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 2022-2023
(July 1, 2022-June 30, 2023)

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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). The GCC and ICW were created in order 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 interconnected waterbodies which were previously hydrologically isolated or minimally connected. Within Gulf, Bay, and Franklin counties, Florida, the GCC and ICW connected St. Andrew Bay, St. Joseph Bay, Apalachicola Bay, and Lake Wimico.

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 modelling 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 connectivity to St. Joseph Bay. As a result, understanding the connectivity between St. Andrew Bay, St. Joseph Bay, and Apalachicola Bay is imperative to 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 result in changes in 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. Currently, the volume, direction, and seasonality of flows (both marine and freshwater) through Lake Wimico are 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 FY2019/2022. 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 Amendment 6, FY2022/2023, the scope of work was condensed to only include data collection efforts to address the question of hydrologic connections and flows through the Intracoastal Waterway. As part of Amendment 6 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 Amendment 6 to Grant AT003. Additional tasks and data which were collected as part of previous amendments during FY2019/2020, FY2020/2021, and/or FY2021/2022, but not under Amendment 6, are not included, but are described in previous annual reports. While Amendment 6 extended from 7/1/2022 through 6/30/2023 all data collected to date are included in the analysis.

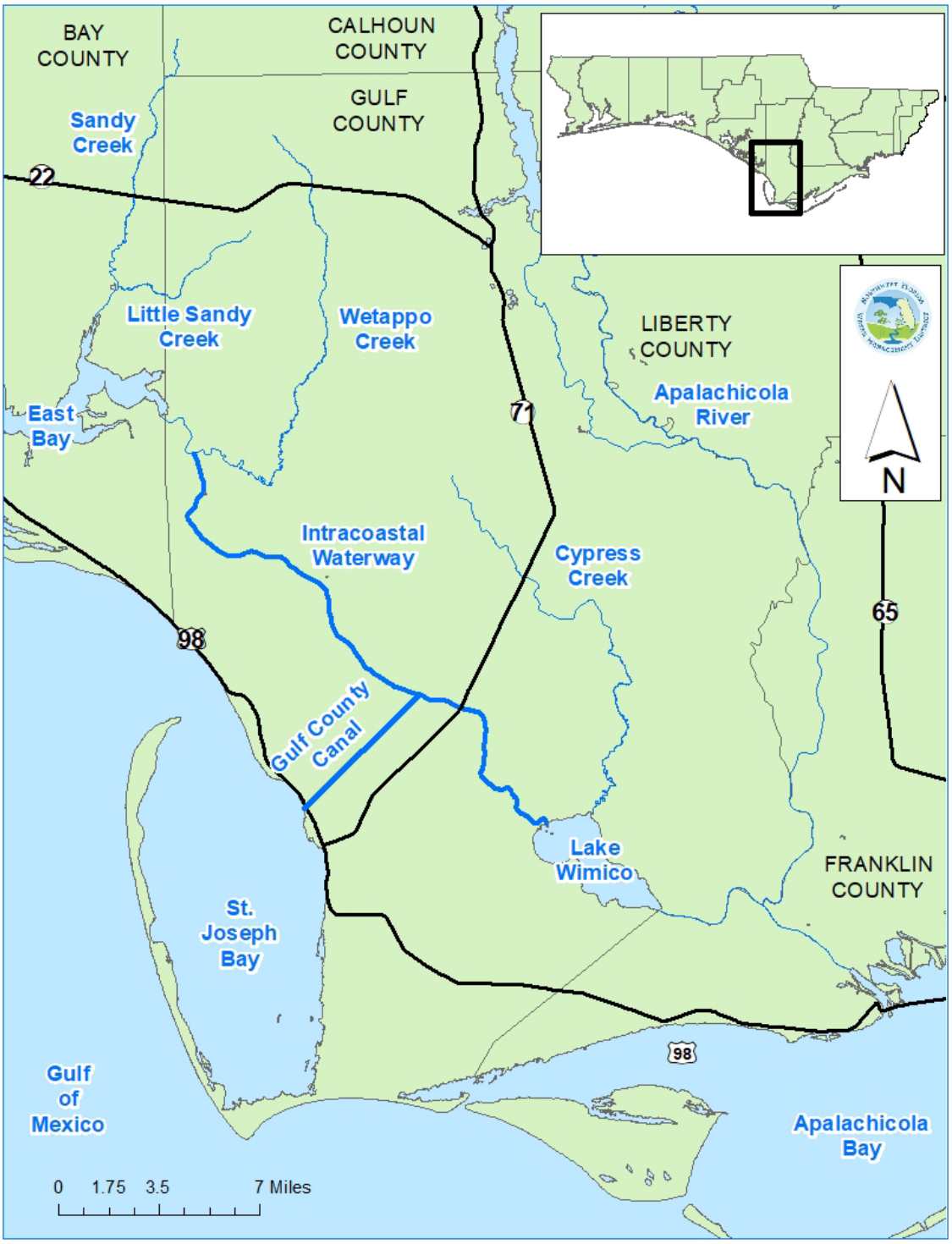

Figure 1: General Study Area for Grant AT003

2 Study Area

The study area for the project includes the Intracoastal Waterway and the Gulf County Canal in Gulf County, FL (Figure 1).

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).

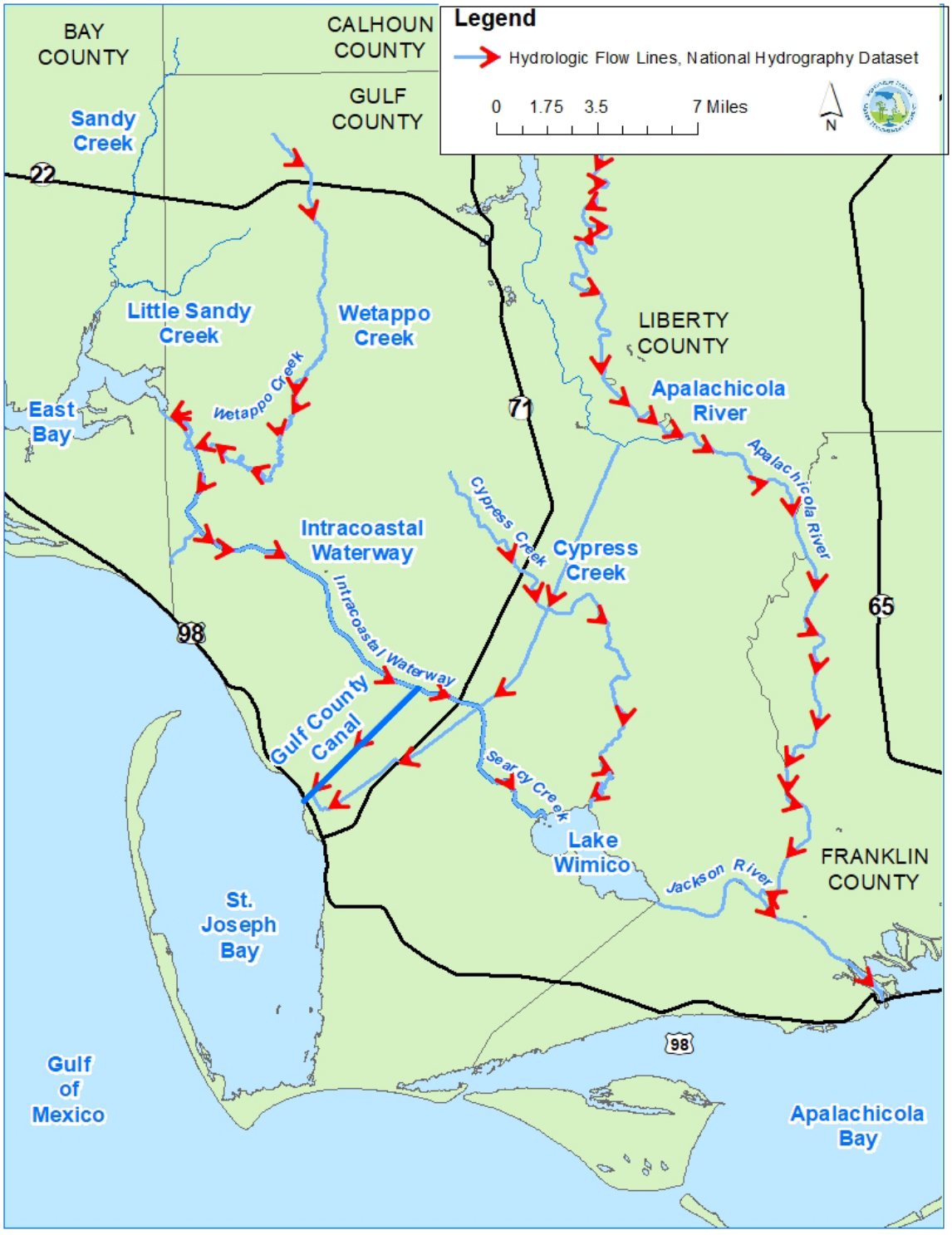

Figure 2: Flow Directions from the National Hydrography Dataset, Version 2

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.

Under a separate contract, the USGS was contracted to construct a third discharge monitoring station located in the Box R Wildlife Management Area on the Jackson River (Figure 3). This site was 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.

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.

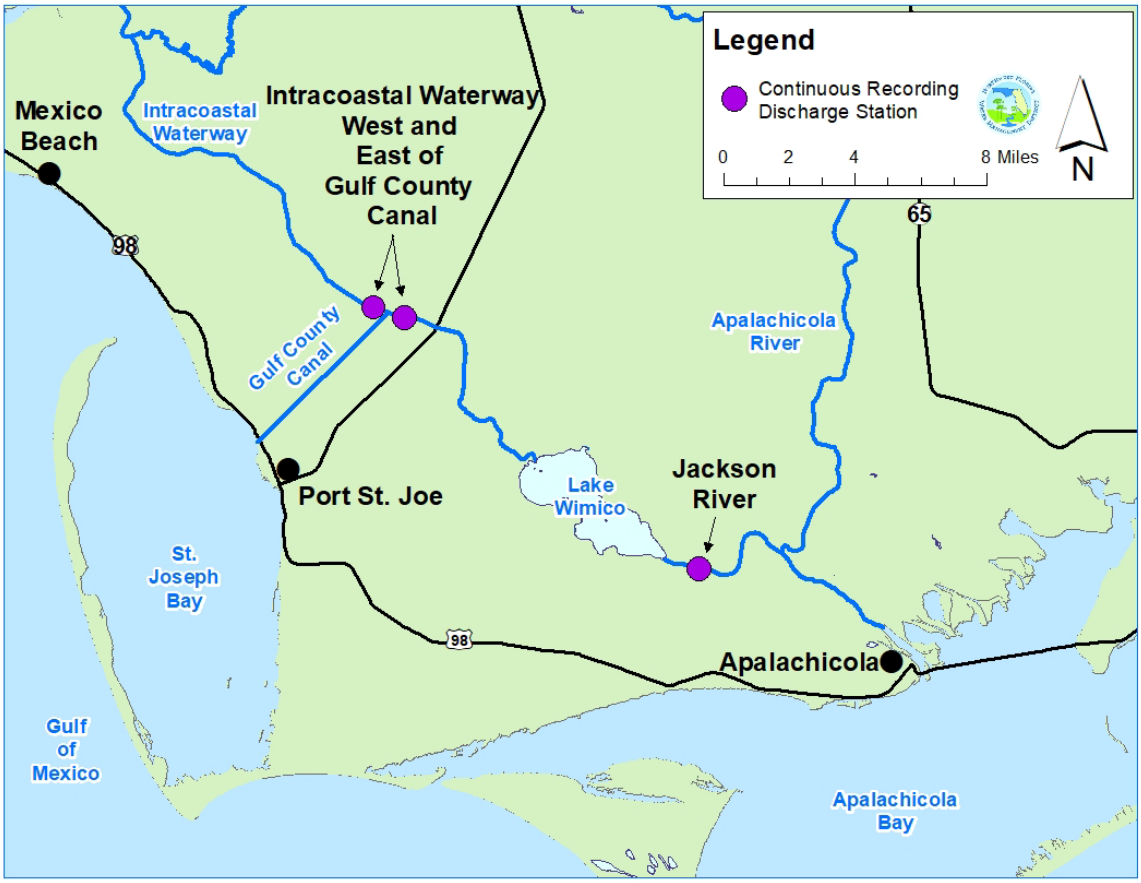

Figure 3: Location of Monitoring Stations

3.2.1 Continuous Station Discharge Results

Due to the complex hydrology of the system, index velocities ratings take an extraordinary amount of information and time to develop. As a result, the discharge data described in this report remains largely 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 874 daily estimates of tidally filtered discharge were available at Station 295323085151700 between 10/24/2020, and 6/30/2023 (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 901 cfs (median = 867 cfs) and ranged between -1,850 cfs (flowing towards the Gulf County Canal) and 3,350 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.

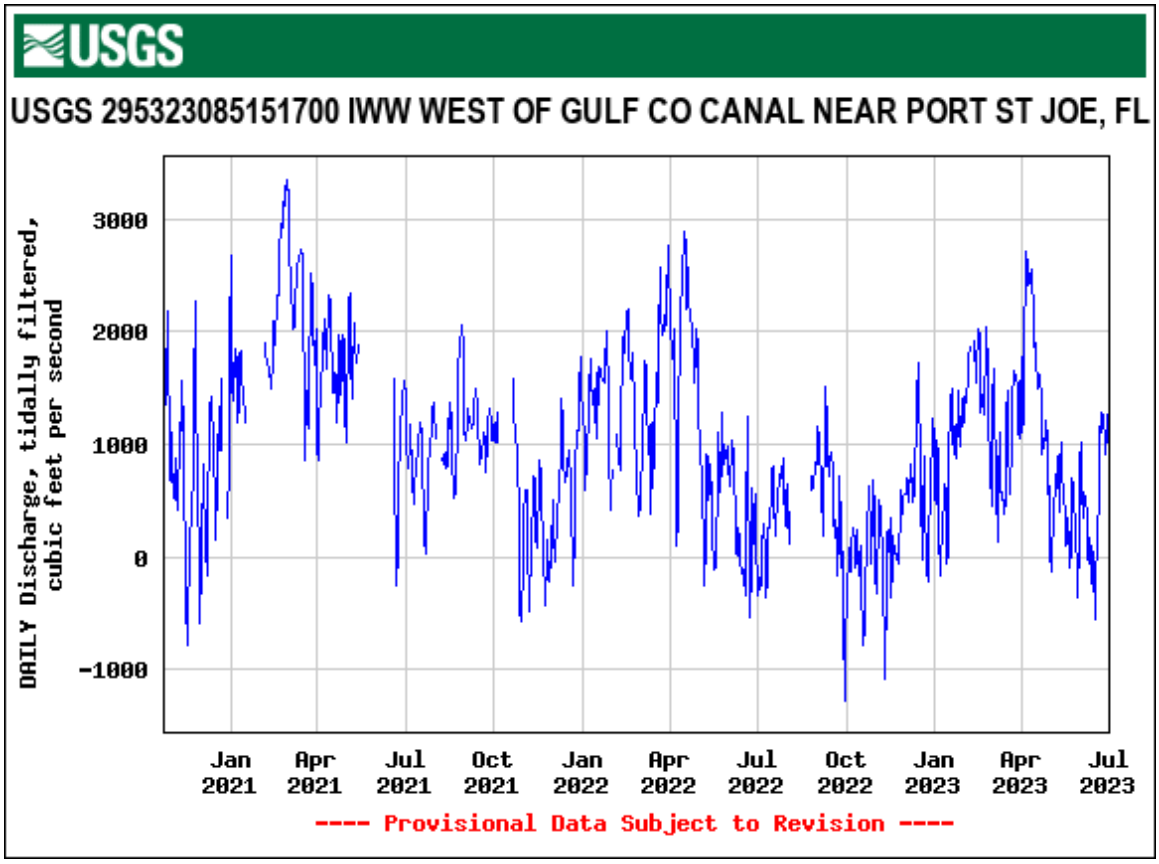

Figure 4: Flows Measured at USGS Station 295323085151700 (IWW WEST OF GULF CO CANAL NEAR PORT ST JOE, FL). Positive flows are towards St. Andrew Bay and negative flows are towards the Gulf County Canal/Lake Wimico.

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

A total of 742 daily estimates of tidally filtered discharge were available at Station 0298308085143700 between 9/25//2020, and 6/30/2023 (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 3,149 cfs (median = 2,835 cfs) and ranged between -2,280 cfs (flows towards Lake Wimico) and 8,990 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 736 days (>99 percent of the time) with available data.

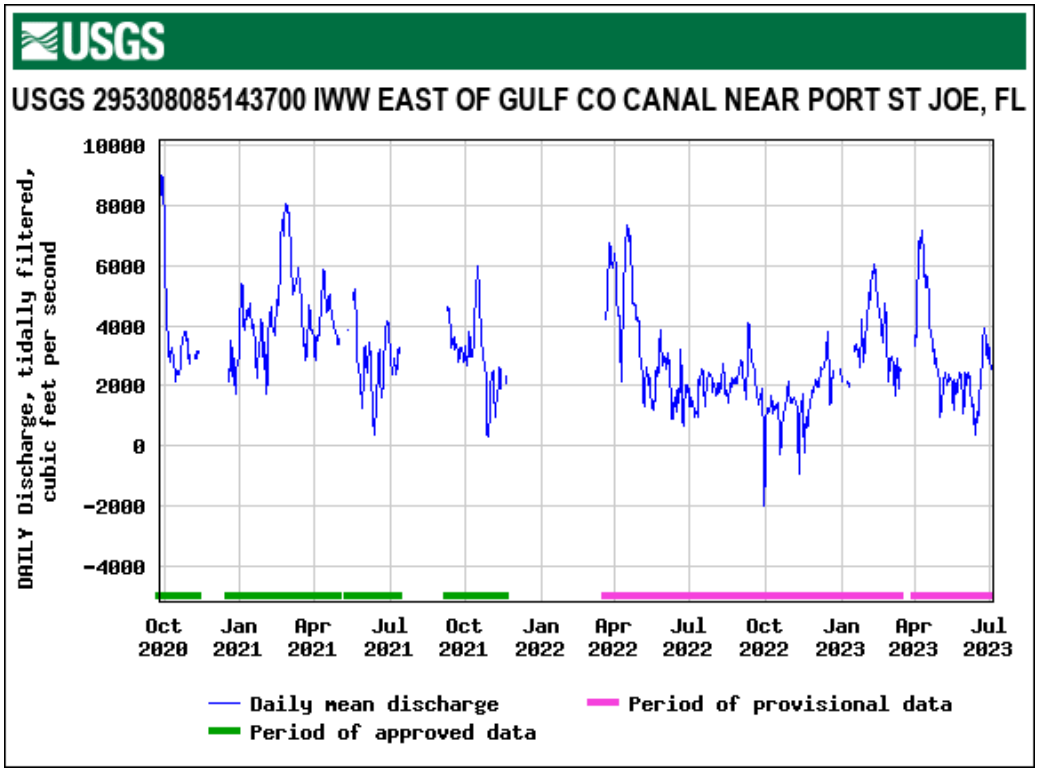

Figure 5: Flows Measured at USGS Station 0298308085143700 (IWW EAST OF GULF CO CANAL NEAR PORT ST JOE, FL. Positive flows indicate flows towards the Gulf County Canal and St. Andrew Bay.

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 619 concurrent daily, tidally filtered flow observations at USGS Station 295323085151700 and USGS Station 0298308085143700 were available between 10/24/2020, and 6/30/2023. Positive flows indicate water flowing into the Gulf County Canal, while negative flows represent flows from the Gulf County Canal into the ICW. During this time period, the average measured discharge was 2,219 cfs (median flow = 2036 cfs) of water flowing into the Gulf County Canal from the ICW (Figure 6). These flows ranged from -430 cfs to 5,370 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 18% 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, the extensive data gaps preclude any conclusions regarding the seasonality of flows.

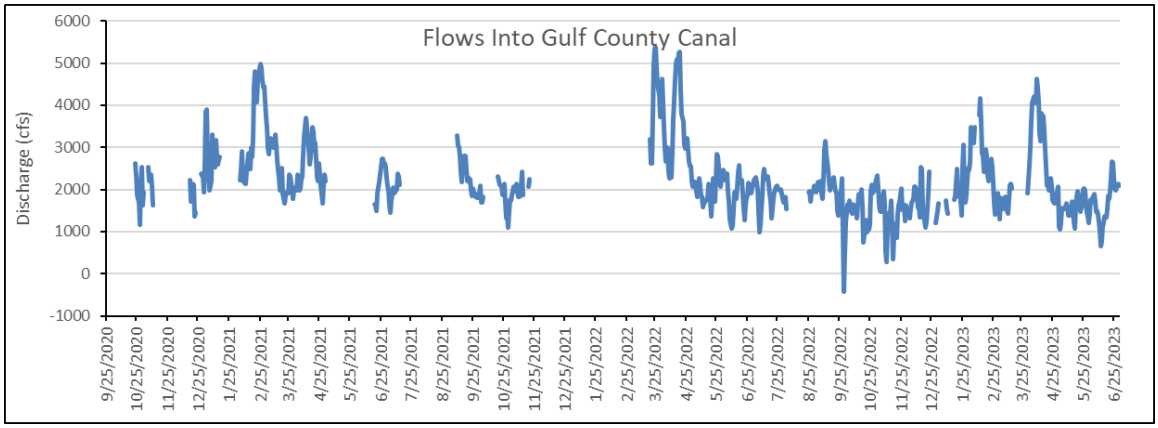

Figure 6: Discharge Entering or Leaving the Gulf County Canal via the Gulf Intracoastal Waterway. Positive flows are entering the Gulf County Canal, with water flowing towards St. Joseph Bay.

4 Water Quality Data – Continuous Discharge Stations

In addition to continuous discharge data, other parameters such as water level, 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)

All stage data 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 0295323085151700 averaged 0.97 ft NAVD 88, ranging between -1.5 ft NAVD 88 and 4.27 ft NAVD 88 (Figure 7). 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 0.17 mg/L, ranging between 0 mg/L and 0.56 mg/L (Figure 8). 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 10/18/2021 has been approved, while data collected after 10/18/2021 remains provisional and is subject to change following USGS QA/QC procedures. Temperature values at Station 0295323085151700 averaged 22.3°C on the surface and 23.0°C on the bottom, ranging between 8.3°C and 8.5°C (surface and bottom, respectively) and 34.5°C and 33.9°C (surface and bottom, respectively) (Figure 9). Higher water temperatures were observed during summer months and lower temperatures were observed during winter months, responding to climatic variations.

The pH data collected between 9/10/2020 and 10/18/2021 has been approved, while data collected after 10/18/2021 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 between 5.0 and 5.2 (surface and bottom, respectively) and 8.5 and 8.9 (surface and bottom, respectively)(Figure 10). 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 10/18/2021 has been approved, while data collected after 10/18/2021 remains provisional and is subject to change following USGS QA/QC procedures. The DO values at Station 0295323085151700 averaged 7.3 mg/L on the surface and 7.1 mg/L on the bottom, ranging between 2.5 mg/L and 1.0 mg/L (surface and bottom, respectively) and 11.4 mg/L and 11.4 mg/L (surface and bottom, respectively)(Figure 11). 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 10/18/2021 has been approved, while data collected after 10/18/2021 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0295323085151700 averaged 2990 microsiemens per centimeter (µS/cm) on the surface and 3903 µS/cm on the bottom, ranging between 66 µS/cm and 62 µS/cm (surface and bottom, respectively) and 44,100 µS/cm and 47,400 µS/cm (surface and bottom, respectively) (Figure 12). 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.

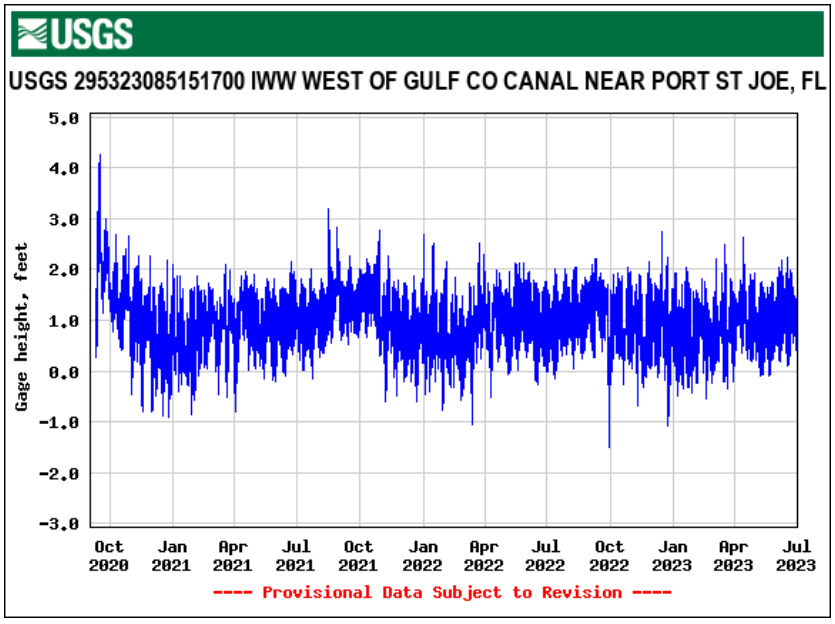

Figure 7: Stage (ft, NAVD 88) as measured at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

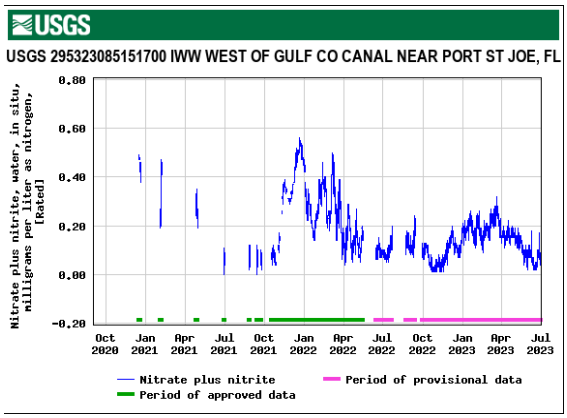

Figure 8: Nitrate plus nitrite (mg/L) as measured at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

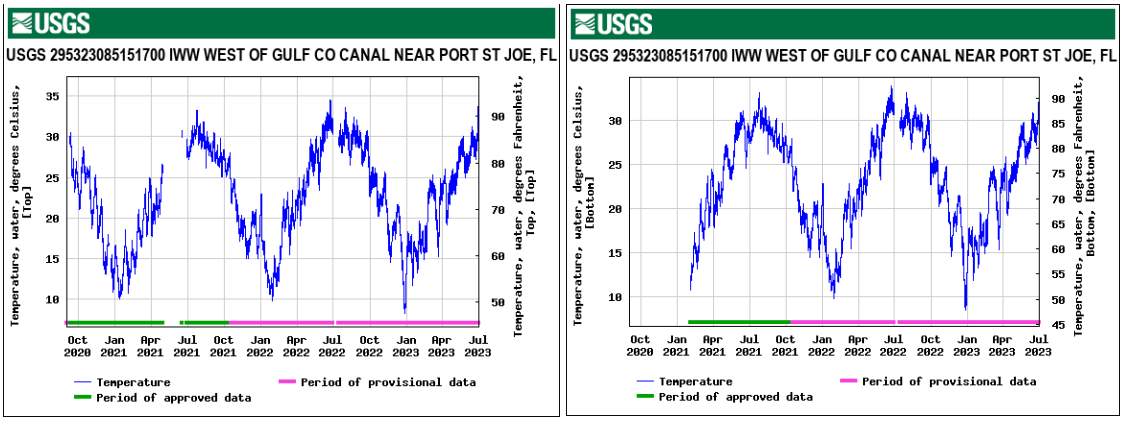

Figure 9: Temperature (°C) as measured on both the surface and bottom at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

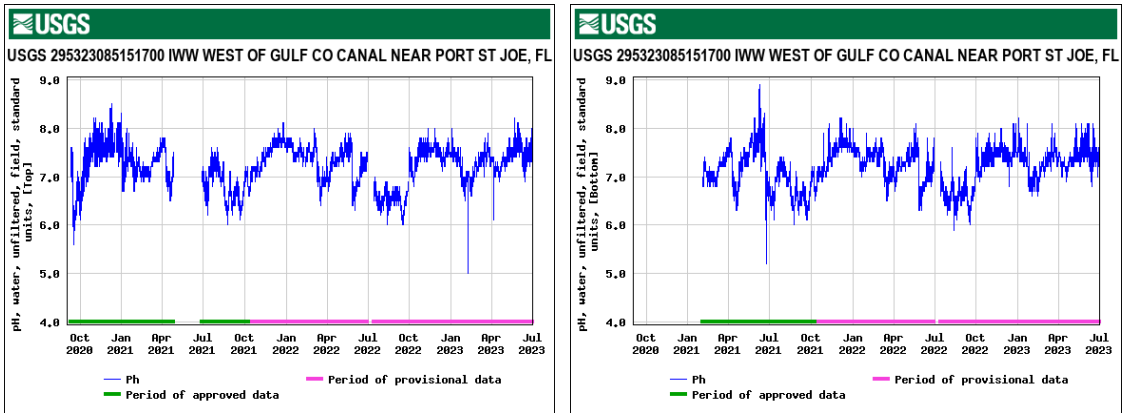

Figure 10: pH as measured on both the surface and bottom at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

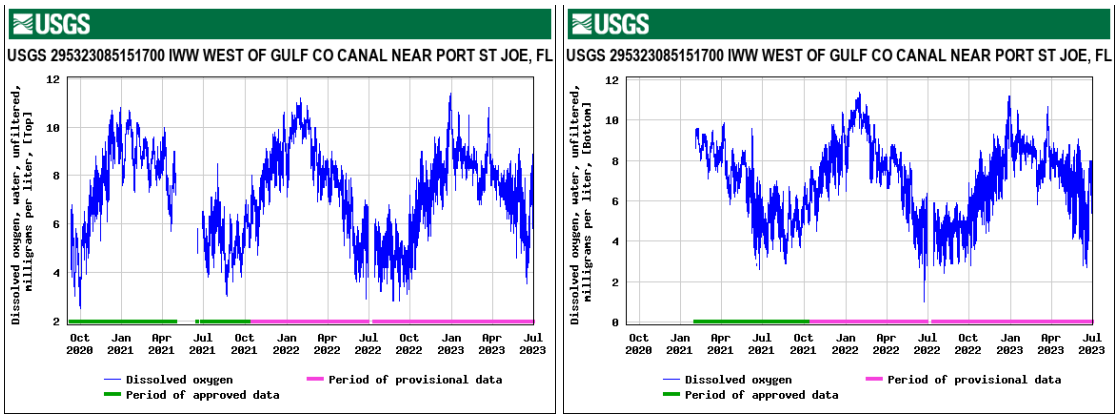

Figure 11: Dissolved oxygen (mg/L) as measured on both the surface and bottom at Station 0295323085151700 (IWW West of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

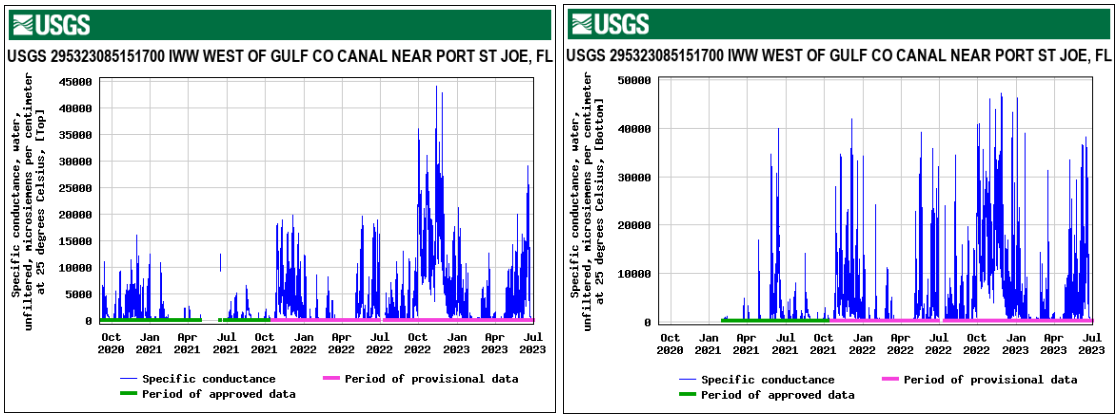

Figure 12: Specific conductance (µS/cm) as measured on both the surface and bottom at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

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

All stage data 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 0298308085143700 averaged 0.87 ft NAVD 88, ranging between -1.62 ft NAVD 88 and 4.27 ft NAVD 88 (Figure 13). 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 0.49 mg/L (Figure 14). 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 11/23/2021 has been approved, while data collected after 11/23/2021 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 23.6°C on the bottom, ranging between 7.8°C and 8.3°C (surface and bottom, respectively) and 34.5°C and 33.4°C (surface and bottom, respectively) (Figure 15). Higher water temperatures were observed during summer months and lower temperatures were observed during winter months, responding to climatic variations.

The pH data between 9/4/2020 and 11/23/2021 has been approved, while data collected after 11/23/2021 remains provisional and is subject to change following USGS QA/QC procedures. The pH values at Station 0298308085143700 averaged 7.3 on surface and 7.2 on the bottom, ranging between 6.0 and 6.1 (surface and bottom, respectively) and 9.1 and 9.0 (surface and bottom, respectively)(Figure 16). 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 11/23/2021 has been approved, while data collected after 11/23/2021 remains provisional and is subject to change following USGS QA/QC procedures. The DO values at Station 0298308085143700 averaged 7.1mg/L on the surface and 7.0 mg/L on the bottom, ranging between 2.6 mg/L and 2.6 mg/L (surface and bottom, respectively) and 11.2 mg/L and 11.6 mg/L (surface and bottom, respectively)(Figure 17). 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 11/23/2021 has been approved, while data collected after 11/23/2021 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0298308085143700 averaged 3,544 microsiemens per centimeter (µS/cm) on the surface and 5,108 µS/cm on the bottom, ranging between 66 µS/cm and 53 µS/cm (surface and bottom, respectively) and 45,200 µS/cm and 49,600 µS/cm (surface and bottom, respectively) (Figure 18). 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.

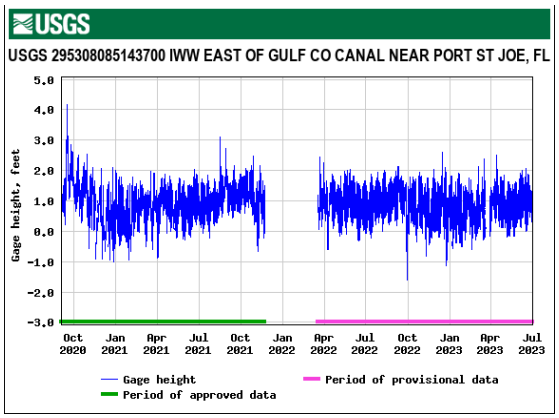

Figure 13: Stage (ft, NAVD 88) as measured at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

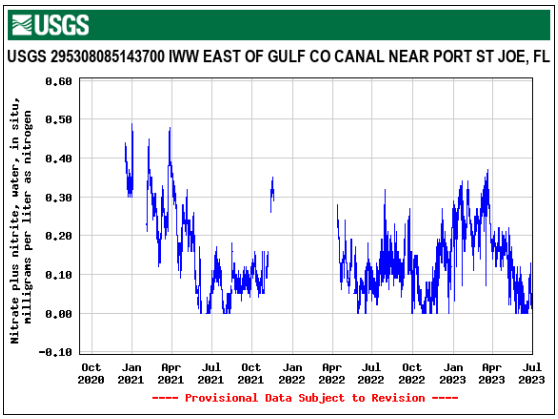

Figure 14: Nitrate plus nitrite (mg/L) as measured at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

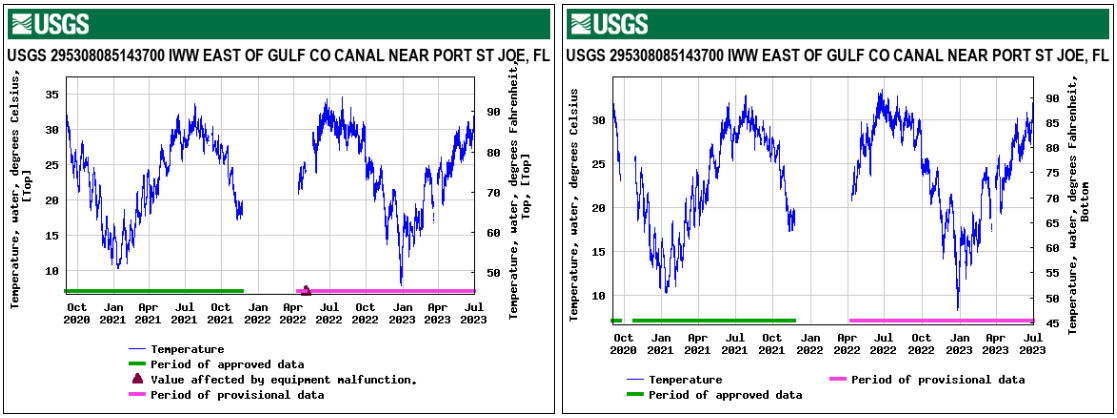

Figure 15: Temperature (°C) as measured on both the surface and bottom at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

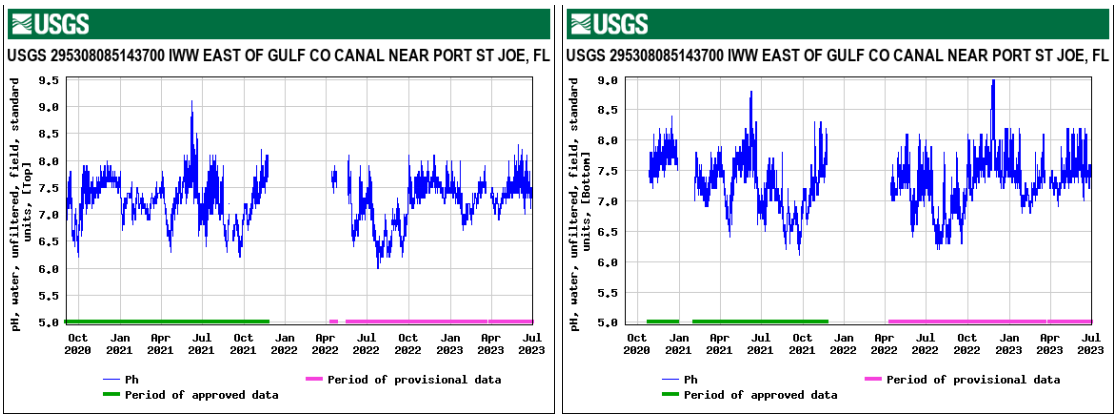

Figure 16: pH as measured on both the surface and bottom at 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

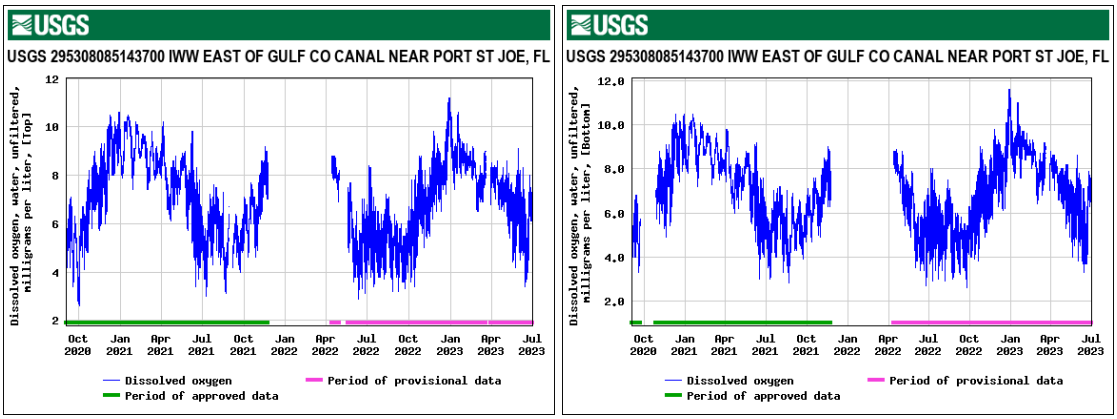

Figure 17: Dissolved oxygen (mg/L) as measured on both the surface and bottom at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

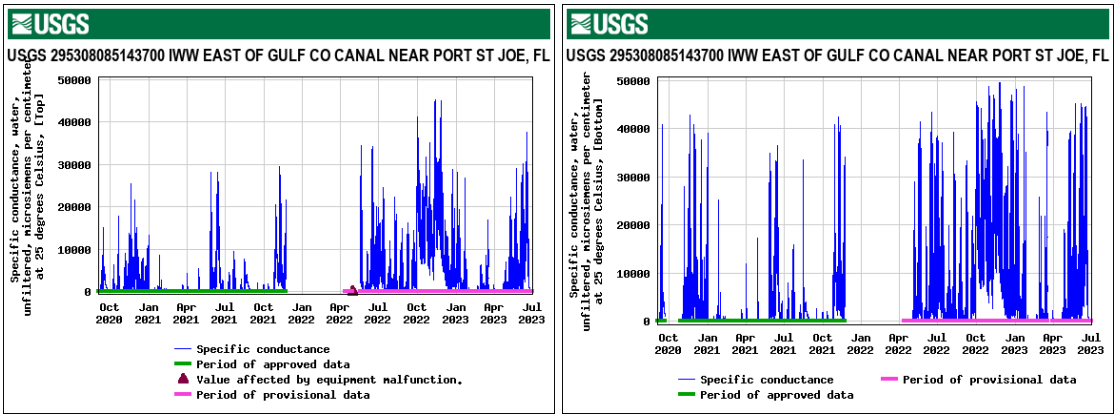

Figure 18: Specific conductance (µS/cm) as measured on both the surface and bottom at Station 0298308085143700 (IWW East of Gulf Co. Canal Near Port St. Joe, Fl.). Figure provided by the USGS.

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

Jackson River – Stage data collected between 9/15/2020 and 11/2/2022 has been approved by the USGS, however data reported after 11/2/2022 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 19). Water surface elevations at this location are highly variable throughout the year.

Temperature data between 9/15/2020 and 10/17/2022 has been approved, while data collected after 10/17/2022 remains provisional and is subject to change following USGS QA/QC procedures. Temperature values at Station 02329223 averaged 21.8°C, ranging between 5.1°C and 34.4°C (Figure 20). 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 10/17/2022 has been approved, while data collected after 10/17/2022 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 21). The pH was highly variable throughout the year at this location.

Dissolved oxygen (DO) data between 9/15/2020 and 10/17/2022 has been approved, while data collected after 10/17/2022 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 14.9 mg/L (Figure 22). 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 10/17/2022 has been approved, while data collected after 10/17/2022 remains provisional and is subject to change following USGS QA/QC procedures. Specific conductivity values at Station 0298308085143700 averaged 226 microsiemens per centimeter (µS/cm), ranging between 29 µS/cm and 28,700 µS/cm (Figure 23). A noticeable increase in specific conductivity occurred on 08/16/2021 associated with storm surge from Tropical Storm Fred. Additionally, specific conductivity showed increases between October and December 2022, presumably as a result of low Apalachicola River flows.

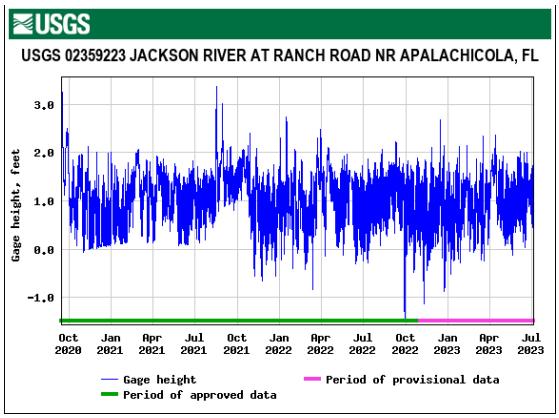

Figure 19: Stage (ft, NAVD 88) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.). Figure provided by the USGS.

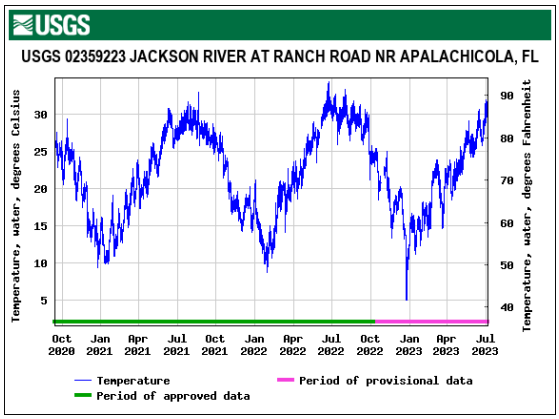

Figure 20: Temperature (°C) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.). Figure provided by the USGS.

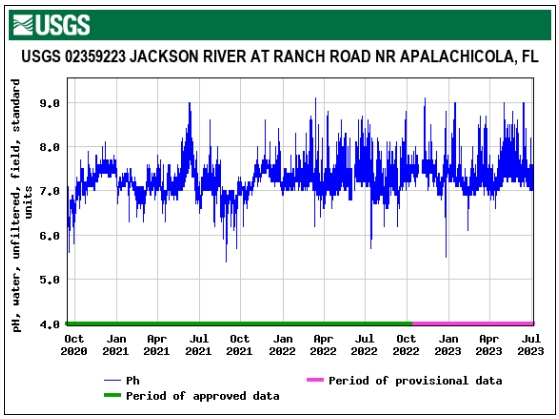

Figure 21: pH as measured at 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.). Figure provided by the USGS.

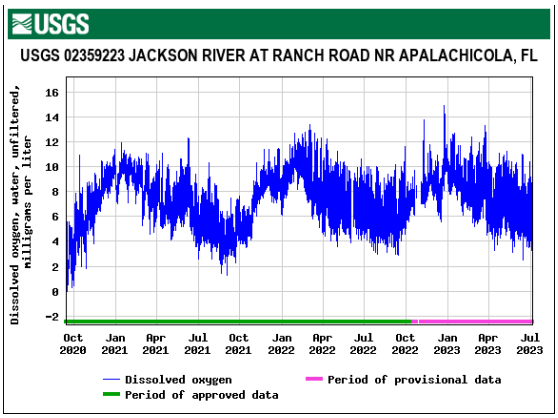

Figure 22: Dissolved oxygen (mg/L) as measured at Station 02359223 (Jackson River at Ranch Road Nr. Apalachicola, Fl.). Figure provided by the USGS.

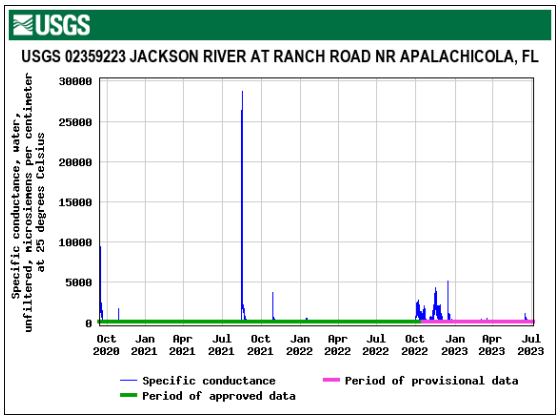

Figure 23: Specific conductance (µS/cm) as measured at Station 02359223 ((Jackson River at Ranch Road Nr. Apalachicola, Fl.). Figure provided by the USGS.

5 Conclusions and Data Synthesis

As a result of the data collected under Grant AT003, a considerable amount of insight into the hydrologic connectivity between St. Joseph Bay (Gulf County Canal) and the Gulf Intracoastal Waterway is now available. Results show that on the 619 days with available data during the study period (10/24/2020 through 6/30/2023), 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 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.

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 inland water levels are typically higher than coastal water levels (when tidal fluctuations are removed), water tends to flow from more inland areas into coastal bays. As a result, 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 Gulf County Canal.

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 potential restoration activities associated with St. Joe Bay. Examples of remaining questions include, but are not limited to:

1- What is the source of net flows into the Gulf County Canal? It is assumed that these flows are largely comprised of fresh water, however it is unknown if this water is arising from surface water flows from the numerous creeks and rivers located to the southeast of the Gulf County Canal, if this water is comprised of groundwater discharge into the waterways, or some combination of the two.
2- How are recent trends in sea level affecting the flow balance in the system? This is further complicated by regional differences in the rates of observed sea level rise.
3- Are the flows measured during the study period representative of those occurring historically, ie since the construction of the Gulf County Canal and Gulf Intracoastal Waterway, or have fundamental changes occurred in the area 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. Joe 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, 2024 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.

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