May 2021

City of Venice

Beach Outfall Monitoring Project



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Executive Summary

The City of Venice has multiple stormwater outfalls which discharge untreated or partially treated stormwater directly into the Gulf of Mexico, Roberts Bay, and the Intracoastal Waterway. These outfalls are located on the island portion of the City of Venice and are connected to an urban stormwater system that was installed in the 1920s. The recent red tide algal blooms generated increased scrutiny of the quality of runoff from these outfalls, and the City began an aggressive effort to monitor these outfalls, estimate pollutant loads, and develop best management practices (BMPs) to reduce pollutant loading.

Under a previous project for the City, pollutant loads were estimated for 28 outfalls, and preliminary water quality monitoring was conducted for 16 primary outfalls. Based upon the results of this project, several of the larger drainage basins were identified for consideration of additional discharge and storm event water quality monitoring. The purpose of this Venice Beach Stormwater Outfall Monitoring Project was to collect field data and perform analyses necessary to document the discharge, water quality, and pollutant loading of five priority drainage basins.

This outfall study included monitoring and analyzing continuous rainfall, water stage and flow, and water quality over a six-month period to evaluate five major outfalls. The monitoring program included monitoring storm flow from June 1, 2020 to December 8, 2020. Monitoring was conducted at Outfalls 2, 5, 8, 10, and 1400, with all but Outfall 1400 discharging directly to the Gulf of Mexico. The drainage basins for these outfalls ranged from 75.7 to 429.5 acres.

Data collection included continuous water stage/discharge and rainfall and water quality monitoring during six to ten storm flow monitoring events at each outfall. An ISCO Avalanche Composite Sampler was used to collect a flow-weighted composite water quality sample that was analyzed for ammonia nitrogen, nitrate and nitrite-nitrogen, total Kjeldahl nitrogen, organic nitrogen, total nitrogen, orthophosphorus, total phosphorus, total suspended solids, and turbidity. A data sonde was used to measure the pH, specific conductivity, water temperature, and dissolved oxygen levels at each station concurrent with water quality sample collection. Grab samples for fecal coliform and -enterococci were also collected for analysis upon sample retrieval.

The total rainfall all five sites ranged from 27.89 to 39.01 inches, compared to a nearby gage that registered 42.21 inches during the study period. The average annual rainfall for the area is approximately 53 inches based on data collected by the Southwest Florida Water Management District (SWFWMD). A total of 15 storm events were monitored with rainfall ranging in size from 0.2 inches to 5.0 inches for the event. The stage, discharge, and salinity data indicate that Outfalls 5, 8, and 1400 were influenced to varying degrees by tidal waters. The discharge at each outfall varied for a number of reasons including drainage basin size, tidal influence, and

impacts from clogged outfall pipes. The observed discharge volumes approximated the modeled discharge, except at Outfall 2, where additional discharge was recorded, presumably due to the lift station at the structure pumping into the adjacent treatment swale and possible secondary sources of water, and at Outfall 10, where the pipe was often clogged.

The observed event mean concentrations (EMCs) for the various parameters were compared to Florida water quality criteria and the model provided EMC values. All water quality parameters, except fecal coliform and enterococci bacteria, were within the state water quality criteria. The storm event sampling program does not follow the specific sampling regime used by Florida to determine compliance with the criteria, but elevated bacteria levels were documented at all sites. Except for total phosphorus, most parameters exhibited lower observed EMCs than those of the model. A nitrogen limited nutrient balance generally appears to explain the lower nitrogen and higher phosphorus EMCs.

Discharge data were combined with the EMCs to determine the pollutant load by storm event and for the study period, and these loads were compared to the pollutant loads anticipated by the model. The observed and modeled pollutant loads, as expected, were generally consistent with the size of the drainage basin. As explained above, flow volumes at Outfall 2 may have been exaggerated by lift station pumping and secondary sources of water, which would contribute to pollutant load estimates that may not reflect direct stormwater runoff representative of the basin area. Because the outfall pipe was often clogged at Outfall 10, it had a disproportionately lower loading of most parameters. In line with the generally lower observed EMCs, the observed pollutant loadings were generally less than those predicted through modeling.

The generally lower observed loadings, compared with the model estimates, likely reflect unique aspects of the stormwater management and conveyance systems in each drainage basin. These data indicate there are opportunities to implement stormwater best management practice projects to reduce discharge volumes and pollutant loads that will improve the receiving waters. A series of recommendations are provided to reduce the discharge to the Gulf of Mexico and to improve the quality of the discharged water.

1.0 Introduction

The City of Venice (City) has multiple stormwater outfalls which generally discharge untreated storm water directly into the Gulf of Mexico, Roberts Bay and the Intracoastal Waterway. These outfalls are located on the Island of Venice and are connected to an urban stormwater system that was installed in the 1920's. The persistent red tide blooms off the southwest coast of Florida, that ended in 2018, generated increased scrutiny of the quality of runoff from these outfalls. The City has embarked on an aggressive effort to monitor their outfalls, identify pollutant loads and priority outfalls, and develop best management practices (BMPs) to reduce loading from these priority outfalls.

In 2019, Taylor Engineering, Inc. (Taylor) and Vanasse Hangen Brustlin, Inc. (VHB) completed an initial project as part of the City's longer-term management strategy which involved estimating pollutant loads for 28 outfalls and conducting initial monitoring for 16 primary outfalls. The outfall pollutant loads were estimated using a hybrid approach incorporating components of the Sarasota County County-Wide Non-Point Source Pollutant Loading Model, prepared by Jones, Edmunds, & Associates, Inc. in August 2005 and more recent methodology established by the Approach to Assessing Level-of-Service, Surface Water Resources, and Best Management Practice Alternatives for Watersheds in Citrus County, Florida, prepared by Jones, Edmunds, & Associates, Inc. in July 2017.

The objective of the pollutant load modeling was to evaluate direct runoff loading to 28 City-identified stormwater outfalls. Taylor estimated pollutant loads with the Spatially Integrated Model for Pollutant Loading Estimates at a seasonal time scale (SIMPLE-Seasonal) that runs with ArcGIS 10.5. VHB collected and analyzed water quality samples following rainfall events at the priority outfalls to provide further information on the pollutant loading. Based upon the modeling and sampling results, critical outfalls were prioritized for potential BMPs.

Based upon the results of this project, six of the larger drainage basins were identified for future consideration of additional discharge and storm event water quality monitoring. The purpose of the monitoring for this project was to collect field data and perform analyses necessary to document the discharge, water quality, and pollutant loading of five priority drainage basins.

2.0 Methodology

Six basins/stormwater outfalls (Outfalls 2, 5, 8, 10, 14 and 17) were identified as potential locations for the intensive monitoring effort. A site inspection was conducted with City staff on April 22, 2020 to determine which five of the six potential outfalls would be monitored, and the preferred sampling location and equipment based upon the site conditions, access, monitoring needs and functionality of the proposed equipment. The conclusions of that inspection and the final station selection and instrumentation were summarized in an April 23, 2020 Technical Memorandum. A copy of this memorandum that recommended Outfalls 2, 5, 8, 10, and 1400 for monitoring is attached as **Appendix A**. The monitoring equipment was installed and tested in May with continuous monitoring generally beginning on June 1, 2020 and ending December 8, 2020. Field data collection was performed by VHB and laboratory analyses were performed by Benchmark EnviroAnalytical, Inc. Provided below are specific details of the sampling program performed for the City of Venice project.

Station Locations

The locations of the five priority drainage basins/outfalls are depicted in **Figure 1**. Outfall 2 is located on the Gulf of Mexico and serves as the discharge point for a 108.6 acre basin. Several potential sampling locations for this outfall were field reviewed with the desire to locate a site where all runoff can be captured prior to the diversion to the pumping facility. The main stormwater pipe is accessible by a manhole in the center of Alhambra Road that captures runoff from the final curb inlet and the entire upstream basin. The velocity meter and stormwater sample intake tubing were routed to the manhole location through the curb inlet approximately 10 feet away. The equipment was installed in the right of way just east of the curb inlet (**Figure 2**).

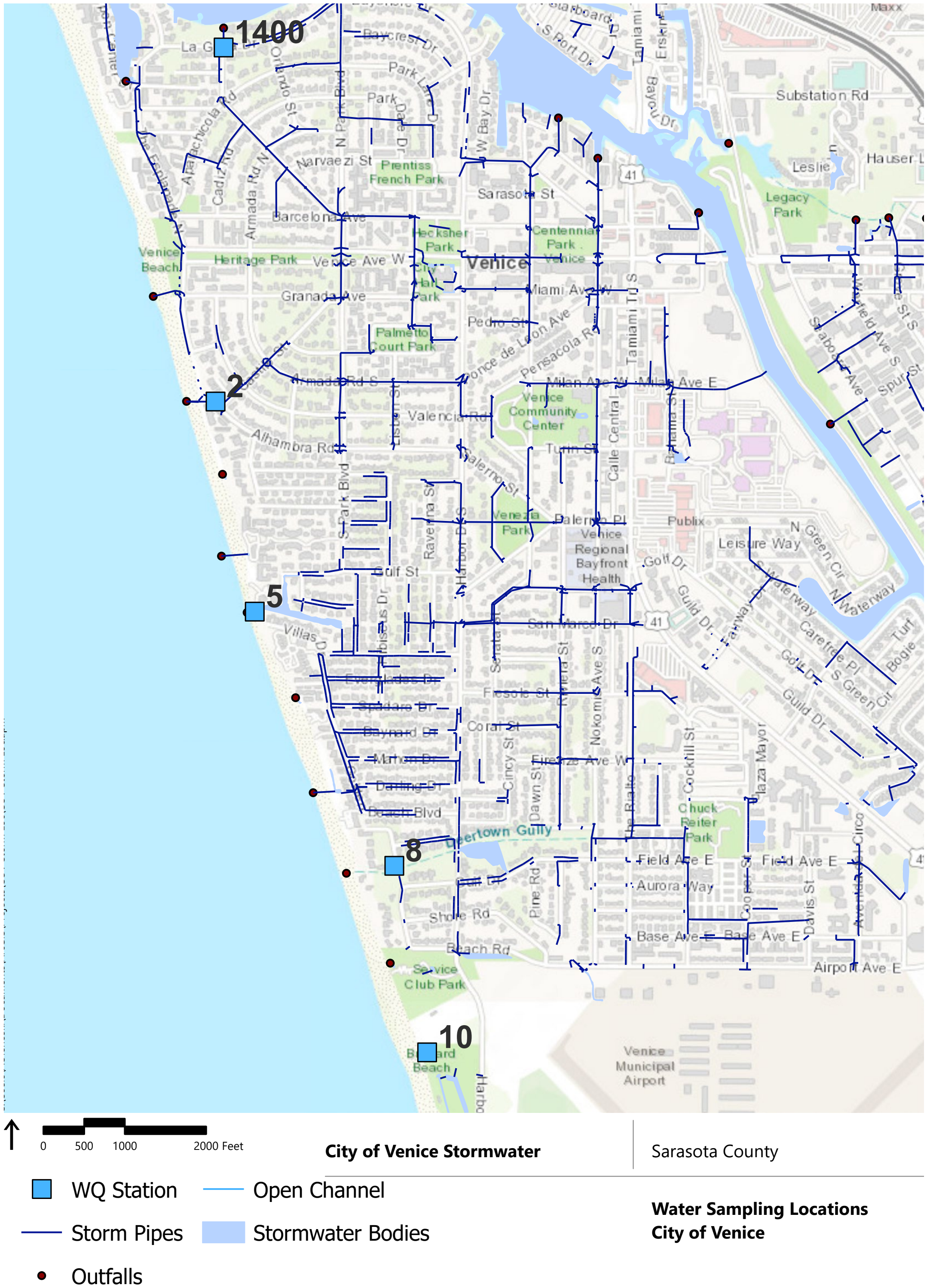
The sampling location for the Flamingo Ditch (Outfall 5) is about 150' landward of the beach in an area where the ditch cross-section appears to be stable. The channel is about 40' wide here and the equipment is located on the south bank (**Figure 3**).

Figure 4 depicts the sampling equipment associated with Outfall 8 on Deertown Gully. The monitring location is where Sunset Drive terminates at the ditch and the sampling equipment was installed in the right of way at the end of Sunset Drive.

The control structure for Outfall 10 is located about 225' landward of the beach outfall. There is a 24" outfall pipe from the outfall structure to the beach and the pipe at the beach is intermittently blocked. The sampling equipment was located adjacent to the control structure on a higher ridge (**Figure 5**).

Figure 6 depicts the equipment location associated with Outfalls 1400 which discharges north into Roberts Bay. The sampling location for Outfall 1400 was in the large culvert just downstream of the open ditch parallel to Osprey Street. The equipment shelter was installed in the right of way on the south side of the La Guna Drive.

Figure 1: City of Venice Outfall Monitoring Stations



The 5 basins/outfalls chosen for additional monitoring from the 16 primary outfalls previously studied.

Figure 2: Equipment set up at Site 2 (Outfall 2)

Site 2 was located just past the intersection of Alhambra Rd and Castille St, where Alhambra dead ends into a beach access.

Figure 3: Equipment set up at Site 5 (Outfall 5)

Site 5 was installed along the banks of the Flamingo Ditch northwest of where Villa Drive dead ends into a beach access, and due north of the gazebo.

Figure 4: Equipment set up at Site 8 (Outfall 8)

Site 8 was installed north of the stream and just south of where Sunset Dr dead ended into the channel.

Figure 5: Equipment set up at Site 10 (Outfall 10)

Site 10 was installed north of the Venice Beach parking lot adjacent the swale with the box culvert, and right in front of the tree line.

Figure 6: Equipment set up at Site 1400 (Outfall 1400)

Site 1400 was located on the Southeast side of the intersection of La Guna Drive and Osprey Street, where the ditch flows under La Guna Drive.

Field Instrumentation

The installation of the onsite monitoring system equipment occurred during May 2020. A listing of the proposed equipment is provided below in **Table 1**. All sites were instrumented in the same manner.

Table 1: Summary of Monitoring Equipment

Data Type	Site (s)	Equipment
Velocity	All	750 Module and Standard Area Velocity Sensor
Automatic Water Sampling	All	ISCO Avalanche Composite Sampler with 10 liter (2.6 gallon) bottle
Rain Gauge	All	674 Rain Gauge (Tipping Bucket)
Modem	Sites 2 & 1400	6712ci Modem Module

Shelter

Wooden platforms were pre-constructed and delivered to the most site and anchored adjacent to the bank, culvert or control structure. Aluminum/fiberglass shelters were bolted to the platform to house and secure the sampling equipment. The shelter was bolted to the railing at Site 1400.

Stage/velocity Equipment

The velocity at all five stations was measured with integrated area velocity or flow meters installed within the culvert, channel or adjacent to the control structures. The ISCO 750 Module was used since it directly communicates with the autosampler and can measure positive and negative discharge. Since the discharge serves to allow for a flow- weighted composite sample, it was important to discriminate between negative and positive discharge so that sampling only occurs for water discharging from these outfalls.

The velocity sensors were located in the center of the culverts for Outfalls 2, 10 and 1400. The Outfalls 5 and 8 velocity sensors were located within the center of the flow channel. The velocity meters are directly wired into the ISCO automatic samplers described below.

Rainfall

Rainfall data were collected with an ISCO 674 Tipping Bucket (0.01" tip) Rain Gauge. A rain gauge was installed at each site and wired into the ISCO autosampler. Rainfall served as the initial trigger to begin sampling.

Automatic Sampler

An ISCO Avalanche Composite Sampler was installed at each of the five stations for the collection of storm-event water quality composite samples. These refrigerated units were placed inside the shelter. Each sampler will be linked to a deep cycle battery(s) with a solar panel to keep it in a constant state of charge. The solar panel will be affixed to the top of a pole adjacent to each shelter. The refrigeration was programmed to activate upon initiation of sample collection and to keep the samples chilled at or below EPA recommended 4 degrees Celsius until VHB retrieved the sample. The vinyl suction sample tubing was placed within a protective pipe originating from the shelter to allow for sample collection near the bottom of the water within the channel or culvert. The automatic samplers were integrated with the velocity meters in order to be activated and regulated by the area discharge relationship for collection of a flow-weighted composite sample. Two of the automatic samplers were equipped with a modem that sent a text message to VHB when the samplers were activated.

Shelter

Wooden platforms were pre-constructed and delivered to the most site and anchored adjacent to the bank, culvert or control structure. Aluminum/fiberglass shelters were bolted to the platform to house and secure the sampling equipment. The shelter was bolted to the railing at Site 1400.

Data Collection

Velocity

In order to accurately program the automatic samplers to collect a flow-weighted composite sample, it was necessary to have area discharge relationships set for each of the five sites. To define this area discharge relationship, the culvert dimensions or channel cross-section were used to determine the flow area based upon stage. The ISCOs are programmed with this information for round culverts and area can easily be calculated for box culverts.

The velocity meters were initially set to record discharge at 15-minute increments, but the frequency was increased to 5-minutes intervals because of the flashy nature of the discharge. The velocity data were downloaded during weekly site visits and reviewed to look for potential problems and corrective measures required. They were inspected, cleaned of any debris, recalibrated and maintained monthly or as necessary to keep them properly functioning.

Rainfall

Rainfall data were collected continuously at all sites and were used to trigger the sampling events. The rainfall data were downloaded weekly and gauges were inspected every month, cleaned as required, calibrated and maintained throughout the life of the project.

Automatic Samplers

The storm event sampling focused on discrete rainfall events greater than 0.2 inches. The automatic samplers were programmed to collect flow proportionate samples based upon calculated discharge from the velocity meters and discharge volumes were refined throughout the project to ensure flow-weighted samples were captured at each station.

The automatic samplers were integrated with the rain gauges in order to be activated after 0.2 inches of rainfall. Once activated by rainfall, the samplers were programmed to collect a flow-weighted composite sample during times of positive discharge. A subsample of 100 ml was collected after each predetermined volume of positive discharge took place. The discharge volume varied by site location based upon their upstream watershed.

The storm flow discharge and area discharge relationships at each station were reviewed to derive the sampling program for each composite sampler. The composite storm event sample consisted of equal size subsamples (100 ml) collected at variable frequency, based upon flow. The subsamples were composited into a 10-liter (2.6 gallon) jar with a disposable ISCO ProPac two-gallon sample bag. The collection of the first subsample activated the refrigeration system to properly chill the sample until collection.

Storm event samples were typically collected within 24 hours of sample initiation and were always collected within 24 hours of sampling completion. Each sample was preserved as required by the Florida Department of Environmental Protection (FDEP) Standard Operating Procedures (SOPs) and placed in a cooler with ice. Filtering of the samples was conducted by the laboratory. The cooler with the samples was delivered promptly to the laboratory, with appropriate chain of custody forms completed.

A YSI or comparable data sonde was used to measure the pH, specific conductivity, salinity, water temperature and dissolved oxygen levels at each station concurrent with sample retrieval. The data sonde measurements were conducted in the approximate center of the discharge flow. Field readings were recorded on electronic field data sheets and general field observations were noted.

In addition to the sample analyses associated with the composite sample, VHB collected a grab sample for enterococci and fecal coliform bacteria at each site for each event. FDEP's SOPs require that grab samples be collected for these parameters because these analyte's characteristics can change significantly with time from biological of physical actions associated with the storage or compositing process. If standing water was absent, then the bacteria sample was taken from the composite sample (note that bacteria analysis of the composite sample may not lead to consistent results).

The automatic samplers were inspected and cleaned after sample collection. The samplers were designed to purge one to two volumes of sample through the tube prior to collection of the sample. The end of the sample tubing was inspected and cleaned as necessary to remove any debris or buildup. The ProPac sample bag was replaced following the collection of each sampling event.

Laboratory Analyses

Each composite storm event sample was analyzed for ammonia nitrogen, nitrite and nitrate nitrogen, total kjeldahl nitrogen, total nitrogen, orthophosphorus, total phosphorus, total suspended solids, and turbidity, and the grab samples were analyzed for enterococci and fecal coliform bacteria. All laboratory analyses were conducted by Benchmark EnviroAnalytical, Inc. (BEI), a NELAC certified laboratory. **Table 2** summarizes the laboratory analytical methods and Method Detection Limits (MDLs) for the storm event sample analyses. BEI's Quality Assurance Plan was provided separately as an electronic appendix.

The laboratory entered the analysis results into an Excel spreadsheet and provided it with a lab report to VHB's QA/QC officer. The QA/QC officer reviewed the data results, chain of custody form, sample hold times, and laboratory precision and accuracy data to assure the validity of the data. Field and equipment blanks, as well as duplicate samples, were collected pursuant to FDEP SOPs.

Table 2: Analytical Methods and Detection Limits of Benchmark EnviroAnalytical, Inc.'s Laboratory Analyses for the City of Venice Stormwater Project

Parameter	Method Reference	Analytical Method Detection Limits (MDLs)
Entercocci	EPA 1600	10/100 ml
Fecal Coliform Bacteria	APHA 9222 D	10/100 ml
Ammonia Nitrogen	EPA 350.1	0.008 mg/L
Nitrate + Nitrite Nitrogen	SYSTEA EASY	0.006 mg/L
Total Kjeldahl Nitrogen	EPA 351.2	0.05 mg/L
Total Nitrogen	EPA 351+ SYSTEA	0.05 mg/L
Orthophosphorus	EPA 365.3	0.002 mg/L
Total Phosphorus	EPA 365.3	0.008 mg/L
Total Suspended Solids (TSS)	APHA 2540 D	0.570 mg/L
Turbidity	EPA 180.1	0.11 NTU

APHA - American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1992. Standard Methods for the Examination of Water and Wastewater, 22nd Edition. American Public Health Association.

EPA - U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Wastes, EPA - 600/4-79-020, National Environmental Research Center, Cincinnati, Ohio.

3.0 Results

Hydrology

Hydrologic data were collected at each monitoring site over a period of 189 days during the evaluation period from June 1 through December 7, 2020. Recorded data were occasionally impacted by electrical failure and equipment problems, as well as the tides. The following sections present the results of rainfall, stage, and flow data collected for the entire evaluation period and during the 15 sampled storm events.

Rainfall

Rainfall data were collected continuously during the study using a tipping bucket rain gauge (with a 0.01 inch resolution) located at all outfalls. The rainfall data from the District's ROMPTR4 rain gauge (Site ID 25600), located 1.2 miles south of Outfall 10 were compared to the on-site data. **Table 3** depicts the observed monthly rainfall from all sites during the sampling program in comparison to the ROMPTR4 rain gauge. There were some months where electrical or equipment failures prevented collection of data for a portion of the month. The raw and daily rainfall data collected at each outfall are provided as an electronic appendix.

A total of 33.42 inches of rainfall (averaged across all sampling outfalls) were recorded during the 189 days of the evaluation period. In general, the total rainfall volume at each outfall was comparable. The highest average rainfall occurred at Outfall 5 (39.01 inches), while the lowest overall rainfall occurred at Outfall 10 (27.89 inches). The totals were less than the District gauge for most months, particularly during July and November when the District gauge totals were consistently higher. Slightly higher amounts of rainfall occurred in the first months of the study (June, July, and August) than the later months, which is expected since the latter months of the study were during the months which typically experience lesser rainfall totals.

Rainfall amounts were calculated for each sampling event defined from the point when rainfall accumulated to 0.2" within a 24-hour period through the completion of sample collection.

Rainfall for the sampled storm events ranged from an average across all outfalls sampled of 0.14 inches during the July 7 event to 4.61 inches during the November 11 sampling event. The average rainfall volume across all storm events for the period of monitoring was 0.99 inches. The total rainfall volumes for each storm flow sampling event are presented in **Table 4**. It should be noted that two of the storm events exceeded FDEP's recommended maximum of 1.5 inches of rainfall.

Table 3: Monthly Rainfall Recorded at Each Outfall and the SWFWMD Reference Gauge from June 1 through December 7, 2020.

Month	Overall	Outfall					
		2	5	8	10	1400	ROMPTR4
June 2020	7.92	7.73	8.44	7.58	0.76	0.61	7.47
July 2020	7.62	6.99	8.07	7.98	7.42	8.12	9.86
August 2020	5.99	6.29	6.92	5.57	5.19	6.63	4.78
September 2020	5.01	2.84	5.33	6.62	5.25	5.45	8.58
October 2020	2.91	2.77	3.07	2.93	2.85	2.90	3.29
November 2020	5.52	5.50	6.04	5.18	5.36	5.51	7.14
December 2020	1.09	0.95	1.14	1.19	1.06	0.88	1.09
Total	**34.26**	**33.07**	**39.01**	**37.05**	**27.89**	**30.10**	**42.21**

NA — The sampling units failed to record rainfall data or the data were corrupted and incomplete for these storm events.

Table 4: Storm Event Rainfall Recorded at Each Outfall and the SWFWMD Reference Gauge.

Month	Overall	Outfall					
		2	5	8	10	1400	ROMPTR4
6/1/2020	2.73	**2.57**	**3.01**	**2.62**	**NA**	**NA**	3.24
6/11/2020	0.27	0.35	**0.34**	0.21	0.16	**0.44**	0.41
7/7/2020	0.17	0.13	**0.20**	**0.22**	0.13	0.01	0.09
7/16/2020	1.16	**0.93**	1.25	**1.24**	1.20	**1.46**	2.12
7/21/2020	0.28	0.40	**0.35**	**0.24**	0.14	**0.48**	0.07
8/16/2020	0.78	0.93	**0.91**	0.71	0.57	1.61	0.10
9/3/2020	0.93	**0.69**	**0.85**	**1.24**	NA	0.27	1.05
9/10/2020	0.56	**0.38**	0.65	0.69	0.50	**0.31**	0.80
9/20/2020	0.17	0.03	**0.21**	**0.20**	0.22	**0.22**	0.07
9/29/2020	0.66	**0.55**	0.63	**0.72**	**0.73**	0.44	0.72
10/9/2020	0.55	**0.44**	0.49	0.55	0.70	0.42	0.95
10/26/2020	0.52	0.53	**0.52**	**0.50**	0.54	**0.48**	0.77
11/11/2020	4.57	**4.65**	**5.00**	**4.20**	**4.43**	**4.79**	5.16
11/30/2020	0.52	**0.39**	0.48	**0.63**	**0.57**	**0.38**	1.36
12/7/2020	1.08	**0.95**	**1.14**	1.16	**1.05**	**0.84**	1.09
Average	**0.99**	**0.93**	**1.07**	**1.01**	**0.84**	**0.87**	**1.20**
Total	**14.01**	**13.92**	**16.03**	**15.13**	**10.94**	**12.15**	**18.00**

NA The sampling units failed to record rainfall data or the data were corrupted and incomplete for these storm events.

Text Indicates a sample was taken at this outfall for the storm event.

Flow Volume

Continuous stage and velocity data were generally obtained from when field monitoring began on June 1, 2020, until the final samples were collected on December 8, 2020. Hourly flow and daily rainfall data are presented for each outfall in **Figures 7** through **11**. The bars on the figures that appear thicker are consecutive hours of rainfall or discharge. Three monitoring sites (Outfall 5 – Figure 8, Outfall 8 – Figure 9, and Outfall 1400 – Figure 11) were influenced to varying degrees by incoming tidal waters. Outfall 2 (Figure 7) and Outfall 10 (Figure 10) were not tidally influenced, but Outfall 2 discharge was affected by pumped discharge to the treatment swale and Outfall 10 discharge was affected by beach sand regularly clogging the outfall pipe. There were also periods of missing data because of equipment and power failures and periods of questionable data caused by debris and faltering equipment. The flow volume and raw flow rate data collected at each outfall are provided as an electronic appendix.

The total observed flow for the evaluation period was highest at Outfall 8 (492 acre-feet), which is expected because Outfall 8 receives runoff from the largest drainage basin (429.5 acres). The lowest overall flow was observed for Outfall 10 at 34 acre-feet from June to early December 2020. Total flow for Outfalls 2, 5, and 1400 were 426 acre-feet, 304 acre-feet, and 122 acre-feet, respectively. Evaporation, transpiration, and infiltration appeared to reduce overall runoff volumes from Outfalls 5, 8, and 10 as blocked outfalls held runoff back for large periods of time.

Stormflow Volume

Flow data were analyzed to calculate discharge volumes for each of the 15 sampled storm events (**Table 5**). For the purpose of storm event monitoring, discharge volumes were determined to begin when flow volumes elevated after rainfall began and ended when flow measurements returned to zero or resumed typical flow patterns during baseflow conditions. Note that every outfall was not sampled each storm event and Table 3.1-3 provides the overall average volume for all 15 events and the sampled event average volume to document the volume actually sampled. Due to the influence of tidal water entering the systems during storm events, it's likely some of the flow volumes reported for Outfalls 5, 8, and 1400 are due to saltwater intrusion, and may not be completely representative of stormwater influence.

The highest stormflow volumes occurred at Outfall 8 with an average of 10.71 acre-feet for the 15 sampled storm events. The lowest sampled stormflow volume recorded for this outfall was 0.735 acre-feet, and the highest was 38.0 acre-feet. Stormflow volumes for Outfalls 2, 5, 10, and 1400 averaged 2.92 acre-feet, 9.67 acre-feet, 0.270 acre-feet, and 1.64 acre-feet, respectively.

Predictably, analysis revealed a strong correlation between rainfall and stormflow volumes for the recorded storm events. The highest flow volumes for all outfalls, except Outfall 8, were observed during the November 11 storm event, which received an average of 4.61 inches of rain.

Figure 7: Continuous discharge and rainfall for Outfall 2

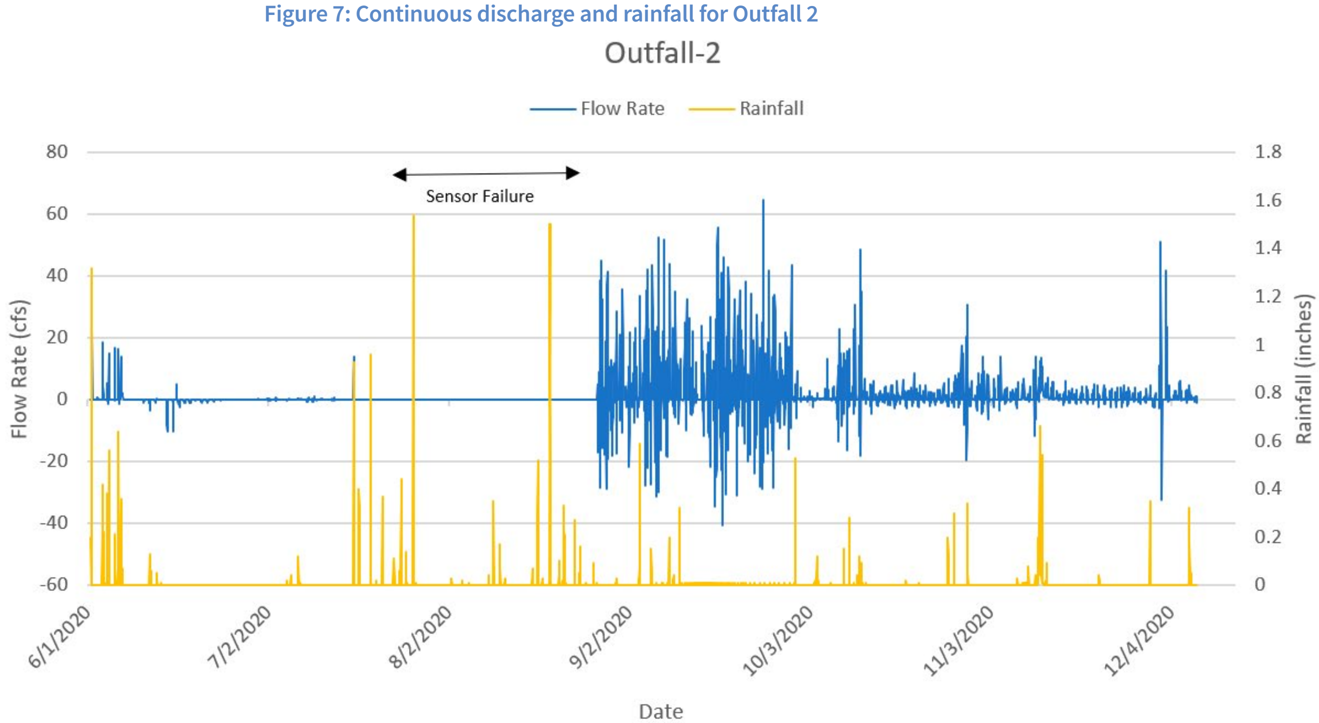


Figure 8: Continuous discharge and rainfall for Outfall 5

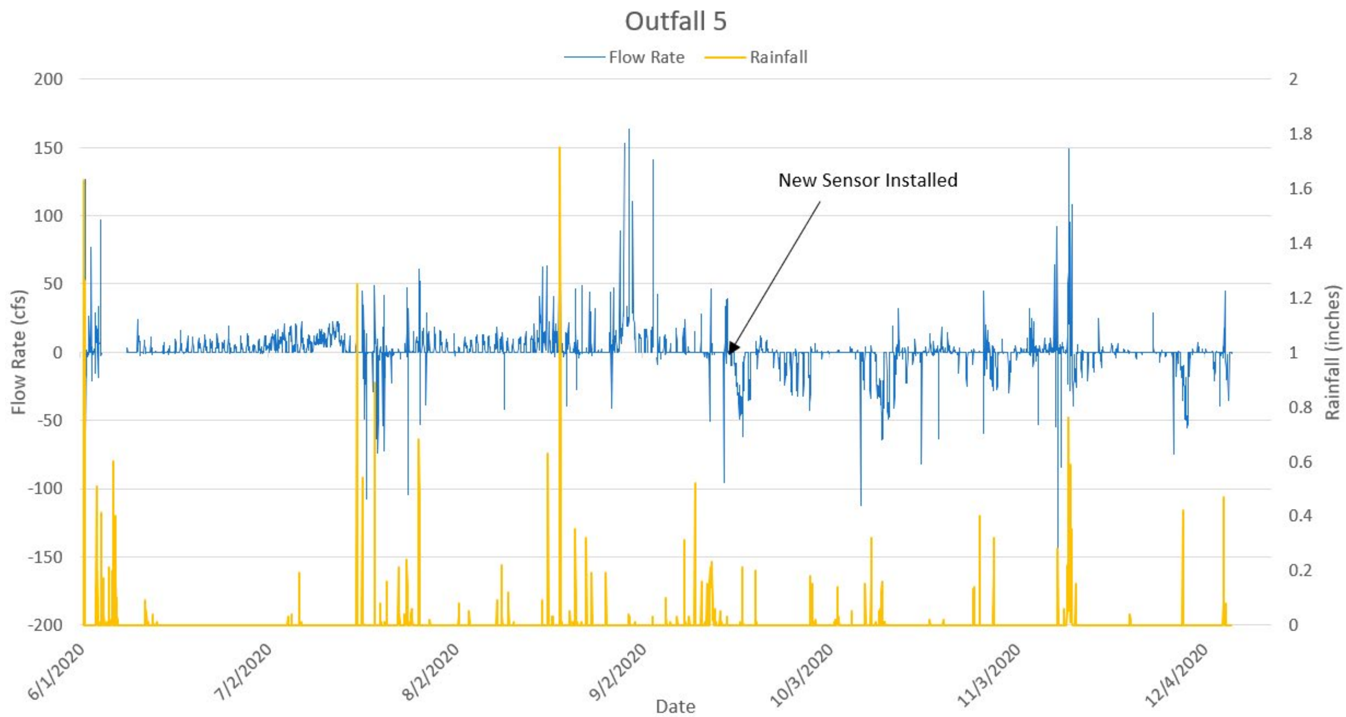


Figure 9: Continuous discharge and rainfall for Outfall 8

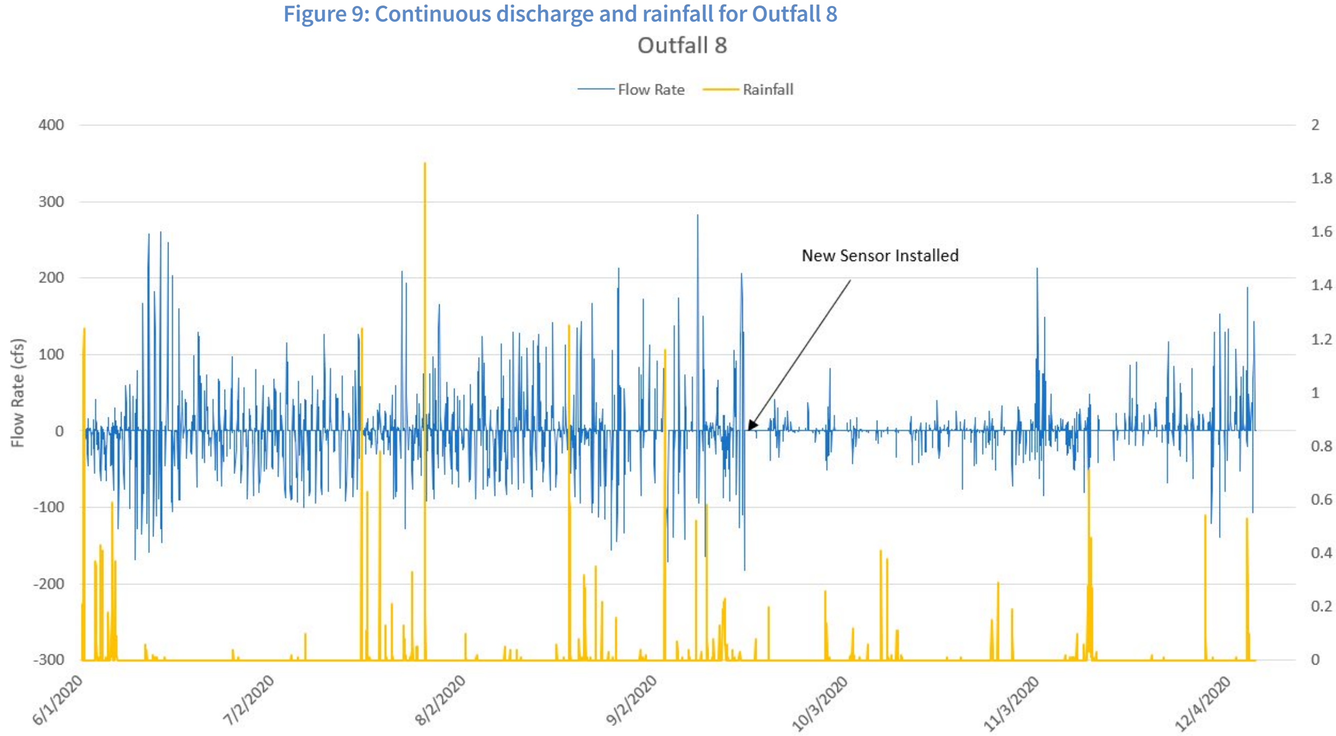


Figure 10: Continuous discharge and rainfall for Outfall 10

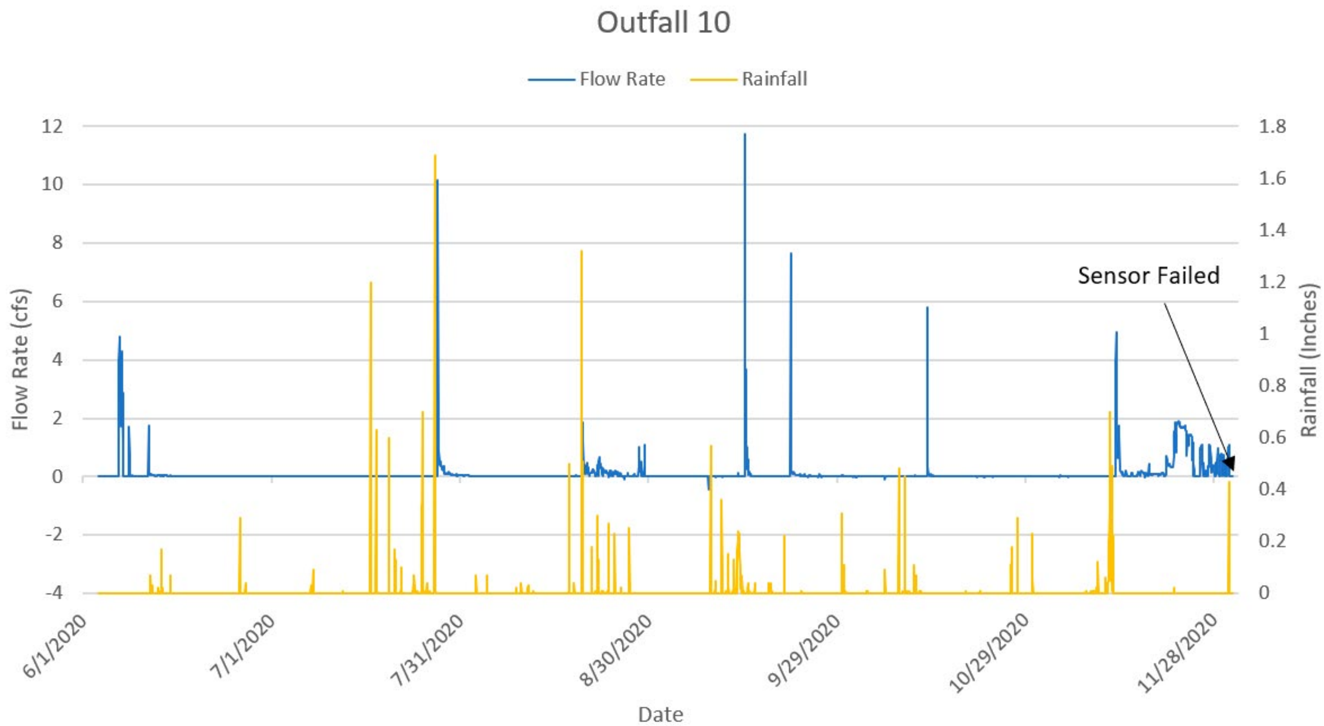


Figure 11: Continuous discharge and rainfall for Outfall 1400

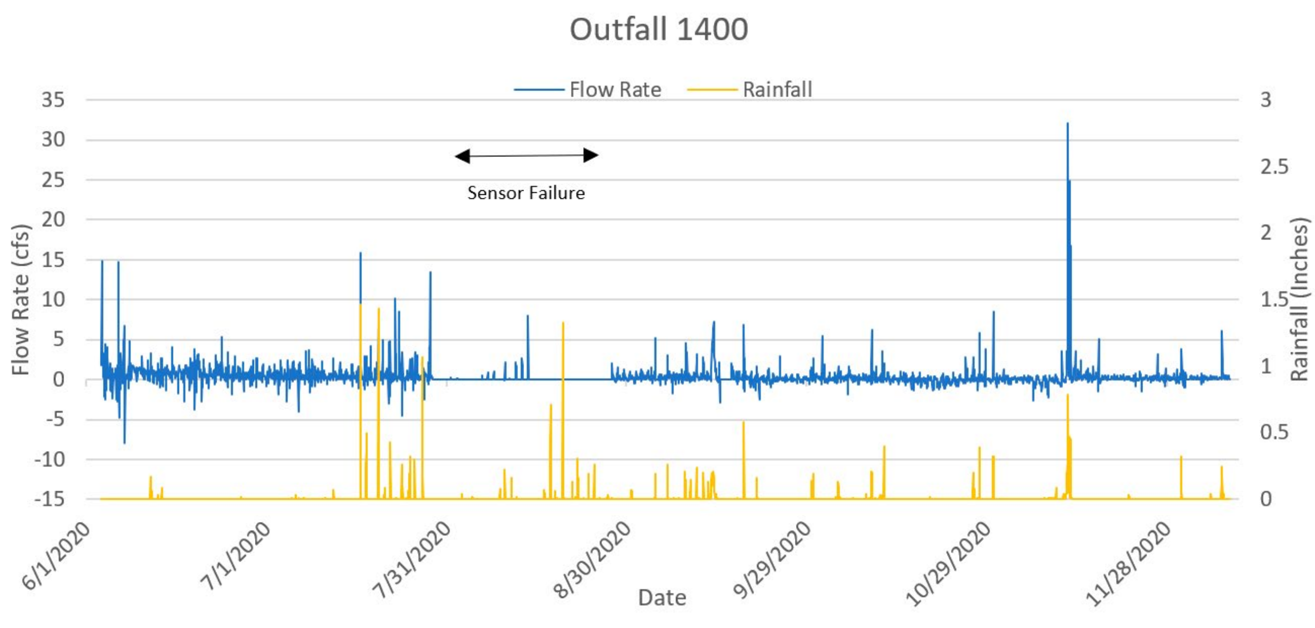


Table 5: Storm Event Flows (Acre-Feet) Recorded at Each Outfall Station.

Storm Event Initiated	Outfall				
	2	5	8	10	1400
6/1/2020	**7.37**	**17.2**	**38.0**	**NA**	**NA**
6/11/2020	NA	**2.37**	27.2	0.412	**3.09**
7/7/2020	0.179	**12.2**	**6.87**	0	0.185
7/16/2020	**2.10**	1.764	**12.9**	0.012	**1.89**
7/21/2020	0	**0.279**	**5.43**	0	**0.549**
8/16/2020	0	**23.9**	2.79	0	0
9/3/2020	**6.06**	**15.4**	**25.5**	NA	0.606
9/10/2020	**3.22**	1.49	2.91	0	**0.742**
9/20/2020	0.763	**4.03**	**1.65**	0	**0.465**
9/29/2020	**2.08**	1.08	**0.735**	**0.014**	0.715
10/9/2020	**4.56**	0.382	0.421	0	0.850
10/26/2020	0.609	**0.490**	**1.93**	0	**0.596**
11/11/2020	**11.7**	**47.7**	**4.00**	**2.33**	**10.5**
11/30/2020	**0.808**	NA	**6.35**	**0.465**	**0.809**
12/7/2020	**1.48**	**7.10**	24.0	**NA**	**1.97**
Overall Average	**2.92**	**9.67**	**10.71**	**0.270**	**1.64**
Sampled Event Average	**12.95**	**13.07**	**10.34**	**2.812**	**2.295**
Total	**40.9**	**135**	**161**	**3.24**	**23.0**

NA	The sampling units failed to record discharge data or the data were corrupted and incomplete for these storm events.
Text	Indicates a sample was taken at this outfall for the storm event.

Event Mean Concentrations

Water quality samples were collected from a total of 15 separate rainfall events, and a discrete grab sample. Samples were all flow-weighted composites except for the November 23 and December 8, 2020 samples from Outfall 10, which were grab samples. Six sampling events occurred at Outfall 10, nine events at Outfall 2, and 10 events each at Outfalls 5, 8, and 1400.

The event mean concentrations (EMCs), event averages and outfall averages are provided for each parameter in **Tables B1** through **B11** in **Appendix B**. The tables provide the EMC for each event at each site as well as the average EMC for each event and outfall. Florida water quality standards (Chapter 62-302 Florida Administrative Code) and/or Numeric Nutrient Criteria are provided below each table for reference purposes.

Bacteria

The EMC of enterococci for all sites ranged between 2,234 and 12,642 colonies/100 mL, and the overall average EMC was 6,441 colonies/100 mL (**Table 6**). The minimum value for a single sampling event was 50 colonies/100 mL and was recorded at Outfall 5, and the maximum sampling event value was 78,000 colonies/100 mL at Outfall 8 (**Table B1** – Appendix B).

Table 6: Observed Average EMCs for Each Parameter and Outfall

Parameter	Units	Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	Overall Average
Enterococci	#/100 mL	6,284	2,234	12,642	4,605	5,558	**6,441**
Fecal Coliform	#/100 mL	21,788	10,883	4,479	1,596	6,267	**9,686**
Turbidity	NTU	5.86	30.3	7.49	3.49	8.36	**11.8**
Total Suspended Solids	mg/L	18.4	45.6	27.8	3.06	23.6	**23.7**
Ammonia Nitrogen	mg/L	0.126	0.375	0.299	0.045	0.140	**0.211**
Total Kjeldahl Nitrogen	mg/L	1.33	1.05	1.53	1.34	0.985	**1.31**
Organic Nitrogen	mg/L	1.21	0.676	1.23	1.29	0.845	**1.10**
Nitrate+Nitrite as N	mg/L	0.168	0.035	0.175	0.154	0.155	**0.133**
Total Nitrogen	mg/L	1.50	1.08	1.70	1.49	1.14	**1.44**
Ortho Phosphorus as P	mg/L	0.148	0.184	0.134	0.311	0.132	**0.194**
Total Phosphorus as P	mg/L	0.250	0.356	0.407	0.483	0.259	**0.374**

Average Fecal Coliform EMCs ranged from 1,596 to 21,788 colonies/100 mL across the various outfalls, and the overall average was 9,686 colonies/100 mL (Table 6). The highest event averages peaked during summer and early fall during the July 17, July 22 and September 4, 2020 events for both Enterococci and Fecal Coliform (Table B1 and **B2**– Appendix B).

Turbidity and Total Suspended Solids

Turbidity values were generally low, with averages from 3.5 to 8.4 NTU, apart from Outfall 5 which had an average of 30.3 NTU (Table 6). The June 3, 2020 sample from Outfall 5 (**Table B3** – Appendix B) had the highest single value for turbidity when 100 NTU was measured. This high turbidity may have been influenced by water from the Gulf of Mexico.

EMCs for total suspended solids (TSS) averaged 23.7 mg/L for all outfalls. Outfall 10 had the lowest average at 3.1 mg/L, while Outfall 5 had an overall average of 45.6 mg/L (Table 6). There were occasional high values of TSS particularly at Outfall 5 and during the October 27, 2020 event (**Table B4** - Appendix B).

Nutrients

Ammonia levels were occasionally elevated (Table 6), particularly at Outfalls 5 and 8 which averaged 0.375 and 0.299 mg/L, respectively, but generally occurred when organic nitrogen and nitrate+nitrite (NOx) nitrogen concentrations were low. The highest EMCs occurred in fall during the September 21, 2020 and November 12, 2020 storm events at 0.608 and 0.466 mg/L, respectively (**Table B5** – Appendix B). Outfalls 5 and 8 recorded their maximum values for ammonia nitrogen during these fall events.

Organic nitrogen concentrations peaked in late September and October at the end of the growing season (**Table B7** – Appendix B). EMCs were similar across all sites and averaged between 0.676 and 1.29 mg/L, with the lowest value occurring at Outfall 5 (Table 6). The overall average EMC for organic nitrogen was 1.10 mg/L. A comparable trend was apparent for NOx which maintained similar averages across the sites ranging from 0.154 to 0.175 mg/L, except for Outfall 5 which had an average of 0.035 mg/L (Table 3.2-1).

EMCs for total nitrogen (Table 6) averaged 1.44 mg/L across all outfall locations. Outfall 8 exhibited the highest average concentration at 1.70 mg/L, while Outfall 5 had the lowest at 1.08 mg/L.

The average orthophosphorus EMCs range from 0.132 mg/L at Outfall 1400 to 0.311 mg/L at Outfall 10 and average 0.194 mg/L overall (Table 6). Total Phosphorus concentrations averaged 0.374 mg/L and were also highest at Outfall 10 (0.483 mg/L). Total Phosphorus peaked in September and October, with an event average of 0.550 mg/L for the September 30 storm event and an event average of 0.688 mg/L for the October 17 storm event (**Table B11** – Appendix B).

Outfall 10 generally had the lowest inorganic nitrogen concentrations, so the higher phosphorus levels appear to indicate a system with an imbalance of nutrients where available inorganic nitrogen is readily incorporated into plant protoplasm through photosynthesis.

Field Measurements

The field measurements are provided for each parameter in **Tables C1** through **C6** in **Appendix C**. The tables provide the EMC and field measurement for each event at each site as well as the average measurement for each event/monitoring outfall. Any applicable Florida water quality standard is provided below each table for reference purposes. The average field measurements are summarized by outfall in **Table 7**.

A strong influence of tidal waters is apparent for specific conductivity and salinity in the channel, and sometimes the sample bottle, at Outfalls 5, 8, and 1400 (Table 7). Overall averages for these parameters showed tidal water intrusion in the composite samples for several storm events (**Tables C1 and C2** – Appendix C). Outfalls 2 and 10 showed no tidal influence.

Temperature within the channel was fairly uniform at all sites ranging from 22.2°C to 27.7°C, with an overall average of 26.5°C (Table 7). Temperature was observed to peak in late summer (September 11, 2020), then dropped to the lowest values in December (**Table C3** – Appendix C).

The pH of the sites influenced by tidal waters were neutral to slightly basic, whereas the strictly freshwater sites were slightly acidic (Table 7). Overall averages of pH in the culverts and channels for all outfalls ranged from 6.6 at Outfall 10 to 7.4 at Outfall 5.

The percent saturation and concentration of dissolved oxygen were highest at Outfall 1400 with a channel average of 72.5% and may reflect the unshaded and shallow, frequently moving nature of the sampling location (Table 7). Conversely, Outfall 10 was observed to have the lowest percent saturation at 28.7% in the channel, as the site seldom discharged, was generally stagnant, and is heavily shaded.

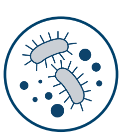
Table 7: Average of Field Measurements by Outfall

		Outfall 2		**Outfall 5**		**Outfall 8**		**Outfall 10**		**Outfall 1400**		**Overall Average**	
Parameter	**Units**	**Bottle**	**Channel**	**Bottle**	**Channel**	**Bottle**	**Channel**	**Bottle**	**Channel**	**Bottle**	**Channel**	**Bottle**	**Channel**
Conductivity	µS/cm	340	765	34,074	29,539	20,661	14,071	627	676	11,278	24,937	**13,396**	**13,998**
Salinity	ppt	0.2	0.4	21.6	19.0	13.2	8.8	0.3	0.3	6.6	16.3	**8.4**	**9.0**
Temperature	°C	6.1	27.7	14.6	27.4	21.8	27.5	14.7	22.0	15.8	27.7	**14.6**	**26.5**
pH	pH units	7.7	6.9	7.5	7.4	7.0	6.8	7.6	6.6	7.2	7.1	**7.4**	**7.0**
Dissolved Oxygen	% Sat	79.4	65.1	69.8	63.7	65.0	42.9	87.4	28.7	88.7	72.5	**78.1**	**54.6**
Dissolved Oxygen	mg/L	10.0	5.2	6.6	4.6	5.0	3.3	9.1	2.6	8.6	5.3	**7.9**	**4.2**

Pollutant Loads

Event mean concentrations were applied to the flow volumes reported by the sampling equipment to determine the pollutant loads for each outfall. Pollutant loads were calculated for each storm event and for the overall study period.

Storm Event Loads



Bacteria

Observed enterococci loads ranged from 16 billion colonies to 6,532 billion colonies, with an overall total loading of 27,353 billion colonies for all storm events (**Table 8**). As with other pollutant loads, the highest loads were observed for storm event 13, which accounted for 30.6% of all enterococci loads for the sampled storm events. Five of the 15 sampled storm events experienced enterococci loads over 1,000 billion colonies.

Table 8: Pollutant Loading for Storm Events

Event	Total Suspended Solids (KG)	Ammonia Nitrogen (KG)	Total Kjeldahl Nitrogen (KG)	Organic Nitrogen (KG)	Nitrate+ Nitrite as N (KG)	Total Nitrogen (KG)	Ortho Phosphorus as P (KG)	Total Phosphorus as P (KG)	Enterococci (billion)	Fecal Coliform (billion)
1	672	22.5	98.1	75.6	5.53	104	16.8	25.1	6,532	10,894
2	174	0.370	4.63	4.26	0.920	5.54	0.933	1.88	40	37
3	794	2.47	20.1	17.7	0.071	20.1	2.77	6.05	77	414
4	378	0.701	25.6	24.9	0.924	26.4	6.44	11.6	1,542	4,179
5	277	0.781	4.25	3.47	0.136	4.37	0.429	1.00	5,255	429
6	705	6.58	14.7	8.14	5.75	20.5	2.01	3.30	266	1,564
7	1,092	4.29	64.6	60.4	4.25	68.8	3.54	14.1	5,821	24,740
8	19.4	0.351	3.37	3.02	0.644	4.01	0.462	0.957	199	346
9	183	6.12	12.5	6.37	0.168	12.6	0.938	3.12	16	32
10	73.7	0.988	6.10	5.11	1.65	7.73	0.629	0.966	113	220
11	33.7	0.450	9.28	8.83	0.568	9.84	0.832	1.29	84	112
12	215	0.863	8.18	7.31	0.346	8.53	0.748	2.12	151	84
13	5,949	67.8	93.7	25.9	4.43	97.9	11.8	34.7	6,308	4,429
14	301	5.76	9.61	3.86	0.536	10.1	1.24	2.86	757	526
15	203	3.41	11.4	7.98	0.787	12.2	2.81	4.15	192	229
Total Stormflow Loading	**11,069**	**123**	**386**	**263**	**26.7**	**412**	**52.3**	**113**	**27,353**	**48,236**

Pollutant loads for fecal coliform were noticeably higher than for enterococci, with an overall total of 48,236 billion colonies. Fecal coliform loads ranged from 32 billion colonies during storm event 9 to 24,740 billion colonies (Table 8) during storm event 7. Loading during storm event 7 contributed 51.3% of the total loading for all sampled storm events. In contrast to enterococci and some other parameters, storm event 13 (which experienced the highest total flow volume of all storm events) contributed only 9.2% of fecal coliform for the 15 sampled storm events.

Higher fecal coliform loads compared to enterococci loads may be attributed to a greater proportion of freshwater in the larger storm events than for smaller events where saltwater intrusion from tidal influence was captured at Outfalls 5, 8, and 1400.

Total Suspended Solids

Pollutant loads for total suspended solids ranged from 19.4 kg to 5,949 kg, with an overall total of 11,069 kg of loading for all storm events (see Table 8). The highest loading was observed during storm event 13, which initiated on November 11, 2020 from an average of 4.61 inches of rainfall across all sampled outfalls. TSS loads were over 1,000 kg for 2 of the 15 storm events sampled, and three events reported total TSS loads under 100 kg.

Nutrients

Overall loading of ammonia nitrogen was 123 kg for all storm events (see Table 8). The lowest loading observed for ammonia nitrogen was 0.351 kg, and the highest was 67.8 kg, during storm events 8 and 13, respectively. This indicates 54.9% of all ammonia nitrogen loading occurred during a single event. Loading from most of the other storm events contributed significantly less loading.

Loading for organic nitrogen ranged from 3.02 kg to 75.6 kg, with a total overall load of 263 kg for all storm events. The highest loading was recorded for storm event 1, which initiated on June 1, 2020. Over 15 kg of organic nitrogen were observed during 5 of the 15 sampled storm events, with the remaining storm events contributing much less. Loading for nitrate+nitrite nitrogen was significantly lower than loading for ammonia or organic nitrogen, with total a load of 26.7 kg for all events. This indicates that organic nitrogen represented 63.7% of the total nitrogen observed.

Total nitrogen loads ranged from 4.01 kg to 104 kg, with an overall total of 412 kg of nitrogen loading for all storm events. As expected, the highest loads were observed during storm events 1 and 13, which experienced noticeably higher rainfall than most other events. These two events contributed 48.9% of all total nitrogen loading during the storm event monitoring period. Total nitrogen loading was below 10 kg for six of the sampled events.

Pollutant loads from the 15 sampled storm events for ortho phosphorus ranged from 0.429 kg to 16.8 kg. The overall total loading for all events was 52.3 kg. Only two of the sampled storm events (Events 1 and 13) contributed over 10 kg of ortho phosphorus. Ortho phosphorus consisted of 46.3% of the total phosphorus observed during the storm events.

Total phosphorus loads ranged from 0.957 kg to 34.7 kg for the sampled storm events, with an overall total load of 113 kg for all events. As with ortho phosphorus, the highest total phosphorus loads were observed for storm events 1 and 13. For 13 of the 15 sampled storm events storm events, total phosphorus to total nitrogen loads exceeded a 6.8:1 ratio, indicating nitrogen is the limiting nutrient in the system (Odum, 1959 and GESAMP, 1987).

Overall Loads

Overall pollutant loads for the 189-day monitoring period from June 1 to December 7, 2020 were developed by applying the observed average EMCs for all storm events for each outfall to the total flow volumes observed at that outfall.

Bacteria

Overall pollutant loading for enterococci ranged from 1,919 billion colonies to 70,683 billion colonies during the entire study period, with an overall total of 122,488 billion colonies for all monitoring sites (**Table 9**). The highest loading was observed at Outfall 8, which accounted for 57.7% of all enterococci loading.

Table 9: Total Pollutant Loading for Study Period from June 1 to December 8, 2020

Parameter	Units	Site 2	Site 5	Site 8	Site 10	Site 1400	Total Load
Enterococci	Billion	33,015	8,538	70,683	1,919	8,333	**122,488**
Fecal Coliform	Billion	107,986	38,431	33,720	832	8,801	**189,770**
Total Suspended Solids	KG	9,641	17,444	15,523	127	3,538	**46,273**
Ammonia Nitrogen	KG	66.2	143	167	1.88	21.0	**400**
Total Kjeldahl Nitrogen	KG	700	402	855	55.7	148	**2,160**
Organic Nitrogen	KG	633	259	626	54	127	**1,698**
Nitrate+Nitrite as N	KG	88.3	13.2	97.8	6.4	23.2	**229**
Total Nitrogen	KG	788	414	952	62	171	**2,388**
Ortho Phosphorus as P	KG	77.8	70.2	75.1	13.0	19.9	**256**
Total Phosphorus as P	KG	131.3	136.1	227.4	20.1	38.9	**554**

Overall loading for fecal coliform during the study period ranged from 832 billion colonies to 107,986 billion colonies, with an overall total loading of 189,770 colonies for all outfalls. The highest loading of fecal coliform was observed at Outfall 2, which comprised 56.9% of all observed fecal coliform during the monitoring period. Higher loading of fecal coliform compared to enterococci at Outfall 2 may be due to the predominately freshwater passing through this system, as enterococci is largely considered a marine indicator species. Conversely, higher loads of enterococci were observed at Outfall 8, which received consistent saltwater intrusion from tidal influence.

Total Suspended Solids

Overall pollutant loads for total suspended solids for the monitoring period ranged from 127 kg to 17,444 kg (Table 9). The lowest loads were from Outfall 10, while the highest loads were observed for Outfall 5. Pollutant loads for Outfall 8 were also high, with 15,523 kg for the monitoring period. The total loading of TSS for all outfalls was 46,273 kg. The low levels of loading observed at Outfall 10 were likely due to the extended periods where the discharge pipe was blocked, reducing recorded flow volumes.

Nutrients

Overall ammonia nitrogen loading during the entire study period ranged from 1.88 kg at Outfall 10 to 167 kg at Outfall 8 (Table 9). The overall total loading for ammonia nitrogen was 400 kg. Loads for ammonia nitrogen at Outfall 5 (143 kg) were close to maximum, which indicates Outfalls 5 and 8 accounted for 77.7% of all ammonia nitrogen observed during the study.

Nitrate+nitrite nitrogen ranged from 6.41 kg at Outfall 10 to 97.8 kg at Outfall 8 (Table 9). Outfall 2 was also one of the highest at 88.3 kg. Outfall 2 and 8 comprised 81% of the overall nitrate+nitrite loading of 229 kg.

The total pollutant loading for organic nitrogen during the study period was 1,698 kg. The lowest total loading was observed at Outfall 10 (53.9 kg), and the highest total loading was observed at Outfall 2 (633 kg). Outfall 8 also experienced high loads, with 626 kg observed for the study period. Loading for biologically activated nitrogen (ammonia nitrogen, nitrate, and nitrite) were much lower than for organic nitrogen, which accounted for 71.1% of all total nitrogen loading for all flow observed during the study period.

Overall total loading for total nitrogen was 2,388 kg during the study period (Table 9). As with other parameters, the lowest total loading (62.0 kg) was observed at Outfall 10 due to the low flow volumes experienced at this location. The highest loads for total nitrogen were observed at Outfall 8 (952 kg), followed by Outfall 2 (788 kg). These two outfalls accounted for 72.8% of all total nitrogen observed.

Pollutant loading for ortho phosphorus was 256 kg for all flow observed during the study period, ranging from 13.0 kg at Outfall 10 to 77.8 kg at Outfall 2. The distribution of ortho phosphorus loading was relatively even across Outfalls 2, 5, and 8, with noticeably lower levels of loading from Outfalls 10 and 1400.

Overall loading for total phosphorus during the study period ranged from 20.1 kg to 227 kg, with a total load of 554 kg across all outfalls. The highest loading of total phosphorus was observed at Outfall 8. Ortho phosphorus accounted for 46.2% of the total phosphorus observed during the study period.

Pollutant loads of total phosphorus for the study period were higher than a 6.8:1 ratio compared to loads observed for total nitrogen at all monitoring locations, indicating nitrogen is the limiting factor for these systems.

Annual Loads

Rainfall and flow volume data for the study period were analyzed to develop a total rainfall to flow volume ratio to calculate an estimate the total discharge over an annual period. An annual rainfall total of 53 inches was used to match the volumes used by Taylor Engineering from the SIMPLE-Seasonal model in a previous study. The EMCs developed from the sampled storm events were applied to the calculated annual volume estimates to represent total annual loading for each analyte. The calculated annual loading estimates based upon the results of this study are provided in **Table 10**.

Table 10: Annual Pollutant Load Calculations Based on a 53-inch Rainfall Year

Parameter	Units	Site 2	Site 5	Site 8	Site 10	Site 1400	Total Load
Enterococci	Billion	58,132	13,684	96,032	2,745	13,213	**183,806**
Fecal Coliform	Billion	190,142	61,592	45,813	1,190	13,955	**312,692**
Total Suspended Solids	KG	16,977	27,957	21,089	182	5,610	**71,815**
Ammonia Nitrogen	KG	116.6	229.9	227.4	2.7	33.3	**610**
Total Kjeldahl Nitrogen	KG	1,232	644	1,162	80	234	**3,352**
Organic Nitrogen	KG	1,115	414	850	77	201	**2,658**
Nitrate+Nitrite as N	KG	155.4	21.1	132.9	9.17	36.8	**355**
Total Nitrogen	KG	1,387	664	1,294	88.7	271	**3,705**
Ortho Phosphorus as P	KG	136.9	112.5	102	18.5	31.5	**402**
Total Phosphorus as P	KG	231.2	218.1	309	28.8	61.6	**849**

Results Comparisons

Comparison to State Water Quality Standards

Lab Analysis

All Outfalls exceeded state standards for enterococci bacteria. The enterococci standard applies to the marine waters receiving the discharge (not to freshwater systems) and there are no longer any fecal coliform standards. Within freshwater systems E. coli has replaced fecal coliform as a water quality indicator, but fecal coliform bacteria were monitored as an indicator of E. coli because their loadings are better documented from drainage systems in pollutant loading models. Although sampling did not occur at the frequency specified by Florida to measure compliance, it appears that both of these bacteria would exceed the state water quality standards.

All outfalls were well below state standards for turbidity, except for Outfall 5 which exceeded the natural background at 100 and 65 NTUs during the June 3, 2020 and July 22,2020 storm events.

Numeric nutrient criteria are defined for total nitrogen and total phosphorus. Total nitrogen frequently exceeded the annual geomean state standard of 1.65mg/L during single sampling events in September and October, but all the outfalls had a calculated geometric mean that met the state standard.

All outfalls exhibited annual geomeans lower than the 0.49 mg/L state standard for total phosphorus. Total Phosphorus concentrations were highest at Outfall 10 (0.483 mg/L) and were close the state geometric mean water quality criterion.

Field Measurements

The pH bottle value on July 17, 2020 exceeded the acceptable pH range of 6.0 to 8.5 units (**Table C4** – Appendix C). Two readings of dissolved oxygen percent saturation were below the state water quality criteria at each of Outfalls 5 and 8, and five of the six readings were below the percent saturation criteria at Outfall 10. The Outfall 10 channel had an overall average that fell below the DO saturation criteria, but all other sites had averages that complied with state standards.

Comparison to Modeled EMCs

The EMCs developed from the collected water quality samples were compared to the anticipated EMCs developed from the SIMPLE-Seasonal model in a previous phase. The purpose of this effort was to evaluate the potential for unknown sources of pollutants that increase the concentrations, as well as unknown BMPs or other factors that may decrease the concentrations.

Bacteria

The SIMPLE-Seasonal model only projects an EMC for fecal coliform bacteria. For comparison purposes, the observed enterococci and fecal coliform bacteria counts were both compared to the modeled counts. The model predicted an average fecal coliform EMC of 21,555 cells/100 ml, with a range of 18,782 cells/100 ml at Outfall 1400 to 29,735 cells/100 ml for Deertown Gully (Outfall 8). The observed fecal coliform counts ranged from an average of 1,596 cells/100 ml for Outfall 10 to 21,788 cells/100 ml at Outfall 2, with an average of 9,002 cells/100 ml. This translates to observed differences ranging from an increase of 8.2% at Site 2 to a 90.5% decrease at Outfall 10. Outfalls 5, 8 and 1400 also experience much lower concentrations, with EMCs from -47.9% to -79.7% lower than modeled EMCs.

The enterocci differences were greater, ranging from -57.5 to -88.4%. Enterococci is more of a marine indicator species, so the larger differences may reflect the primarily freshwater nature of the discharge.

Total Suspended Solids

The modeled EMC for TSS ranged from 143.1 to 157.7 mg/L and averaged 146.5 mg/L. Conversely, the measured EMC for TSS averaged 23.7 mg/L and ranged from 3.1 mg/L at Outfall 10 to 45.6 mg/L at Outfall 5. The observed difference from modeled to actual TSS EMCs was substantial, ranging from a low of 68.1% less at Outfall 5 to 98.1% less at Outfall 10.

The large difference likely indicates that much of the anticipated solids are not becoming mixed into the stormwater discharge and/or they are settling out before reaching the sampling locations. The largest difference at Outfall 10 likely reflects the blocked nature of the outfall which minimized or eliminated the discharge velocity and allowed the suspended solids in the ponded stormwater to settle out.

Nutrients

Ammonia nitrogen was modeled with an average EMC of 0.293 mg/L and a range of 0.246 to 0.311 mg/L. The observed ammonia EMCs ranged from 0.045 to 0.375 mg/L and average 0.197 mg/L. Open channel Outfalls 5 and 8 were at, to slightly above, their modeled ammonia EMC, with Outfalls 1400 (-54.8%), 2 (-59.5%), and 10 (-81.7%) substantially below their anticipated concentrations.

The modeled nitrate and nitrite EMCs ranged from 0.244 to 0.324 mg/L, with an average of 0.293 mg/L. The observed average EMC for nitrate+nitrate nitrogen was 0.137 mg/L and ranged from 0.035 mg/L at Outfall 5 to 0.175 mg/L at Outfall 8. All of the outfalls had lower nitrate and nitrate levels than expected, with the differences ranging from -31.5% at Outfall 8 to -88.9% at Outfall 5.

The average organic nitrogen EMC was modeled at 0.897 mg/L for the five outfalls and ranged from 0.780 to 0.984 mg/L. The observed organic nitrogen EMCs were more variable, from 0.676 to 1.29 mg/L, and had a higher average at 1.05 mg/L. This resulted in differences from -30.6% for Outfall 5 to +65.6% for Outfall 10. The generally higher levels of organic nitrogen appear to indicate that the biologically active nitrogen forms (ammonia and nitrate+nitrite) were converted to organic forms of nitrogen at a higher rate than modeled. This may also be reflective of the sampling window during the warmer months with longer periods of sunshine when photosynthesis is expected to be more active.

The modeled total nitrogen EMCs ranged from 1.30 to 1.62 mg/L and averaged 1.52 mg/L. The observed EMCs averaged 1.38 mg/L and ranged from 1.08 to 1.70 mg/L. The observed EMCs were from 32.4% less than modeled at Outfall 5 to 16.5% greater at Outfall 8. These averages are reasonably close and may reflect the seasonality of the study. Observed EMCs were lower than the modeled EMCs at Outfalls 5 and 1400, which may be due to the heavier tidal influence at these outfalls.

In a departure from the generally lower nitrogen EMCs observed during the study period, total phosphorus EMCs were higher. The modeled total phosphorus EMCs averaged 0.286 mg/L and ranged from 0.209 to 0.322 mg/L, whereas the observed EMCs averaged 0.351 mg/L and ranged from 0.250 to 0.483 mg/L. The differences were 18.9% and 22.3 % less than expected at Outfalls 1400 and 2, respectively, and 12.3%, 55.5%, and 131.2% higher at Outfalls 5, 8 and 10, respectively.

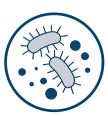
As noted above, the observed nutrient data depicts some of the drainage systems as out of balanced, with nitrogen being the limiting factor.

Comparison to Modeled Pollutant Loads

Table 11 provides a comparison of the modeled annual loading for each outfall with the annual loading calculated from the study for fecal coliform bacteria, TSS, total nitrogen, and total phosphorus.

Table 11: Comparison of Annual Observed and Modeled Loading Based on a 53-inch Rainfall Year

Site	Fecal Coliform (billion)	Total Suspended Solids (KG)	Total Nitrogen (KG)	Total Phosphorus as P (KG)
Site 2				
Observed	190,142	16,977	1,387	231
Modeled	47,264	34,950	398	79
Site 5				
Observed	61,592	27,957	664	218
Modeled	98,399	70,172	798	158
Site 8				
Observed	45,813	21,089	1,294	309
Modeled	253,394	126,571	1,351	246
Site 10				
Observed	1,190	182	89	29
Modeled	164,842	4,734	105	9
Site 1400				
Observed	13,955	5,610	271	62
Modeled	61,748	47,242	528	105
Total Loading				
Observed	**312,692**	**71,815**	**3,705**	**849**
Modeled	**625,646**	**283,668**	**3,180**	**597**



Bacteria

Annual loading for fecal coliform developed in the model ranged from 47,264 billion colonies at Outfall 2 to 252,394 billion colonies at Outfall 1400, with a total annual loading of 625,646 billion colonies for all monitored outfalls. Annual loading developed from observed data ranged from 1,190 billion colonies to 190,142 billion colonies, with a total annual load of 312,692 billion colonies for all outfall locations. Fecal coliform loading observed for Outfall 10 was considerably lower than loads observed for all other sample locations and significantly lower (99%) than the modeled loading. A notable contrast was observed at Outfall 2, where the model predicted the lowest loadings for the five monitored outfalls, but this outfall experienced the highest loading (190,142 billion colonies) during the study period. Overall, observed loading for fecal coliform was 50% lower than loading predicted by the model.

The most likely cause for the difference in modeled versus observed fecal coliform is lower than anticipated concentrations in areas with dense commercial services and high-density residences, where the model predicted higher loading.

Total Suspended Solids

Annual loading for TSS developed in the model ranged from 4,734 kg to 126,571 kg, with a total loading of 283,668 kg (Table 11). Annual loading developed from the observed data were much lower, ranging from 182 kg to 27,957 kg. The total annual loading for TSS was 71,815. These data represent a significant difference in total annual loads estimated from observed data versus modeled data, with observed loads 75% lower than the modeled loads.

The most likely factor in the differences between observed to modeled load estimates is the differences in EMCs developed for these data. As reported in Section 3.4.2, the EMCs developed from the observed water quality samples were also significantly lower than those developed by the model, which is likely due to anticipated solids not mixing into the stormwater discharge or settling out before reaching the sampling locations.

Nutrients

The total annual loading of total nitrogen developed by the model for the five sampled outfalls was 3,180 kg, and annual loading ranged from 105 kg at Outfall 10 to 1,351 kg at Outfall 8 (Table 11). Annual loads developed from the observed data were similar, with a total annual load of 3,705 kg. This represents 17% more annual loading in observed data versus modeled estimates.

Observed annual loads of total nitrogen ranged from 89 kg at Outfall 10 to 1,387 kg at Outfall 2. Outfall 2 was the only outfall where annual load estimates were significantly different from the modeled loads, which is most likely due to the higher than anticipated flow volumes observed at this sampling location. Excess flow through the monitoring station could have been caused by the connected lift station pumping into the adjacent treatment swale.

Modeled annual loads of total phosphorus ranged from 9 kg at Outfall 10 to 246 kg at Outfall 8, with a total annual load of 597 kg for all sampled outfalls. The annual loads developed from the observed data ranged from 29 kg to 309 kg, with a total annual load of 849 kg. As with the modeled loads, the lowest observed annual loads were at Outfall 10, and the highest were at Outfall 8. Overall, total annual observed loads were 42% higher than modeled loads.

In a similar trend as total nitrogen, Outfall 2 was the only outfall with substantially higher observed loading than modeled loading, which is probably due to the excess flow volumes observed at this outfall. Outfall 1400 was the only outfall with lower observed annual loading than modeled annual loading. For both the observed and modeled load estimates, total annual loads were out of balance in respect to total nitrogen to total phosphorus ratios, indicating total nitrogen is the limiting nutrient in the systems.

4.0 Discussion

Flow volumes observed for the study period ranged widely, from 34 ac-ft at Outfall 10 to 453 ac-ft at Outfall 8. These volumes were adjusted to estimate annual flow volumes by developing rainfall to volume ratios and comparing them to the modeled volume estimates from a SIMPLE-Seasonal model. Overall, flow volumes for Outfalls 5, 8, and 1400 were somewhat comparable to the modeled volumes, while Outfall 2 recorded greater than anticipated flow volumes, and Outfall 10 recorded lower than anticipated flow volumes. The discharge pipe at Outfall 10 was regularly blocked by beach sand and was unable to discharge or pass stormwater flow through the system, which likely contributed to the lower recorded flow volumes. Flow volumes recorded for Outfall 2 were higher than estimates from the model. Excess flow observed at this outfall could partially be due to the lift station pumping from the discharge culvert into the nearby treatment swale, but the observed discharge between rainfall events suggests the potential for a secondary source of water (potentially groundwater or irrigation runoff). Obtaining pumping records and comparing the station's pumpage to the observed flow records could assist in parsing out flow volumes that were not directly caused by stormwater runoff.

At Outfalls 5 and 8, the sand berms separating the channels from the Gulf of Mexico blocked stormwater runoff from discharging into the Gulf for extended periods. Water loss through infiltration and evapotranspiration may have caused lower than expected flow recordings when the channel subsequently discharged. Furthermore, tidal surge regularly flowed over these sand berms and entered the channel, creating periods of negative flow and additional detention.

Considering the various observations that would have impacted flow volumes, it appears that the modeled and observed discharge are reasonably consistent.

For all sampled parameters, the overall EMCs were found to be within the limits of the State standards, with the exceptions of enterococci and fecal coliform. The concentrations for both bacteria parameters were consistently above the State criteria at all the monitored outfalls. In most cases, the observed EMCs were lower than the EMCs developed by the model. Observed TSS was significantly lower than projected by the model while observed EMCs for total phosphorus were noticeably higher than the modeled EMCs.

Both the observed EMCs and modeled EMCs indicate total nitrogen is the limiting nutrient for the systems included in the monitoring study. Nitrogen and phosphate are required by aquatic plants in proportions of approximately 6.8:1 on a weight basis. Nitrogen and phosphorus are assimilated in this proportion by the primary producers (rooted aquatic plants and algae) and converted into protoplasm during the process of photosynthesis. Conversely, the unresistant (or digestible) organic forms of nitrogen and phosphate are oxidized back into their biogenic salts during the process of aerobic respiration, e.g. organic decomposition, heterotrophic activity.

A comparison of pollutant loading developed from observed data reinforces this finding. As with the comparison of EMC data, observed pollutant loads of total nitrogen were similar to the estimates predicted by the model, but annual loading of observed total phosphorus 42% higher than the modeled loading. Deviations in pollutant loads developed from observed data and modeling may be contributed to a number of factors, including differences in the development of EMCs and comprehensiveness of the water quality monitoring programs, unique aspects of the stormwater management and conveyance systems in each drainage basin, and inconsistencies with the installed recording equipment. It could also reflect the timing of the study which captured the summer months when photosynthesis would be at its peak.

Recommendations

The study results were complicated at Outfalls 2 and 10 by the pumping to the treatment swale and the frequently clogged pipe, respectively. There is currently no method to determine the volume of water pumped from Outfall 2 to the dune swale treatment area. As this system handles discharge from Outfall 1 and volume pumped from Outfall 2, it is recommended that some form of metering the Outfall 2 pumping be implemented for stormwater management purposes.

There also appears to be a secondary source of runoff discharging at Outfall 2 and it is recommended that the drainage network be evaluated to determine if the source of this water can be determined. This could include conductivity and discharge measurements at various locations in the system moving “upstream” to locate the source and type (e.g., groundwater) of water.

There are additional large drainage basins that contribute to the water quality in the estuary and Gulf, as well as the public beaches. knowing the discharge volumes and unique water quality associated with these basins would help the City’s overall understanding of their non-point source pollutant loading. Additional monitoring of other beach outfalls and large drainage basins is recommended to develop this knowledge base.

The observed and modeled EMCs and pollutant loads for bacteria and nutrients indicates that the basin would benefit from additional stormwater BMPs to reduce the concentration of these parameters and/or their loading through volume reduction. Public health concerns on public beach areas are the primary bacteria concern, so efforts that decrease the number of bacteria in the water and that reduce or eliminate the discharge near public beaches should be a focus. Reduction of nutrients, particularly total phosphorus, would also be beneficial to further the City’s efforts relative to the reduction of impacts from harmful algal blooms (such as red tide). There are several potential projects and BMPs that could be implemented to improve the water quality and reduce the discharge to the Gulf of Mexico. Development of an overall and prioritized stormwater management plan for the implementation of BMPs to meet the City’s water quality improvement objectives.

5.0 References

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Appendix A

Technical Memorandum

To: **Kathleen Weeden, P.E., and Steven B. Berens, E.I., City of Venice**

Through: Jenna Phillips, M.S., E.I., Michael DelCharco, P.E., CFM, and John Loper, P.E., Taylor Engineering, Inc.

From: **Gary Serviss, VHB**

Date: **April 23, 2020**

Re: **Venice Beach Stormwater Outfall Monitoring Site Visit and Final Site Selection**

As part of the Venice Beach Stormwater Outfall Monitoring Project effort (Task 1), VHB completed a site visit on April 22nd to review the final locations and equipment needs for the outfall monitoring project. The field survey was conducted with Steven B. Berens, E.I., from the City of Venice, and Adam Olenoski and Gary Serviss from VHB, to evaluate field conditions and equipment deployment options at each of the six potential stations initially proposed for the Project. A teleconference was held on April 23, 2020 to discuss the findings of the site visit, with the individuals included in this memorandum, and to finalize the monitoring locations.

A description of each site and the final site location decisions are provided below.

SITE CONDITIONS AND RECOMMENDATIONS/DECISIONS

<u>Outfall 2</u>

Several potential sampling locations for this outfall were field reviewed with the desire to locate a site where we can capture all of the runoff prior to the diversion to the pumping facility. The main stormwater pipe is accessible by a manhole in the center of Alhambra Road that captures runoff from the final curb inlet and the entire upstream basin. The velocity meter and stormwater sample intake tubing will need to be routed to the manhole location through the curb inlet approximately 10 feet away. The shelter, autosampler, rain gauge, solar panel and associated equipment will be installed in the right of way just east of the curb inlet.

Team members approved this location. Construction of a new home is proposed adjacent to the right of way, so the City will reach out to the contractor to advise them to be cautious of the equipment.

<u>Outfall 5</u>

The desired sampling location for the Flamingo Ditch is about 150' landward of the beach in an area where the ditch cross-section appears to be stable. The channel is about 40' wide here and the proposed shelter could be located on the south bank. The velocity meter and sampling tubing would be installed in the center of the channel.

Gary spoke with the Villas of Venice Homeowners Association President (Mike Mueller) about the project and requested permission to install the sampling equipment and access through their property.

He sounded optimistic that he could get HOA approval. Gary subsequently sent him an email summary of the project and desired access arrangement along with some photographs of the set up.

Team members approved this location. Kathleen mentioned the City received an agreement for work in the Flamingo Ditch from the Inland Shores community to the north. We can probably use this agreement if needed to access the site should the Villas not grant permission.

<u>Outfall 8</u>

Two locations were reviewed for monitoring Deertown Gully. One potential location is up within the outfall channel about 150 waterward of the beach face. This site would be set up similar to Outfall 5 but would require consent of the landowner on the south side of the Gully. Steven indicated that the house is on the market, so gaining permission for a long term set up could be problematic. Access would also be problematic for installation and downloads as the nearest access is not for the public.

The second potential location is where Sunset Drive terminates at the ditch. The velocity meter and water quality intake can be installed in the center of the Gully downstream of the road inflows so the same stormwater discharge would be sampled. The line and tubing will be routed over a concrete stormwater runoff swale at the end of the road. The shelter and equipment could be installed in the right of way at the end of Sunset Drive.

The location off Sunset Drive was approved, as recommended, because of the stability of the flow cross-section and ease of mobilization, monitoring, and access from City right of way.

<u>Outfall 10</u>

The outfall structure located about 225’ waterward of the beach is the desired monitoring location. There is a 24” outfall pipe from the outfall structure to the beach and the pipe at the beach is covered at this time. The potential for this pipe to be intermittently blocked to different degrees by beach sand indicates that a velocity meter in the discharge pipe up at the structure will provide the most accurate data. The intake tubing will be located in the one-foot deep basin within the structure as the stormwater will be well mixed. The shelter and equipment will be located a few feet waterward on a higher ridge.

Team members approved this location. The City may remove the sand from in front of the beach outfall as a blocked pipe can result in parking lot flooding.

<u>Outfalls 14 and 17</u>

Both of these potential locations were evaluated to determine the best location of the two.

Outfall 17 would need to be sampled through an outfall grate off Santa Maria Street. The grate had to be dug up and is very heavy (took all three of us to lift and replace). (It’s also square so there is a potential for it to fall in when handled). The discharge pipe can be well instrumented with a velocity meter and intake tubing using a scissor ring. The cables and tubing would need to be run through the grate to avoid pinching. The shelter and equipment could be installed on the right of way, but there is substantial tree cover that would adversely impact solar charging and rainfall. An extra modem would be needed to communicate with a different rain gauge to activate this site. Monitoring Outfall 17 would require addition equipment and cell phone service not in the current budget. Potentially, the shelter could be located approximately 20 feet to west on the right of way to reduce tree canopy issues, but this area is gravel and appears to be used for parking.

The proposed sampling location for Outfall 14 is in the large culvert just downstream of the open ditch parallel to Osprey Street. The velocity meter and intake tubing would be installed a few feet into the culvert below the baffle box. The cable and tubing would be protected within flexible PVC pipe installed along the bottom of the headwall. The shelter could be installed on the east side of the ditch at the top of bank in the right of way. The shelter location has unrestricted access to sun and rain for charging and measurement.

Outfall 14 was approved for monitoring under the current contract. However, on the east side of the Osprey Street ditch is a new home and placing the sheltered on the mowed lawn could be an issue. As such, the plan now includes placing the shelter at the top of the bank adjacent to Osprey Street on the west side of the ditch. Kathleen and Steven were okay with VHB securing the protective conduit, containing the cable and water sampling tubing, to the head wall of the culvert to reduce tripping hazards.

Appendix B

Table B1. Summary of storm event and overall EMCs for Enterococci bacteria.

Sampling Event	Date	ENTEROCOCCI (#/100 mL)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	**5,200**	**2,500**	**11,800**	**470**	**570**	4,108
Event 2	6/13/2020		**800**			**440**	620
Event 3	7/8/2020		**370**	**250**			310
Event 4	7/17/2020	**20,000**		**5,400**		**6,900**	10,767
Event 5	7/22/2020		**420**	**78,000**		**3,900**	27,440
Event 6	8/18/2020		**900**				900
Event 7	9/4/2020	**13,000**	**4,000**	**13,000**			10,000
Event 8	9/11/2020	**860**				**18,000**	9,430
Event 9	9/21/2020		**50**	**470**		**670**	397
Event 10	9/30/2020	**3,500**		**2,400**	**6,000**		3,967
Event 11	10/11/2020	**1,500**					1,500
Event 12	10/27/2020		**4,500**	**3,200**		**6,500**	4,733
Event 13	11/12/2020	**3,800**	**7,600**	**4,700**	**16,900**	**4,400**	7,480
Event 14	11/23/2020				**300**		300
Event 15	12/1/2020	**7,400**		**7,200**	**660**	**11,600**	6,715
Event 16	12/8/2020	**1,300**	**1,200**		**3,300**	**2,600**	2,100
Minimum		**440**	**860**	**50**	**250**	**300**	
Maximum		**18,000**	**20,000**	**7,600**	**78,000**	**16,900**	
Average		**5,558**	**6,284**	**2,234**	**12,642**	**4,605**	

Bold Values Exceed Marine Criterion

FAC CH. 62-302 Class III Marine Waters

MPN or MF counts shall not exceed a monthly geometric mean of 35 nor exceed the Ten Percent Threshold Value (TPTV) of 130 in 10% or more of the samples during any 30-day period. Monthly geometric means shall be based on a minimum of 10 samples taken over a 30-day period.

Table B2. Summary of storm event and overall EMCs for Fecal Coliform bacteria.

Sampling Event	Date	FECAL COLIFORM (#/100 mL)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	**10,700**	**2,600**	**20,000**	**4,000**	**2,300**	7,920
Event 2	6/13/2020		**600**			**500**	550
Event 3	7/8/2020		**2,500**	**430**			1,465
Event 4	7/17/2020	**20,000**		**20,000**		**20,000**	20,000
Event 5	7/22/2020		**1,800**	**5,200**		**11,000**	6,000
Event 6	8/18/2020		**5,300**				5,300
Event 7	9/4/2020	**124,000**	**70,000**	**7,000**			67,000
Event 8	9/11/2020	**6,700**				**8,800**	7,750
Event 9	9/21/2020		**250**	**400**		**2,000**	883
Event 10	9/30/2020	**8,500**		**180**	**3,300**		3,993
Event 11	10/11/2020	**2,000**					2,000
Event 12	10/27/2020		**8,400**	**1,100**		**1,000**	3,500
Event 13	11/12/2020	**1,000**	**6,700**	**2,300**	**4,400**	**800**	3,040
Event 14	11/23/2020				90		90
Event 15	12/1/2020	**12,000**		**3,700**	90	**11,600**	6,848
Event 16	12/8/2020	**100**	**2,400**		100	**700**	825
	Minimum	**500**	**100**	**250**	**180**	**90**	
	Maximum	**20,000**	**124,000**	**70,000**	**20,000**	**4,400**	
	Average	**6,267**	**21,788**	**10,883**	**4,479**	**1,596**	

Bold Values Exceed Freshwater Criterion

FAC CH. 62-302 Class III Fresh Waters for E.Coli

MPN or MF counts shall not exceed a monthly geometric mean of 126 nor exceed the Ten Percent Threshold Value (TPTV) of 410 in 10% or more of the samples during any 30-day period. Monthly geometric means shall be based on a minimum of 10 samples taken over a 30-day period.

Table B3. Summary of storm event and overall EMCs for Turbidity.

Sampling Event	Date	TURBIDITY (NTU)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	3.5	**100**	2.2	1.0	1.0	21.5
Event 2	6/13/2020		11			4.3	7.7
Event 3	7/8/2020		21	7.5			14.3
Event 4	7/17/2020	16.2		5.97		2.69	8.3
Event 5	7/22/2020		**65**	3.3		5.8	24.7
Event 6	8/18/2020		1.1				1.1
Event 7	9/4/2020	3.4	5.6	7.7			5.6
Event 8	9/11/2020	2.4				7.7	5.1
Event 9	9/21/2020		23	12		5.7	13.6
Event 10	9/30/2020	5.6		8.3	11		8.3
Event 11	10/11/2020	3.0					3.0
Event 12	10/27/2020		38	11		29	26.0
Event 13	11/12/2020	5.2	31	10	2.3	13	12.3
Event 14	11/23/2020				0.6		0.6
Event 15	12/1/2020	10		6.9	1.1	11	7.3
Event 16	12/8/2020	3.42	6.97		4.96	3.45	4.7
	Minimum	**1.0**	**2.4**	**1.1**	**2.2**	**0.6**	
	Maximum	**29.0**	**16.2**	**100**	**12.0**	**11.0**	
	Average	**8.4**	**5.9**	**30.3**	**7.5**	**3.5**	

FAC CH. 62-302 Class III Waters Criteria: ≤ 29 above natural background conditions

Bold =Exceeds Class III Waters Criteria

Table B4. Summary of storm event and overall EMCs for Total Suspended Solids.

Sampling Event	Date	TOTAL SUSPENDED SOLIDS (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	16.5	15.0	4.33	2.50	3.25	8.3
Event 2	6/13/2020		44.0			12.0	28.0
Event 3	7/8/2020		35.8	30.0			32.9
Event 4	7/17/2020	35.2		17.0		6.40	19.5
Event 5	7/22/2020		114	33.8		16.9	54.9
Event 6	8/18/2020		23.9				23.9
Event 7	9/4/2020	4.80	13.20	25.6			14.5
Event 8	9/11/2020	0.976				17.0	9.0
Event 9	9/21/2020		22.5	31.0		13.8	22.4
Event 10	9/30/2020	15.7		36.7	6.33		19.6
Event 11	10/11/2020	6.00					6.0
Event 12	10/27/2020		83.0	45.5		76.0	68.2
Event 13	11/12/2020	19.0	87.7	28.7	2.67	28.3	33.3
Event 14	11/23/2020				0.600		0.6
Event 15	12/1/2020	50.0		25.0	2.00	54.0	32.8
Event 16	12/8/2020	17.0	17.3		4.23	8.33	11.7
Minimum		**3.25**	**0.98**	**13.2**	**4.33**	**0.60**	
Maximum		**76.0**	**50.0**	**114**	**45.5**	**6.33**	
Average		**23.6**	**18.4**	**45.6**	**27.8**	**3.06**	

No FAC CH. 62-302 Class III Waters Criteria

Table B5. Summary of storm event and overall EMCs for Ammonia Nitrogen.

Sampling Event	Date	AMMONIA NITROGEN (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	0.147	0.611	0.174	0.016	0.202	0.230
Event 2	6/13/2020		0.008 U			0.094	0.049
Event 3	7/8/2020		0.116	0.085			0.101
Event 4	7/17/2020	0.242		0.008 U		0.008 U	0.083
Event 5	7/22/2020		0.119	0.110		0.008 U	0.078
Event 6	8/18/2020		0.223				0.223
Event 7	9/4/2020	0.068	0.135	0.039			0.081
Event 8	9/11/2020	0.075				0.058	0.067
Event 9	9/21/2020		1.00	0.461		0.364	0.608
Event 10	9/30/2020	0.309		0.212	0.120		0.214
Event 11	10/11/2020	0.080					0.080
Event 12	10/27/2020		0.208	0.286		0.075	0.190
Event 13	11/12/2020	0.015	0.982	0.920	0.010	0.403	0.466
Event 14	11/23/2020				0.087		0.087
Event 15	12/1/2020	0.072		0.703	0.033	0.165	0.243
Event 16	12/8/2020	0.126	0.355		0.008 U	0.030	0.129
Minimum		**0.015**	**0.008 U**	**0.008 U**	**0.008 U**	**0.008 U**	
Maximum		**0.309**	**1.000**	**0.920**	**0.120**	**0.403**	
Average		**0.126**	**0.375**	**0.299**	**0.045**	**0.140**	

No Single sampling event criteria for FAC CH. 62-302 Class III Waters Criteria

U = Values below Method Detection Limits - used half of MDL for calculations

Table B6. Summary of storm event and overall EMCs for Total Kjeldahl Nitrogen.

Sampling Event	Date	TOTAL KJELDAHL NITROGEN (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	1.22	1.56	1.15	0.914	0.621	1.093
Event 2	6/13/2020		0.421			0.892	0.657
Event 3	7/8/2020		0.618	1.27			0.944
Event 4	7/17/2020	2.09		1.20		0.418	1.236
Event 5	7/22/2020		0.314	0.558		0.601	0.491
Event 6	8/18/2020		0.499				0.499
Event 7	9/4/2020	0.799	1.17	1.16			1.043
Event 8	9/11/2020	0.685				0.711	0.698
Event 9	9/21/2020		1.00	3.43		0.956	1.795
Event 10	9/30/2020	1.30		3.00	2.21		2.170
Event 11	10/11/2020	1.65					1.650
Event 12	10/27/2020		3.10	1.75		2.90	2.583
Event 13	11/12/2020	1.27	1.04	1.04	0.967	0.484	0.960
Event 14	11/23/2020				1.56		1.560
Event 15	12/1/2020	1.59		0.742	1.32	1.46	1.278
Event 16	12/8/2020	1.38	0.792		1.05	0.804	1.007
Minimum		**0.685**	**0.314**	**0.558**	**0.914**	**0.418**	
Maximum		**2.09**	**3.10**	**3.43**	**2.21**	**2.90**	
Average		**1.33**	**1.05**	**1.53**	**1.34**	**0.985**	

FAC CH. 62-302 Criteria for Nutrients

A. The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C.

B. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

Table B7. Summary of storm event and overall EMCs for Organic Nitrogen.

Sampling Event	Date	ORGANIC NITROGEN (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	1.07	0.949	0.976	0.898	0.419	0.863
Event 2	6/13/2020		0.417			0.798	0.608
Event 3	7/8/2020		0.502	1.19			0.844
Event 4	7/17/2020	1.85		1.20		0.414	1.153
Event 5	7/22/2020		0.195	0.448		0.597	0.413
Event 6	8/18/2020		0.276				0.276
Event 7	9/4/2020	0.731	1.04	1.12			0.962
Event 8	9/11/2020	0.610				0.653	0.632
Event 9	9/21/2020		0.001 U	2.97		0.592	1.187
Event 10	9/30/2020	0.991		2.79	2.09		1.956
Event 11	10/11/2020	1.57					1.570
Event 12	10/27/2020		2.89	1.46		2.83	2.394
Event 13	11/12/2020	1.255	0.058	0.120	0.957	0.081	0.494
Event 14	11/23/2020				1.47		1.473
Event 15	12/1/2020	1.52		0.039	1.29	1.30	1.035
Event 16	12/8/2020	1.25	0.437		1.05	0.774	0.878
Minimum		**0.610**	**0.001 U**	**0.039**	**0.898**	**0.081**	
Maximum		**1.85**	**2.89**	**2.97**	**2.09**	**2.83**	
Average		**1.21**	**0.676**	**1.23**	**1.29**	**0.845**	

FAC CH. 62-302 Criteria for Nutrients

A. The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C.
B. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

U = Values below Method Detection Limits - used half of MDL for calculations

Table B8. Summary of storm event and overall EMCs for Nitrate + Nitrite Nitrogen.

Sampling Event	Date	NITRATE+NITRITE AS N (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	0.278	0.009	0.060	0.007	0.310	0.133
Event 2	6/13/2020		0.006 U			0.239	0.121
Event 3	7/8/2020		0.006 U	0.006 U			0.006 U
Event 4	7/17/2020	0.316		0.006 U		0.024	0.114
Event 5	7/22/2020		0.035	0.006 U		0.154	0.064
Event 6	8/18/2020		0.195				0.195
Event 7	9/4/2020	0.136	0.006 U	0.101			0.080
Event 8	9/11/2020	0.128				0.149	0.139
Event 9	9/21/2020		0.010	0.022		0.128	0.053
Event 10	9/30/2020	0.144		1.390	0.892		0.809
Event 11	10/11/2020	0.101					0.101
Event 12	10/27/2020		0.031	0.079		0.189	0.100
Event 13	11/12/2020	0.051	0.053	0.064	0.015	0.017	0.040
Event 14	11/23/2020				0.006 U		0.003
Event 15	12/1/2020	0.186		0.025	0.006 U	0.153	0.092
Event 16	12/8/2020	0.172	0.006 U		0.006 U	0.184	0.091
Minimum		**0.051**	**0.006 U**	**0.006 U**	**0.006 U**	**0.017**	
Maximum		**0.316**	**0.195**	**1.390**	**0.892**	**0.310**	
Average		**0.168**	**0.035**	**0.175**	**0.154**	**0.155**	

FAC CH. 62-302 Criteria for Nutrients

A. The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C.
B. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

U = Values below Method Detection Limits - used half of MDL for calculations

Table B9. Summary of storm event and overall EMCs for Total Nitrogen.

Sampling Event	Date	TOTAL NITROGEN (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	1.50	1.57	1.21	0.921	0.931	1.226
Event 2	6/13/2020		0.421			1.13	0.776
Event 3	7/8/2020		0.618	1.27			0.944
Event 4	7/17/2020	2.41		1.20		0.442	1.351
Event 5	7/22/2020		0.349	0.558		0.755	0.554
Event 6	8/18/2020		0.694				0.694
Event 7	9/4/2020	0.935	1.17	1.26			1.122
Event 8	9/11/2020	0.813				0.860	0.837
Event 9	9/21/2020		1.01	3.45		1.08	1.847*
Event 10	9/30/2020	1.44		4.39	3.10		2.977*
Event 11	10/11/2020	1.75					1.750*
Event 12	10/27/2020		3.13	1.83		3.09	2.683*
Event 13	11/12/2020	1.32	1.09	1.10	0.982	0.501	0.999
Event 14	11/23/2020				1.56		1.560
Event 15	12/1/2020	1.78		0.767	1.32	1.61	1.369
Event 16	12/8/2020	1.55	0.792		1.05	0.988	1.095
Minimum		**0.813**	**0.349**	**0.558**	**0.921**	**0.442**	
Maximum		**2.41**	**3.13**	**4.39**	**3.10**	**3.09**	
Average		**1.50**	**1.08**	**1.70**	**1.49**	**1.14**	
Geo Mean		**1.43**	**0.891**	**1.41**	**1.35**	**0.978**	

FAC 62-302.531 Numeric Interpretations of Narrative Nutrient Criteria for Class III Waters Criteria:
Annual Geomean for freshwater streams - <1.65 mg/L

Table B10. Summary of storm event and overall EMCs for Orthophosphorus.

Sampling Event	Date	ORTHO PHOSPHORUS AS P (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	0.174	0.297	0.190	0.273	0.151	0.217
Event 2	6/13/2020		0.078			0.185	0.132
Event 3	7/8/2020		0.131	0.094			0.113
Event 4	7/17/2020	0.274		0.352		0.045	0.224
Event 5	7/22/2020		0.022	0.053		0.098	0.058
Event 6	8/18/2020		0.068				0.068
Event 7	9/4/2020	0.082	0.153	0.002 U			0.079
Event 8	9/11/2020	0.092				0.106	0.099
Event 9	9/21/2020		0.096	0.187		0.142	0.142
Event 10	9/30/2020	0.168		0.211	0.343		0.241
Event 11	10/11/2020	0.148					0.148
Event 12	10/27/2020		0.613	0.107		0.166	0.295
Event 13	11/12/2020	0.046	0.152	0.056	0.449	0.045	0.150
Event 14	11/23/2020				0.252		0.252
Event 15	12/1/2020	0.165		0.093	0.286	0.186	0.183
Event 16	12/8/2020	0.183	0.227		0.264	0.200	0.219
	Minimum	**0.046**	**0.022**	**0.002 U**	**0.252**	**0.045**	
	Maximum	**0.274**	**0.613**	**0.352**	**0.449**	**0.200**	
	Average	**0.148**	**0.184**	**0.134**	**0.311**	**0.132**	

FAC CH. 62-302 Criteria for Nutrients

A. The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C.
B. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

U = Values below Method Detection Limits - used half of MDL for calculations

Table B11. Summary of storm event and overall EMCs for Total Phosphorus.

Sampling Event	Date	TOTAL PHOSPHORUS AS P (mg/L)					Event Average
		Outfall 2	Outfall 5	Outfall 8	Outfall 10	Outfall 1400	
Event 1	6/3/2020	0.271	0.432	0.287	0.370	0.212	0.314
Event 2	6/13/2020		0.179			0.355	0.267
Event 3	7/8/2020		0.217	0.327			0.272
Event 4	7/17/2020	0.439		0.644		0.090	0.391
Event 5	7/22/2020		0.156	0.124		0.172	0.151
Event 6	8/18/2020		0.112				0.112
Event 7	9/4/2020	0.218	0.287	0.223			0.243
Event 8	9/11/2020	0.174				0.292	0.233
Event 9	9/21/2020		0.243	0.864		0.282	0.463
Event 10	9/30/2020	0.175		0.552	0.922		0.550
Event 11	10/11/2020	0.229					0.229
Event 12	10/27/2020		1.14	0.458		0.465	0.688
Event 13	11/12/2020	0.239	0.442	0.323	0.577	0.151	0.346
Event 14	11/23/2020				0.321		0.321
Event 15	12/1/2020	0.183		0.265	0.389	0.374	0.303
Event 16	12/8/2020	0.321	0.352		0.317	0.200	0.298
	Minimum	**0.174**	**0.112**	**0.124**	**0.317**	**0.090**	
	Maximum	**0.439**	**1.14**	**0.864**	**0.922**	**0.465**	
	Average	**0.250**	**0.356**	**0.407**	**0.483**	**0.259**	
	Geo Mean	**0.239**	**0.286**	**0.354**	**0.445**	**0.235**	

FAC 62-302.531 Numeric Interpretations of Narrative Nutrient Criteria for Class III Waters Criteria:
Annual Geomean for freshwater streams - <0.49 mg/L

Appendix C

Table C1. Summary of storm event and overall data for Specific Conductivity.

Sampling Event	Date	Specific Conductivity (µS/cm)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		786		**45,340**		**44,606**		366		**50,564**		28332
Event 2	6/13/2020				**19,070**						**3,006**		11038
Event 3	7/8/2020			**38,392**	**15,404**	771	**12,603**					19582	14004
Event 4	7/17/2020	191	552		**8,261**	450	427				**47,741**	320	14245
Event 5	7/22/2020			**47,520**	**51,513**	**47,169**	**31,834**			**11,852**	**54,579**	35514	45975
Event 6	8/18/2020			**51,605**	**54,740**							51605	54740
Event 7	9/4/2020	132	553	**35,279**	**43,225**	184	145					11865	14641
Event 8	9/11/2020	466	751							**5,450**	**1,331**	2958	1041
Event 9	9/21/2020				**42,617**	**40,116**	1,090			**16,372**	**1,498**	28244	15068
Event 10	9/30/2020		817			**6,051**	**19,839**	914	839	**12,909**	**37,693**	6625	14797
Event 11	10/11/2020	670	859									670	859
Event 12	10/27/2020	311	838	**10,311**	**6,658**	**19,276**	584			43	**42,772**	7485	12713
Event 13	11/12/2020	192	810	**36,867**	**20,119**	**39,798**	828	340	307	**27,681**	**32,864**	20976	10986
Event 14	11/23/2020								864				864
Event 15	12/1/2020	422	825			**32,131**	**28,755**		899	**14,833**	1,114	15795	7898
Event 16	12/8/2020		854	**18,547**	**17,986**				779	1,082	1,145	9814	5191
	Minimum	**132**	**552**	**10,311**	**6,658**	**184**	**145**	**340**	**307**	**43**	**1,114**		
	Maximum	**670**	**859**	**51,605**	**54,740**	**47,169**	**44,606**	**914**	**899**	**27,681**	**54,579**		
	Average	**340**	**765**	**34,074**	**29,539**	**20,661**	**14,071**	**627**	**676**	**11,278**	**24,937**		

Bold =Value exceeds Fresh Water Criteria (indicating tidal influence at these locations)

FAC CH.62-302 Class III Fresh Waters Criteria: Shall not be increased more than 50% above background or to 1275, whichever is greater.

Table C2. Summary of storm event and overall data for Salinity.

Sampling Event	Date	Salinity (ppt)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		0.39		29.87		29.33		0.18		33.77		18.71
Event 2	6/13/2020				11.50						1.58		6.54
Event 3	7/8/2020			23.56	9.12	0.38	7.34					11.97	8.23
Event 4	7/17/2020	0.09	0.27		4.65	0.22	0.21				31.68	0.15	9.20
Event 5	7/22/2020			31.30	34.47	31.22	20.17			6.86	36.78	23.13	30.47
Event 6	8/18/2020			34.52	36.96							34.52	36.96
Event 7	9/4/2020	0.06	0.27	22.56	28.35	0.09	0.07					7.57	9.56
Event 8	9/11/2020	0.22	0.37							2.98	0.67	1.60	0.52
Event 9	9/21/2020				27.87	25.80	0.55			9.50	0.76	17.65	9.73
Event 10	9/30/2020		0.40			3.33	12.00	0.45	0.42	7.68	24.31	3.82	9.28
Event 11	10/11/2020	0.32	0.43									0.32	0.43
Event 12	10/27/2020	0.15	0.41	5.81	3.69	11.63	0.29			0.02	27.98	4.40	8.09
Event 13	11/12/2020	0.09	0.40	22.43	12.15	25.79	0.41	0.16	0.15	17.05	20.86	13.10	6.79
Event 14	11/23/2020								0.43				0.43
Event 15	12/1/2020	0.20	0.41			20.23	17.99		0.45	8.44	0.56	9.62	4.85
Event 16	12/8/2020		0.42	10.81	10.70				0.38	0.54	0.58	5.67	3.02
	Minimum	**0.06**	**0.27**	**5.81**	**3.69**	**0.09**	**0.07**	**0.16**	**0.15**	**0.02**	**0.56**		
	Maximum	**0.32**	**0.43**	**34.52**	**36.96**	**31.22**	**29.33**	**0.45**	**0.45**	**17.05**	**36.78**		
	Average	**0.16**	**0.38**	**21.57**	**19.03**	**13.19**	**8.83**	**0.31**	**0.33**	**6.63**	**16.32**		

Table C3. Summary of storm event and overall data for Temperature.

Sampling Event	Date	Temperature (°C)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		29.95		28.34		27.96		25.27		29.01		28.11
Event 2	6/13/2020				28.92						28.92		28.92
Event 3	7/8/2020			5.07	30.36	28.80	30.45					16.93	30.41
Event 4	7/17/2020	5.98	29.51		29.37	9.19	27.36				30.96	7.59	29.30
Event 5	7/22/2020			21.14	27.98	28.37	28.91			23.88	27.72	24.46	28.20
Event 6	8/18/2020			27.17	31.07							27.17	31.07
Event 7	9/4/2020	6.58	30.56	25.02	31.65	27.89	27.96					19.83	30.06
Event 8	9/11/2020	9.77	31.20							21.12	31.69	15.45	31.44
Event 9	9/21/2020				27.85	17.72	29.11			9.10	29.34	13.41	28.76
Event 10	9/30/2020		27.29			23.40	26.86	11.89	25.17	27.77	28.41	21.02	26.93
Event 11	10/11/2020	4.70	29.67									4.70	29.67
Event 12	10/27/2020	5.73	28.76	11.01	27.44	16.55	27.47			14.74	27.78	12.01	27.86
Event 13	11/12/2020	5.34	27.07	4.27	22.25	25.43	25.41	17.54	25.89	14.03	24.71	13.32	25.07
Event 14	11/23/2020								21.19				21.19
Event 15	12/1/2020	4.62	22.46			18.89	23.47		19.54	6.14	25.13	9.88	22.65
Event 16	12/8/2020		20.21	8.72	16.33				14.95	10.02	21.31	9.37	18.20
Minimum		**4.62**	**20.21**	**4.27**	**16.33**	**9.19**	**23.47**	**11.89**	**14.95**	**6.14**	**21.31**		
Maximum		**9.77**	**31.20**	**27.17**	**31.65**	**28.80**	**30.45**	**17.54**	**25.89**	**27.77**	**31.69**		
Average		**6.10**	**27.67**	**14.63**	**27.41**	**21.80**	**27.50**	**14.71**	**22.00**	**15.85**	**27.72**		

Table C4. Summary of storm event and overall data for pH.

Sampling Event	Date	pH (units)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		6.48		7.39		6.97		6.49		7.78		7.02
Event 2	6/13/2020				7.22						6.65		6.94
Event 3	7/8/2020			7.72	7.18	6.56	7.02					7.14	7.10
Event 4	7/17/2020	**8.60**	7.24		7.10	6.82	7.12				7.70	7.71	7.29
Event 5	7/22/2020			8.08	7.90	7.15	6.73			7.16	7.99	7.46	7.54
Event 6	8/18/2020			7.47	8.07							7.47	8.07
Event 7	9/4/2020	7.01	6.30	6.82	7.52	7.01	6.55					6.95	6.79
Event 8	9/11/2020	7.14	6.60							7.15	6.54	7.14	6.57
Event 9	9/21/2020				7.72	7.70	6.78			7.42	6.73	7.56	7.08
Event 10	9/30/2020		7.34			7.42	6.67	8.40	6.81	6.82	7.18	7.55	7.00
Event 11	10/11/2020	7.60	6.93									7.60	6.93
Event 12	10/27/2020	7.99	7.35	7.77	7.33	6.80	6.85			7.54	7.37	7.52	7.23
Event 13	11/12/2020	8.32	6.82	7.61	7.23	7.24	6.74	6.84	6.48	7.74	7.27	7.55	6.91
Event 14	11/23/2020								6.47				6.47
Event 15	12/1/2020	7.53	6.93			6.67	6.31		6.71	6.25	6.49	6.82	6.61
Event 16	12/8/2020		7.09	7.18	7.02				6.91	7.21	6.44	7.19	6.87
	Minimum	**7.01**	**6.30**	**6.82**	**7.02**	**6.56**	**6.31**	**6.84**	**6.47**	**6.25**	**6.44**		
	Maximum	**8.60**	**7.35**	**8.08**	**8.07**	**7.70**	**7.12**	**8.40**	**6.91**	**7.74**	**7.99**		
	Average	**7.74**	**6.91**	**7.52**	**7.43**	**7.04**	**6.77**	**7.62**	**6.65**	**7.16**	**7.10**		

Bold =Value exceeds FAC CH. 62-302 Class III waters Criteria: pH range 6-8.5

Table C5. Summary of storm event and overall data for Dissolved Oxygen Percent Saturation.

Sampling Event	Date	Dissolved Oxygen (% Saturation)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		62.99		53.57		**34.42**		**18.47**		59.73		45.84
Event 2	6/13/2020				72.68						95.30		83.99
Event 3	7/8/2020			58.68	**30.28**	14.95	85.44					36.81	57.86
Event 4	7/17/2020	78.80	52.79		**16.95**	55.79	76.09				36.37	67.30	45.55
Event 5	7/22/2020			85.13	81.91	68.92	11.66			101.22	85.97	85.09	59.85
Event 6	8/18/2020			91.49	95.88							91.49	95.88
Event 7	9/4/2020	73.50	52.07	12.50	64.62	85.52	33.81					57.17	50.17
Event 8	9/11/2020	68.70	44.54							110.70	105.76	89.70	75.15
Event 9	9/21/2020				63.51	55.00	71.52			75.68	122.02	65.34	85.68
Event 10	9/30/2020		61.97			80.29	16.84	114.94	**7.51**	62.96	42.85	86.07	32.29
Event 11	10/11/2020	69.53	60.77									69.53	60.77
Event 12	10/27/2020	91.47	72.85	102.80	65.91	78.19	48.52			98.00	53.62	92.61	60.22
Event 13	11/12/2020	84.57	69.97	69.49	91.65	75.31	41.07	59.90	44.45	85.80	64.37	75.02	62.30
Event 14	11/23/2020								**35.40**				35.40
Event 15	12/1/2020	89.42	80.21			71.16	**9.64**		**27.82**	83.41	68.03	81.33	46.42
Event 16	12/8/2020		92.52	68.70	63.99				**38.33**	91.46	63.62	80.08	64.62
	Minimum	**68.70**	**44.54**	**12.50**	**16.95**	**14.95**	**9.64**	**59.90**	**7.51**	**62.96**	**36.37**		
	Maximum	**91.47**	**92.52**	**102.80**	**95.88**	**85.52**	**85.44**	**114.94**	**44.45**	**110.70**	**122.02**		
	Average	**79.43**	**65.07**	**69.83**	**63.72**	**65.01**	**42.90**	**87.42**	**28.66**	**88.65**	**72.51**		

Rule 62-302.533 Dissolved Oxygen Criteria - Minimum DO saturation levels: the daily average percent DO saturation shall not be below 42 percent saturation in more than 10 percent of the values in Class III marine waters. Minimum DO saturation levels: Class III predominantly freshwaters - No more than 10 percent of the daily average percent dissolved oxygen (DO) saturation values shall be below 38 percent.

Bold =Value exceeds FAC CH. 62-302 Class III waters Criteria

Table C6. Summary of storm event and overall data for Dissolved Oxygen (mg/L).

Sampling Event	Date	Dissolved Oxygen (mg/L)										Bottle Average	Channel Average
		Outfall 2 BOTTLE	Outfall 2 CHANNEL	Outfall 5 BOTTLE	Outfall 5 CHANNEL	Outfall 8 BOTTLE	Outfall 8 CHANNEL	Outfall 10 BOTTLE	Outfall 10 CHANNEL	Outfall 1400 BOTTLE	Outfall 1400 CHANNEL		
Event 1	6/3/2020		4.78		3.55		2.30		1.52		3.83		3.20
Event 2	6/13/2020				5.27						7.30		6.28
Event 3	7/8/2020			6.42	2.16	1.16	6.19					3.79	4.17
Event 4	7/17/2020	10.23	4.05		1.27	4.30	6.06				2.29	7.27	3.42
Event 5	7/22/2020			6.34	5.32	4.53	0.81			8.26	5.54	6.37	3.89
Event 6	8/18/2020			6.01	5.84							6.01	5.84
Event 7	9/4/2020	9.06	3.92	0.91	4.10	6.74	2.66					5.57	3.56
Event 8	9/11/2020	7.79	3.29							9.68	7.74	8.73	5.52
Event 9	9/21/2020				4.29	4.49	5.50			8.25	9.31	6.37	6.36
Event 10	9/30/2020		4.91			6.73	1.27	12.42	0.62	4.77	2.92	7.97	2.43
Event 11	10/11/2020	9.10	4.62									9.10	4.62
Event 12	10/27/2020	11.52	5.65	10.99	5.13	5.91	3.85			9.99	3.63	9.60	4.56
Event 13	11/12/2020	10.71	5.56	7.79	7.43	5.34	3.36	5.72	3.61	7.90	4.75	7.49	4.94
Event 14	11/23/2020								3.16				3.16
Event 15	12/1/2020	11.63	7.01			5.92	0.75		2.57	9.88	5.65	9.15	3.99
Event 16	12/8/2020		8.45	8.06	6.33				3.90	10.41	5.69	9.24	6.09
	Minimum	**7.79**	**3.29**	**0.91**	**1.27**	**1.16**	**0.75**	**5.72**	**0.62**	**4.77**	**2.29**		
	Maximum	**11.63**	**8.45**	**10.99**	**7.43**	**6.74**	**6.19**	**12.42**	**3.90**	**10.41**	**9.31**		
	Average	**10.01**	**5.22**	**6.65**	**4.61**	**5.01**	**3.27**	**9.07**	**2.57**	**8.64**	**5.33**		