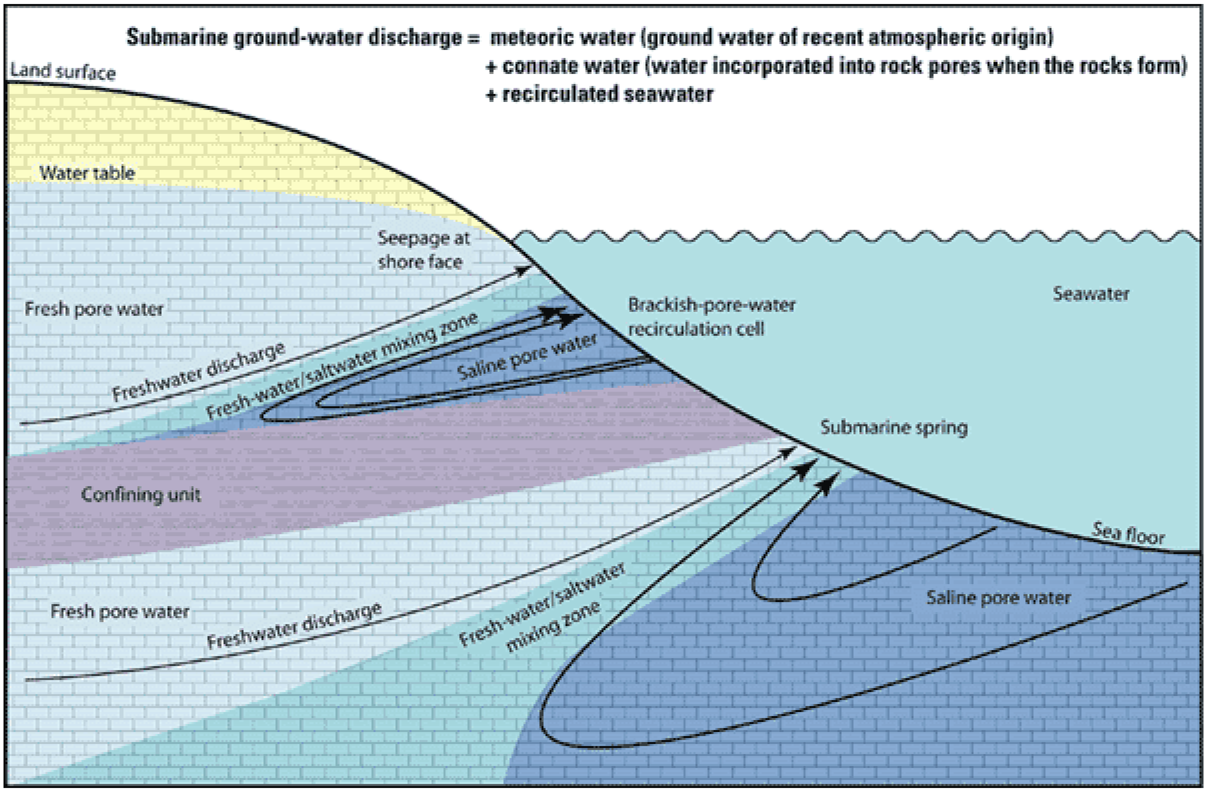

Figure 5. Submarine Groundwater Discharge Schematic. Image provided by the U.S. Geological Survey (https://www.usgs.gov/media/images/submarine-groundwater-discharge-schematic).

Task 5. Assess Sediment Transport Into St. Joseph Bay via the Gulf County Canal and Gulf Intracoastal Waterway System

Sedimentation is a primary concern raised by multiple stakeholders. Concerns have been raised for two primary types of sedimentation within St. Joseph Bay: organic and inorganic sedimentation. Organic sedimentation has been identified throughout the bay and is of concern to resource managers due to the potential for adverse effects on seagrasses and other benthic communities. While the severity of this concern and potential causes of any organic sedimentation remain unconfirmed, researchers at the University of Florida are currently assembling a proposal to investigate organic sedimentation in the bay. Inorganic sedimentation has also been identified as a source of concern near the mouth of the Gulf County Canal in St. Joseph Bay. At this location, sediment which appears to largely be sand is forming a sandbar/delta on either side of the channel for the Gulf County Canal (Figure 6). Two sources of this sediment have been proposed: 1- spoil deposited on the northwest side of the Gulf County Canal from the canal construction and 2- sediment transported from the Apalachicola River through the Gulf Intracoastal Waterway System. Currently, the source of sediment at the mouth of the canal has not been characterized or otherwise studied and it is unknown whether water velocities in the Gulf Intracoastal Waterway are sufficient to promote sediment transport.

In order to investigate sedimentation concerns at the mouth of the Gulf County Canal, a screening analysis is proposed which would require limited data collection. Sediment samples would be taken from multiple locations including the sediment accumulation location, the edge of the Gulf County Canal, dredge spoil piles along the Apalachicola River, and/or other likely sources of sediment. Sediment could be dried, sifted and sorted according to grain size, and characterized for comparison to identify a sediment source. This information could then be combined with measured water velocities along the Gulf Intracoastal Waterway, Gulf County Canal, and Lake Wimico and compared to established sediment transport curves to qualitatively assess the potential for sediment transport through the system. In addition, existing discrete discharge measurements could be screened for the presence of a moving bed which would indicate sediment transport at the time of measurement. Additional discrete discharge measurements could be taken during periods of maximum flow at alternate locations if deemed necessary.

This effort is anticipated to be completed in less than a year. Costs of this effort would be dependent upon the number of samples collected and the contractor selected for the analysis, however it is anticipated that this effort would cost less than $100,000.

Figure 6. Sediment Accumulation around the Mouth of the Gulf County Canal in Port St. Joe. Image taken in December 2022 and obtained from Google Earth.

Task 6. Develop a Citizen Science Initiative

Interaction with public stakeholders is crucial to not only understanding what citizens are concerned about regarding St. Joseph Bay but can also be used to obtain information which would be otherwise difficult to obtain. While enhanced data collection activities in and around St. Joseph Bay can provide increased resolution of high-quality data, observations from individuals consistently working on St. Joseph Bay can help provide real time observations of conditions and trends which may not be detectable with more formal data collection efforts. This can also be a cost-effective method of collecting large volumes of basic data over long periods of time. This task will attempt to utilize individuals spending considerable amounts of time on St. Joseph Bay (i.e. recreational fishing charter captains, shoreline residents, commercial fishermen, etc.) to collect information in areas not typically sampled.

Selected individuals will be trained in best data collection practices and provided with basic sampling equipment in order to collect data during their time on the water. Sampling equipment which could be provided to citizens includes a Secchi disk to be used for water clarity estimates, a thermometer for water temperature, and a refractometer to provide salinity values. This equipment is extremely quick and easy to utilize and could provide researchers with data at multiple locations the individuals visit throughout the day. Participating citizens would be provided with data sheets (Table 1) to record data which would resemble the final database the data would be housed in. Ideally, participating citizens would be provided with access to an online platform in which they could enter data for submission. Alternatively, data sheets could be emailed directly to the managing entity for data submission and entry. This form would be formatted for automated uploading into a central database. Information requested would include items such as date, time, tide, location, water clarity, salinity, weather conditions, photographic documentation, and depth. Information gathered in this effort could be used to verify hydrodynamic model performance, obtain recent observations about St. Joseph Bay, and improve public relations between researchers, managers, and local stakeholders.

It is anticipated that a pilot project for this effort could be funded for less than $20,000 for up to 20 citizens to be provided with and trained in the use of sampling equipment. Additional costs associated for the development of an on-line data submission platform are not included in this cost estimate. These efforts could be implemented quickly and continue for multiple years. Depending on the success of this effort, this task could be expanded.

Table 1. Example Data Sheet to Potentially be Provided to Citizen Scientists

Date: ____________________ Sampler: ______________________

Time	Tide	Wind	Latitude	Longitude	Depth	Secchi Depth	Salinity	Substrate	Notes

Date: Date of sampling
Time: Time of sample collection including Time Zone if not in Eastern.
Tide: Low, low rising, mid rising, high rising, high, high falling, mid falling, low falling
Wind: estimated wind speed (in miles per hour) and direction the wind is blowing from (compass reading)
Latitude: Latitude in decimal degrees
Longitude: Longitude in decimal degrees
Depth: Depth from water surface to the bottom in feet
Secchi Depth
Salinity: Salinity as measured in principal salinity units (psu)
Substrate: Type of bottom. Seagrass (including type), sand, mud, oyster, etc.
Notes – Please include any other information you feel is important for resource managers to know.

Task 7. Develop and Evaluate Satellite-Based Estimates of Water Quality in St. Joseph Bay

In order to identify spatial and temporal trends in water quality and subsequently mitigate for adverse water quality conditions, detailed mapping of locations with water quality impairment are required. This often requires regular sampling at multiple locations. However, historical water quality data throughout St. Joseph Bay is largely deficient and inconsistent. Existing data was collected using lab-analyzed grab samples, which, while accurate, represent conditions at single locations at a single moment in time. As a result, extensive data collection in future years would be required to identify any spatial patterns and/or trends in water quality impairment.

Emerging technology is increasing the ability to measure numerous water quality parameters utilizing the extended data sets produced in association with high resolution satellite images. The use of satellite imagery to map water quality trends has the potential to not only generate high resolution maps of water quality parameters (Figure 7) but can also provide estimates of historical conditions for periods where suitable imagery exists. These maps of water quality could be combined with the land use maps proposed in Task 9 of this Plan which would help identify the sources of the impairment and possible solutions.

Discussions with one consultant, Satelytics, which is a leader in the development of this technology, has indicated that satellite-based water quality mapping is a rapid method of developing large quantities of historical water quality estimates in a short period of time. For example, developing estimates for five years of previously available satellite images could be provided in several months. It is anticipated that prior to any restoration activities, any locations identified which require restoration would be verified using lab-analyzed water quality grab samples described elsewhere in this Plan.

A Request for Proposals (RFP) will be required for this task. Multiple consultants will have the opportunity to provide qualifications, propose scopes of work, and cost estimates prior to executing contracts. Actual costs associated with this task would be dependent upon the spatial extent of the analysis and the parameters included.

Multiple different parameters are of interest for satellite mapping efforts. These parameters include, but are not limited to: nitrogen, total phosphorus, water color, chlorophyll-a, substrate type and coverage (ie seagrass, sand, mud, etc.), PFAS, sediment accumulation, and water temperature. Different contractors are likely to have varying capabilities regarding what parameters available for analysis. In addition, as technology develops new parameters are consistently becoming available. Prior to contractor selection and contract execution all available parameters will be discussed with DEP and appropriate partners in order to develop the final scope of work.

Once a contract is executed, obtaining results from this effort should be possible within 2-3 months and may provide insight into water quality patterns over the previous 5-10 years for the entire St. Joseph Bay. It is proposed that this effort be initially completed a single time over a multi-year period. Once results are obtained, they can be critically analyzed to determine the usefulness of this technology moving forward. It is anticipated that the cost of this initial effort would not exceed $350,000.

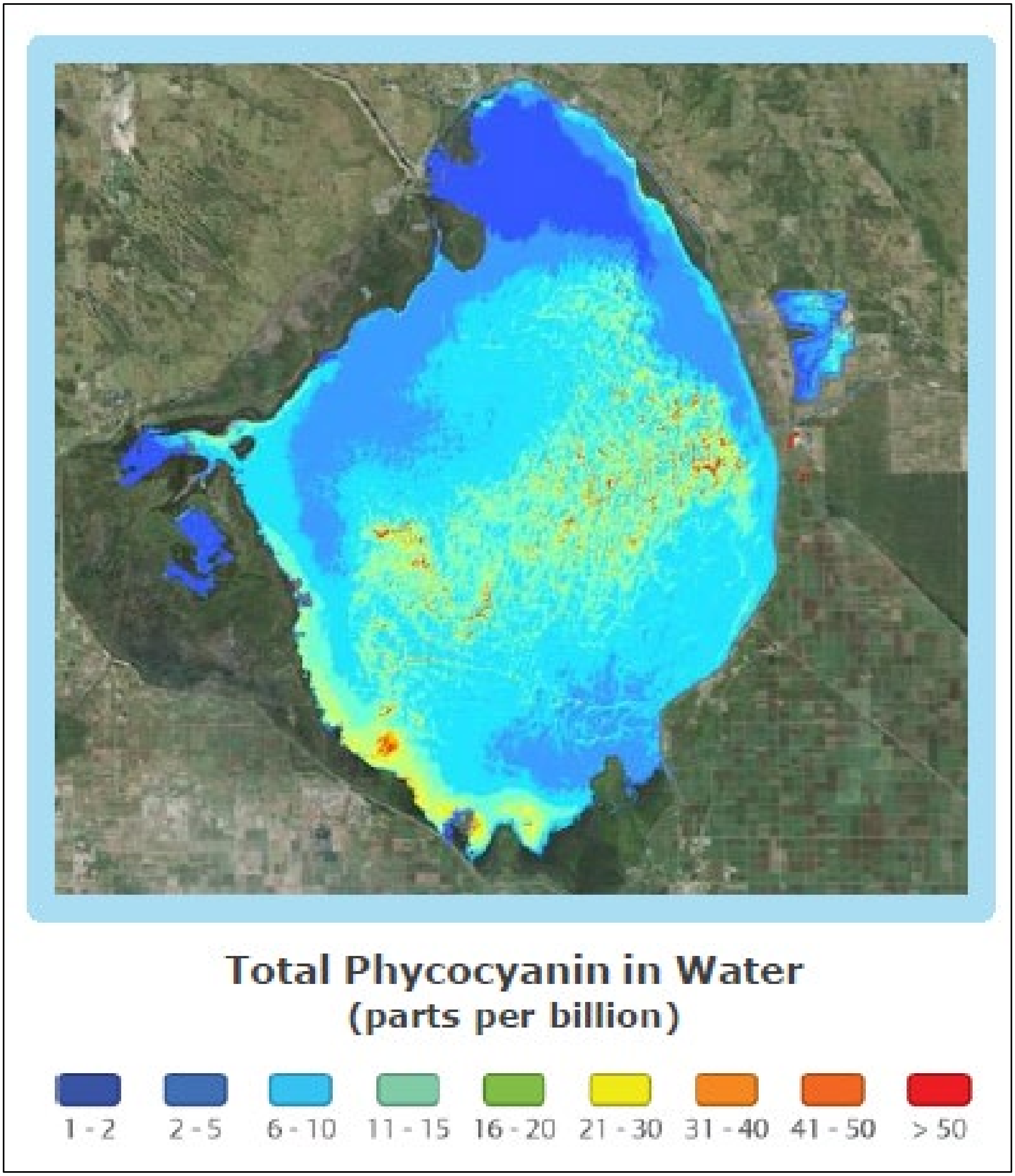

Figure 7. Example of Water Quality Mapping Conducted Using Satellite Imagery. Example provided is for total phycocyanin concentrations from satellite image in Lake Okeechobee on July 12, 2016. Image provided by Satelytics.

Task 8. Monitoring of Surface Water Inputs into St. Joseph Bay for Water Quality

As discussed previously, water quality is a critical component to understanding and managing the health of St. Joseph Bay. In 2020, the District identified a total of 28 potential locations for surface water to enter St. Joseph Bay, including artificially constructed canals such as the Gulf County Canal, stormwater drainages, tidal creeks, and any other conveyances with the potential to transport relatively large volumes of fresh water into St. Joseph Bay (Figure 8). While most of these conveyances are relatively small, the potential exists for these locations to serve as a source of not only surface water to the bay, but as point sources of water quality constituents such as nitrates, phosphates, and bacteria.

While efforts such as satellite-based water quality mapping, and water quality data collected using continuous recorders can provide large volumes of data with relatively low effort, these data require calibration using known accurate data. The most accurate data are obtained from water samples analyzed in a laboratory. During previous years, lab-analyzed water quality samples have been collected from several locations along the mainland (east side) of St. Joseph Bay. These samples, however, have not been collected at regular intervals across multiple years or seasons. Details and results of these sampling efforts can be found in NWFWMD (2022). This task would increase the sampling periodicity and number of sites around St. Joseph Bay which are sampled for water quality parameters to include samples capable of identifying seasonal fluctuations in water quality and include samples collected from Cape San Blas and the St. Joseph Bay peninsula. These two locations have seen large increases in housing development in recent years, particularly since Hurricane Michael in 2018. These data could be used to help validate satellite-based observations and would also provide insight into other water quality parameters not measured using other methods.

Sample parameters would be determined in consultation with the District and DEP. Example parameters are provided in Table 2. In addition to the grab samples, field parameters including (at a minimum) salinity, dissolved oxygen, pH, temperature, latitude and longitude, specific conductivity, and sample depth would be collected. All sample collections would follow DEP standard operating procedures as found at: https://floridadep.gov/dear/quality-assurance/content/dep-sops (I.e. FS 2000 and FS2100). In addition, digital images would be taken in the four cardinal directions at each sampling point. Digital images would be clearly labeled with the location, direction, and date included in the title. Digital images would be stored in a District database for future reference of site conditions.

Lab analyzed samples should be collected at regular intervals throughout the year over multiple years to capture seasonal and annual fluctuations in water quality trends associated with fluctuations in both population and environmental factors. A single round of laboratory analyzed water quality samples at up to 10 locations around St. Joseph Bay is anticipated to cost less than \$20,000. For example, four quarterly samples at 10 locations around the bay would be projected to cost \$80,000. This cost could be reduced if the DEP lab were available to process samples and a private lab was not required.

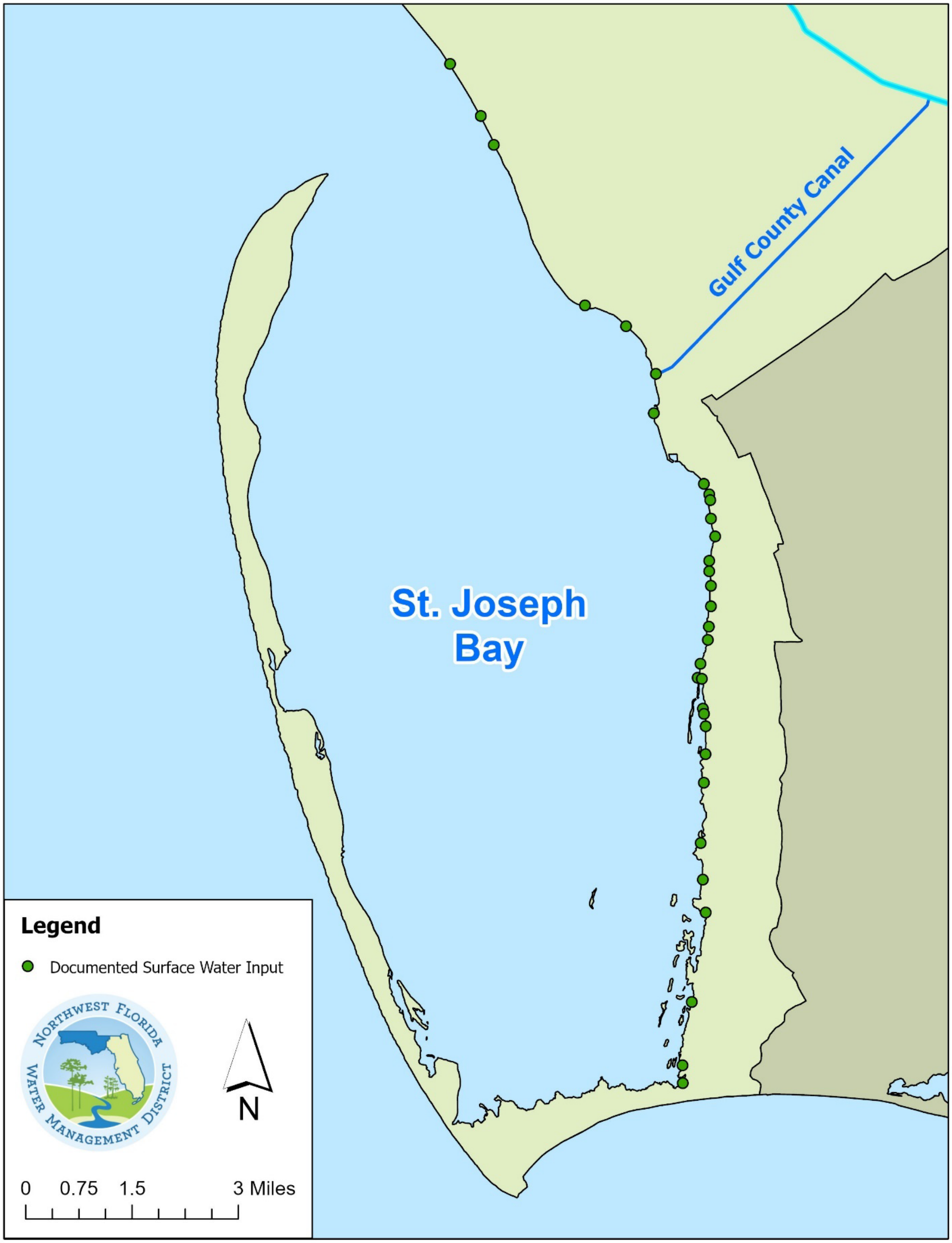

Figure 8. Location of Confirmed Surface Water Inputs on the Mainland Side of St. Joseph Bay

Table 2. Example List of Parameters to be Analyzed in Water Quality Grab Samples.

To be Lab Analyzed	
Alkalinity - Total	Ortho-Phosphate
Ammonia	Sulfate
Bromide	TKN – Total Kieldahl N
Chloride	Total Organic Carbon
Chlorophyll-a Suite	Total Phosphorus
Color (true)	Total Dissolved Solids
Fluoride	Total Suspended Solids
Nitrate-Nitrite N	Turbidity
E. coli	
To be Collected Using a Calibrated YSI	
Dissolved Oxygen	Specific Conductivity
pH	Temperature
Salinity	Depth

Task 9. Evaluate Changes in Land Use and Estimated Nutrient Loading in the St. Joseph Bay Watershed

A primary concern identified by all stakeholders and St. Joseph Bay Initiative partners is changes in surrounding land use and their potential effects on nutrient and contaminant loading into the bay. While land use to the east of St. Joseph Bay, including areas surrounding Lake Wimico and the Apalachicola River, are largely preserved, under public ownership, and therefore at reduced risk of major changes in land use; areas in the north and western portion of the watershed are not. Historically, much of this area was used for pine silviculture. Following Hurricane Michael, changes in land use in the St. Andrew Bay/St. Joseph Bay watershed have been occurring at an accelerated rate with many areas of former planted pines being switched to cattle pasture.

This task would identify changes in land use which have occurred in recent years and changes anticipated to occur in future years and predict their effects on nutrient and bacteria concentration in water flowing into St. Joseph Bay. To the largest extent possible, this effort will leverage existing data regarding land use such as the Florida Land Use, Cover, and Forms (FLUCCS) database (Figure 9), and Nitrogen Source Inventory Loading Tool (NSILT). Previously available versions of land use and cover maps will be reviewed to estimate how land use has changed over the last 20 years. In order to estimate the most current land use, the most recent land cover information will be compared to the most recently available aerial images to identify where and how land use changes are occurring within the watershed. The best way to analyze aerial images requires future consideration, however, emerging technology such as artificial intelligence (AI) provided by Ecopia (www.ecopiatech.com) may be a cost- and time-effective option. These land uses will then be compared to established estimates of nutrient loading for each type of land use to identify the most likely sources of nutrient loading into St. Joseph Bay. In addition to changes in land use, additional items will be included which are likely to significantly affect nutrient loading such as the presence of septic tanks and the 78-acre sprayfield associated with the wastewater treatment plant in Port St. Joe.

This information can be combined with measured flow information in the Gulf Intracoastal Waterway and Gulf County Canal to estimate when water from different areas in the watershed may be flowing into St. Joseph Bay and affecting water quality. A well calibrated hydrodynamic model can then help estimate how this water may circulate through the bay potentially affecting seagrasses, scallop beds, and other habitats.

It is estimated that the cost of this effort would be less than $200,000 depending on the number of land use maps analyzed.

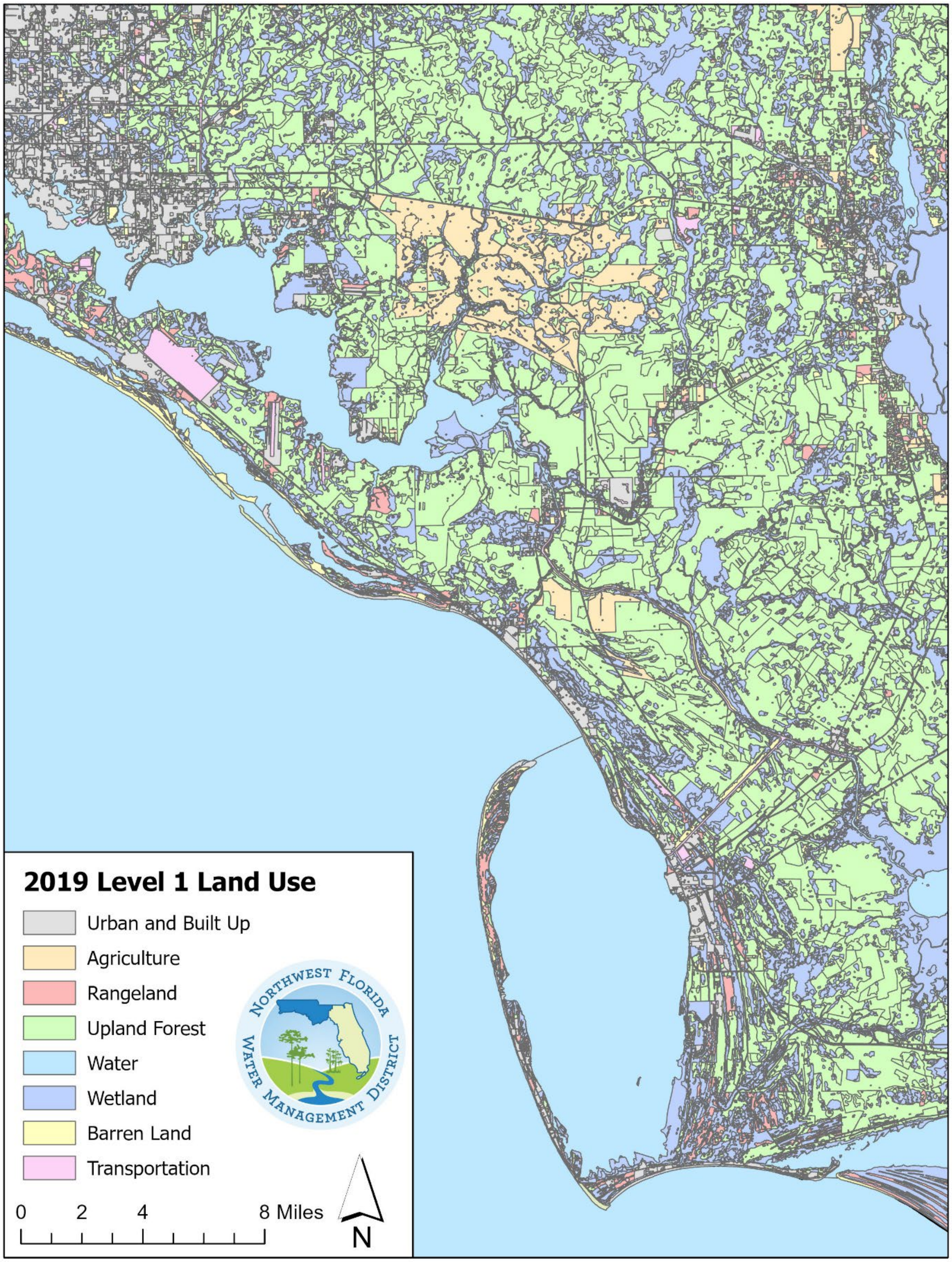

Figure 9. Example FLUCCS Land-Use Map

Summary and Scheduling

The tasks described in this document are aimed at improving our understanding of conditions within St. Joseph Bay by addressing some of the large data gaps identified. The large data gaps identified in conversations with stakeholders include two broad categories: 1- bay circulation and hydrodynamics and 2- water quality including both salinity and chemical constituents.

The hydrodynamics of St. Joseph Bay is poorly understood. A mechanism to investigate circulation and chemical/particulate mixing in through the system has been identified by most stakeholders as of great interest. Such an understanding would help determine the importance of Gulf County Canal inflows, groundwater seepage, etc., in determining the spatial and temporal patterns of salinity observed in the bay. Such information has been requested, for example, by FWC to help investigate measured changes in seagrass coverage. In addition, information about the fate of chemical contaminants (nitrogen, bacteria, etc.) entering the bay would be better understood. Task 1 through Task 6 are all aimed at answering questions related to bay hydrodynamics.

In recent years, the areas surrounding the bay have experienced considerable growth which has the potential for adverse impacts to water quality. Task 7 through Task 9 are directly related to nutrient, bacterial, and/or other chemical contaminants in St. Joseph Bay. Understanding the current condition and recent trends of water quality is of vital importance to successfully managing the health of St. Joseph Bay. An increased understanding of the water quality patterns in St. Joseph Bay will help identify restoration projects which may improve conditions in the bay. Table 3 proposes an estimated cost and the length of time anticipated to complete each task described in this Plan.

Table 3. Task and (Sub-Task) Duration Length and Anticipated Costs

Task	Description	Year 1 (Sub-Task)	Year 2 (Sub-Task)	Year 3 (Sub-Task)	Year 4 (Sub-Task)	Year 5 (Sub-Task)	Total
1	Continuous Discharge Monitoring Stations	$241,030	$240,000	$250,000	$260,000	$270,000	$1,246,250
2[1]	Hydrodynamic Modeling of St. Joseph Bay	$100,000 (1)	Unknown (2)	$300,000 (3)	-	-	$400,000
3	Additional Continuous Monitoring Stations	$200,000	$150,000	$155,000	$160,000	$165,000	830,000
4[2]	Surficial Aquifer	$50,000 (1)	$150,000	$50,000	$50,000	Unknown	$300,000
5	Sediment Transport - GCC	$100,000	-	-	-	-	$100,000
6[3]	Citizen Science Initiative	$20,000	-	-	-	-	$20,000
7[4]	Surface Water Quality Lab-Samples	$80,000	$85,000	$90,000	$95,000	$100,000	$150,000
8	Satellite Based WQ Mapping	$350,000	$100,000	$100,000	$100,000	$100,000	$750,000
9	Effect of Land Use Changes on WQ	$200,000	-	-	-	-	$200,000
Total							$3,546,250

[1]Costs in year 2 are unknown and dependent on the results of Sub-task 1 (year 1)
[2]Costs in year 5 are unknown and are for Sub-task 4 Measuring Groundwater Seepage
[3]Costs does not include the development of an on-line data submission platform.
[4]Cost Estimate based on Quarterly Sample Collection at up to 10 Locations

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