Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

GLO Contract No. 19-043-000-B077

Final Report

Coastal Management Program- Cycle 23

Prepared by:

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Texas Community Watershed Partners

Stormwater Wetland Program Specialist

August 2020

THIS PROJECT IS FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

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Project Overview

As development increases, so does the requirement for drainage infrastructure, currently there is a lot of talk and emphasis on Green Infrastructure or using nature-based approaches to mitigate stormwater issues such as flooding and water quality. Flood mitigation aspects of stormwater wetlands are easier to see and quantify, and have been well documented at these and other projects in the area. On the other hand the water quality, especially chemical and bacterial components are harder to see and there was little research on these benefits of stormwater wetlands in our area. Addressing the need for water quality data in the Lower Galveston Bay Watershed projects led the decision by Texas A&M AgriLife Extension Service (AgriLife) and their project partners to study the water quality benefits of their stormwater wetland demonstration projects in various basin types and watersheds in this area. As more wetlands are implemented as green infrastructure Best Management Practices, more robust water quality data is needed to verify the effectiveness of the technique and guide modifications in the design of subsequent wetland prototypes.

Using CMP Cycle 23 funds, AgriLife developed a Quality Assurance Project Plan (QAPP) covering water quality monitoring protocol and sampled three stormwater wetland sites designed and planted by Texas A&M in the Galveston Bay Area. Sampling occurred at three locations: Exploration Green Conservation and Recreation Area, Phase 1, the University of Texas Research Park (UTRP) stormwater wetland and the Proton Therapy Parking Lot Expansion (PTWB) stormwater wetland basin on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center. Sites were sampled by ISCO 6712 automated samplers during qualifying rain events, then samples were collected by AgriLife staff after the events. We expected an average of 2 events per month. The plan was to collect samples on 5-8 events per site which will provide data on up to 72 samples over the sampling period. The samples collected were sent to Eastex Labs for analysis then AgriLife compiled the results of the lab analysis reports and field collected data for dissemination on a webpage on the TCWP AgriLife system website, web based presentations to our project partners and a white paper.

Project Partners and Site Background

This project was designed working with project partners from UT MD Anderson and Exploration Green conservancy and the Clear Lake City Water Authority. These partners provided demonstration project site and were very interested in knowing more about the water quality features of their sites and how the constructed stormwater wetlands are performing in our area. A little bit of history on the three sites selected for this project. These sites are located in 2 sub-watersheds, Brays Bayou and Clear Creek, of the Lower Galveston Bay Watershed. The sites were completed at different times from 2016-2020 and are in variable states of establishment, they have urban, downtown Houston, and suburban, Clear Lake neighborhood, characteristics and are of variable sizes, ranging from just under 0.5 acres to approximately 6 acres.

A. University of Texas Recreation Park MD Anderson Campus (UTRP) Wetland
The University of Texas Research Park stormwater wetland is a 0.33-acre stormwater wetland basin on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center located near 7510 Bertner Rd. Houston, TX. The basin mitigates a 3 acre parking lot expansion, and is in the Brays Bayou watershed which is listed as impaired by the Texas Commission on Environmental Quality (TCEQ). Construction started around July 2016 with planting being completed in September 2017. This wetland has been established for 2 years prior to the start of the stormwater wetland water quality sampling beginning in September 2019.

Figure 1. UTRP from Inflow looking east

Figure 2. UTRP from outflow looking north

B. Exploration Green Recreation Park Phase 1 (EG) Stormwater Wetland
Exploration Green Conservation and Recreation Area is transforming the defunct Clear Lake Golf Course into a stormwater detention facility with five segments ("Phases") each containing an open water lake, constructed wetlands, habitat island, and walking trails. The 200-acre site receives stormwater runoff from an approximately 2000-acre predominantly suburban watershed, which is itself in the Armand Bayou watershed, 303 (d) listed as impaired by the US EPA and TCEQ. Exploration Green Phase 1 is located in Clear Lake City between Diana Ln and Ramada Dr. The primary inflow and outflow for this Phase of the 5 Phase project are located along the Reseda Dr. side of the detention basin. There are 7 backflow drains and a secondary stormwater drain that flow into Phase 1 from around the project. All of the inflow drains are under the ordinary water level. Phase 1 is a 14-acre lake containing 6 acres of wetlands planted in phases from 2016-2018. This wetland was established for roughly 1 year prior to the start of the water quality sampling beginning in December 2019. The adjacent Phase 2 detention

basin was under construction during the time of sampling and water levels fluctuated with the construction process.

Figure 3. Exploration Green Phase 1 stormwater wetland inside the trail

C. Proton Therapy Parking Lot Expansion Wetland Basin MD Anderson South Campus (PTWB)

The PTWB stormwater wetland is located at the corner of Fannin and Old Spanish Trail in 1800 block of Old Spanish Trail. This is a 0.62 acre site that collects stormwater from the parking lot expansion. This site was just completed in June 2019 and recently planted in June 2019 – February 2020. As these plants are still growing and filling in this wetland space, it has not had time to establish before the water quality testing began in March 2020.

Figure 4. Proton Therapy basin in February 2020

Figure 5. Proton Therapy basin in May 2020 during sampling

Task 1: Develop Project Methodology/Quality Assurance

AgriLife staff developed a Quality Assurance Project plan (QAPP) based on previous research to look at water quality of smaller scale projects and revised the QAPP to detail project description and methodology, including data collection in accordance with accredited certified lab practices and hold times for samples. AgriLife contracted with Eastex Labs to supply sample collection bottles in the appropriate size for each parameter sampled. Since our office does not have laboratory facilities available, Eastex also provided all the preservatives in the pre supplied bottles for each of the parameters being tested. Eastex Labs performed analysis of the samples and provided assistance with the development of the protocols and methodology identified by the QAPP. The protocols were based on the ISCO 6712 sampler capabilities and software. AgriLife already had several automated samplers and used cycle 23 funds to upgrade to solar arrays for the MD Anderson site. These sites were chosen for the solar arrays because of the distance from the office, limiting the travel for field maintenance and power resupply by the staff. Other funds were used to provide remote access to the sites via Verizon LTE modems and internal hardware upgrades to the ISCO 6712 automated samplers. These features made text alerts from the field capable to alert staff during a storm event that the samplers were sampling and another alert when the samples were complete and ready to be collected from the site to transport to the lab.

Figure 6. ISCO 6712 sampler, modem, power supply and array connections inside the sampling boxes.

All of these task as well as purchase of other ancillary supplies had to be completed before the installation of the samplers at the respective sites. Set up occurred at each of the sites in a staggered pattern to limit the need for more equipment. The first 2 samplers were set up, calibrated and tested at the UTRP site in September 2019.

Figure 7. Inflow sampler setup at UTRP

Figure 8. Outflow sampler set up at UTRP

Figure 9. Set up at UTRP in the inflow pipe

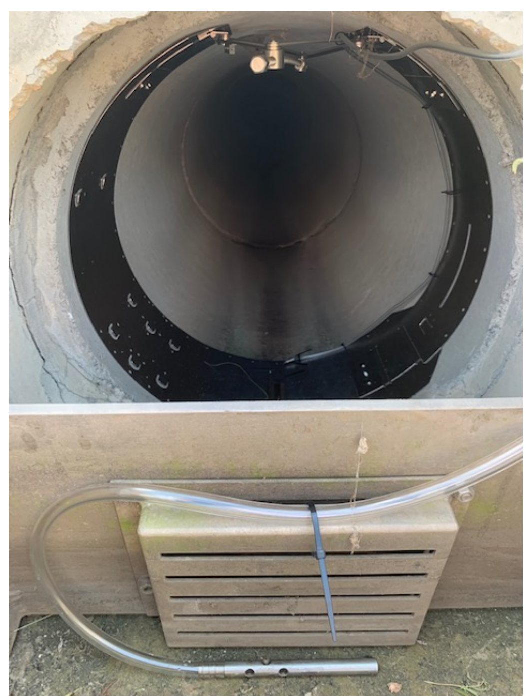


Figure 10. Set up at UTRP outflow pipe with control structure

The next sampler was set up, calibrated and tested at the outflow of the Exploration Green Phase 1 site in December 2019.

There was only one sampler used at this location due to all the inflows being under the permanent water level, the QAPP was adjusted to include grab samples collected near the inflow pipes in this case.

Figure 11. Sampler set up at Exploration Green Phase 1 at the outflow horseshoe area near Reseda Dr. Bridge.

The final sampler installation, calibration and testing took place in February 2020 at the MD Anderson PTWB location. This site has two inflows from the parking lot expansion we only sampled the inflow farthest from the outflow location.

Figure 12. PTWB inflow set up

Figure 13. PTWB outflow set up

Task 2: Water Quality Sampling

With the paired sampling sites identified for each of the three locations selected as identified on the map in Figure 14 below and the QAPP and protocols written sampling began for the following water quality parameters: total suspended solids, conductivity, dissolved oxygen, nitrate and nitrite, total phosphorous, ammonia and E. coli. Additional compounds of interest at the MD Anderson site were heavy metals and total petroleum hydrocarbons, because the watersheds of these basins are almost entirely composed of runoff from the adjacent parking lots.

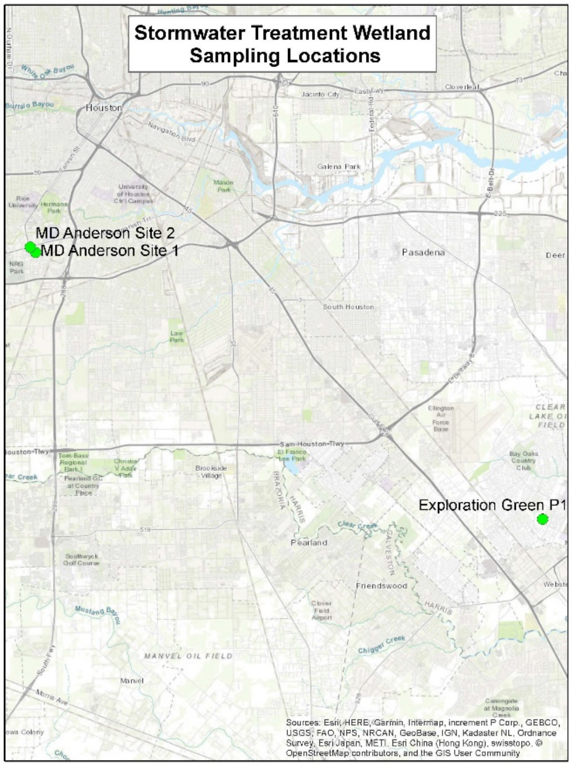


Figure 14. Map depicting sampling locations

Samples were collected as composite samples in 9L sampling jars at 10 minute intervals and grab samples taken at the Exploration Green Phase 1 inflow pipe location during each qualifying rain event. A qualifying rain event was described as 0.1”-0.3” (the rainfall amount criteria was increased at the PTWB location due to the design of the outfall) of rain per hour recorded by the tipping bucket rain gauge attached to the inflow location automated sampler. Inflow samplers were enabled when both the rainfall amount and flow level criteria were met. The flow level criteria was added due to only having one rain gauge per location. Flow level was measured with the ISCO 730 Bubble Flow Meter attached to the sampler. The flow meter criteria was set to 1” – 3” change in flow volume level. It was 1” change for UTRP and Exploration Green the level had to be adjusted at the PTWB location due to the design of the outflow control structure picture below.

Figure 15. Outflow structure at PTWB.

It is hard to tell from this image but the outfall pipe is approximately 2 inches above the suction line located on the concrete base of the outfall structure. Due to this design we needed higher rainfall events to create enough volume for a sample to flow out the outflow and create a paired sample for comparison.

Once the criteria to enable the samplers was tested and determined for the unique conditions at each site the samplers were programmed and running.

Figure 16. Photo of enable criteria setting on instrument. **Figure 17. Photo of screen when program is running**

Figure 18. Photo of sample display when samples are completed.

Samples were collected for approximately 5 months at each of the three stormwater wetland locations allowing for sampling in both cool and warm seasons. Samples were collected at UTRP from Sept. 2019 – February 2020, Exploration Green Phase 1 from December 2020 - June 2020, and PTWB from March 2020 – July 2020.
All the project details were recorded in 2 write in the rain field notebooks as shown in Figure 19. Field sample data was collected with the handheld YSI probe and recorded on field data sheets, shown in Figure 20, before samples were separated into the appropriate size testing jars for transport to the Eastex Labs for analysis.

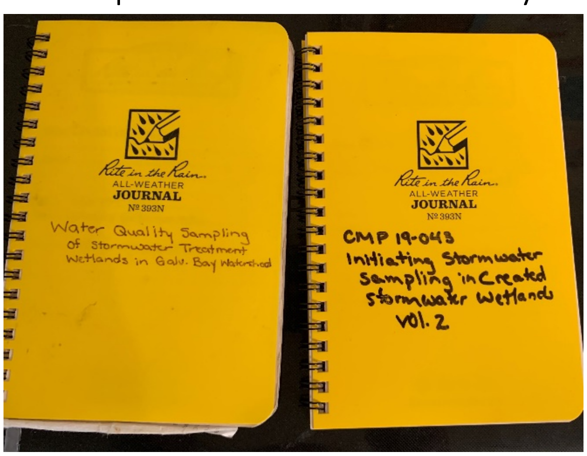
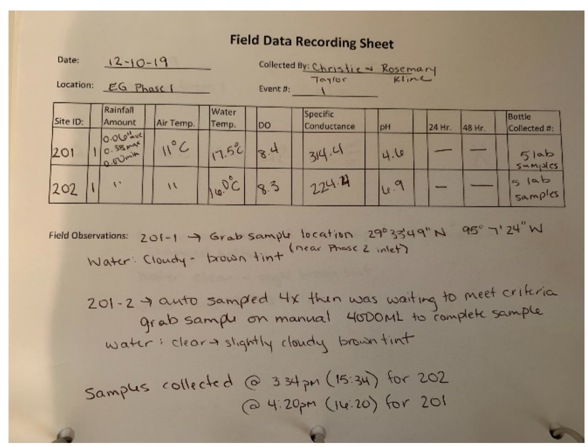


Figure 19. Field notebooks



Field Data Recording Sheet

Date: 12-10-19
Collected By: Christie Taylor + Rosemary Kline
Location: EG Phase I
Event #: 1

Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
201	1	0.06" ave 0.38 max 0.00 min	11°C	17.5°C	8.4	314.4	4.6	—	—	5 lab samples
202	1	"	"	16.0°C	8.3	224.4	6.9	—	—	5 lab samples

Field Observations: 201-1 → Grab sample location 29°33'49" N 95° 7' 24" W (near Phase 2 inlet)
Water: Cloudy - brown tint

201-2 → auto sampled 4x then was waiting to meet criteria grab sample on manual 4000ML to complete sample
water: clear → slightly cloudy brown tint

Samples collected @ 3:34pm (15:34) for 202
@ 4:20pm (16:20) for 201

Figure 20. Field data recording sheet

Field recorded data sheets and lab reports were added to the webpage and reported to the sponsor semi- quarterly as available from the lab. AgriLife staff updated sponsor on progress of project and data collection through quarterly progress reports and email communication.

Task 3: Data Sharing and Outreach

To share the results of this project, AgriLife create a dedicated project webpage at https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/ on the TCWP website (tcwp.tamu.edu). This page was updated over the course of the project. As results accumulate from the lab analyses, they were entered into tables summarized graphically in charts and graphs and distributed on the webpage.

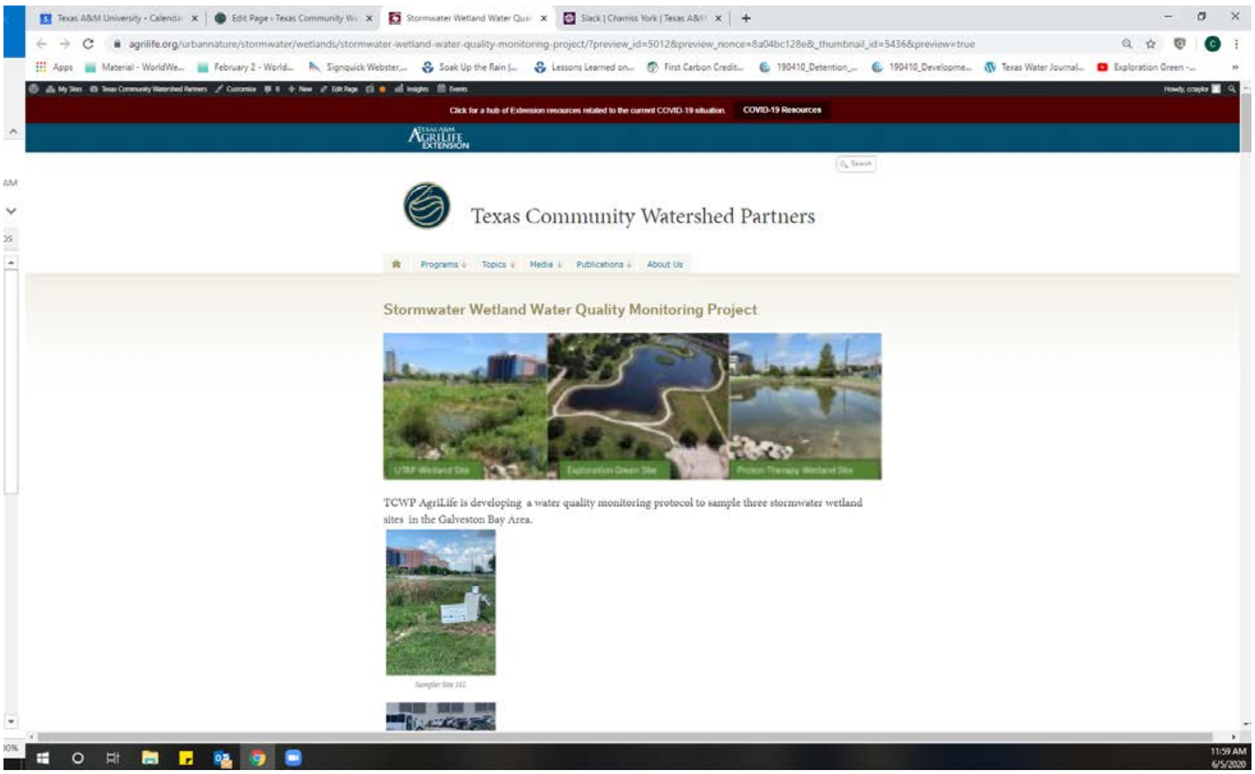


Figure 21. Screen shot of dedicated webpage

The links of the field data and lab reports are shown in Figure 22 as blue links.

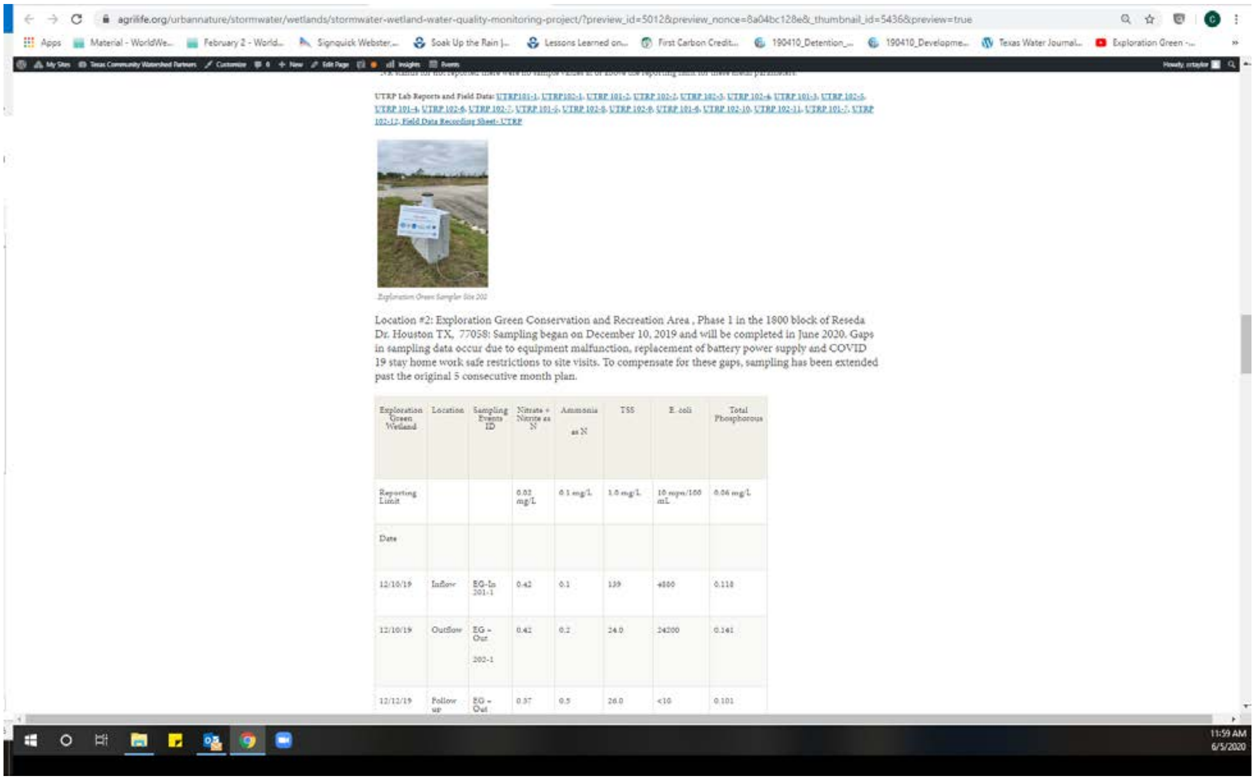
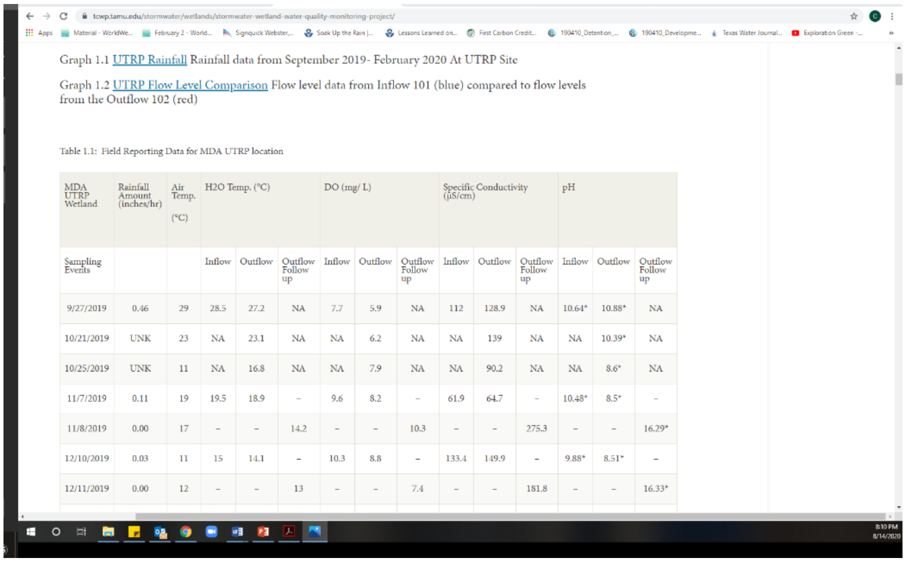


Figure 22. Screenshot of webpage showing links to lab report and division of page with table and updates

The webpage was created in three divisions, one for each location separated by photos of each sample site set up. This was to make it easier to find information for individual sites. Site updates and tables were included under each group of site photos. Graphs created by the ISCO Flowlink software for rainfall data and flow level data collected for each site were linked to the webpage as shown in Figure 23. Samples of the graphs are shown in Figures 24 and 25 below.



tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

Graph 1.1 UTRP Rainfall Rainfall data from September 2019- February 2020 At UTRP Site

Graph 1.2 UTRP Flow Level Comparison Flow level data from Inflow 101 (blue) compared to flow levels from the Outflow 102 (red)

Table 1.1: Field Reporting Data for MDA UTRP location

MDA UTRP Wetland	Rainfall Amount (inches/hr)	Air Temp. (°C)	H2O Temp. (°C)			DO (mg/ L)			Specific Conductivity (µS/cm)			pH		
Sampling Events			Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up
9/27/2019	0.46	29	28.5	27.2	NA	7.7	5.9	NA	112	128.9	NA	10.64*	10.88*	NA
10/21/2019	UNK	23	NA	23.1	NA	NA	6.2	NA	NA	139	NA	NA	10.39*	NA
10/25/2019	UNK	11	NA	16.8	NA	NA	7.9	NA	NA	90.2	NA	NA	8.6*	NA
11/7/2019	0.11	19	19.5	18.9	–	9.6	8.2	–	61.9	64.7	–	10.48*	8.5*	–
11/8/2019	0.00	17	–	–	14.2	–	–	10.3	–	–	275.3	–	–	16.29*
12/10/2019	0.03	11	15	14.1	–	10.3	8.8	–	133.4	149.9	–	9.88*	8.51*	–
12/11/2019	0.00	12	–	–	13	–	–	7.4	–	–	181.8	–	–	16.33*

Figure 23. Screenshot of Graph links (shown in blue)

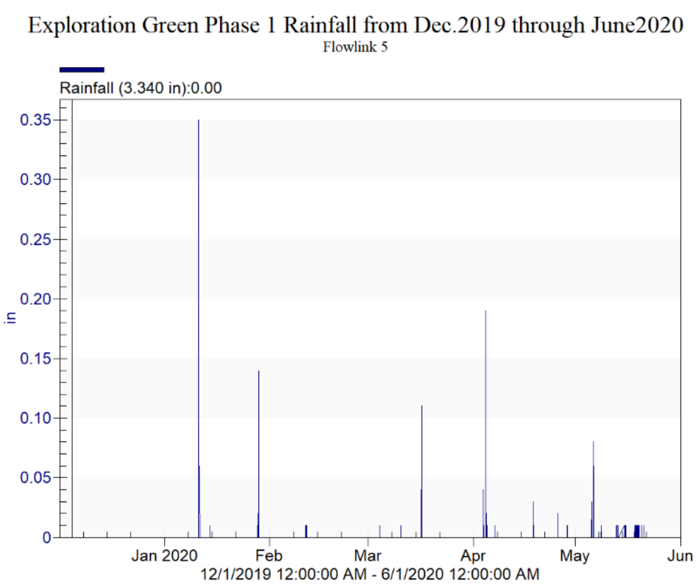


Figure 24. Screenshot of sample rainfall data collected from ISCO Flowlink software

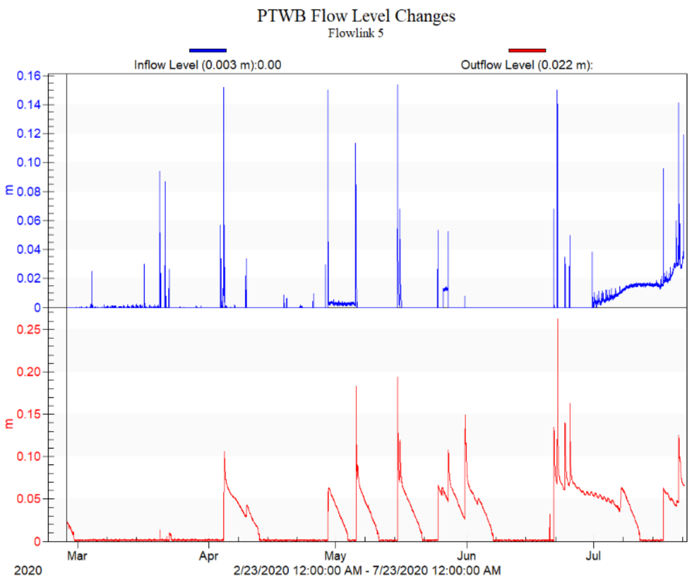


Figure 25. Screenshot of sample comparison chart of flow level changes over time recorded by ISCO Flowlink software

Charts depicting the tabular data are created in Excel and posted to the webpage as shown if Figure 26. All data collected by parameter for all three locations, or two locations in the case of metal parameters, are combined in one table and analyzed by paired t-test with tables and results posted to the webpage as shown in Figure 27. Sponsor logos and funding statement included on the webpage as shown in Figure 28.

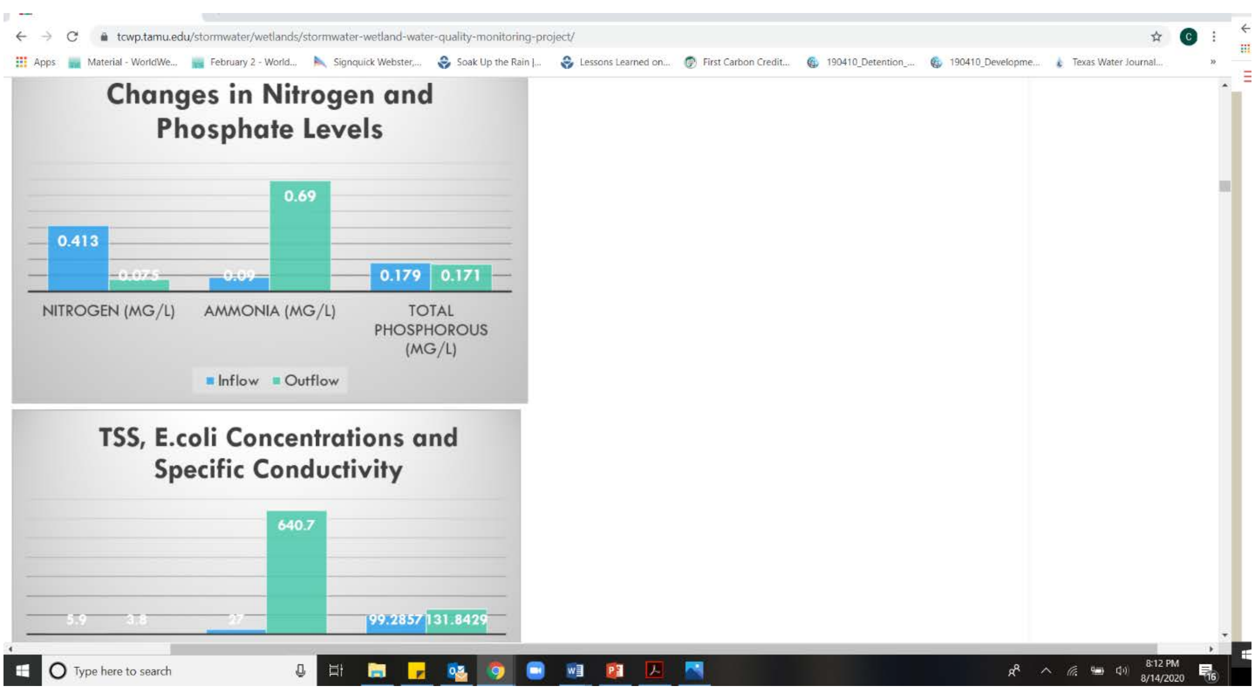
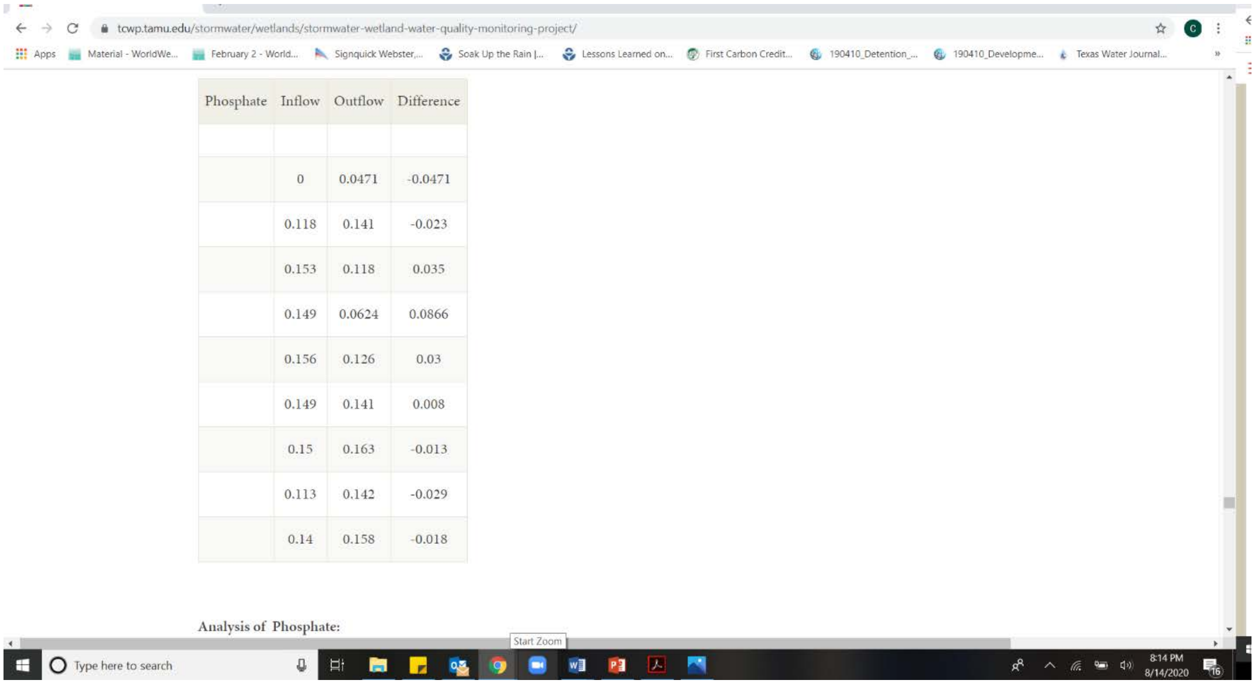


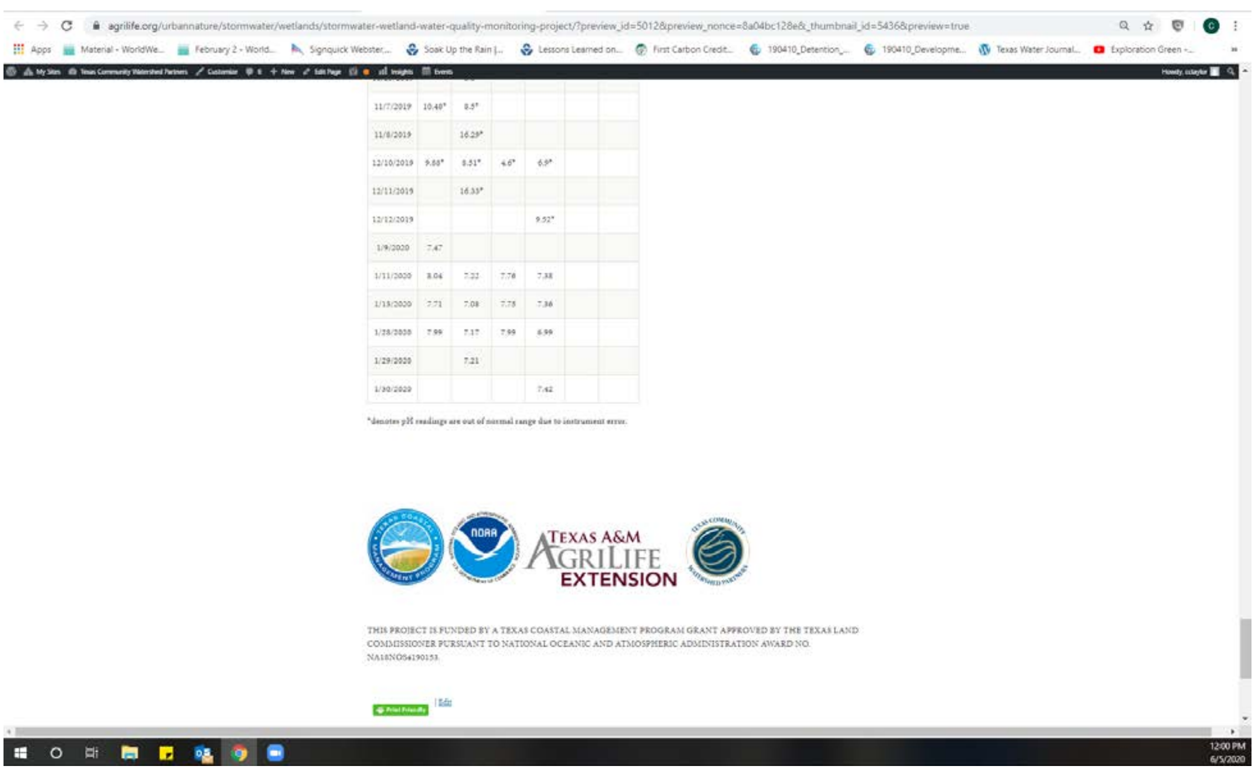
Figure 26. Screenshot of charts summarizing data compiled in tables by site on webpage



Phosphate	Inflow	Outflow	Difference
	0	0.0471	-0.0471
	0.118	0.141	-0.023
	0.153	0.118	0.035
	0.149	0.0624	0.0866
	0.156	0.126	0.03
	0.149	0.141	0.008
	0.15	0.163	-0.013
	0.113	0.142	-0.029
	0.14	0.158	-0.018

Analysis of Phosphate:

Figure 27. Screenshot of Phosphate table totally data across all three locations.



11/7/2019	10.40*	8.5*				
11/8/2019		16.29*				
12/10/2019	9.88*	8.51*	4.6*	6.9*		
12/11/2019		16.33*				
12/12/2019				9.52*		
1/9/2020	7.47					
1/11/2020	8.04	7.22	7.76	7.38		
1/15/2020	7.71	7.08	7.75	7.36		
1/28/2020	7.99	7.17	7.99	6.99		
1/29/2020		7.21				
1/30/2020				7.42		

*denotes pH readings are out of normal range due to instrument error.

TEXAS A&M AGRILIFE EXTENSION

THIS PROJECT IS FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

Figure 28. Partner and sponsor logos and funding statement as depicted on the webpage

Changes to staff and unforeseen circumstances related to the COVID-19 global pandemic that cancelled field trips and in person class meetings student visits originally proposed were cancelled. AgriLife staff shared information about the sampling technique and data collected with interested stakeholders who questioned staff onsite. And directed them to the QR on the moveable signs located at the sampler boxes. Water sampling description of parameters and testing method was shared with groups on the tours given by staff during a Wetland Walkabout event hosted by Exploration Green Conservancy and the Galveston Bay Foundation in February 2020. In Figure 30 below Christie Taylor is leading one of the tour groups discussing the important features of the stormwater wetland at Exploration Green Phase 1. This photo is taken near the inflow between Phases 1 and 2 of the project where grab samples were taken. In Figure 31 AgriLife staff are handing out material on Stormwater wetlands and discussing some of the wetland plants.

Movable signage to inform the public were designed, produced, and placed at each of the stormwater wetland sites during monitoring (shown in set up photos in Figures 7, 8, 12, and 13). The signage briefly describes the study, participants, and provide a link and a Quick Response Code (QRC) (Figure 29) to the project website.

Figure 29. QRC designed to direct traffic to the webpage o disseminate project information to the public.

Figure 30 Christie Taylor leading tour with Galveston Bay Foundation staff discussing the wetland creation at Phase 1 of Exploration Green and the water quality testing going on at this site. Photo courtesy of Jessica Bates.

Figure 31 Rosemary and Colleen manning the AgriLife table and talking about the plants and water quality benefits of stormwater wetlands at Wetland Walkabout February 2020. Photo courtesy of Jessica Bates.

AgriLife staff, Christie Taylor, presented the graphs and tables from this project to the Exploration Green Conservancy Board on August 11, 2020 at the monthly board meeting via Zoom. There were 11 board and advisory board members present at the meeting. The presentation shared is included in Appendix 4. This presentation was also emailed to the Clear Lake City Water Authority partners and discussed at their board meeting on Thursday August 13, 2020. A second presentation was prepared to share with the partners from UT MD Anderson, this presentation is also included in Appendix 4. The presentation was emailed to the partners and scheduled for presentation and discussion late August. The partners from Exploration Green and the Clear Lake City Water Authority have expressed interest in further water quality testing at their sites.

AgriLife staff have completed the white paper summarizing the results of the study. The white paper has been linked to the webpage for dissemination seen in Figure 32. A copy of the white paper is also added to this report in Appendix 5.

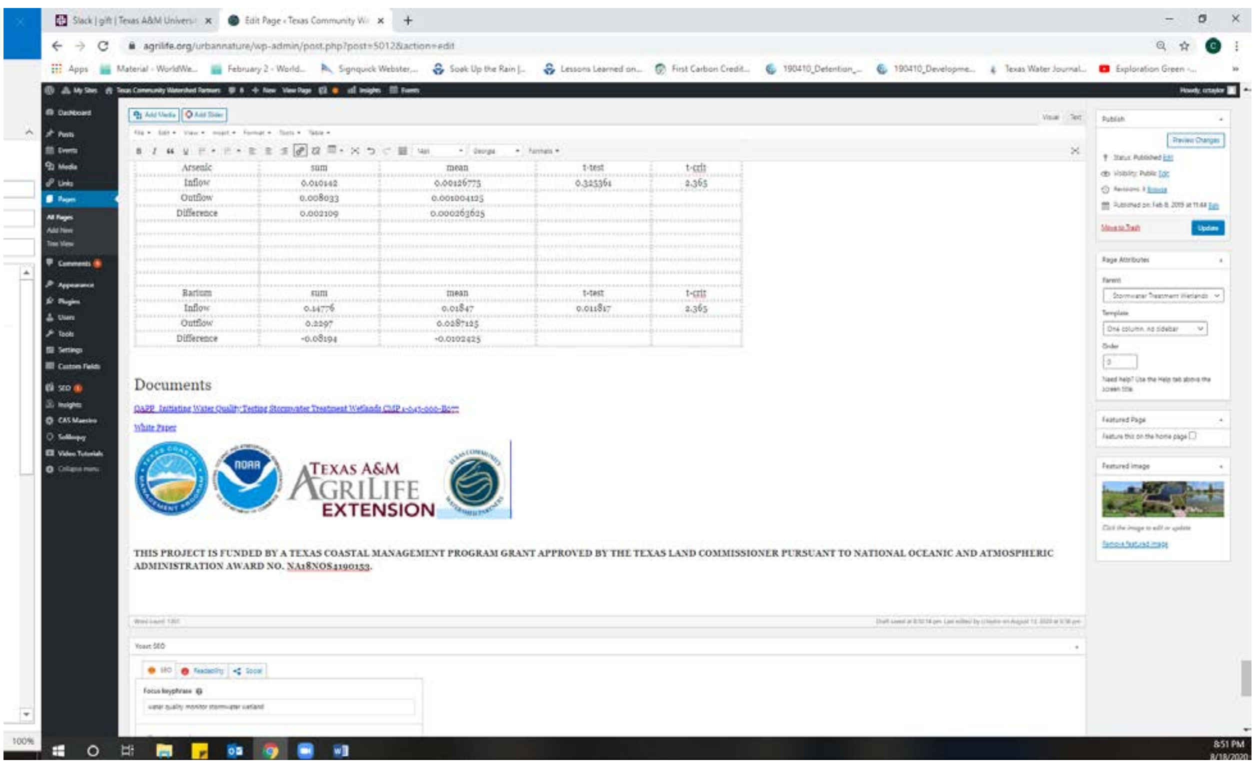


Figure 32 Screen shot of webpage showing the Documents section links to the QAPP and white paper report for this project.

Appendix 1: QAPP including lab accreditation

QUALITY ASSURANCE PROJECT PLAN (QAPP)

Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

GLO Contract No. 19-043-000-B077

Coastal Management Program- Cycle 23

Prepared by:

Texas A&M Agrilife Extension Service

Texas Community Watershed Partners

Stormwater Wetland Program

Effective Period: One year from date of final approval

Questions concerning this quality assurance project plan should be directed to:

Christie Taylor

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979-399-4009

cctaylor@tamu.edu

Table of Contents

Distribution List

Organizations and individuals which will receive copies of the approved QAPP and any subsequent revisions include:

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Houston, TX 77058

Name: Jennifer Morrow

Title: General Manager

Name: John Branch

Title: Board President

Exploration Green Conservancy Board

2323 Clear Lake City Blvd. Suite 180, Box 265

Houston, TX 77062

Name: Frank Weary

Title: President

MD Anderson Cancer Center

Name: Iris Clawson

Title: MDA Facilities/ Operations Manager

Name: Jim Power

Title: MDA Facilities/ Operations Chief Engineer

TAMU Agrilife Extension

1335 Regents Park Drive, Ste 260

Houston, TX 77058

Name: Christie Taylor

Title: Extension Program PM

Name: Charriss York

Title: Extension Program QA Officer

List of Abbreviations

CMP………….... Coastal Management Program

DO…………….. Dissolved Oxygen

EPA…………… Environmental Protection Agency

Extension……...Texas A&M Agrilife Extension Services

GLO……………General Land Office

NOAA………… National Oceanic and Atmospheric Association

NPS……………Nonpoint Source

PM……………..Project Manager

QA……………..Quality Assurance

QAO…………...Quality Assurance Officer

QAPP………….Quality Assurance Project Plan

SOP……………Standard Operating Procedure

TAMUG………. Texas A&M University Galveston

TCWP………… Texas Community Watershed Partners

TPH……………Total Petroleum Hydrocarbons

TSS…………….Total Suspended Solids

Project / Task Organization

The following is a list of organizations and individuals participating in the project with their specific roles and responsibilities:

GLO Coastal Management Program (CMP)

Ben Wilson, CMP PM

Provides the primary point of contact between the Extension and CMP. Tracks and reviews deliverables to ensure that tasks in the workplan are completed as specified in the contract.

TAMU Agrilife Extension

Christie Taylor, Extension Program PM

The PM is the primary contact between the CMP and the Extension. The PM drafts the QAPP, any QAPP revisions as needed, progress reports, signage, graphic and textual deliverables for the project. The PM oversees the collection of samples, reporting and analysis of data as outlined in the QAPP. Ensures that all staff involved in collections have been trained in collection procedure, programming of ISCO 6712 samplers, and use of YSI multiprobe for sample data collection. As well as ensuring all field documentation is handled properly and reported back to the PM.

Charriss York, Extension Program QA Officer

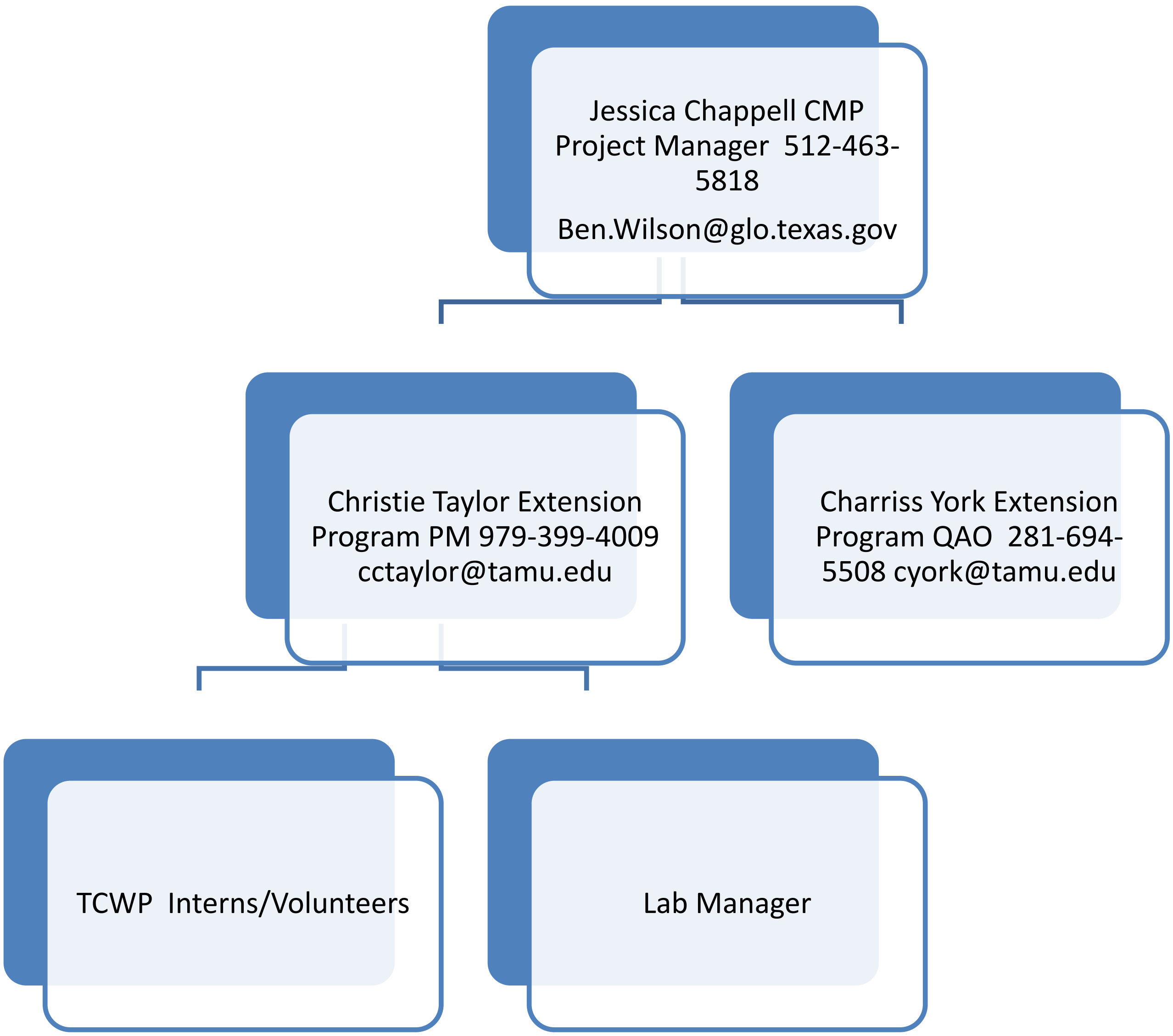
The QAO reviews the chain of custody forms a makes sure the transfers to the lab happen as specified in the QAPP. The QAO verifies the successful transfer of data from the lab to the Extension Program PM. The QAO enforces any corrective action, as required. Assures that all staff involved in collection of samples are competent on ISCO 6712 and YSI multiprobe.

LAB

Lab Manager

Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all laboratory operations, ensuring that all QA/QC requirements are met, and documentation related to the analysis is completely and accurately reported. Responsible for ensuring laboratory corrective actions are implemented, documented, reported and verified. Enforces corrective action, as required.

Figure 1.1 Project Organizational Chart- Lines of Communication



PROJECT TITLE

Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

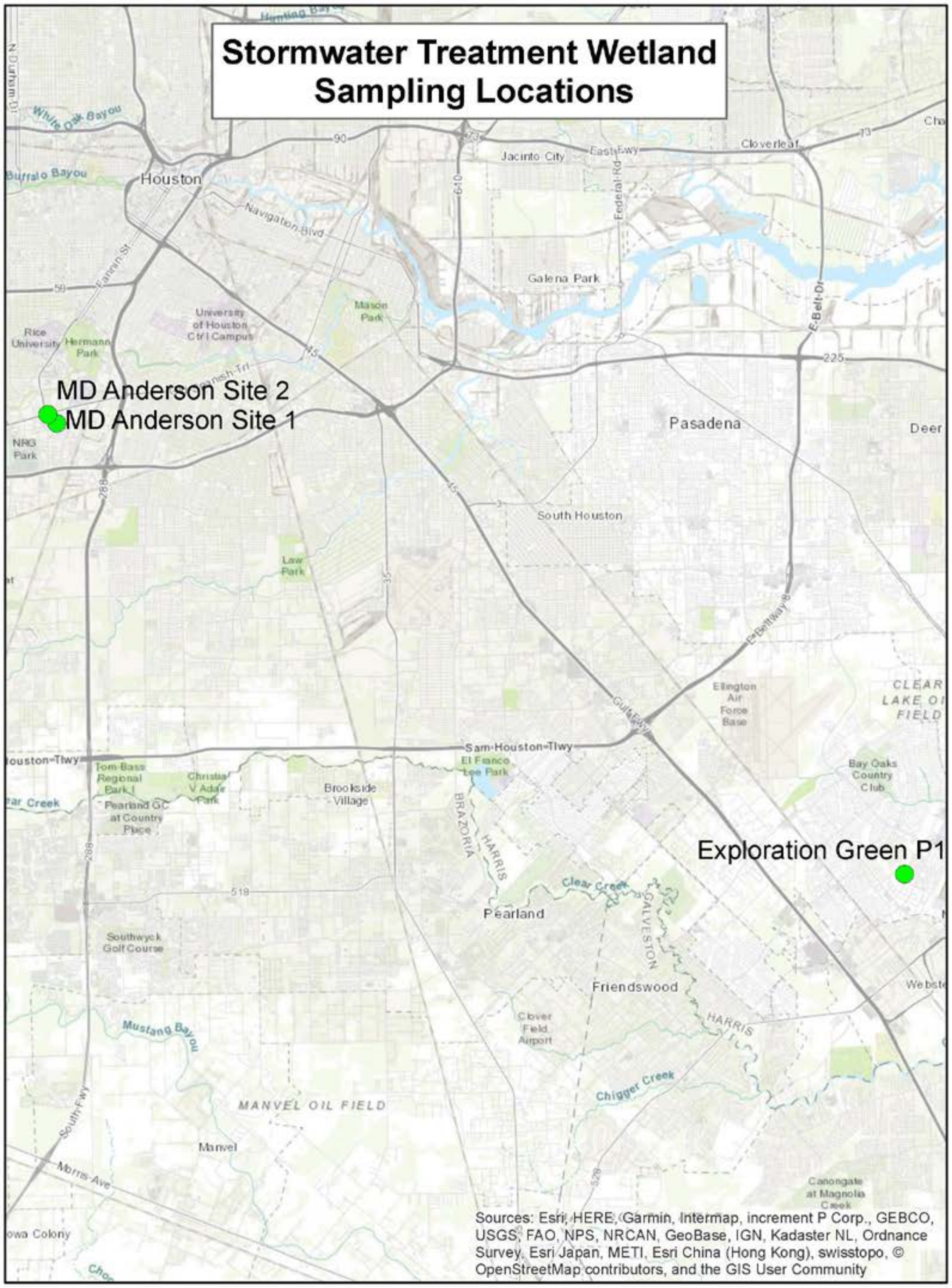
A. GENERAL DESCRIPTION OF STUDY:

A1. Problem:

Currently, water quality data is limited for stormwater treatment wetlands in the lower Galveston Bay watershed. As more wetlands are implemented to demonstrate this relatively new Best Management Practice, there is a need for robust water quality data to verify the effectiveness of the technique, or to guide modifications in the design of subsequent prototypes.

Texas Community Watershed Partners (TCWP) as part of the TAMU Agrilife Extension proposes to develop a QAPP for a water quality monitoring protocol and sample three stormwater wetland locations designed and planted by TCWP in the Galveston Bay Area. Location 1: The University of Texas Research Park stormwater wetland is a 0.33-acre stormwater wetland basin on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center. The basin mitigates a 3 acre parking lot expansion, and is in the Brays Bayou watershed which is listed impaired. Location 2: Exploration Green Conservation and Recreation Area is transforming the defunct Clear Lake Golf Course into a stormwater detention facility with five segments ("Phases") each containing a lake, habitat island, and walking trails. The 200-acre site receives stormwater runoff from an approximately 2000-acre predominantly suburban watershed, which is itself in the Armand Bayou watershed, 303 (d) listed as impaired by the US EPA. Phase 1 is a 14-acre lake containing 6 acres of wetlands planted 2016-2018. Location 3: MD Anderson parking lot expansion at the corner of Fannin and Old Spanish Trail in 1800 block of Old Spanish Trail. This is a 0.62 acre site that collects stormwater from the parking lot expansion. This site was just completed in June 2019 and recently planted.

Figure A1.1 Sampling Location Map



A2. Background:

TCWP TAMU AgriLife Extension and project partners are designing and implementing stormwater wetland demonstration projects in various basin types and watersheds. In contrast to the standard detention basin, basins that incorporate stormwater wetlands can provide a multiplicity of benefits: water quality, wildlife habitat, aesthetics and recreation. The stormwater wetlands are being designed to retain water for approximately 48-72 hours post storm event to allow the wetlands to remove debris, sediments and harmful chemicals and bacteria before the water is released downstream and into Galveston Bay. However, there has not been sufficient studies of the effectiveness of these designs on improving water quality.

For example, in one study of Mason Park marsh, the region's first constructed treatment wetland in Houston, TX results were inconclusive due to extreme drought [Guillen UHCL 2012]. The other study of this site was conducted by citizen science, but there are limited other studies of this type of constructed wetland in our area which to compare the data.

In a similar study of this BMP design from Pine Lake, Georgia, research shows that using wetlands and bioretention features reduce the amount of total coliform*, E. coli,* and conductivity thus improving the quality of water discharged from the stormwater wetland. This study collected water samples after storm events that occurred after a 48 hour antecedent dry period. They also collected influent and effluent samples at the same time [Styes, Zarus, and Ryan April 2015 Stormwater- Magazine].

As development increases, so does the requirement for drainage infrastructure, but currently, standard stormwater basins are ecologically and aesthetically bleak. Stormwater wetlands provide a method of combining multiple functions into a single site. Gaining data on the stormwater wetland practice is necessary as the technique is promoted for its multiplicity of benefits. The project will look at the water quality data aspect of the stormwater wetland BMP and provide quality and comparable data for this BMP in the lower Galveston Bay Watershed.

Data will be available on the TCWP website at https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/ and thus accessible for decision makers effecting change in drainage infrastructure planning. Stormwater wetland effects on water quality are documented in other areas of the U.S. and internationally, [Center for Watershed Protections's National Pollutant Removal Database for Stormwater Treatment Practices] but there is less documentation of Houston regional stormwater wetlands. Data from local demonstration projects can result in the better buy-in by local decision makers.

A3. Project Task Description:

Project Objective:

The project will generate data of known and acceptable quality to accurately depict the amount of water quality improvements provided by stormwater wetlands at the selected demonstration sites within the Galveston Bay Watershed.

Each of the three locations will be sampled at the influent and effluent sites for five consecutive months to provide data in cooler and warmer weather. There will be portable ISCO 6712 samplers located at a minimum of one influent and effluent site to collect samples at location 1 and 3 (the 2 MDA locations, in the medical center complex). There will be one ISCO sampler at the outfall site only of location 2 (exploration Green Phase 1, Clear Lake City, Houston, Texas) and grab samples collected near the inflow site with GPS coordinates recorded for each influent collection. A minimum of 10 up to a maximum of 24 samples taken from each of the three locations. Up to 5 samples will be collected at the influent sites during qualifying rainfall events and up to 5 samples from the effluent sites during qualifying rainfall events. Then TCWP staff will attempt to return and sample the effluent sampler again 24-48 hours after the qualifying event (up to 5 events), pending there was not another rain event within that time and the collection time doesn't fall on a weekend when couriers are not available, to determine if water quality changes the longer the water is in contact with the wetland before being released to the receiving body. For the purpose of this sampling method, qualifying rainfall events will be those preceded by a minimum of 48 hour dry period. Each sampler will be given a distinct number. Samples will be collected by TCWP staff and transferred to NELAP certified lab for testing.

Parameter to be tested for all samples include pH, TSS, DO, specific conductivity, nitrite, nitrate, total phosphorus, ammonia and E. coli. The approximately 16 samples from the M. D. Anderson location sites will be additionally tested for heavy metals and total petroleum hydrocarbons because the watershed at this location is almost totally composed of adjacent parking lots.

Lab results will be delivered as both electronic and hard copies to the extension program PM and the extension program QAO. The lab results and analysis will be compiled by the extension program PM. Lab results and graphic representation of water quality changes will be uploaded to the designated webpage on the TCWP website (https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/) by the extension program PM. Line and/or bar graphs will show parameter values per event (date) for influent sites and parameter value per event (date) for effluent sites. There will also be a trend graphic for effluent sites 24hr after event or 48hr after event depending on location site conditions. The measured data from the influent site and effluent site for each location will be compared using a series of paired t-test for each parameter. Each parameter will be graphed as linear trend analysis.

In order to produce results in a timely manner, the water quality sampling project will follow the timeline described in Table A3.1

Table A3.1

Task	Project Milestones	Start	End
1.1	Develop QAPP	M4	M9
1.3	Contract NELAP certified lab	M4	M6
2.2	Begin sampling and reporting data to webpage	M12	M16
3.5	Present data	M17	M18

A4. Quality Objectives and Criteria

The project objective is to evaluate and quantify the effectiveness of constructed stormwater wetlands on water quality. The purpose of collecting influent and effluent samples at the time of the storm event is to verify that the water is being treated to a measureable degree during the capture by the wetland basin. This method is comparable to other studies of stormwater wetlands as best management practices. The purpose of the follow up effluent sample 24-48 hours after the initial event is to determine if the delayed release of the stormwater is providing any significant continuation of improved water quality the longer the water is in contact with the wetland basin.

Table A4.1: Quality Objectives

Procedure	Completeness	Precision	Representativeness	Comparability
Collect water quality samples using automated sampling equipment ISCO 6712 and YSI multiprobe in the field	It is the goal of this project to have 90% of all potential data available for use in reporting and analysis.	The degree to which measurement of the same location under similar conditions conform to themselves. Agreement between replicate samples	Ensure the number of samples taken at each site is enough to accurately characterize the water quality conditions of each site during storm events that produce measurable runoff	Dedication to using approved sampling and analysis methods. Report data in standard units; according to known laboratory practices. So data can be compared to other local SWQM data and national projects of similar BMPs.

A5. Special Training / Certifications

TCWP staff involved in collection of samples will be trained on the ISCO 6712 set up and collection procedures, rain gauge, flow loggers and chain of custody procedures. Sample collecting staff will be trained in YSI sonde calibration protocols according to manufacturer's manual for calibration procedures. A list of trained TCWP staff will be maintained by the Extension QAO.

NELAP lab accreditations will be available for review.

A6. Documents and Records

Records produced by this project will consist of the results of data collection, data monitoring, and data analysis. Progress reports on data collection, processing and analysis will be submitted quarterly.

Laboratory Test Reports must document the test results clearly and accurately. The data reports should include information necessary for the interpretation and validation of data. The requirements for reporting data are as follows

- Name of client
- Sample name
- Sample matrix
- Date and time of collection
- Units of measure
- Date and time of sample receipt
- Date and time of sample analysis
- Indication of Method used
- Identification of samples that did not meet QA requirements and why
- Certification of NELAP compliance on a result by result basis

Data will be reported on the dedicated project webpage https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/) on the TCWP website. Tabular and graphical representation of the data will be reported on the webpage semi-quarterly as available for each of the three locations.

Data validation and QA checks will be conducted by the Extension QAO. Copies of data documentation generated by the Extension program project personnel will be stored on the server. The Extension will ensure against catastrophic loss of data (e.g. physical damage/data loss due to fire or storm damage) by storing data backups offsite at a secure location utilizing the TAMU Syncplicity cloud through TAMU system. The data report and web-based products will be organized according to sample site location. Hard copies will be kept in a waterproof/ fireproof safe.

The final assessment data report will be produced electronically and as a hard copy, and all files used to produce the report will be saved electronically by TAMU for at least five years and will be available for transfer to the CMP PM.

Table A6.1: Project Quality Assurance Documents and Records

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	TAMU	5 years	Electronic/ Paper
QAPP distribution documentation	TAMU	5 years	Electronic
Chain of Custody Forms, Field Notes, and Sample Results	TAMU	5 years	Electronic/ Paper
Quarterly Progress Reports, data collection, data monitoring, data analysis	TAMU	5 years	Electronic/ Paper
Presentations and white paper	TAMU	5 years	Electronic/ Paper
Final report	TAMU	5 years	Electronic/ Paper
All Backups	TAMU	1 year	Electronic

B. MEASUREMENT AND DATA ACQUISITION

B1. EXPERIMENTAL DESIGN

The experimental design of this project aims to demonstrate the effectiveness of constructed stormwater wetlands as a BMP for improved water quality in stormwater detention. Three different constructed wetland sites were chosen. The sites are different sizes and at different stages of completeness, MD Anderson UTRP basin site completed in 2018, the Exploration Green Nature Park Phase 1 stormwater wetland which was completed in Fall 2018 and the MD Anderson Proton Therapy Parling Lot Expanson Wetland was completed and planted in June 2019. The sites are located in two different sub-watersheds of the Galveston Bay Watershed, Brays Bayou (MD Anderson sites 1 and 3) and Clear Creek (Exploration Green).

TableB1.1 Location Description

Location	Site	Latitude Longitude	Sample code	Start Date	End Date	Mode of Sampling	Sample Matrix	Monitoring Frequency

MD Anderson UTRP	Influent	**To Be Recorded at Time of Install**	101-#	Sept. 2019	Feb. 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson UTRP	Effluent	**To Be Recorded at Time of Install**	102-#	Sept. 2019	Feb. 2020	automatic	water	Up to 16x within 5 months; with qualifying event
Exploration Green Park Phase 1	Influent	**To Be Recorded at Time of Install**	201-#	Nov. 2019	April 2020	Grab sample only	water	Up to 8x within 5 months; with qualifying rainfall event
Exploration Green Park Phase 1	Effluent	**To Be Recorded at Time of Install**	202-#	Nov. 2019	April 2020	automatic	water	Up to 16x within 5 months; with qualifying event
MD Anderson Site 2 Parking Lot Expansion	Influent	**To Be Recorded at Time of Install**	301-#	Mar. 2020	Aug. 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson Site 2 Parking Lot Expansion	Effluent	**To Be Recorded at Time of Install**	302-#	Mar. 2020	Aug. 2020	automatic	water	Up to 16x within 5 months; with qualifying event

This experiment will compare water quality parameters at the influent and effluent sites of each basin location. Automated samples will be located at the influent and effluent sites for five consecutive months according to the schedule provided in Table B1.1. Up to eight samples will be collected at each influent site and a maximum of 16 samples from each effluent site. Samples will be collected within the first 24 hours after the rainfall event at both the influent and effluent sites for that location. Then a follow up effluent sample will be collected 24-48 hours after rainfall event. Twenty-four hours for smaller shallow basins and forty-eight hours for the larger retention basin at Exploration Green. Rainfall amounts will be measured using an ISCO 674 tipping bucket rain gauge at each location. Rainfall amount will be recorded on the field collection data form. Data will be collected for storms producing 0.29 inches or more of rain preceded by a 48-72 hour dry period. At location 1 MD Anderson site, up to 4 storm events will be tested for the runoff parameters heavy metals and TPH. The ISCO 6712 automated sampler with the a 730 bubble flow meter with accompanying power supply will be secured at the inflow and outflow points of the constructed wetland and will be used to collect both inflow and outflow composite samples and flow volume data. There will be at least one modem at each location, most likely attached to the influent sampler. The modem allows remote access to the sampler as well as the capability to send text messages to a dedicated number when the sampler program initiates and stops to inform the staff when the sample is ready to be collected and sent to the lab. The use of modems along with monitoring of the weather reports and predicted rainfall amounts from local sources will help to insure the specific hold times for bacteriological samples are not exceeded.

B1.2 Experimental Method Summary by Location

Location	Inflow Volume	Inflow Pollutant Concentration	Outflow Volume	Outflow Pollutant Concentration	Means of computing Pollution Load Reduction
MD Anderson UTRP Basin	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

	composited in a 9L bottle.		composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded from the ISCO 730 bubble flow meter.		
Exploration Green Nature Park Phase 1	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

	composited in a 9L bottle.		composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded from the ISCO 730 bubble flow meter.		
MD Anderson Site 2 Parking Lot Expansion	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

composited in a 9L bottle.	composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded from the ISCO 730 bubble flow meter.

B2. SAMPLING METHODS

Field Sampling Procedures

Field sampling data will be documented on Field Data Reporting Form (Appendix B). For all sampling visits, location id, sampling time, sampling date, sample collector's name and signature, rainfall amount, sample volumes, preservatives added to samples are recorded. Values for measured field parameters are recorded on the Field Data Reporting Form. The field data notebook should also include any visual observations, and time since last recorded rainfall event, etc. Basic rules for recording information for this project are

1. Legible writing in indelible, waterproof ink with no modifications, cross-outs, write-overs,
2. Changes should be made by crossing out original entry with 1 single line, entering the change and initial and date corrections,
3. Closeouts on incomplete pages with an initialed and dated diagonal line.

An YSI Professional Series multiprobe will be used to measure dissolved oxygen (DO), specific conductance, pH, and water temperature and this data will be recorded on the field data reporting form.

Automated Sampling Procedures

Automated samplers will be programmed in accordance with manufacturer user guides for automatic sampler data collection. At least one sampler per location, most likely the influent site will be equipped with modem to allow for text messaging from sampler to dedicated staff phone number to alert when the sampler program is initiated, completed or there is a problem with the sampler. Ice or gel pack will be added to the insulated sampler bases as necessary to maintain the appropriate temperature for the samples. Sample bottles and coolers for sample storage and sample pick up will be provided by the lab. Sample types, container types, minimum sample volume, preservation requirements and hold times are specified in Table B2.1. Samples will be collected in one large composite sample and separated into the appropriate sample containers for transport to the lab. Then the courier will be contacted for pick up samples.

Table B2.1 Sampling Protocol

Parameter	Matrix	Sample Type	Container	Preservation	Sample Volume	Hold Time
E.coli	water	composite	Sterile, plastic	Sodium Thiosulfate <6^0 C	100ml	8 hours
TSS	water	composite	Plastic or glass	<6^0C	1000ml	7 days
NO3 + NO2	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Total Phosphorus	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Ammonia as N	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Heavy Metals	water	composite	Plastic	On ice <6^0 C	1000ml	6 months
Mercury	water	composite	Plastic	On ice <6^0 C	1000ml	28 days
TPH	water	composite	Plastic or glass	Hydrochloric acid <6^0 C	40ml vials (3x)	14 days to extraction 14 days from extraction to analysis

B3. SAMPLE HANDLING AND CUSTODY

Sample Labeling

Samples from the field are labelled on the container with an indelible marker. Label includes:

1. Site identification
2. Date and time collected
3. Preservative added, if applicable
4. Sample type(i.e. analysis) to be performed

Sample Handling

Samples are collected at the field site after each qualifying rain event by AgriLife Extension staff and then labeled and appropriately preserved for laboratory analysis. Once preserved, the samples will be packaged in coolers by field staff according to laboratory specifications.

Samples will be transferred from TCWP to NELAP certified lab by courier. Samples analyzed by a sub-contracted laboratory will be documented on a chain of custody (COC) from that laboratory. A copy of the COC and custody procedures from the participating laboratory is found in Appendix C.

Upon receipt, the condition of the samples, including any abnormalities or departures from the standard condition will be recorded. All samples will have a traceable COC. Every sample accepted will be logged into a secure electronic database. Each sample is given a unique Lab ID number that is listed on the report for the sample. Samples that do not meet volume, preservation, hold time, temperature requirements will be qualified and the Extension PM will be contacted for guidance. All samples requiring thermal preservation are considered acceptable if the arrival temperature is within +/- 2^0 C of required temperature of the method specified range. Where applicable the lab verifies chemical preservation using readily available techniques prior to or during sample preparation or analysis. Samples are handled and prepared as directed in the lab's analytical SOP for each analysis. Laboratory SOPs will be provided as an appendix to this QAPP once the contract is finalized.

B4. ANALYTICAL METHODS

Laboratories reporting data under this QAPP must be NELAP accredited for the appropriate parameters, methods and matrices.

- *Analytical methods*
- *Quality control tests*
- *Non-Direct Measurements*
  All acquired raw data must be NELAP-accredited.

Table B4.1 Measurement Performance Specifications

Parameter	Units	Matrix	Method	PAREMETER CODE	AWRL	Limit of Quantitation (LOQ	PRECISION (RPD of LCS/LCSD)	BIAS (%Rec. of LCS)	LOQ CHECK STANDARD %Rec	Lab
Field Parameters (Water Column)										
Rainfall	Inches	Water	gauge	46529	NA	NA	NA	NA	NA	Field
pH	pH. units	water	YSI multiprobe	00400	NA	NA	NA	NA	NA	Field
DO	mg/L	water	YSI multiprobe	00300	NA	NA	NA	NA	NA	Field
Conductivity	uS/cm	water	YSI multiprobe	00094	NA	NA	NA	NA	NA	Field
Flow	Gallons	water	ISCO flow meter		NA	NA	NA	NA	NA	Field
Temperature	^{0}C	Water	YSI multiprobe		NA	NA	NA	NA	NA	Field
Conventional Parameters (Water)										
Ammonia-N	mg/L	water	SM 4500-N G	00610	0.1	0.02	20	80-120	70-130	Eastex
T-PO4-P	mg/L	water	SM 4500-P E	00665	0.06	0.06	20	80-120	70-130	Eastex
TPH	mg/L	water	TCEQ 1005	NA	NA	NA	NA	NA	NA	Eastex
Heavy metals	mg/L	water	EPA 200.8	NA	NA	NA	NA	NA	NA	Eastex
Mercury	mg/L	water	EPA 245.1	NA	NA	NA	NA	NA	NA	Eastex
NO3 +NO2	mg/L	water	SM 4500-NO3 F	00630	0.05	0.02	20	80-120	70-130	Eastex
E.coli		water	Idexx Laboratories Colilert 18	31699	1	NA	0.5	NA	NA	Eastex
TSS	mg/L	water	SM2540 D	00530	4	1	20	80-120	NA	Eastex

B5. QUALITY CONTROL

B5.1 Instrument/ Equipment testing, inspection and maintenance

Automated sampler testing and maintenance are reference at the following locations:

ISCO 6712: http://www.isco.com/manuals/UP001DT6.pdf

ISCO 730 Bubble Module: http://www.isco.com/manuals/UP001ATF.pdf

YSI Professional Plus hand held multiprobe: http://www.ysi.com/File%20Library/Documents/Manuals/605596-YSI-ProPlus-User-Manual-RevD.pdf

Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the AgriLife Extension Field Supervisor.

All laboratory tools, gauges, instruments and equipment testing and maintenance requirements are contained within the laboratory QAMs. Testing and maintenance records are maintained and available.

B5.2 Instrument Calibration and Frequency

All instruments and devices used in obtaining environmental data will be calibrated prior to use as needed. Calibration methods are contained in the manufacturer's instruction manuals reference above. YSI multiprobes will be calibrated before and after sampling, following protocols outlined in the SWQM Procedures volume 1. Calibration reagents are stored at TCWP offices. The reagents are catalogued as they are received and used.

Calibration procedures for laboratory equipment will be included in the SOPs attached to this QAPP after contract finalization.

B5.3 Inspection / Acceptance of Supplies and Consumables

The laboratory QA officer and laboratory technical director oversee all required checks of supplies and chemicals and assure all records are complete. These include all routine and non-routine maintenance acivities and reference material verifications.

Field sampling equipment is tested by extension staff prior to use, any changes or calibrations are noted in the field notebook and field data reporting sheets. All sample bottles are provided by Eastex and undergo inspection before they are delivered to the Extension office. Probe calibration solutions are maintained per manufacturer suggestions.

B6. DATA MANAGEMENT

Field staff will visit sites following qualifying rainfall events to collect samples and download flow data. On each visit notes will be made on the field data recording sheets and the field notebook. If no samples are collected or there is a problem with the collection of samples the visit will be recorded into the field notebook. If visits are made to calibrate, maintenance, or otherwise check the equipment these site visits will also be recorded in the field notebook.

Samples collected on-site will be labelled for transportation to the laboratory. Site name, time of collection, comments and other data will be copied from field notebook to COC. The COC and sample bottles will be submitted to laboratory analyst with relinquishing and receiving signatures on COC filled out by the field researcher.

All field data will be manually entered into an electronic spreadsheet. The spreadsheet will be created using Microsoft Excel software. The spreadsheet will be stored on the PM computer as well as Syncplicity and shared with the QAO. All files will be backed up monthly to an external hard drive. The QAO will check 10 percent of all the manually recorded spreadsheet entries to the field records to ensure there were no transcription errors. The tables, charts and graphs created from the data analysis will be uploaded to the dedicated webpage monthly.

All paper records and electronic files will be stored for at least five years by the Extension office.

C. Assessments and Oversight

C1. Assessments and Response Actions

The following table identifies the types of assessments and response actions for project activities applicable to this QAPP.

Table C1.1 Assessments and Response Requirements

Assessment Activity	Schedule	Responsible Party	Scope	Response Requirement
Status Monitoring	Continuous	Extension PM	Monitor project status and records ensure requirements are being fulf	Quarterly repor to CMP PM
Monitoring Systems Audit	Dates to be deter by CMP PM/ Extension QAO	CMP PM Extension QAC	To ensure field sampling, handling, measurements are happening in accordance with the QAPP. Review data management as it relates to this project.	Complete CAP And / or Response to CM PM in a timely manner

Deficiencies are any deviations from the QAPP or equipment manual protocols. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may include samples being discarded and recollected. Deficiencies are documented in the field logbook, field data sheets, etc. by field or laboratory staff. It is the responsibility of the Extension PM, in consultation with the Extension QAO, to ensure that the corrective actions and resolutions to the problems are documented and records are maintained in accordance with the QAPP. In addition, these actions and resolutions are reported to the CMP PM in writing in email, quarterly progress reports and by completion of CAP.

C2. Reports to Management

All the reports in this section are contract deliverables for the AgriLife Extension and are transferred to the CMP PM in accordance with contract requirements.

The QAPP, associated appendices and amendments detail the sample handling and data reporting for this project.

Quarterly Progress Reports summarize activities for each task; reports moitoring status, problems, delays, corrective actions; and outlines the status of each deliverable task.

Final Project Report summarizes the activities for the entire project period including a description and documentation of major project activities, evaluation of project results and environmental benefits and a conclusion drawn from the research.

D. Data Validation and Usability

D1. Data Review, Verification, and Validation

For the purpose of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the QAPP. Validation means the processes taken independently of data generation processes to evaluate the technical usability of verified data with respect to the objectives or intention of the project.

All data obtained from the field and laboratory measurements will be reviewed and verified for conformance to project requirements, and the validated against the data quality criteria in section A4 of this QAPP. Data which are supported by these verification and validation controls will be considered acceptable and reported on the webpage.

D2. Verification and Validation Methods

All data will be verified by Extension PM to ensure they are representative of the samples analyzed and the locations where the measurements were made and that the data and quality control measures were made accurately in accordance with the project specifications.

The staff and management of the respective field, laboratory, and analysis and data management tasks are responsible for the integrity, verification, and validation of the data each task generates or handles throughout each process of the project.

The data to be verified (listed in Table D2.1) are evaluated for against performance specifications (section B4) and are checked for errors in transcription, calculations, and data input. If an error is found the person who entered the data will be notified to address the issue. Issues that can be corrected are corrected and documented electronically or by initialing and dating the appropriate paperwork. If the error cannot be corrected the data associated with the error will be rejected and not reported.

Table D2.1 Data Verification Procedures

Data to be Verified	Field Task	Laboratory Task	Extension Data Management Task
Sample documentation complete, sample labeled, site id	Y	Y	
Field samples collected	Y		
Standards and reagents traceable	Y	Y	
Sample preservation and handling acceptable	Y	Y	
COC Complete	Y	Y	
Hold times not exceeded	Y	Y	
Collection, Preparation, Analysis consistent with SOPs and QAPP	Y	Y	Y
Field Documentation	Y		
Instrument calibration	Y	Y	

QC samples analyzed at required frequency	Y	Y	Y
QC results meet performance specifications	Y	Y	Y
Analytical Sensitivity consistent with QAPP		Y	Y
Results , calculations, transcriptions checked	Y	Y	Y
Laboratory samples analyzed for all parameters		Y	
Nonconforming activities documented	Y	Y	Y
Outliers confirmed and documented; reasonableness checked			Y
Results reported in standard measures and formats			Y
Sampling and data gaps documented and checked	Y	Y	Y
10 % data manually reviewed			Y

Data, Analysis, Results reported on webpage quarterly	Y

D3. Reconciliation with User Requirements

Data collected from this project will be analyzed and reported on the dedicated webpage located on the TCWP website and in a final white paper to the CMP to show the performance of stormwater wetlands as a BMP. The purpose is to show the reduction in NPS loadings of water that has passed through the stormwater wetland. The paper will discuss the limitations of the data collected. The results will be used by local officials as they review ordinances and design standards for future stormwater retention in their communities. Data will also be used in AgriLife Extension outreach programs to provide unbiased, science- based, quality assured data on the effectiveness of stormwater wetlands for reducing NPs loadings on the Texas Gulf Coast.

Appendix A: Contract Scope of Work

Contract: 19-043-000-B077

Project Name: Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

Subrecipient: Texas A&M AgriLife Extension Service

Project Description:

Texas A&M AgriLife Extension Service (AgriLife) and their project partners are designing and implementing stormwater wetland demonstration projects in various basin types and watersheds. In contrast to the standard detention basin, basins that incorporate stormwater wetlands can provide a multiplicity of ecological benefits to water quality, habitat, and recreation. Currently, water quality data to assess the effectiveness of stormwater treatment wetlands is limited in the lower Galveston Bay watershed. As more wetlands are implemented as green infrastructure Best Management Practices, more robust water quality data is needed to verify the effectiveness of the technique and guide modifications in the design of subsequent wetland prototypes.

Using CMP Cycle 23 funds, AgriLife proposes to develop a Quality Assurance Project Plan (QAPP) covering water quality monitoring protocol and sample three stormwater wetland sites designed and planted by Texas A&M in the Galveston Bay Area. Sampling will occur at three locations: Exploration Green Conservation and Recreation Area, Phase 1, MD Anderson Site 2 Parking Lot Expansion on the corner of Fannin and Old Spanish Trail and the University of Texas Research Park stormwater wetland on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center. Sites will be sampled during qualifying rain events. An expected average of 2 events per month. The plan is to collect samples on 8 events per site which will provide data on 72 samples over the sampling period (11 months).will give data on 39 events over the sampling period (15 months). AgriLife will prepare the results for dissemination in a white paper, presentations, and on AgriLife system websites.

Project Budget:

	CMP	Subrecipient	Third Party	Project Totals
Salaries	$43,838.00	$14,321.00	$0.00	$58,159.00
Fringe	$14,752.00	$4,818.00	$0.00	$19,570.00
Travel	$780.00	$0.00	$0.00	$780.00

Supplies	$650.00	$0.00	$0.00	$650.00
Equipment	$10,000.00	$0.00	$0.00	$10,000.00
Contractual	$0.00	$0.00	$0.00	$0.00
Other	$8,506.00	$0.00	$8,667.00	$17,173.00
Subtotal:	$78,526.00	$19,139.00	$8,667.00	$106,332.00
Indirect	$0.00	$24,546.00	$0.00	$24,546.00
Total:	$78,526.00	$43,685.00	$8,667.00	$130,878.00

Special Award Conditions:

1. This project must be completed as described in this work plan.
2. The GLO and/or NOAA must approve any changes in the scope of work or budget requests that change the total project cost.
3. CMP and NOAA logos, including appropriate acknowledgment statement, must be printed on education/outreach materials, signs, final reports and/or publications.
4. Data must be shared in the appropriate manner as specified in the contract.
5. The subrecipient must coordinate with the GLO prior to issuing press releases, conducting media events, or otherwise engaging in media related communications for this project.

Task 1: Develop Project Methodology/Quality Assurance

A QAPP will be written to provide a detailed project methodology, including data collection in accordance with a NELAP certified lab. A NELAP lab will be contracted for analysis of the samples and will assist with the development of the protocol. Based on the protocol, automated sampling equipment (e.g. ISCO 6712) and accessories will be selected and purchased.

Task 1 Deliverables:

1. Quality Assurance Project Plan (QAPP)
   Due Date: 3/20/2019
2. Selection and purchase of automated monitoring equipment and accessories, set-up and trial testing
   Due Date: 8/20/2019
3. National Environmental Laboratory Accreditation Program (NELAP) lab selected and contracted

Due Date: 3/20/2019

Task 2: Water Quality Sampling

The standard parameters for water quality will be tested: total suspended solids, conductivity, dissolved oxygen, nitrate and nitrite, total phosphorous, ammonia and E. coli. Additional compounds of interest at the MD Anderson site are heavy metals and total petroleum hydrocarbons, because the watershed of the basin is almost entirely composed of the adjacent parking lot. Both composite and grab samples will be taken following each qualifying rain event. A portable automated sampler (e.g. ISCO 6712) will be placed at both the inflow and outflow of the wetland basin. The set of samplers will be at each of the three stormwater wetland sites for 5 months, allowing for sampling in both cool and warm seasons.

Task 2 Deliverables:

1. Map showing sample site locations
   Due Date: 2/15/2019
2. Quarterly data reports to GLO and posted to Texas Community Watershed Partners (TCWP) website's dedicated project page
   Due Date: 07/31/2020
3. Photographs of samplers and signs in place at each of the three sites
   Due Date: 04/30/2020

Task 3: Data Sharing and Outreach

To share the results of this project, AgriLife will create a dedicated project webpage at the TCWP website (tcwp.tamu.edu). This page will be updated over the course of the project. As results accumulate from the lab analyses, they will be summarized graphically to distribute them via presentations, a white paper, and the internet. Data will be shared with local entities, such as the Harris County Flood Control District.

Professors at Texas A&M University - Galveston (TAMU-G) will incorporate the Exploration Green sites into the curriculum of their chemistry and microbiology lab coursework. Students will visit the monitoring sites and discuss the equipment, methods and objectives of this project.

Movable signage to inform the public will be designed and produced to place at the stormwater wetland sites during monitoring. The signage will briefly describe the study, participants, and provide a link and a Quick Response Code (QRC) to the project website. AgriLife will submit the signage design to GLO for approval.

Task 3 Deliverables:

1. Notification of dedicated webpages established for the project
   Due Date: 2/1/2019
2. Draft signage design
   Due Date: 2/1/2019
3. Final signage design
   Due Date: 2/15/2019
4. Photos of TAMUG student site visits
   Due Date: 07/31/2020
5. Copies of the presentations and white paper summarizing and graphically representing data
   Due Date: 07/31/2020

Task 4 Description: Project Monitoring & Reporting

AgriLife will prepare and submit all reports, deliverables, and requests for reimbursement as required in the contract, to CMPReceipts@GLO.TEXAS.GOV. Quarterly progress reports are due to CMPReceipts@GLO.TEXAS.GOV on the 10th day of every month starting with January 10, 2019. Requests for reimbursement are to be submitted in a timely manner to CMPReceipts@GLO.TEXAS.GOV, as specified in the contract.

The final report will summarize work completed under each project task and include photos of outreach efforts.

Task 4 Deliverables:

1. Quarterly progress reports and requests for reimbursement
   Due Date: As specified in contract
2. Draft final report
   Due Date: 8/15/2020
3. Final report
   Due Date: 8/31/2020
4. Project closeout form
   Due Date: 8/31/2020

Appendix B: Field Data Recording Sheet

Field Data Recording Sheet

Date: ____________________ Collected By: ____________________

Location: ____________________ Event #: ________________

Site ID:		Rainfall Amount		Air Temp.		Water Temp.		DO		Specific Conductance		pH		24 Hr.	48 Hr.		Bottle Collected #:

Field Observations:

Appendix C: Chain of Custody

EASTEX ENVIRONMENTAL LABORATORY, INC.

P. O. Box 1089 * Coldspring, TX 77331 | P. O. Box 631375 * Nacogdoches, TX 75963-1375
(800) 525-0508 * FAX (936) 653-3172 | (936) 569-8879 * FAX (936) 569-8951
www.eastexlab.com

REPORT TO:	INVOICE TO:	⑧ ANALYSIS REQUESTED
① Company	② Company	
Address	Address	
Attn.	Attn.	
Phone #	Phone #	
Fax #	Fax #	
	P.O. #	
Sampler's Name (please print)	Sampler's Signature	

Project Number	③ Project Name										⑦ Containers			
Remarks:														
Order ID	④ Sample ID	Date	Time	⑤ C/G	DO	PH	Cl2	Flow	Temp	⑥ Matrix	# Con	Size	Type	Pres

Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received and/or Checked In By: (Signature)	Date	Time	Received Iced: Yes / No

LAB USE ONLY Sample Condition Acceptable Yes / No	Temp °C	* Therm ID	Logged In By: (Signature)	Date	Time	White Copy-Follows Samples Yellow Copy-Laboratory Pink copy-Client Copy
Alternate Check In (Signature) Date Time						***SEE BACK FOR INSTRUCTIONS***

Chain of Custody Revision 2: 03/24/17

* Thermometer has 0.0 factor and recorded temperature is actual temperature.

Eastex Environmental Laboratory, Inc.

INSTRUCTIONS

Please be complete and accurate when filling out the Chain-of-Custody sheet, as all information will be printed on the final lab report.

1 REPORT TO:	Name of company, address, #'s, and where you want the report sent.
2 INVOICE TO:	Name of company, address, #'s, and where you want the report sent.
3 PROJECT NAME:	What you will call this sample.
4 SAMPLE ID:	How you will refer to this sample.
5 SAMPLE TYPE:	C3=3pt Comp. C6=6pt Comp. C12=12hr Comp. C24=24hr Comp. G=Grab
6 MATRIX:	DW=Drinking Water WW=Wastewater SO=Soil/Sludge OL=Oils FL=Filter LE=Leachate SD=Solid RE=Resin OT=Other
7 CONTAINER(S)	
SIZE:	1=Gallon 2=1/2 Gallon 3=Quart/Liter 4=Pint 5=1/2 pt (250 ml) 6=125 ml/4 oz. 7=60 mls/2 oz 8-Vial 9=Other
TYPE:	P=Plastic G=Glass T=Teflon S=Sterile
PRESERVATIVE:	C=Chilled S=Sulfuric Acid N=Nitric Acid B=Base/Caustic Z=Zn Acetate H=Hydrochloric Acid ST=Sodium Thiosulfate O=Other
8 ANALYSIS REQUESTED	Please be as specific as possible when listing which samples get what results.

Appendix D: Eastex Lab Bid and Requirement Specifications

Eastex Environmental Laboratory PO Box 1089 Coldspring, Texas 77331

Christina Taylor
Extension Program Specialist
Stormwater Wetlands Program
Texas Community Watershed Partners
Texas A&M AgriLife Extension Service

March 6, 2018

Response for Bid – Texas Community Watershed Partners Stormwater Quality Project
Grant Award Number NA18NOS4190153

Thank you for the opportunity to bid on your analyses.

Eastex Environmental Laboratory is very familiar with the analysis requirements for this task. We are an approved Clean River Program Laboratory and have been meeting the bacteriological holding times for these projects in the Houston/Galveston area. We have 3-4 Field Technicians in the Houston/Galveston area daily and coordinate sample pick-up for similar tasks regularly.

We are TNI accredited, HUB Certified laboratory and have been servicing the Houston/Galveston area for the past 32 years meeting our clients analytical needs. Eastex Environmental performs all items in the tasks at our facilities under our scope of accreditation. All analytical procedures will be conducted according to NELAP procedures, EPA Standards, AWWA and TCEQ guidelines. The procedures include the following, as a minimum requirement: comparisons against known standards in each run; one in ten sample duplicates and a monthly review against known spiked samples. Detection Limits will be our normal reporting limits unless otherwise specified by project requirements. The price includes sample bottles, pick-up, coolers as needed and delivery of data.

Enclosed you will find the following:

Section 1 – Bid Documents

Bid Specification with Scope of Services,

Section 2 - HUB Certificate,

Once again, thank you for this opportunity. If you need any additional information or any further assistance, please feel free to call me at 936-653-3249 or 1-800-525-0508. You may also visit our website at www.eastexlabs.com .

Respectfully,

Kathleen Harrott

Kathleen Harrott, Technical Director, Eastex Environmental Laboratory, Inc.

Appendix E: Eastex Laboratory NELAP Accreditations

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 08, 2018

9485 5090 0527 6008 6739 69

CERTIFIED MAIL

Ms. Tiffany Guerrero
Eastex Environmental Laboratory, Inc. - Coldspring
P. O. Box 1089
Coldspring, TX 77331-1089

Re: Amendment application

Dear Ms. Guerrero:

Based on the amendment request submitted on April 05, 2018, I am enclosing an updated NELAP accreditation certificate and Fields of Accreditation listing. They replace the previous ones issued on November 01, 2017.

Please review the enclosures for accuracy and completeness. Your laboratory's accreditation is valid until the expiration date on the certificate and scope, contingent on continued compliance with the standards for accreditation and requirements of the state of Texas.

Please let me know if I can provide any additional information regarding this matter. You may also contact me at (512) 239-1990 or *ken.lancaster@tceq.texas.gov*.

Sincerely,

Kristy M. Beaver
for
Ken Lancaster
Manager, Laboratory & Quality Assurance Section

Enclosures

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • tceq.texas.gov
How is our customer service? tceq.texas.gov/customersurvey

Appendix 2: Field Data Recording Sheets

Field Data Recording Sheet

Date: 1-9-2020   Collected By: Christie Taylor

Location: UTRP   Event #:

Time	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
17:53	101	–	0.02"	23°C	20.2°C	82 mg/L	200.4	7.47			∅
	102	-	—	—	—	—	—	—			—

Field Observations: Recalibrated YSI pH setting corrected

water level 0.00' → not enough sample to send to lab.

Sampler collected w/o meeting both criteria ??

Site 102 did not sample

manually stopped sampling @ 155 sample due to no water over suction line Error not recording

Field Data Recording Sheet

Date: 1-11-20   Collected By: Christie Taylor

Location: UTRP   Event #: 4

Time	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
5:24	101	4	0.19"/hr	16°C	17.7°C	9.5	80.6	8.04			9
6:15	102	7	0.13"/hr	16°C	16.9°C	9.2	73.4	7.22			9

max Rainfall for event 0.71"/hr

Field Observations: Early morning still dark → sunrise overcast cloudy

level: @ site 101 0.083 ave 0.415 max

@ site 102 not recorded

Final TPH & metals collection @ this location

Field Data Recording Sheet

Date: 1-11-20 Collected By: Christie Taylor

Location: EG Event #: 2

Time	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
7:43	202	3	0.38"	13°C	17.1°C	8.4	287.0	7.58			5
8:15	201	2	0.33	13°C	18.3°C	8.2	326.3	7.76			5

max 0.70"

Field Observations: cloudy overcast morning; drizzle

Note: Battery failed @ enable (not enough power to collect sample)
Charged battery collected grab sample
Expecting gaps in data due to battery issues. Likely due to age of batteries

water level min. 0.710'
max 2.091' @ 1:45am
ave 1.523'

201-2 location 29 33 49 N
95 07 24 N

Field Data Recording Sheet

Date: 1-13-20 Collected By: Christie Taylor

Location: EG Event #: 3

Time	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
[illegible]	202	4	0.33" Total	16°C	16.5°C	8.6	264.9	7.36			5
	201	3	0.34" Total	16°C	16.9°C	8.6	297.8	7.75			5

Field Observations: 201-3 location 29 33 46 N
95 07 21 W

Field Data Recording Sheet

Date: 4-5-20 Collected By: Christic Taylor

Location: Exploration Green Event #: Y (field only)

	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
collect 4-5-20 13:57	201	Y	0.04"	22°C	23.9°C	7.3	405.9	7.69			Ø
collect 13:24	202	Y	0.04"	22°C	20°C	8.2	135.9	7.21			Ø

enabled 4-4-20 14:48

Field Observations: YSI batteries died had to replace & recalibrate YSI

~~Sampled~~

Modem not communicating. Collected samples 23 hrs. after event during COVID restricted travel.

Field Data Recording Sheet

Date: 4-29-20 Collected By: Christie Taylor

Location: EG Event #: 5 (plus)

	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
12:04	201	5	0.10" WU	20°C	25°C	7.5	434.9	8.12	X	X	5
12:15	202	7	0.10" WU	20°C	24.1°C	7.9	353.4	7.71	X	X	5

NO Data

NOT DOING FOLLOW UP COVID

Field Observations: Cloudy, not currently raining, clearing skies
Samples both about 1/2 jar
water cloudy, orange tinted

Samples collected and given to courier @ 13:50.

Field Data Recording Sheet

Date: 5/6/20 | Collected By: Christie Taylor

Location: Exploration Green | Event #: 6

	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
9:50	201	6	0.01"	28°C	26.5	6.3	464.2	8.36	X	X	7
10:15	202	8	0.01"	28°C	26.5	7.5	419.8	7.61	X	X	7

Field Observations: Level not recorded

2(250mL) $NO_2 + NO_3$ & NH_3N

Field Data Recording Sheet

Date: 4-28-20 Collected By: Christie Taylor

Location: PTWB Event #: 301- A

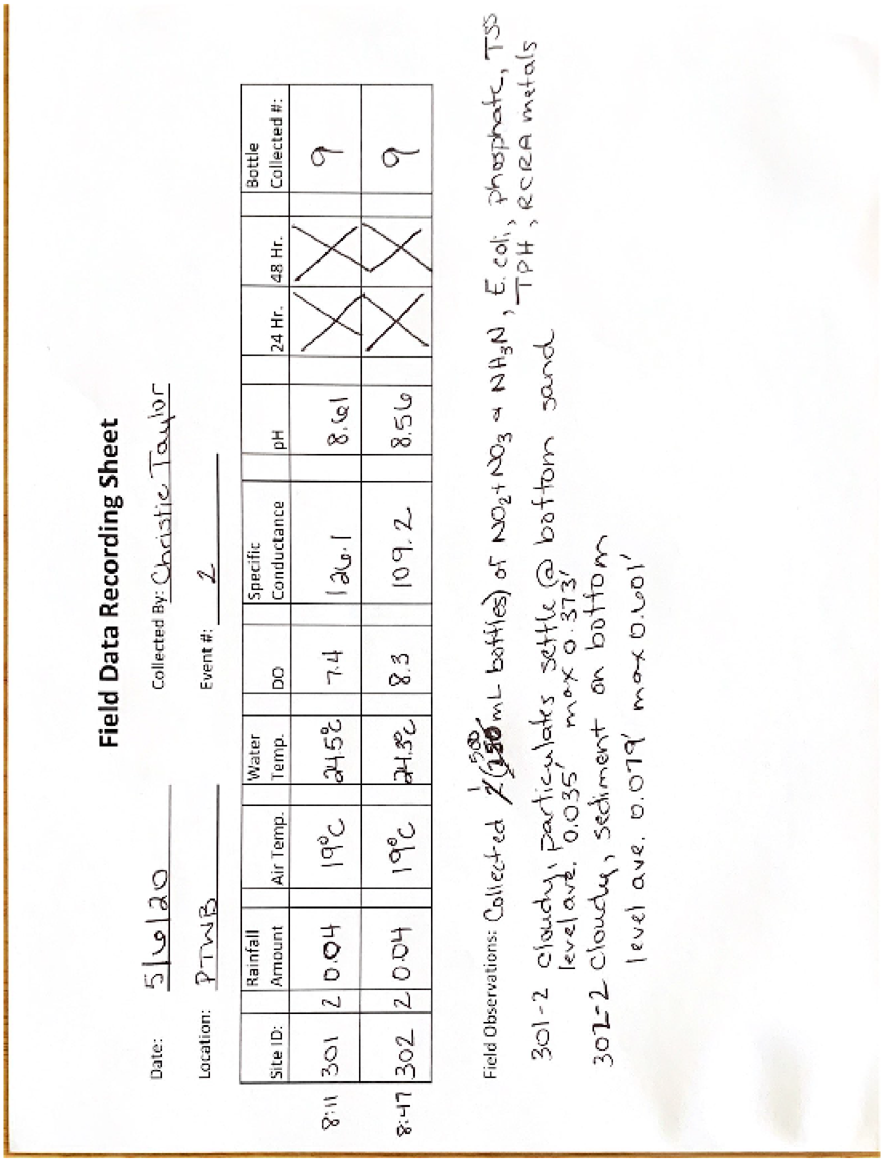
Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
18:00 301	A	0.03" @14:00	31°C	25.7°C	7.9	312.2	8.75	X	X	Ø
302	Ø	—	—	—	—	—	—	X	X	—

Not doing followup during COVID

Field Observations: 302 no sample collected. Water level 2' below outfall. Overall water level low.

No samples collected for lab due to lack of comparison sample

301 sample jar 2/3 full program completed @ 16:37 max level 0.097 @ 13:20 ave level 0.003



Field Data Recording Sheet

Date: 5/6/20 Collected By: Christie Taylor

Location: PTWB Event #: 2

	Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
8:11	301	2	0.04	19°C	24.5°C	7.4	126.1	8.61	X	X	9
8:47	302	2	0.04	19°C	24.3°C	8.3	109.2	8.56	X	X	9

Field Observations: Collected ~~2~~ 1 (~~250~~ 500 mL bottles) of $NO_2 + NO_3$ & NH_3N, E. coli, phosphate, TSS, TPH, RCRA metals

301-2 cloudy, particulates settle @ bottom sand level ave. 0.035' max 0.373'

302-2 Cloudy, sediment on bottom level ave. 0.079' max 0.601'

Field Data Recording Sheet

Date: 7/22/20 Collected By: Christie Taylor

Location: PTWB Event #: 5

Site ID:		Rainfall Amount	Air Temp.	Water Temp.	DO	Specific Conductance	pH	24 Hr.	48 Hr.	Bottle Collected #:
301	5	0.03"	27.7	30.1	6.8	260.1	8.76	—	—	11
302	5	0.03"	27.7	29.6	8.4	206.4	8.67	—	—	11

Field Observations:

Appendix 3: Lab Reports

See the lab report links at the follow website
https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

https://tcwp.tamu.edu/files/2020/02/UTRP101-1.pdf

https://tcwp.tamu.edu/files/2020/02/UTRP102-1.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-8.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-9.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-10.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-11.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-12.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-3.pdf

https://tcwp.tamu.edu/files/2020/05/EG-201-4.pdf

https://tcwp.tamu.edu/files/2020/05/EG201-5.pdf

https://tcwp.tamu.edu/files/2020/06/Eg-201-6.pdf

https://tcwp.tamu.edu/files/2020/06/EG-201-7.pdf

https://tcwp.tamu.edu/files/2020/07/EG-201-8.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-3.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-4.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-5.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-6.pdf

https://tcwp.tamu.edu/files/2020/05/EG202-7.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-8.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-9.pdf

https://tcwp.tamu.edu/files/2020/07/EG-202-10.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-301-1.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-2.pdf

https://tcwp.tamu.edu/files/2020/06/PTWB-301-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-301-5.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-302-1.pdf

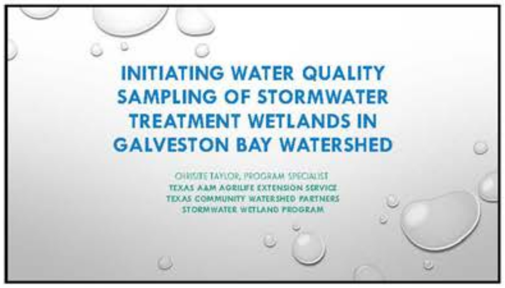
https://tcwp.tamu.edu/files/2020/07/PTWB-302-2.pdf

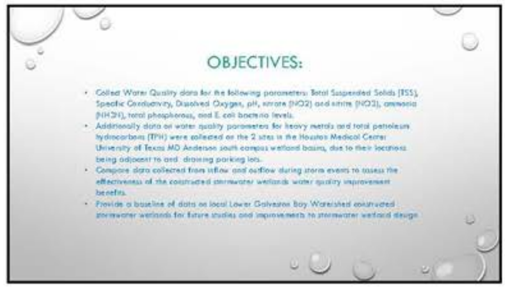
https://tcwp.tamu.edu/files/2020/06/PTWB-302-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-302-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-302-5.pdf

Appendix 4: Presentations

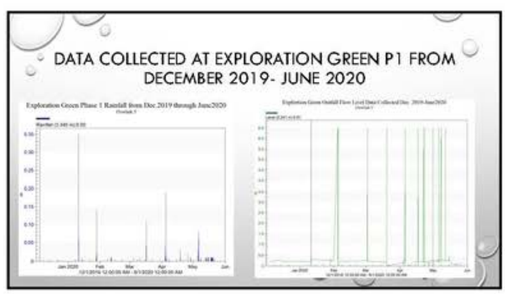

INITIATING WATER QUALITY SAMPLING OF STORMWATER TREATMENT WETLANDS IN GALVESTON BAY WATERSHED
CHRISTIE TAYLOR, PROGRAM SPECIALIST
TEXAS A&M AGRILIFE EXTENSION SERVICE
TEXAS COMMUNITY WATERSHED PARTNERS
STORMWATER WETLAND PROGRAM


OBJECTIVES:
• Collect Water Quality data for the following parameters: Total Suspended Solids (TSS), Specific Conductivity, Dissolved Oxygen, pH, nitrate (NO2) and nitrite (NO3), ammonia (NH3N), total phosphorous, and E. coli bacteria levels.
• Additionally data on water quality parameters for heavy metals and total petroleum hydrocarbons (TPH) were collected on the 2 sites in the Houston Medical Center University of Texas MD Anderson south campus wetland basins, due to their locations being adjacent to and draining parking lots.
• Compare data collected from inflow and outflow during storm events to assess the effectiveness of the constructed stormwater wetlands water quality improvement benefits.
• Provide a baseline of data on local Lower Galveston Bay Watershed constructed stormwater wetlands for future studies and improvements to stormwater wetland design

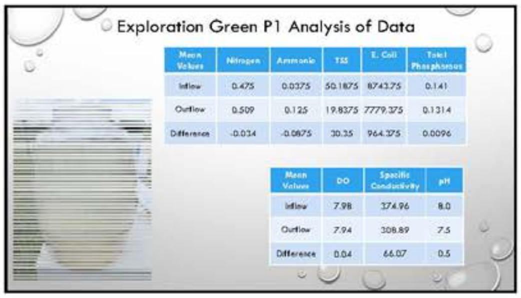

STORMWATER WETLAND LOCATIONS
MDA UTRP STORMWATER WETLAND (UTRP)
EXPLORATION GREEN STORMWATER WETLAND (EG)
MDA PROTON THERAPY STORMWATER WETLAND (PTWB)

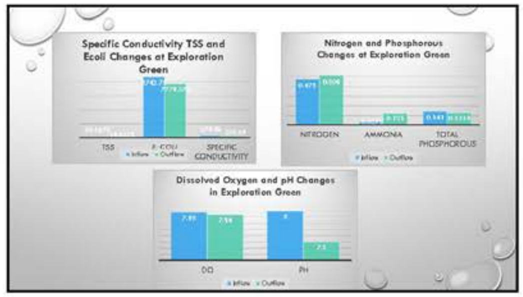

SITE DESCRIPTIONS AND DIFFERENCES
MDA UTRP
SIZE: 0.33 ACRES
YEAR COMPLETED: 2017
NUMBER OF INFLOWS: 1
SAMPLE COLLECTION PERIOD: SEPT. 2019-FEB. 2020
NUMBER OF SAMPLES COLLECTED: 7+
EXPLORATION GREEN
SIZE: 6 ACRES
YEAR COMPLETED: 2018
NUMBER OF INFLOWS: 9
SAMPLE COLLECTION PERIOD: DEC. 2019-JUNE 2020
NUMBER OF SAMPLES COLLECTED: 8+
MDA PTWB
SIZE: 0.65 ACRES
YEAR COMPLETED: 2020
NUMBER OF INFLOWS: 2
SAMPLE COLLECTION PERIOD: FEB. 2020- JULY 2020
NUMBER OF SAMPLES COLLECTED: 5

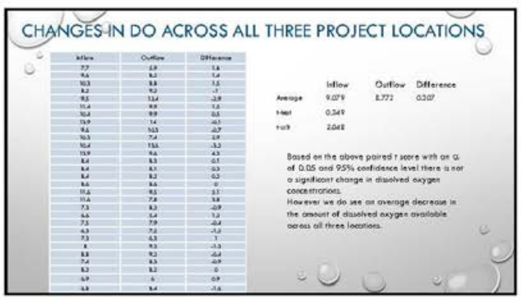

SET UP AND EQUIPMENT
• ISCO 6712 AUTOMATED SAMPLERS WITH 9L COMPOSITE COLLECTION JARS
• ISCO 730 BUBBLE FLOW METER
• VERIZON MODEMS
• BATTERIES AND SOLAR ARRAYS
• ISCO TIPPING BUCKET RAIN GAUGE
• RUBBERMAID STORAGE CABINETS WITH GROUND ANCHORS
• FLOW LINK SOFTWARE

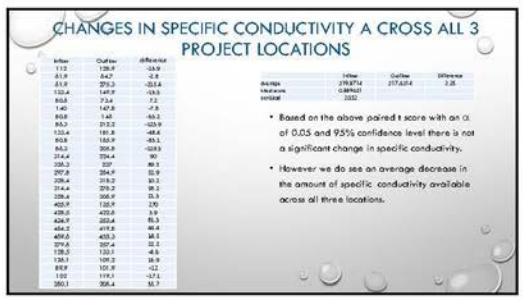

DATA COLLECTED AT EXPLORATION GREEN P1 FROM DECEMBER 2019- JUNE 2020

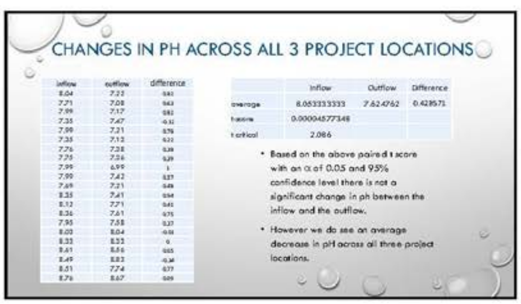
1

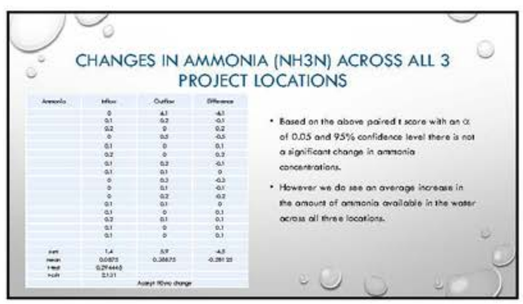

Exploration Green P1 Analysis of Data
Mean Values | Nitrogen | Ammonia | TSS | E. Coli | Total Phosphorous
Inflow | 0.475 | 0.0375 | 50.1875 | 8743.75 | 0.141
Outflow | 0.509 | 0.125 | 19.8375 | 7779.375 | 0.1314
Difference | -0.034 | -0.0875 | 30.35 | 964.375 | 0.0096
Mean Values | DO | Specific Conductivity | pH
Inflow | 7.98 | 374.96 | 8.0
Outflow | 7.94 | 308.89 | 7.5
Difference | 0.04 | 66.07 | 0.5


Specific Conductivity TSS and Ecoli Changes at Exploration Green
TSS
E. COLI
SPECIFIC CONDUCTIVITY
Inflow
Outflow
Nitrogen and Phosphorous Changes at Exploration Green
NITROGEN
AMMONIA
TOTAL PHOSPHOROUS
Dissolved Oxygen and pH Changes in Exploration Green
DO
PH

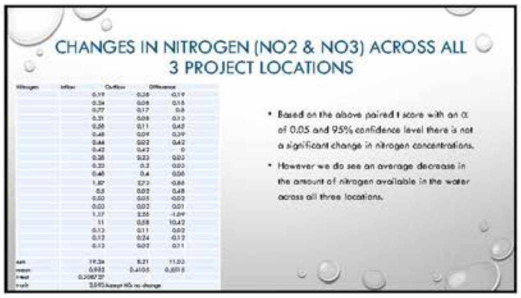

CHANGES IN DO ACROSS ALL THREE PROJECT LOCATIONS
Inflow
Outflow
Difference
Average 9.079 8.772 0.307
t-test 0.349
t-crit 2.048
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in dissolved oxygen concentrations.
However we do see an average decrease in the amount of dissolved oxygen available across all three locations.

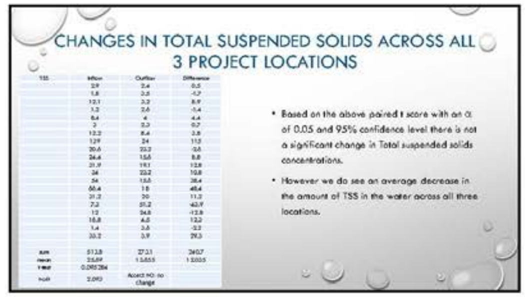

CHANGES IN SPECIFIC CONDUCTIVITY A CROSS ALL 3 PROJECT LOCATIONS
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in specific conductivity.
However we do see an average decrease in the amount of specific conductivity available across all three locations.

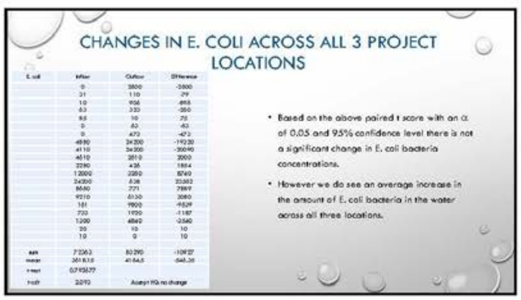

CHANGES IN PH ACROSS ALL 3 PROJECT LOCATIONS
inflow
outflow
difference
Inflow Outflow Difference
average 8.053333333 7.624762 0.428571
t critical 2.086
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in ph between the inflow and the outflow.
However we do see an average decrease in pH across all three project locations.

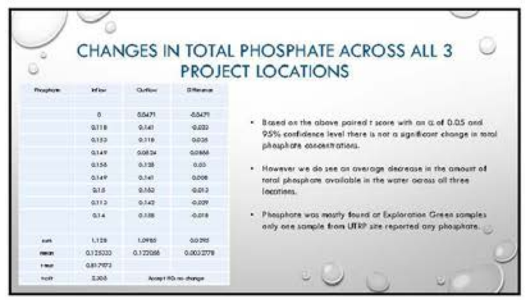

CHANGES IN AMMONIA (NH3N) ACROSS ALL 3 PROJECT LOCATIONS
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in ammonia concentrations.
However we do see an average increase in the amount of ammonia available in the water across all three locations.

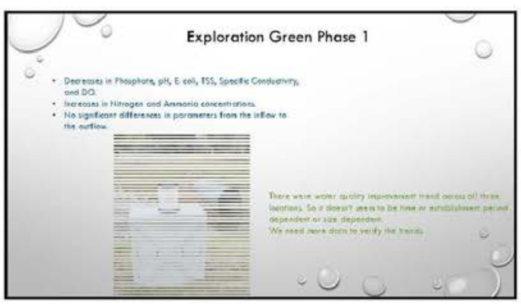
2


CHANGES IN NITROGEN (NO2 & NO3) ACROSS ALL 3 PROJECT LOCATIONS
• Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in nitrogen concentrations.
• However we do see an average decrease in the amount of nitrogen available in the water across all three locations.


CHANGES IN TOTAL SUSPENDED SOLIDS ACROSS ALL 3 PROJECT LOCATIONS
• Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in Total suspended solids concentrations.
• However we do see an average decrease in the amount of TSS in the water across all three locations.


CHANGES IN E. COLI ACROSS ALL 3 PROJECT LOCATIONS
• Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in E. coli bacteria concentrations.
• However we do see an average increase in the amount of E. coli bacteria in the water across all three locations.


CHANGES IN TOTAL PHOSPHATE ACROSS ALL 3 PROJECT LOCATIONS
• Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in total phosphate concentrations.
• However we do see an average decrease in the amount of total phosphate available in the water across all three locations.
• Phosphate was mostly found at Exploration Green samples only one sample from UTRP site reported any phosphate.


Exploration Green Phase 1
• Decreases in Phosphate, pH, E. coli, TSS, Specific Conductivity, and DO.
• Increases in Nitrogen and Ammonia concentrations.
• No significant differences in parameters from the inflow to the outflow.


LESSONS LEARNED AND AREAS FOR IMPROVEMENT
1. Consistent power source is key. Solar power is the best for remote locations.
2. Sonde attached to instrument can collect during event data more accurately.
3. Longer hold time on E.coli bacteria samples can lead to increased levels of bacteria. Hold time for stormwater samples is 24 hours. Normal sample hold times are 8 hours.
4. Need more training to fully utilize the software capabilities.
5. Good start for data collection but we need more data to verify trends we are seeing and how quality changes over time and seasons.

3

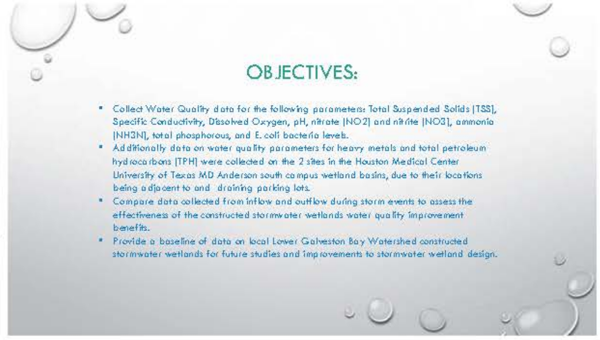
8/15/2020


QUESTIONS?
Link to the webpage for more details on the lab reports, field data, and the QAPP and white paper.


Thanks to our project location partners UT MD Anderson,
Exploration Green Conservancy
Clear Lake City Water Authority.
And a special thanks to our project sponsors the Coastal Management Program of the Texas General Land Office and the National Oceanic and Atmospheric Administration and all those interested in stormwater improvement projects in the Lower Galveston Bay Watershed.
TEXAS A&M AGRILIFE EXTENSION
THIS PROJECT IS FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

4

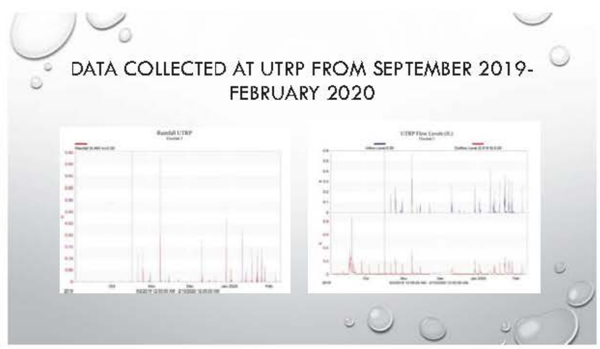

INITIATING WATER QUALITY SAMPLING OF STORMWATER TREATMENT WETLANDS IN GALVESTON BAY WATERSHED
CHRISITE TAYLOR, PROGRAM SPECIALIST
TEXAS A&M AGRILIFE EXTENSION SERVICE
TEXAS COMMUNITY WATERSHED PARTNERS
STORMWATER WETLAND PROGRAM

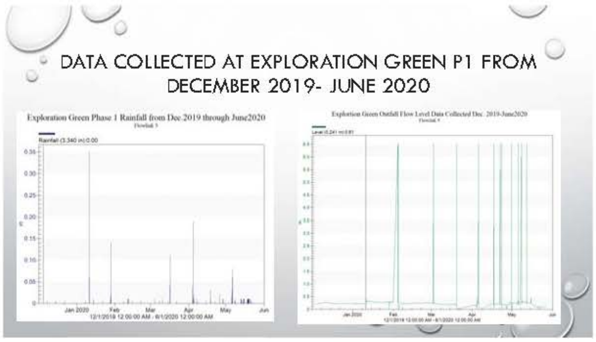

OBJECTIVES:
• Collect Water Quality data for the following parameters: Total Suspended Solids (TSS), Specific Conductivity, Dissolved Oxygen, pH, nitrate (NO2) and nitrite (NO3), ammonia (NH3N), total phosphorous, and E. coli bacteria levels.
• Additionally data on water quality parameters for heavy metals and total petroleum hydrocarbons (TPH) were collected on the 2 sites in the Houston Medical Center University of Texas MD Anderson south campus wetland basins, due to their locations being adjacent to and draining parking lots.
• Compare data collected from inflow and outflow during storm events to assess the effectiveness of the constructed stormwater wetlands water quality improvement benefits.
• Provide a baseline of data on local Lower Galveston Bay Watershed constructed stormwater wetlands for future studies and improvements to stormwater wetland design.

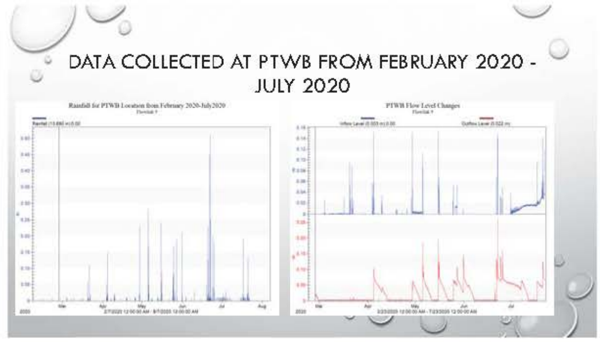

STORMWATER WETLAND LOCATIONS
MDA UTRP STORMWATER WETLAND (UTRP)
EXPLORATION GREEN STORMWATER WETLAND (EG)
MDA PROTON THERAPY STORMWATER WETLAND (PTWB)

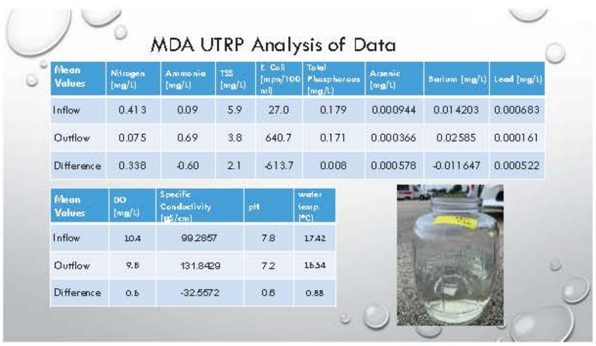

SITE DESCRIPTIONS AND DIFFERENCES
MDA UTRP
SIZE: 0.33 ACRES
YEAR COMPLETED: 2017
NUMBER OF INFLOWS: 1
SAMPLE COLLECTION PERIOD: SEPT. 2019-FEB. 2020
NUMBER OF SAMPLES COLLECTED: 7+
EXPLORATION GREEN
SIZE: 6 ACRES
YEAR COMPLETED: 2018
NUMBER OF INFLOWS: 9
SAMPLE COLLECTION PERIOD: DEC. 2019-JUNE 2020
NUMBER OF SAMPLES COLLECTED: 8+
MDA PTWB
SIZE: 0.65 ACRES
YEAR COMPLETED: 2020
NUMBER OF INFLOWS: 2
SAMPLE COLLECTION PERIOD: FEB. 2020 - JULY 2020
NUMBER OF SAMPLES COLLECTED: 5


SET UP AND EQUIPMENT
• ISCO 6712 AUTOMATED SAMPLERS WITH 9L COMPOSITE COLLECTION JARS
• ISCO 730 BUBBLE FLOW METER
• VERIZION MODEMS
• BATTERIES AND SOLAR ARRAYS
• ISCO TIPPING BUCKET RAIN GAUGE
• RUBBERMAID STORAGE CABINETS WITH GROUND ANCHORS
• FLOW LINK SOFTWARE


DATA COLLECTED AT UTRP FROM SEPTEMBER 2019-FEBRUARY 2020



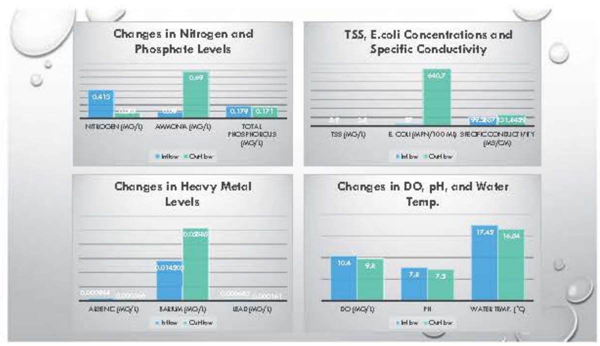


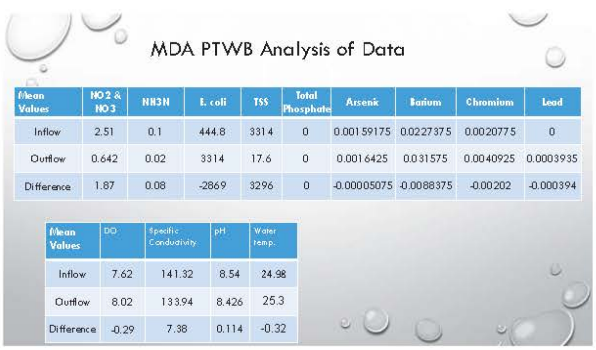


MDA UTRP Analysis of Data

Mean Values	Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. Coli (mpn/100 ml)	Total Phosphorous (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Lead (mg/L)
Inflow	0.413	0.09	5.9	27.0	0.179	0.000944	0.014203	0.000683
Outflow	0.075	0.69	3.8	640.7	0.171	0.000366	0.02585	0.000161
Difference	0.338	-0.60	2.1	-613.7	0.008	0.000578	-0.011647	0.000522

Mean Values	DO (mg/L)	Specific Conductivity (µS/cm)	pH	water temp. (°C)
Inflow	10.4	99.2857	7.8	17.42
Outflow	9.8	131.8429	7.2	16.54
Difference	0.6	-32.5572	0.6	0.88

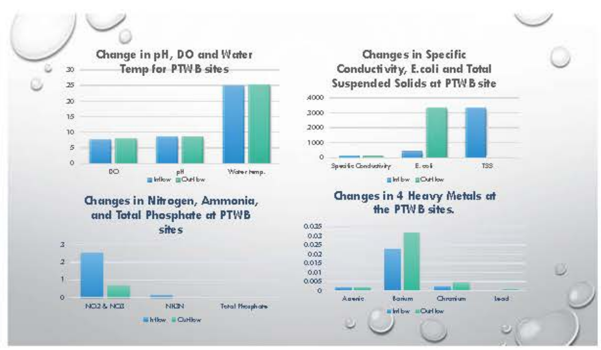


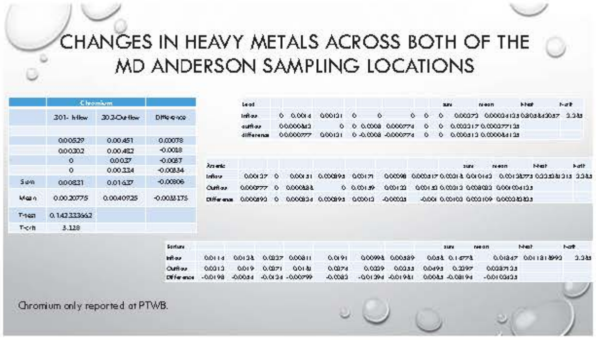


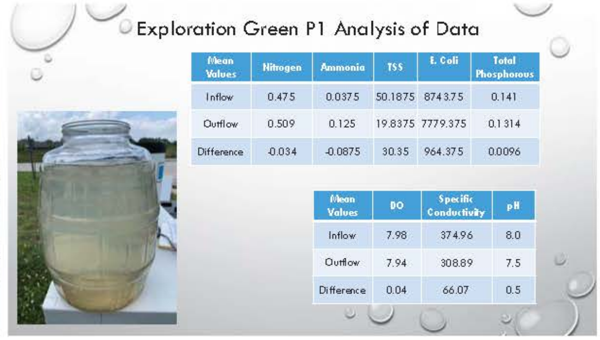
MDA PTWB Analysis of Data

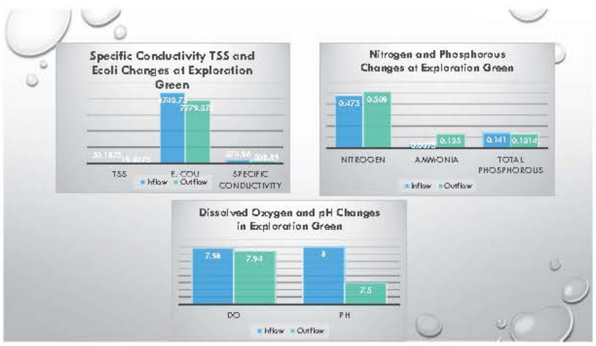
Mean Values	NO2 & NO3	NH3N	E. coli	TSS	Total Phosphate	Arsenic	Barium	Chromium	Lead
Inflow	2.51	0.1	444.8	3314	0	0.00159175	0.0227375	0.0020775	0
Outflow	0.642	0.02	3314	17.6	0	0.0016425	0.031575	0.0040925	0.0003935
Difference	1.87	0.08	-2869	3296	0	-0.00005075	-0.0088375	-0.00202	-0.000394

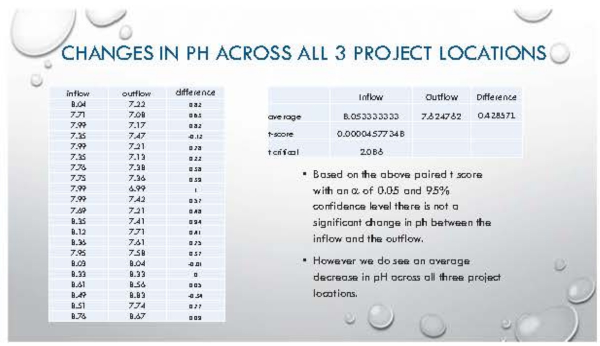
Mean Values	DO	Specific Conductivity	pH	Water temp.
Inflow	7.62	141.32	8.54	24.98
Outflow	8.02	133.94	8.426	25.3
Difference	-0.29	7.38	0.114	-0.32

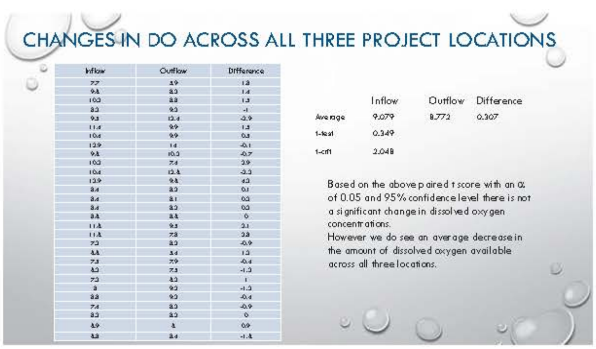


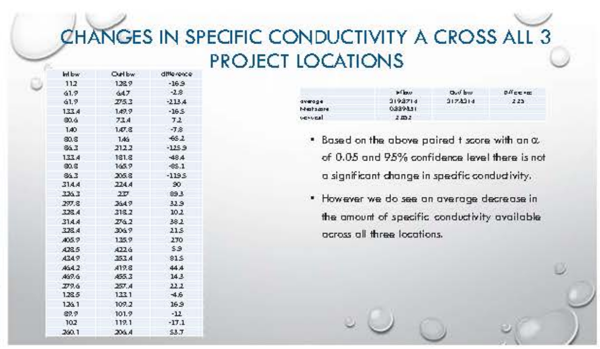

CHANGES IN HEAVY METALS ACROSS BOTH OF THE MD ANDERSON SAMPLING LOCATIONS
Chromium only reported at PTWB.


Exploration Green P1 Analysis of Data
Mean Values | Nitrogen | Ammonia | TSS | E. Coli | Total Phosphorous
Inflow | 0.475 | 0.0375 | 50.1875 | 8743.75 | 0.141
Outflow | 0.509 | 0.125 | 19.8375 | 7779.375 | 0.1314
Difference | -0.034 | -0.0875 | 30.35 | 964.375 | 0.0096
Mean Values | DO | Specific Conductivity | pH
Inflow | 7.98 | 374.96 | 8.0
Outflow | 7.94 | 308.89 | 7.5
Difference | 0.04 | 66.07 | 0.5


Specific Conductivity TSS and Ecoli Changes at Exploration Green
TSS
E. COLI
SPECIFIC CONDUCTIVITY
Inflow
Outflow
Nitrogen and Phosphorous Changes at Exploration Green
NITROGEN
AMMONIA
TOTAL PHOSPHOROUS
Dissolved Oxygen and pH Changes in Exploration Green
DO
PH


CHANGES IN PH ACROSS ALL 3 PROJECT LOCATIONS
inflow | outflow | difference
| Inflow | Outflow | Difference
average | 8.053333333 | 7.624762 | 0.428571
t-score | 0.000045773348
t critical | 2.086
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in ph between the inflow and the outflow.
However we do see an average decrease in pH across all three project locations.


CHANGES IN DO ACROSS ALL THREE PROJECT LOCATIONS
Inflow | Outflow | Difference
Average | 9.079 | 8.772 | 0.307
t-test | 0.349
t-crit | 2.048
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in dissolved oxygen concentrations.
However we do see an average decrease in the amount of dissolved oxygen available across all three locations.


CHANGES IN SPECIFIC CONDUCTIVITY A CROSS ALL 3 PROJECT LOCATIONS
Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in specific conductivity.
However we do see an average decrease in the amount of specific conductivity available across all three locations.

CHANGES IN TOTAL SUSPENDED SOLIDS ACROSS ALL 3 PROJECT LOCATIONS

TSS	Inflow	Outflow	Difference
	2.9	2.4	0.5
	1.8	3.5	-1.7
	12.1	3.2	8.9
	1.2	2.6	-1.4
	8.4	4	4.4
	3	2.3	0.7
	12.2	8.4	3.8
	139	24	115
	20.6	23.2	-2.6
	24.4	15.6	8.8
	31.9	19.1	12.8
	34	23.2	10.8
	54	15.6	38.4
	66.4	18	48.4
	31.2	20	11.2
	7.3	51.2	-43.9
	12	24.8	-12.8
	16.8	4.5	12.3
	1.4	3.6	-2.2
	33.2	3.9	29.3
sum	513.8	273.1	240.7
mean	25.69	13.655	12.035
t-test	0.095284		
t-crit	2.093	Accept H0, no change	

- Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in Total suspended solids concentrations.
- However we do see an average decrease in the amount of TSS in the water across all three locations.

CHANGES IN E. COLI ACROSS ALL 3 PROJECT LOCATIONS

E. coli	Inflow	Outflow	Difference
	0	2600	-2600
	31	110	-79
	10	906	-896
	63	323	-260
	85	10	75
	0	63	-63
	0	473	-473
	4880	24200	-19320
	4110	24200	-20090
	4610	2610	2000
	2280	426	1854
	12000	3260	8740
	24200	638	23562
	8660	771	7889
	9210	6130	3080
	161	9800	-9639
	733	1920	-1187
	1300	4840	-3540
	20	10	10
	10	0	10
sum	72363	83290	-10927
mean	3618.15	4164.5	-546.35
t-test	0.792677		
t-crit	2.093	Accept H0: no change	

- Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in E. coli bacteria concentrations.
- However we do see an average increase in the amount of E. coli bacteria in the water across all three locations.

CHANGES IN AMMONIA (NH3N) ACROSS ALL 3 PROJECT LOCATIONS

Ammonia	Inflow	Outflow	Difference
	0	4.1	-4.1
	0.1	0.2	-0.1
	0.2	0	0.2
	0	0.5	-0.5
	0.1	0	0.1
	0.2	0	0.2
	0.1	0.2	-0.1
	0.1	0.1	0
	0	0.3	-0.3
	0	0.1	-0.1
	0	0.2	-0.2
	0.1	0.1	0
	0.1	0	0.1
	0.2	0.1	0.1
	0.1	0	0.1
	0.1	0	0.1
sum	1.4	5.9	-4.5
mean	0.0875	0.36875	-0.28125
t-test	0.294446		
t-crit	2.131		
		Accept H0:no change	

- Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in ammonia concentrations.
- However we do see an average increase in the amount of ammonia available in the water across all three locations.

CHANGES IN NITROGEN (NO2 & NO3) ACROSS ALL 3 PROJECT LOCATIONS

Nitrogen	Inflow	Outflow	Difference
	0.19	0.38	-0.19
	0.24	0.08	0.16
	0.77	0.17	0.6
	0.21	0.08	0.13
	0.56	0.11	0.45
	0.48	0.09	0.39
	0.44	0.02	0.42
	0.42	0.42	0
	0.26	0.23	0.03
	0.23	0.2	0.03
	0.46	0.4	0.06
	1.87	2.73	-0.86
	0.5	0.02	0.48
	0.03	0.05	-0.02
	0.03	0.02	0.01
	1.17	2.26	-1.09
	11	0.58	10.42
	0.13	0.11	0.02
	0.12	0.24	-0.12
	0.13	0.02	0.11
sum	19.24	8.21	11.03
mean	0.962	0.4105	0.5515
t-test	0.308727		
t-crit	2.093	Accept H0: no change	

- Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in nitrogen concentrations.
- However we do see an average decrease in the amount of nitrogen available in the water across all three locations.

CHANGES IN TOTAL PHOSPHATE ACROSS ALL 3 PROJECT LOCATIONS

Phosphate	Inflow	Outflow	Difference
	0	0.0471	-0.0471
	0.118	0.141	-0.023
	0.153	0.118	0.035
	0.149	0.0624	0.0866
	0.156	0.126	0.03
	0.149	0.141	0.008
	0.15	0.163	-0.013
	0.113	0.142	-0.029
	0.14	0.158	-0.018
sum	1.128	1.0985	0.0295
mean	0.125333	0.122056	0.0032778
t-test	0.817973		
t-crit	2.306	Accept H0: no change	

- Based on the above paired t score with an α of 0.05 and 95% confidence level there is not a significant change in total phosphate concentrations.
- However we do see an average decrease in the amount of total phosphate available in the water across all three locations.
- Phosphate was mostly found at Exploration Green samples only one sample from UTRP site reported any phosphate.

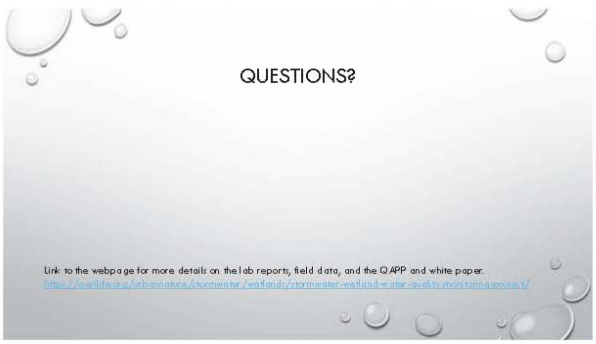
SOME CONCLUSIONS BASED ON THESE DATA SETS

MD Anderson Locations UTRP and PTWB

- Only 4 of the 8 heavy metal parameters tested at MD Anderson sites had any reported levels.
- TPH was not a factor (no reported values) for either wetland location at MD Anderson.
- Sample trends show decrease in: Dissolved Oxygen, pH, Specific Conductivity, nitrogen, total phosphate, and TSS
- Sample trends show increase in: ammonia, E. coli bacteria
- No significant changes in any of the parameters based on this sample size.
- The increases in E. coli bacteria could be from hold time variations or most likely the runoff is coming from surface flow and animal activity away from inflow pipes.


Exploration Green Phase 1
Decreases in Phosphate, pH, E. coli, TSS, Specific Conductivity, and DO.
Increases in Nitrogen and Ammonia concentrations.
No significant differences in parameters from the inflow to the outflow.
There were water quality improvement trend across all three locations. So it doesn't seem to be time or establishment period dependent or size dependent.
We need more data to verify the trends.


LESSONS LEARNED AND AREAS FOR IMPROVEMENT
1. Consistent power source is key. Solar power is the best for remote locations.
2. Sonde attached to instrument can collect during event data more accurately.
3. Longer hold time on E.coli bacteria samples can lead to increased levels of bacteria. Hold time for stormwater samples is 24 hours. Normal sample hold times are 8 hours.
4. Need more training to fully utilize the software capabilities.
5. Good start for data collection but we need more data to verify trends we are seeing and how quality changes over time and seasons.


QUESTIONS?
Link to the webpage for more details on the lab reports, field data, and the QAPP and white paper.
https://agrilife.org/urbannature/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/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Clear Lake City Water Authority.
And a special thanks to our project sponsors the Coastal Management Program of the Texas General Land Office and the National Oceanic and Atmospheric Administration and all tose interested in stormwater improvement projects in the Lower Galveston Bay Watershed.
TXGLO
NOAA
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THIS PROJECT IS FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

Appendix 5: White paper

Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

GLO Contract No. 19-043-000-B077

Coastal Management Program- Cycle 23

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List of Abbreviations

QAPP	Quality Assurance Project Plan
BMP	Best Management Practices
UTRP	University Texas Recreation Park
PTWB	Proton Therapy Wetland Basin
EG	Exploration Green
TCWP	Texas Community Watershed Partners
TAMU	Texas A&M University
AgriLife	AgriLife Extension Service
TSS	Total Suspended Solids
NO2	nitrate
NO3	nitrite
DO	dissolved oxygen
TPH	total petroleum hydrocarbons
NH3N	ammonia
GI	Green Infrastructure
COC	Chain of Custody

Abstract

Development pressures in the Lower Galveston Bay Area are leading public officials, developers, stakeholders and other conservation minded parties to look at Green Infrastructure (GI), nature based solutions for stormwater mitigation and water quality improvements. Much has been said in recent years about the importance of using natural areas to our advantage. The flood mitigation impacts of GI are easier to see and often well documented, however it is harder to identify the improvements to water quality. Water quality takes a look at water chemistry and bacterial levels. This requires testing and lab analysis of the water. This project looks at the water quality parameters of total suspended solids (TSS), specific conductivity, E.coli bacteria levels, dissolved oxygen (DO) levels, pH, ammonia, nitrate and nitrite levels, total phosphorous, other heavy metals and total petroleum hydrocarbons (TPH). The project samples water at influent (inflow pipes) and effluent (outflow pipes) for three different constructed stormwater wetland basins in Lower Galveston Bay Watershed sub-watersheds. Automated ISCO 6712 samplers are used in combination with grab sample methods (were samplers are not practical) to test stormwater runoff during qualifying rain events of a minimum of 0.1 inches per hour. Samples were collected and field recorded in notebooks and field data forms. Then the samples were sent to Eastex Labs for analysis of the previously stated parameters. Lab results were then tabulated and disseminated through the Texas Community Watershed Partners (TCWP) website a division of Texas A&M University (TAMU) AgriLife Extension Service (AgriLife). The tables were then visually charted using bar graph to show the difference in each of the parameters at individual site and at stormwater wetland projects as a whole. The trends in the charts show that there is some improvement of water quality seen across all three sites no matter the size or establishment of the project itself. Which lends support for the practice of stormwater wetlands in general. Further paired t-test of the influent and effluent sample water quality parameters values from analysis do not show significant changes at an =0.05 and a 95% confidence level. While we conclude this was a good start to this study and there are improvements to water quality through stromwater wetlands more study, over longer durations at more intervals, is needed to address the significance of these improvements.

Introduction

As development increases, so does the requirement for drainage infrastructure, but currently, standard stormwater basins are ecologically and aesthetically bleak. Stormwater wetlands provide a method of combining multiple functions into a single site. Gaining data on the stormwater wetland practice is necessary as the technique is promoted for its multiplicity of benefits. While the water quantity and flooding benefits are well documented and easily identified by the public, there is less documentation of the water quality benefits provided by constructed stormwater wetlands. The project looks at the water quality data aspect of the stormwater wetland BMP and provide quality and comparable data for this BMP in the lower Galveston Bay Watershed. This water quality data can help to verify the effectiveness of the technique, or to guide modifications in the design of subsequent green stormwater infrastructure prototypes.

Texas Community Watershed Partners (TCWP) as part of the TAMU Agrilife Extension developed a QAPP (https://agrilife.org/urbannature/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/) for a water quality monitoring protocol and sampled three stormwater wetland locations designed and planted by TCWP in the Galveston Bay Area. The purpose of this project and QAPP is to generate data of acceptable quality to accurately depict the amount of water quality improvements provided by stormwater wetlands at the selected demonstration sites within the Galveston Bay Watershed as a model of testing that can be applied to other project sites in the future.

Background of Selected Sites

A little bit of history on the three sites selected for this project. These sites are located in 2 sub-watersheds of the Lower Galveston Bay Watershed. The sites were completed at different times and are in variable states of establishment, they have urban and suburban characteristics and are of variable sizes.

D. University of Texas Recreation Park MD Anderson Campus (UTRP) Wetland
   The University of Texas Research Park stormwater wetland is a 0.33-acre stormwater wetland basin on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center located near 7510 Bertner Rd. Houston, TX. The basin mitigates a 3 acre parking lot expansion, and is in the Brays Bayou watershed which is listed as impaired by the Texas Commission on Environmental Quality (TCEQ). Construction started around July 2016 with planting being completed in September 2017. This wetland has been established for 2 years prior to the start of the stormwater wetland water quality sampling beginning in September 2019.
E. Exploration Green Recreation Park Phase 1 (EG) Stormwater Wetland
   Exploration Green Conservation and Recreation Area is transforming the defunct Clear Lake Golf Course into a stormwater detention facility with five segments ("Phases") each containing an open water lake, constructed wetlands, habitat island, and walking trails. The 200-acre site receives stormwater runoff from an approximately 2000-acre predominantly suburban watershed, which is itself in the Armand Bayou watershed, 303 (d) listed as impaired by the US EPA and TCEQ. Exploration Green Phase 1 is located in Clear Lake City between Diana Ln and Ramada Dr. The inflow and outflow for this Phase of the 5 Phase project are located along the Reseda Dr. side of the detention basin. Phase 1 is a 14-acre lake containing 6 acres of wetlands planted 2016-2018. This wetland was established for roughly 1 year prior to the start of the water quality sampling beginning in December 2019.
F. Proton Therapy Parking Lot Expansion Wetland Basin MD Anderson South Campus (PTWB)
   The PTWB stormwater wetland is located at the corner of Fannin and Old Spanish Trail in 1800 block of Old Spanish Trail. This is a 0.62 acre site that collects stormwater from the parking lot expansion. This site is also located in the Brays Bayou Watershed. This

site was just completed in June 2019 and recently planted in June 2019 – February 2020. As these plants are still growing and filling in this wetland space, it has not had time to establish before the water quality testing began in late February to early March 2020.

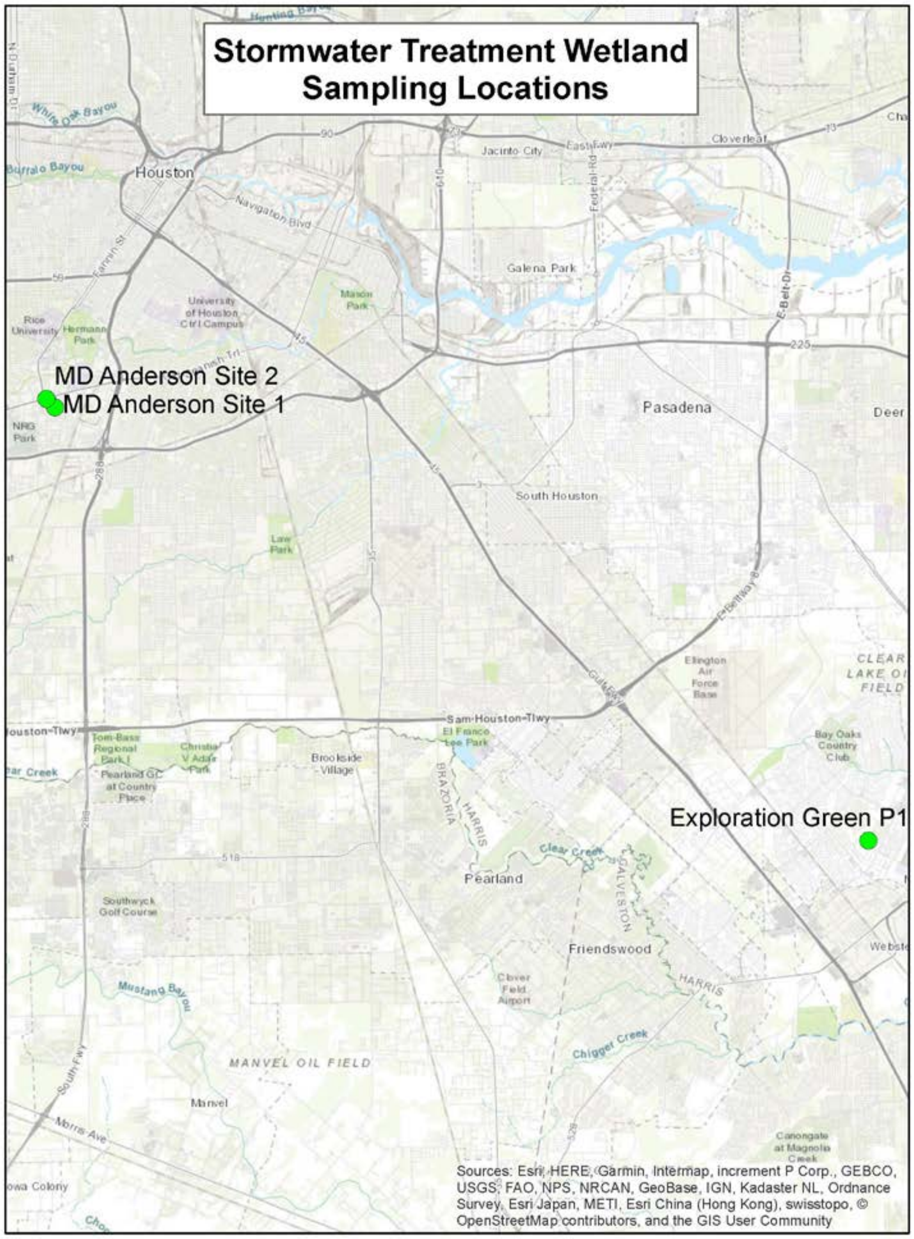

Figure 1.1 Map of Project Sampling Locations

Method

The experimental design of this project aims to demonstrate the effectiveness of constructed stormwater wetlands as a BMP for improved water quality in stormwater detention. Three different constructed wetland sites were chosen. The sites are different sizes and at different stages of establishment. The sites are located in two different sub-watersheds of the Galveston Bay Watershed, Brays Bayou (MD Anderson sites 1(UTRP) and 3(PTWB)) and Clear Creek (Exploration Green).

Table 1.1 Location Description

Location	Site	Sample code	Start Date	End Date	Mode of Sampling	Sample Matrix	Monitoring Frequency
MD Anderson UTRP	Influent	101-#	Sept. 2019	Feb. 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson UTRP	Effluent	102-#	Sept. 2019	Feb. 2020	automatic	water	Up to 16x within 5 months; with qualifying event
Exploration Green Park Phase 1	Influent	201-#	Nov. 2019	June 2020	Grab sample only	water	Up to 8x within 5 months; with qualifying rainfall event
Exploration Green Park Phase 1	Effluent	202-#	Nov. 2019	June 2020	automatic	water	Up to 16x within 5 months; with

							qualifying event
MD Anderson PTWB	Influent	301-#	Feb. 2020	July 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson PTWB	Effluent	302-#	Feb. 2020	Jul. 2020	automatic	water	Up to 16x within 5 months; with qualifying event

This experiment compares water quality parameters at the influent and effluent sites of each basin location. Automated samples were located at the influent and effluent sites for a minimum of five consecutive months according to the schedule provided in Table B1.1. 5 -8 samples were collected at each influent site and a maximum of 12 samples from each effluent site. Samples were collected from the automated samplers within 8 hours after the rainfall event at both the influent and effluent sites for that location. Then as occasions allowed follow up effluent sample were collected 24-48 hours after rainfall event. Twenty-four hours for smaller shallow basins and forty-eight hours for the larger retention basin at Exploration Green. Rainfall amounts were measured using an ISCO 674 tipping bucket rain gauge at each location. Rainfall amount will be recorded on the field collection data form. Data collected for storms producing 0.29 inches or more of rain preceded by a 48-72 hour dry period. At locations 1 and 3 MD Anderson UTRP and PTWB sites respectively, 4 storm events were tested for the runoff parameters of heavy metals and TPH. The ISCO 6712 automated sampler with the a 730 bubble flow meter with accompanying power supply will be secured at the inflow and outflow points of the constructed wetland and will be used to collect both inflow and outflow composite samples and flow volume data. There will be at least one modem at each location, attached to the influent sampler except at EG it was attached to the outflow sampler because only one sampler was used at this location. The modem allows remote access to the sampler as well as the capability to send text messages to a dedicated number when the sampler program initiates and stops to inform the staff when the sample is ready to be collected and sent to the lab. The use of modems along with monitoring of the weather reports and predicted rainfall amounts from local sources will help to insure the specific hold times for samples are not exceeded.

Table1.2 Experimental Method Summary by Location

Location	Inflow Volume	Inflow Pollutant Concentration	Outflow Volume	Outflow Pollutant Concentration	Means of computing Pollution Load Reduction
MD Anderson UTRP Basin	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

			Flow volume will be recorded from the ISCO 730 bubble flow meter.		
Exploration Green Nature Park Phase 1	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

			volume will be recorded from the ISCO 730 bubble flow meter.		
MD Anderson Site 2 Parking Lot Expansion	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

be recorded from the ISCO 730 bubble flow meter.

Field Sampling Procedures

Field sampling data was documented on Field Data Reporting Form (Appendix B). For all sampling visits, location id, sampling time, sampling date, sample collector's name and signature, rainfall amount, sample volumes, preservatives added to samples are recorded on the Chain of Custody (COC) form supplied by Eastex labs and attached to the copy of the lab analysis for record. Values for measured field parameters are recorded on the Field Data Reporting Form. The field data notebook should also include any visual observations, and time since last recorded rainfall event, etc. Basic rules for recording information for this project included

4. Legible writing in indelible, waterproof ink or pencil with no modifications, single cross-outs, write-overs,
5. Changes should be made by crossing out original entry with 1 single line, entering the change and initial and date corrections,

An YSI Professional Series multiprobe was used to measure dissolved oxygen (DO), specific conductance, pH, and water temperature and this data recorded on the field data reporting form and the field notebook.

Automated Sampling Procedures

Automated samplers will be programmed in accordance with manufacturer user guides for automatic sampler data collection. At least one sampler per location equipped with modem for text messaging from sampler to dedicated staff phone number to alert when the sampler program was running, enabled, done or there was an error with the sampler. Sample bottles and coolers for sample storage and sample pick up were be provided by the lab and transported by AgriLife staff on collection days. Sample types, container types, minimum sample volume, preservation requirements and hold times are specified in Table 1.3. Samples were collected in one 9 liter composite sample jar and separated into the appropriate sample containers for transport to the lab. Then staff contacted a courier for pick-up of samples.

Table 1.3 Sampling Protocol

Parameter	Matrix	Sample Type	Container	Preservation	Sample Volume	Hold Time
E.coli	water	composite	Sterile, plastic	Sodium Thiosulfate <6^0 C	100ml	24 hours
TSS	water	composite	Plastic or glass	<6^{0}C	1000ml	7 days
NO3 + NO2	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Total Phosphorus	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Ammonia as N	water	composite	Plastic or glass	Sulfuric acid <6^0 C	500ml	28 days
Heavy Metals	water	composite	Plastic	On ice <6^0 C	1000ml	6 months
Mercury	water	composite	Plastic	On ice <6^0 C	1000ml	28 days
TPH	water	composite	Plastic or glass	Hydrochloric acid <6^0 C	40ml vials (3x)	14 days to extraction 14 days from extraction to analysis

<u>Sample Labeling</u>

Samples from the field were labelled on the container with an indelible marker. Label includes:

5. Site identification (location id-#)
6. Date and time collected
7. Preservative added, if applicable
8. Sample type(i.e. analysis) to be performed

Sample Handling

Samples were collected at the field site after each qualifying rain event by AgriLife staff and then labeled and appropriately preserved for laboratory analysis. Once preserved, the samples were packaged in secondary containment, 1-2 gallon ziplock bags and placed in coolers by field staff according to laboratory specifications. Samples transferred from TCWP to Eastex lab by courier with proper COC, supplied by laboratory a copy of COC attached in Appendix C.

Analytical Methods

All analytical methods are to follow the Eastex Lab, accredited lab, standard operating procedures for each of the specified test. Any anomalies in the data were communicated to the AgriLife staff by email communications and noted on the appropriate lab reports.

Table 1.4 Measurement Performance Specifications

Parameter	Units	Matrix	Method	PAREMETER CODE	AWRL	Limit of Quantitation (LOQ	PRECISION (RPD of LCS/LCSD)	BIAS (%Rec. of LCS)	LOQ CHECK STANDARD %Rec	Lab
Field Parameters (Water Column)										
Rainfall	Inches	Water	gauge	46529	NA	NA	NA	NA	NA	Field
pH	pH. units	water	YSI multiprobe	00400	NA	NA	NA	NA	NA	Field
DO	mg/L	water	YSI multiprobe	00300	NA	NA	NA	NA	NA	Field
Conductivity	uS/cm	water	YSI multiprobe	00094	NA	NA	NA	NA	NA	Field
Flow	Gallons	water	ISCO flow meter		NA	NA	NA	NA	NA	Field
Temperature	^{0}C	Water	YSI multiprobe		NA	NA	NA	NA	NA	Field
Conventional Parameters (Water)										
Ammonia-N	mg/L	water	SM 4500-N G	00610	0.1	0.02	20	80-120	70-130	Eastex
T-PO4-P	mg/L	water	SM 4500-P E	00665	0.06	0.06	20	80-120	70-130	Eastex
TPH	mg/L	water	TCEQ 1005	NA	NA	NA	NA	NA	NA	Eastex
Heavy metals	mg/L	water	EPA 200.8	NA	NA	NA	NA	NA	NA	Eastex
Mercury	mg/L	water	EPA 245.1	NA	NA	NA	NA	NA	NA	Eastex
NO3 +NO2	mg/L	water	SM 4500-NO3 F	00630	0.05	0.02	20	80-120	70-130	Eastex
E.coli		water	Idexx Laboratories Colilert 18	31699	1	NA	0.5	NA	NA	Eastex
TSS	mg/L	water	SM2540 D	00530	4	1	20	80-120	NA	Eastex

Quality Control Methods

Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the AgriLife Extension Field Supervisor and documented in the field notebook.

All laboratory tools, gauges, instruments and equipment testing and maintenance requirements are contained within the Eastex laboratory QAMs. Testing and maintenance records are maintained and available from the lab.

All instruments and devices used in obtaining environmental data will be calibrated prior to use as needed. Calibration methods are contained in the manufacturer's instruction manuals. YSI multiprobes will be calibrated before sampling and monthly after sampling begins. Calibration reagents are stored at TCWP offices. The reagents are catalogued as they are received and used. Instruments are rinsed with clean distilled water between uses and stored according to manufacturer instructions.

Data

Data was collected in a field notebook and paper field recording data sheets. All notes, field methods, programming changes, battery test and site visits are recorded in the field notebook. Along with all field data recorded on the paper field data sheets. Field data sheets were also scanned and stored both as paper copies in the binder and electronic copies in shared folders and posted to the stormwater wetland water quality webpage on the TCWP website at the link below:

https://agrilife.org/urbannature/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

Data collected from both the field and the lab test are compiled in the following tables (Table2.1-2.15).

Table 2.1: Field Reporting Data for MDA UTRP location

MDA UTRP Wetland	Rainfall Amount (inches/hr)	Air Temp. (°C)	H2O Temp. (°C)			DO (mg/ L)			Specific (µS/cm)			Conductivity	pH	
Sampling Events			Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up
9/27/19	0.46	29	28.5	27.2	NA	7.7	5.9	NA	112	128.9	NA	10.64*	10.88*	NA
10/21/19	UNK	23	NA	23.1	NA	NA	6.2	NA	NA	139	NA	NA	10.39*	NA

10/25/19	UNK	11	NA	16.8	NA	NA	7.9	NA	NA	90.2	NA	NA	8.6*	NA
11/7/19	0.11	19	19.5	18.9	-	9.6	8.2	-	61.9	64.7	-	10.48*	8.5*	-
11/8/19	0.00	17	-	-	14.2	-	-	10.3	-	-	275.3	-	-	16.29*
12/10/19	0.03	11	15	14.1	-	10.3	8.8	-	133.4	149.9	-	9.88*	8.51*	-
12/11/19	0.00	12	-	-	13	-	-	7.4	-	-	181.8	-	-	16.33*
1/9/20	0.02	23	20.2	NA	NA	8.2	NA	NA	260.4	NA	NA	7.47	NA	NA
1/11/20	0.13	16	17.7	16.9	NA	9.5	9.2	NA	80.6	73.4	NA	8.04	7.22	NA
1/13/20	0.01	17	14.6	15	NA	11.4	12.4	NA	140	147.8	NA	7.71	7.08	NA
1/28/20	0.02	15	16.5	16.1	-	10.4	9.9	-	80.8	146	-	7.99	7.17	-
1/29/20	0.00	13	-	-	15.1	-	-	13.6	-	-	165.9	-	-	7.21
2/6/20	0.01	5	7.4	7.6	-	13.9	14.0	-	86.3	212.2	-	7.35	7.47	-
2/7/20	0.00	11	-	-	8.4	-	-	9.6	-	-	205.8	-	-	7.13

Table 2.2: Lab Results reported for MDA UTRP location

MDA UTRP Wetland	Location	Sampling Events ID	Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. coli (mpn/100ml)	Total Phosphate (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH

Reporting Limit			0.02	0.1	1	10	0.06	0.0005	0.003	0.001	0.003	0.0005	0.0002	0.005	0.0005	4.9-5
9/27/2019	Inflow	UTRP 101-1	0.19	<0.1	2.9	<10	<1.00	0.00137	0.0114	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<4.98339
	Outflow	UTRP 102-1	0.38	<0.1	2.4	2600	<1.00	0.000777	0.0312	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<4.901961
10/21/2019	Exta	UTRP 102-2	0.15	<0.1	2.4	350	0.347									
11/7/2019	Inflow	UTRP 101-2	0.24	<0.1	1.8	31	<0.02	<0.0005	0.0136	<0.001	<0.003	0.00142	<0.0002	<0.005	<0.0005	<4.95
	Outflow	UTRP 102-3	0.08	4.1	3.5	110	0.0471	<0.0005	0.019	<0.001	<0.003	0.000643	<0.0002	<0.005	<0.0005	<4.92* corrected
11/8/2019	Follow up	UTRP 102-4	<0.02	0.8	2.3	24	0.0258									
12/10/2019	Inflow	UTRP 101-3	0.77	0.1	12.1	10	<0.06	0.00151	0.0237	<0.001	<0.003	0.00131	<0.0002	<0.005	<0.0005	<5.0
	Outflow	UTRP 102-5	0.17	0.2	3.2	906	<0.06	0.000686	0.0371	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
12/11/2019	Follow up	UTRP 102-6	0.02	0.1	15.8	121	<0.06									
1/11/2020	inflow	UTRP 101-4	0.21	0.2	1.2	63	<0.06	0.000895	0.00811	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0

	outflow	UTRP 102-7	0.08	<0.1	2.6	323	<0.06	<0.0005	0.0161	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
1/13/2020	Inflow	UTRP 101-5	0.56	<0.1	8.4	85	<0.06									
	outflow	UTRP 102-8	0.11	0.5	4	10	<0.06									
1/28/2020	Inflow	UTRP 101-6	0.48	0.1	3	<10	<0.06									
	outflow	UTRP 102-9	0.09	<0.01	2.3	63	<0.06									
1/29/2020	Follow up	UTRP 102-10	0.04	0.3	6.8	<10	<0.06									
2/6/2020	Inflow	UTRP 101-7	0.44	0.2	12.2	<10	<0.06									
	Outflow	UTRP 102-11	0.02	<0.1	8.4	473	<0.06									
2/7/2020	Follow up	UTRP 102-12	<0.02	0.5	7.9	10	<0.06									

Rainfall amount from each of three locations depicted below in Figures 1.2, Figure, 1.4, and Figure 1.6 for UTRP, EG, and PTWB respectively. This information was recorded by the ISCO automated sampler and download from the instrument and graphed using the ISCO Flowlink software. Rain fall amount varied by event and time during events.

Flow level data was also recorded by the ISCO automated samplers for each site collected by the samplers. This data is also graphed in the ISCO Flowlink software and depicted in Figures 1.3, 1.5, and 1.7 for UTRP, EG, and PTWB respectively.

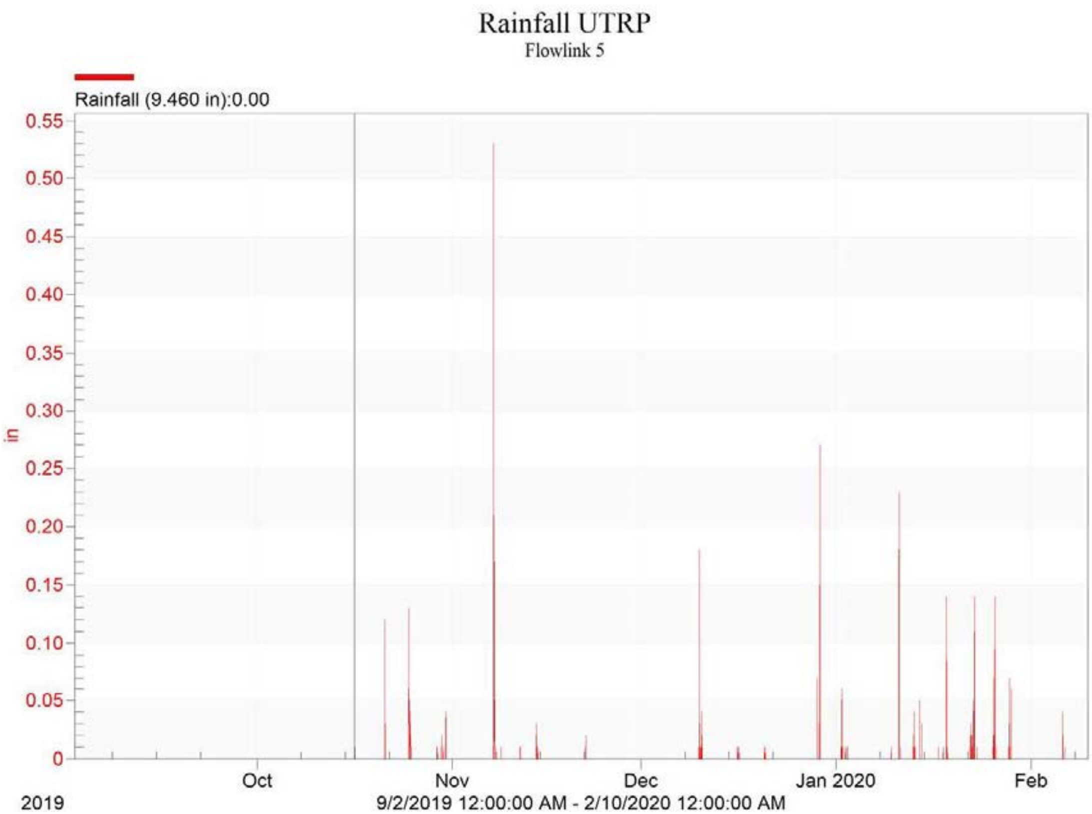

Figure 1.2 Graph 1.1 UTRP Rainfall Rainfall data from September 2019- February 2020 At UTRP Site

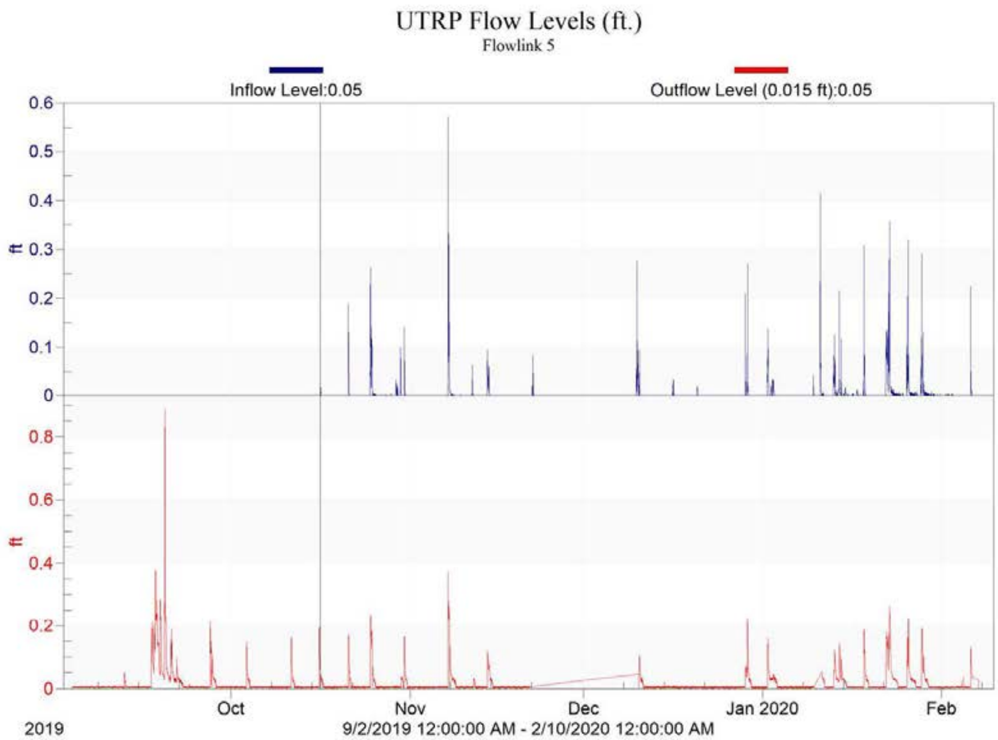

Figure 1.3 Graph 1.2 UTRP Flow Level Comparison Flow level data from Inflow 101 (blue) compared to flow levels from the Outflow 102 (red)

Table 2.3 Field Reporting Data from EG location

Exploration Green Wetland	Air Temp. (°C)	H2O Temp. (°C)			DO (mg/ L)			pH			Specific Conductivity (µS/cm)		
Sampling Events		Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up

12/10/19	11	17.5	16.0	15.1	8.4	8.3	8.1	4.6	6.9	9.52	314.4	224.4	276.2
1/11/20	13	17.1	18.3	N/A	8.4	8.2	N/A	7.38	7.76	N/A	237.0	326.3	N/A
1/13/20	16	16.5	16.9	N/A	8.6	8.6	N/A	7.36	7.75	N/A	264.9	297.8	N/A
1/28/20	18	17	15.6	14.4	11.6	9.5	7.8	7.99	6.99	7.42	328.4	318.2	306.9
4/5/20	22	23.9	20	N/A	7.3	8.2	N/A	7.69	7.21	N/A	405.9	135.9	N/A
4/20/20	16	22.7	23.1	N/A	6.6	5.4	N/A	8.35	7.41	N/A	428.5	422.6	N/A
4/29/20	20	25	24.1	N/A	7.5	7.9	N/A	8.12	7.71	N/A	434.9	353.4	N/A
5/6/20	28	26.5	26.5	N/A	6.3	7.5	N/A	8.36	7.61	N/A	464.2	419.8	N/A
5/13/20	22	26.8	25.1	N/A	7.3	6.3	N/A	7.95	7.58	N/A	469.6	455.3	N/A
6/24/20	29	28.3	29.9	N/A	8.0	9.3	N/A	8.03	8.04	N/A	279.6	257.4	N/A

Table 2.4 Lab Results Reported for EG location

Exploration Green Wetland	Location	Sampling Events ID	Nitrate + Nitrite as N	Ammonia as N	TSS	E. coli	Total Phosphorous
Reporting Limit			0.02 mg/L	0.1 mg/L	1.0 mg/L	10 mpn/100 mL	0.06 mg/L
Date							
12/10/19	Inflow	EG 201-1	0.42	0.1	139	4880	0.118
12/10/19	Outflow	EG 202-1	0.42	0.2	24.0	24200	0.141

12/12/19	Follow up	EG 202-2	0.37	0.5	26.0	<10	0.101
1/11/20	Inflow	EG 201-2	0.26	0.1	20.6	4110	0.153
1/11/20	Outflow	EG 202-3	0.23	0.1	23.2	24200	0.118
1/13/20	Inflow	EG 201-3	0.23	<0.1	24.4	4610	0.149
1/13/20	Outflow	EG 202-4	0.2	0.3	15.6	2610	0.0624
1/28/20	Inflow	EG 201-4	0.46	<0.1	31.9	2280	0.156
1/28/20	Outflow	EG 202-5	0.40	0.1	19.1	426	0.126
4/29/20	Inflow	EG- 201-5	1.87	<0.01	34.0	12000	0.149
4/29/20	Outflow	EG-202-7	2.73	0.2	23.2	3260	0.141
05/06/20	inflow	EG 201-6	0.05	0.1	54.0	24200	0.150
05/06/20	outflow	EG 202-8	0.02	0.1	15.6	638	0.163
05/13/20	Inflow	EG 201-7	0.03	<0.1	66.4	8660	0.113
05/13/20	Outflow	EG 202-9	0.05	<0.1	18.0	771	0.142
06/24/20	Inflow	EG 201-8	0.03	<0.1	31.2	9210	0.140
06/24/20	Outflow	EG 202-10	0.02	<0.1	20.0	6130	0.158

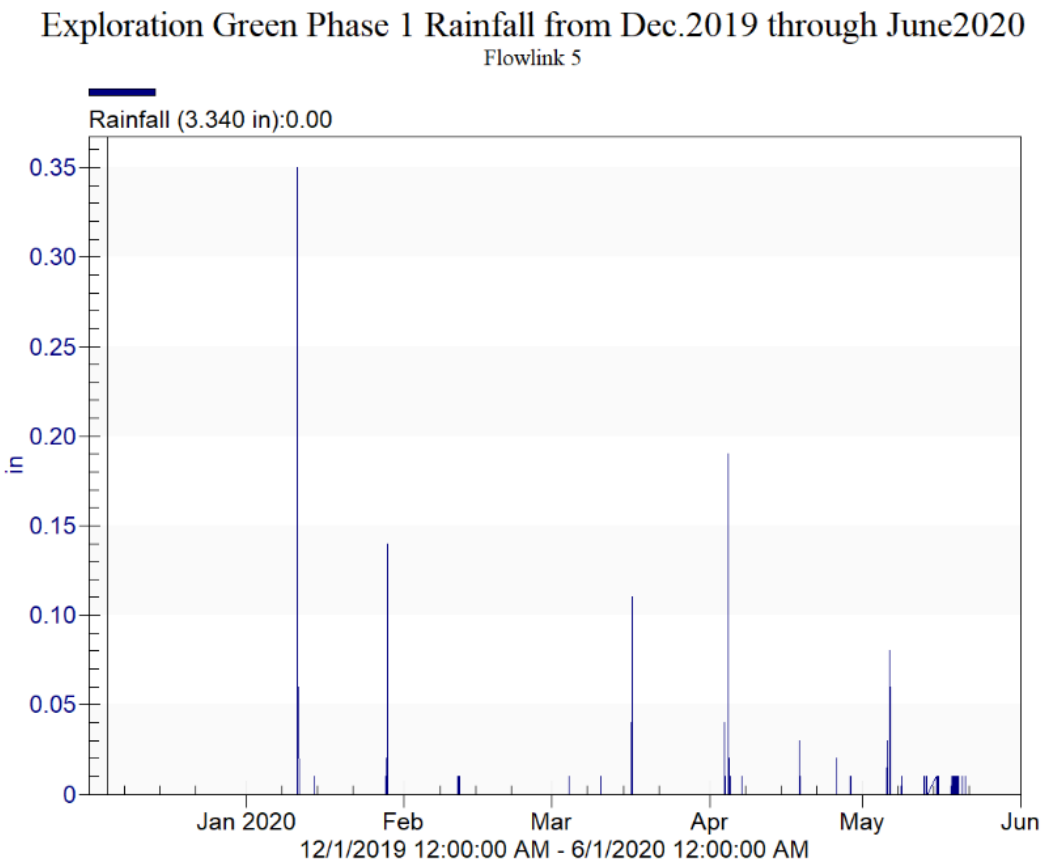

Figure 1.4 Graph 2.2 EG Rainfall Rainfall data from December 2019- June 2020

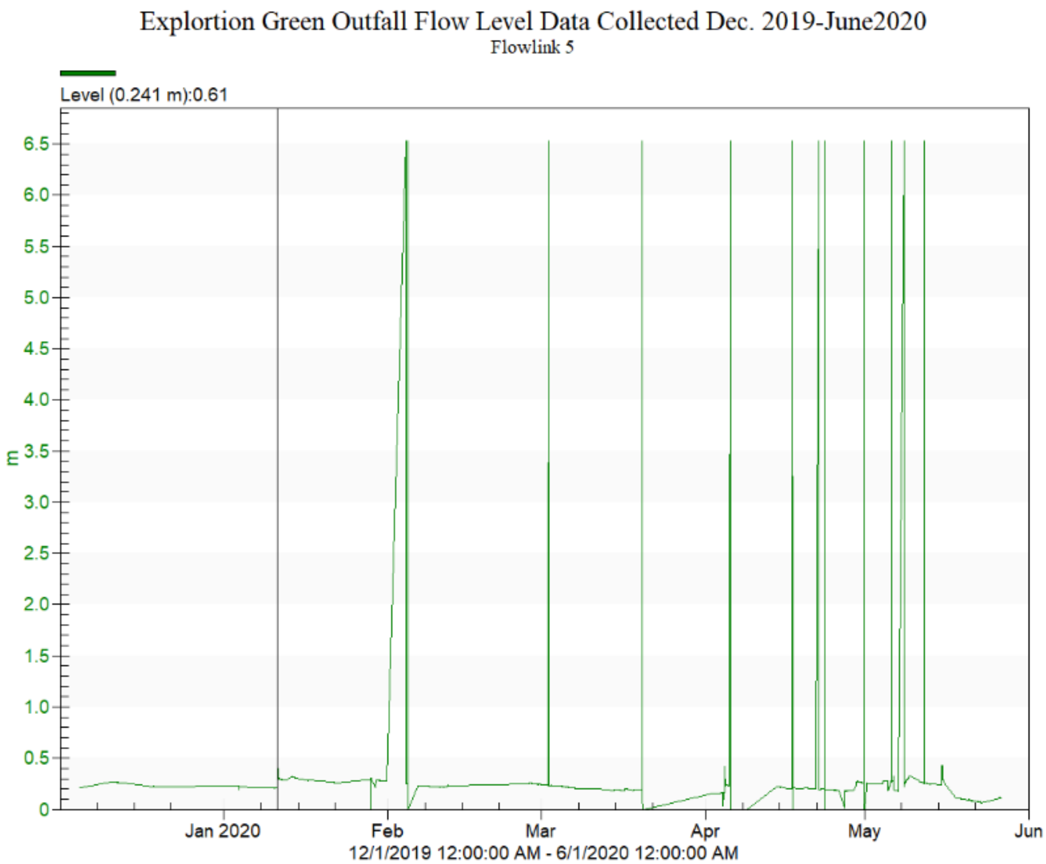

Figure 1.5 Graph 2.3 [EG Outfall flow level]Flow level data from EG Phase 1 Outfall from Dec.2019-June 2020

Table 2.5 Field Reporting Data from PTWB location

PTWB Wetland	Rainfall Amount (inches/hr)	Air Temp. (°C)	H2O (°C)	Temp.	DO (mg/ L)		Specific Conductivity (µS/cm)		pH	
Sampling Event			Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow

4/28/2020	0.03	31	25.7	N/A	7.9	N/A	312.2	N/A	8.75	N/A
4/29/2020	0.08	21	20.2	21	8.8	9.2	128.5	133.1	8.33	8.33
5/6/2020	0.04	19	24.5	24.3	7.4	8.3	126.1	109.2	8.61	8.56
5/15/2020	0.07	22	24.8	25.1	8.2	8.2	89.9	101.9	8.49	8.83
6/22/2020	0.11	22	25.3	26.5	6.9	6	102	119.1	8.51	7.74
7/22/2020	0.03	27.7	30.1	29.6	6.8	8.4	260.1	206.4	8.76	8.67

Table 2.6 Lab Report Results for PTWB location

MDA PTWB Wetland	Location	Sampling Events ID	Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. coli (mpn/100ml)	Total Phosphate (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)
Reporting Limit			0.02	0.1	1	10	0.06	0.0005	0.003	0.001	0.003	0.0005	0.0002	0.005	0.0005	5
Date																
4/29/2020	Inflow	PTWB 301-1	1.17	0.1	7.3	161	<0.06									

4/29/2020	Outflow	PTWB 302-1	2.26	<0.1	51.2	9800	<0.06									
5/6/2020	Inflow	PTWB 301-2	11	0.2	12	733	<0.06	0.00171	0.0191	<0.001	0.0529	<0.0005	<0.0002	<0.005	<0.0005	<5.0
5/6/2020	Outflow	PTWB 302-2	0.58	0.1	24.8	1920	<0.06	0.00159	0.0274	<0.001	0.0451	0.0008	<0.0002	<0.005	<0.0005	<5.0
5/15/2020	Inflow	PTWB 301-3	0.13	<0.1	16.8	1300	<0.06	0.00098	0.00996	<0.001	0.00302	<0.0005	<0.0002	<0.005	<0.0005	<5.0
5/15/2020	Outflow	PTWB 302-3	0.11	<0.1	4.5	4840	<0.06	0.00133	0.0239	<0.001	0.00482	0.000774	<0.0002	<0.005	<0.0005	<5.0
6/22/2020	inflow	PTWB 301-4	0.12	<0.1	1.4	20	<0.06	0.000517	0.00589	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
6/22/2020	outflow	PTWB 302-4	0.24	<0.1	3.6	10	<0.06	0.00152	0.0255	<0.001	0.00370	<0.0005	<0.0002	<0.005	<0.0005	<5.0
7/22/2020	Inflow	PTWB 301-5														
7/22/2020	outflow	PTWB 302-5														

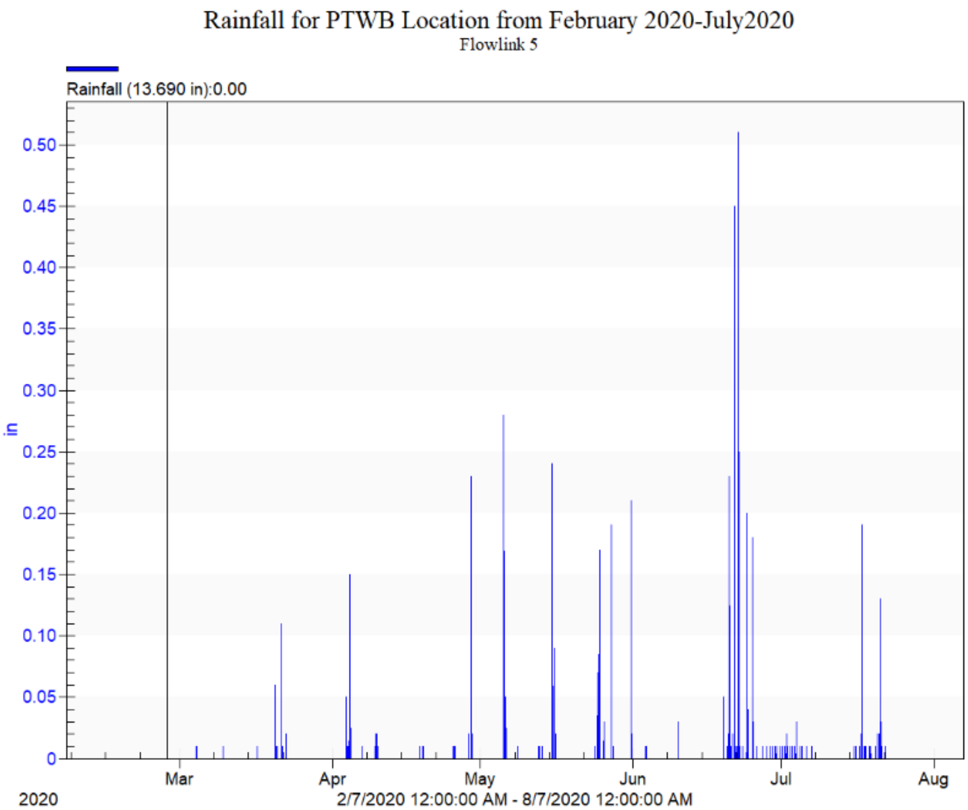

Figure 1.6 Graph 3.1 PTWB Rainfall Rainfall at PTWB site from March - July 2020

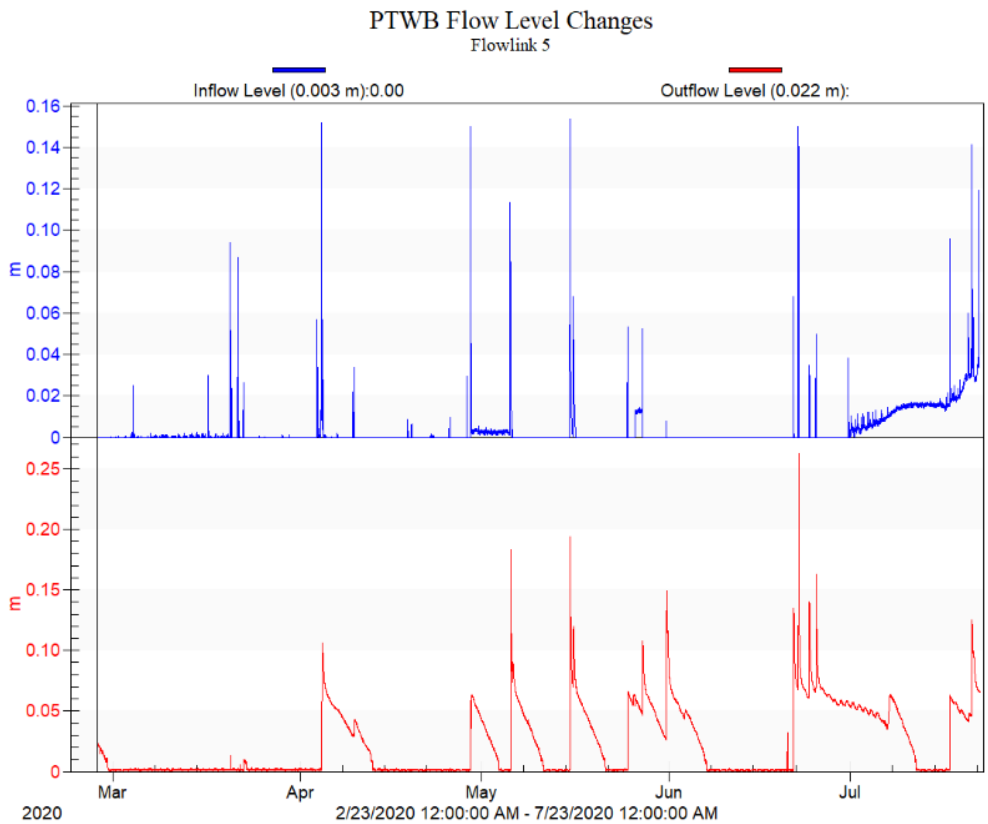

Figure 1.7 Graph 3.2 PTWB Flow Level Comparison Flow Level comparison from Inflow 301 (blue) compared to Outflow 302 (red) for the period from March - July 2020

Data for all sites divided by specific parameters tabulated in Tables 2.7-2.15 below.

Table 2.7 DO (mg/ L): all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	101 Inflow	102 Outflow	102 Follow up	201 Inflow	202 Outflow	202 Follow up	301 Inflow	302 Outflow
9/27/2019	7.7	5.9						
11/7/2019	9.6	8.2	10.3					
12/10/2019	10.3	8.8	7.4	8.4	8.3	8.1		
1/9/2020	8.2	9.2						
1/11/2020	9.5	12.4		8.4	8.2			

1/13/2020	11.4	9.9		8.6	8.6			
1/28/2020	10.4	9.9	13.6	11.6	9.5	7.8		
2/6/2020	13.9	14	9.6					
4/5/2020				7.3	8.2			
4/20/2020				6.6	5.4			
4/29/2020				7.5	7.9		8.8	9.2
5/6/2020				6.3	7.5		7.4	8.3
5/13/2020				7.3	6.3			
5/15/2020							8.2	8.2
6/22/2020							6.9	6
6/24/2020				8	9.3			
7/22/2020							6.8	8.4

Table 2.8 Specific Conductivity (μS/cm): all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	Inflow	Outflow	follow up	Inflow	Outflow	follow up	Inflow	Outflow
9/27/2019	112	128.9						
11/7/2019	61.9	64.7	275.3					
11/8/2019								
12/10/2019	133.4	149.9	181.8	314.4	224.4	276.2		
1/11/2020	80.6	73.4		326.3	237			
1/13/2020	140	147.8		297.8	264.9			
1/28/2020	80.8	146	165.9	328.4	318.2	306.9		
2/6/2020	86.3	212.2	205.8					
4/5/2020				405.9	135.9			

4/20/2020				428.5	422.6			
4/29/2020				434.9	353.4		128.5	133.1
5/6/2020				464.2	419.8		126.1	109.2
5/13/2020				469.6	455.3			
5/15/2020							89.9	101.9
6/22/2020							102	119.1
6/24/2020				279.6	257.4			
7/22/2020							260.1	206.4

Table 2.9 pH all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	Inflow	Outflow	follow up	Inflow	Outflow	follow up	Inflow	Outflow
9/27/2019	10.64*	10.88*						
11/7/2019	10.48*	8.5*	16.29*					
12/10/2019	9.88*	8.51*	16.33*	4.6*	6.9*	9.52*		
1/11/2020	8.04	7.22		7.76	7.38			
1/13/2020	7.71	7.08		7.75	7.36			
1/28/2020	7.99	7.17	7.21	7.99	6.99	7.42		
2/6/2020	7.35	7.47	7.13					
4/5/2020				7.69	7.21			
4/20/2020				8.35	7.41			
4/29/2020				8.12	7.71		8.33	8.33
5/6/2020				8.36	7.61		8.61	8.56
5/13/2020				7.95	7.58			
5/15/2020							8.49	8.83
6/22/2020							8.51	7.74
6/24/2020				8.03	8.04			
7/22/2020							8.76	8.67

Table 2.10 TSS: Total Suspended Solids combined for all 3 locations

TSS	Inflow	Outflow	Difference
	2.9	2.4	0.5
	1.8	3.5	-1.7
	12.1	3.2	8.9
	1.2	2.6	-1.4
	8.4	4	4.4
	3	2.3	0.7
	12.2	8.4	3.8
	139	24	115
	20.6	23.2	-2.6
	24.4	15.6	8.8
	31.9	19.1	12.8
	34	23.2	10.8
	54	15.6	38.4
	66.4	18	48.4
	31.2	20	11.2
	7.3	51.2	-43.9
	12	24.8	-12.8
	16.8	4.5	12.3
	1.4	3.6	-2.2
	33.2	3.9	29.3

Table 2.11 E.Coli data for all three locations

E. coli	Inflow	Ouflow	Difference
	0	2600	-2600
	31	110	-79
	10	906	-896
	63	323	-260
	85	10	75
	0	63	-63
	0	473	-473
	4880	24200	-19320
	4110	24200	-20090
	4610	2610	2000
	2280	426	1854
	12000	3260	8740
	24200	638	23562

8660	771	7889
9210	6130	3080
161	9800	-9639
733	1920	-1187
1300	4840	-3540
20	10	10
10	0	10

Table 2.12 Phosphate: Phosphate data for all 3 locations

Phosphate Inflow	Outflow	Difference
0	0.0471	-0.0471
0.118	0.141	-0.023
0.153	0.118	0.035
0.149	0.0624	0.0866
0.156	0.126	0.03
0.149	0.141	0.008
0.15	0.163	-0.013
0.113	0.142	-0.029
0.14	0.158	-0.018

Table 2.13 Ammonia: Ammonia data for all 3 locations

AmmoniaInflow	Outflow	Difference
0	4.1	-4.1
0.1	0.2	-0.1
0.2	0	0.2
0	0.5	-0.5
0.1	0	0.1
0.2	0	0.2
0.1	0.2	-0.1
0.1	0.1	0
0	0.3	-0.3
0	0.1	-0.1
0	0.2	-0.2

0.1	0.1	0
0.1	0	0.1
0.2	0.1	0.1
0.1	0	0.1
0.1	0	0.1

Table 2.14 Nitrogen: Nitrogen data for All 3 locations

Nitrogen	Inflow	Outflow	Difference
	0.19	0.38	-0.19
	0.24	0.08	0.16
	0.77	0.17	0.6
	0.21	0.08	0.13
	0.56	0.11	0.45
	0.48	0.09	0.39
	0.44	0.02	0.42
	0.42	0.42	0
	0.26	0.23	0.03
	0.23	0.2	0.03
	0.46	0.4	0.06
	1.87	2.73	-0.86
	0.5	0.02	0.48
	0.03	0.05	-0.02
	0.03	0.02	0.01
	1.17	2.26	-1.09
	11	0.58	10.42
	0.13	0.11	0.02
	0.12	0.24	-0.12
	0.13	0.02	0.11

Table 2.15 Heavy Metals: Data analysis of metals reported in both UTRP and PTWB locations

Lead								
inflow	0	0.0014	0.00131	0	0	0	0	0
outflow	0	0.000643	0	0	0.0008	0.000774	0	0
difference	0	0.000777	0.00131	0	-0.0008	-0.000774	0	0

Arsenic

Inflow	0.00137	0	0.00151	0.000895	0.00171	0.00098	0.000517	0.00316
Outflow	0.000777	0	0.000686	0	0.00159	0.00133	0.00152	0.00213
Difference	0.000593	0	0.000824	0.000895	0.00012	-0.00035	-0.001	0.00103

Barium								
Inflow	0.0114	0.0136	0.0237	0.00811	0.0191	0.00996	0.00589	0.056
Outflow	0.0312	0.019	0.0371	0.0161	0.0274	0.0239	0.0255	0.0495
Difference	-0.0198	-0.0054	-0.0134	-0.00799	-0.0083	-0.01394	-0.01961	0.0065

All the data tables are also available on the stormwater wetland water quality webpage.

Results

The initial analysis of each site date was to average the parameter values recorded for each site. The averages are recorded in Tables 3.1-3.3for the site UTRP, EG, and PTWB respectively. Then bar charts were created to show the differences between the influent and effluent samples. The charts for UTRP are shown in Figures 1.8-1.11. The charts created for EG are shown in Figures 1.12-1.14. The charts from the last location PTWB are shown in Figures 1.15-1.18.

Table 3.1: Initial Analysis of data from MDA UTRP location

		Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. coli (mpn/100ml)	Total Phosphate (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)
Inflow Mean Values		**0.413**	**0.09**	**5.9**	**27.0**	**0.179**	**0.000944**	**0.014203**	**NR**	**NR**	**0.000683**	**NR**	**NR**	**NR**	**NR**
Outflow Mean Values		**0.133**	**0.69**	**3.8**	**640.7**	**0.171**	**0.000366**	**0.02585**	**NR**	**NR**	**0.000161**	**NR**	**NR**	**NR**	**NR**
Inflow Mean Values	**Subset**	**0.483**	**0.10**	**7.3**	**10.3**	**0.040**									
Outflow Mean Values	**Subset**	**0.090**	**1.08**	**4.4**	**388.0**	**0.049**									

Follow Up Mean Values	**Subset**	**0.020**	**0.10**	**5.7**	**38.8**	**0.044**

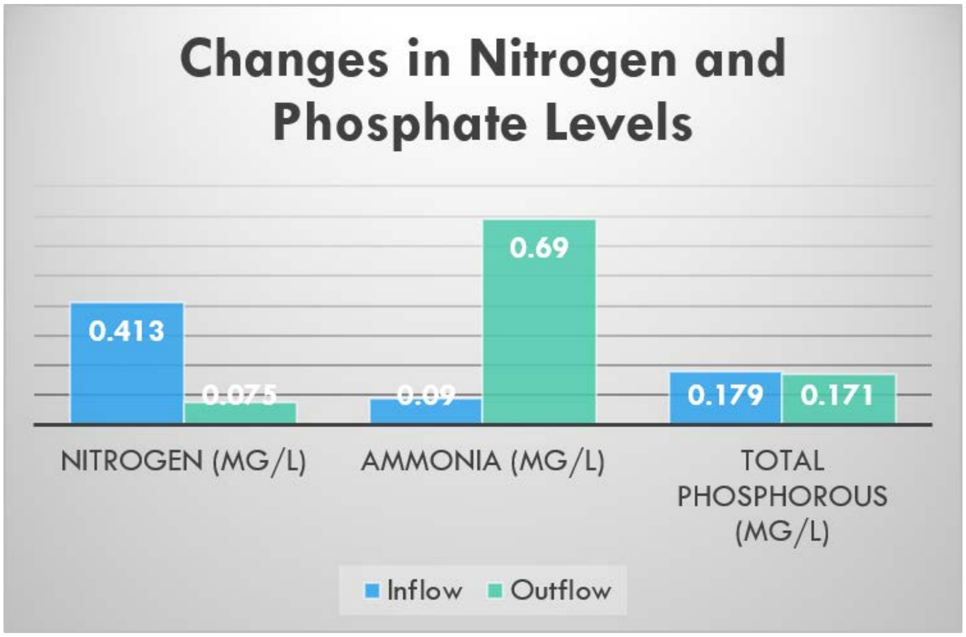

Figure 1.8 Changes in nitrogen and phosphorous at UTRP

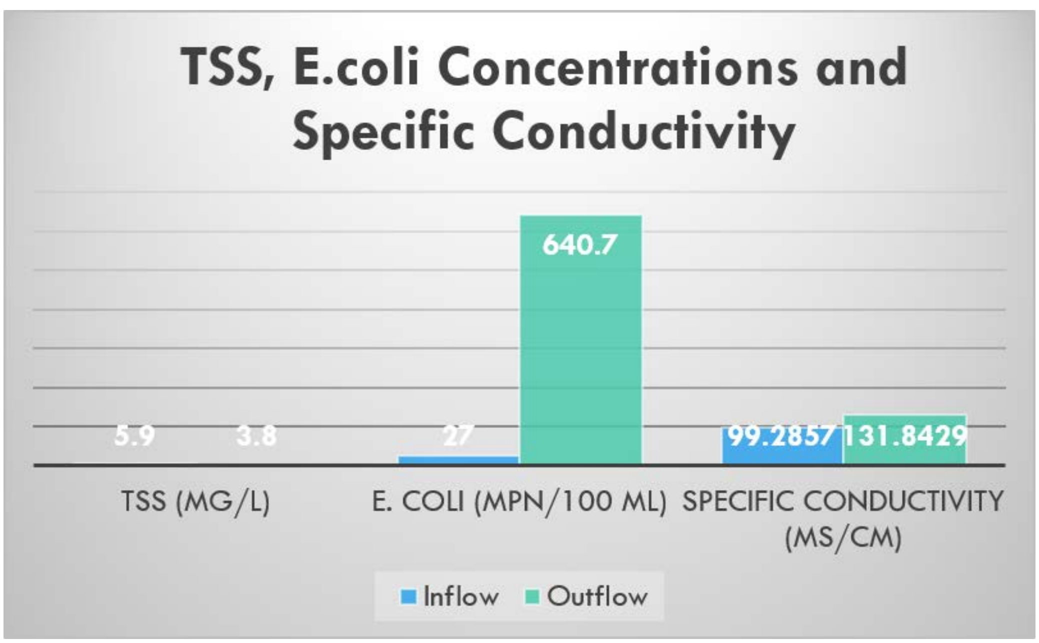

Figure 1.9 Changes in Total suspended solids, E.coli, and Specific conductivity at UTRP

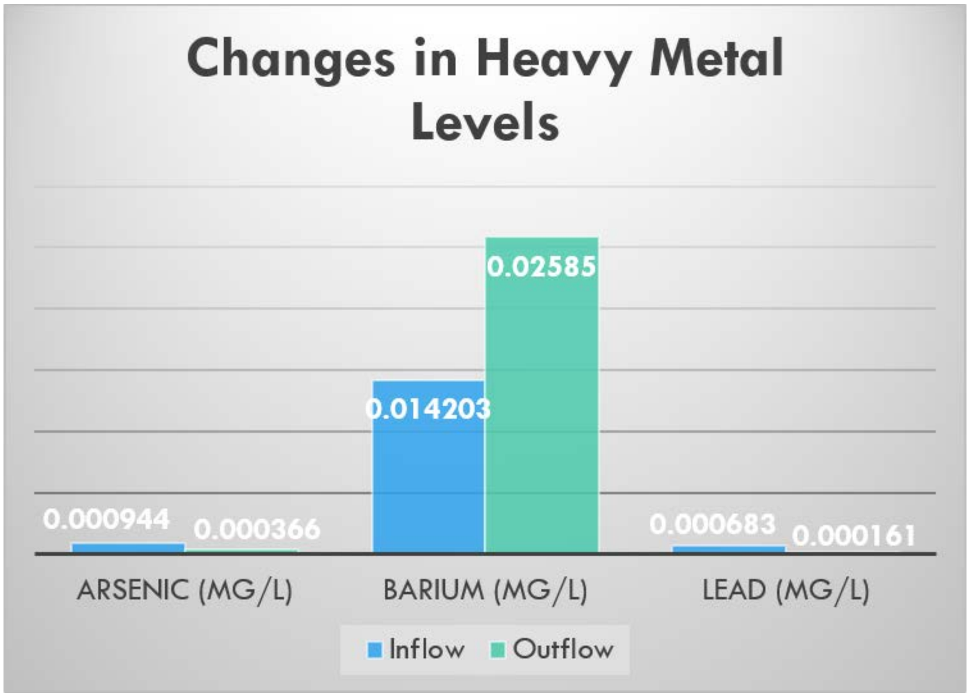

Figure 1.10 Changes in heavy metals present at UTRP

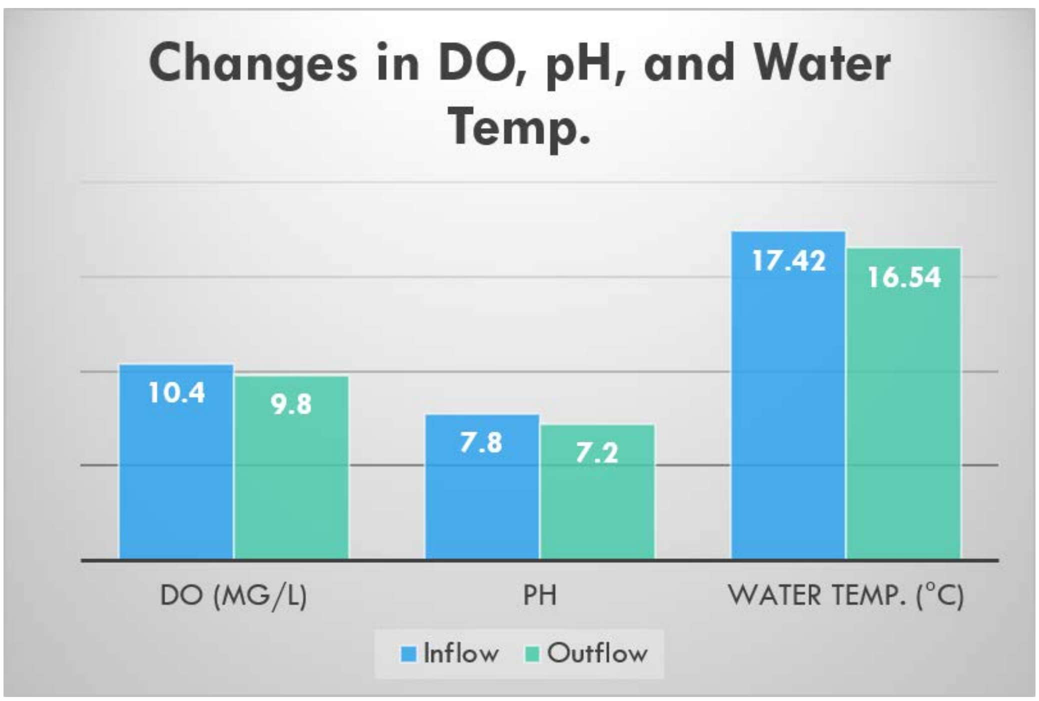

Figure 1.11 Changes in dissolved oxygen, pH, and water temperature at UTRP

Table 3.2: Initial Analysis of data from Exploration Green site locations

Mean Values	Nitrogen	Ammonia	TSS	E. Coli	Total Phosphorous	DO	Specific Conductivity	pH
Inflow	0.475	0.0375	50.2	8743.8	0.141	7.98	374.96	8
Outflow	0.509	0.125	19.8	7779.4	0.1314	7.94	308.89	7.5
Difference	-0.034	-0.0875	30.4	964.38	0.0096	0.04	66.07	0.5

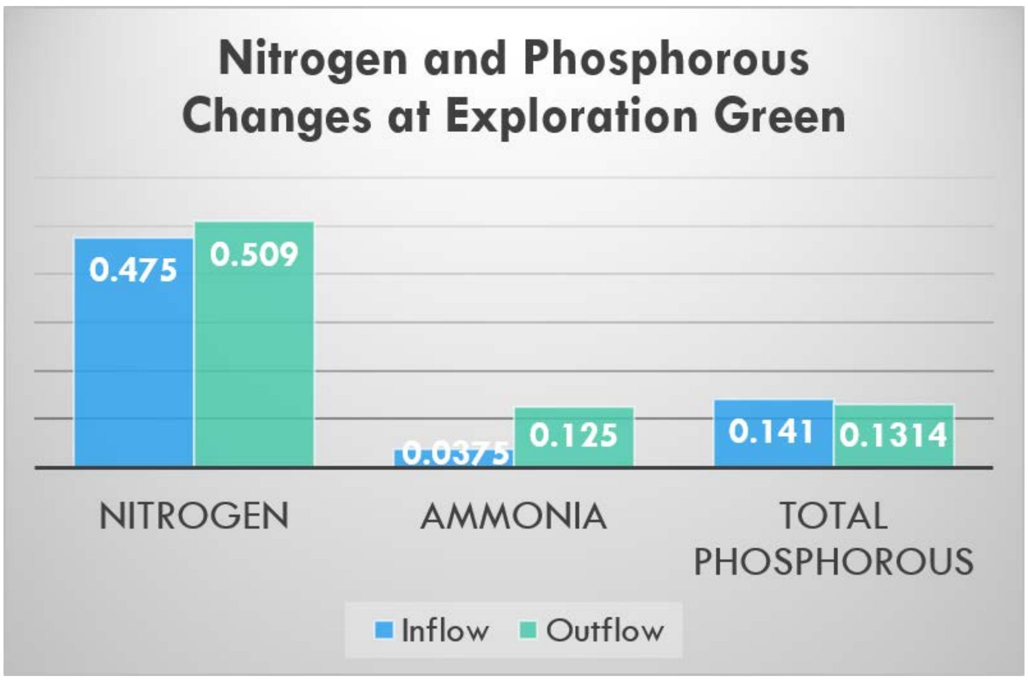

Figure 1.12 Changes in nitrogen and phosphorous levels at Exploration Green

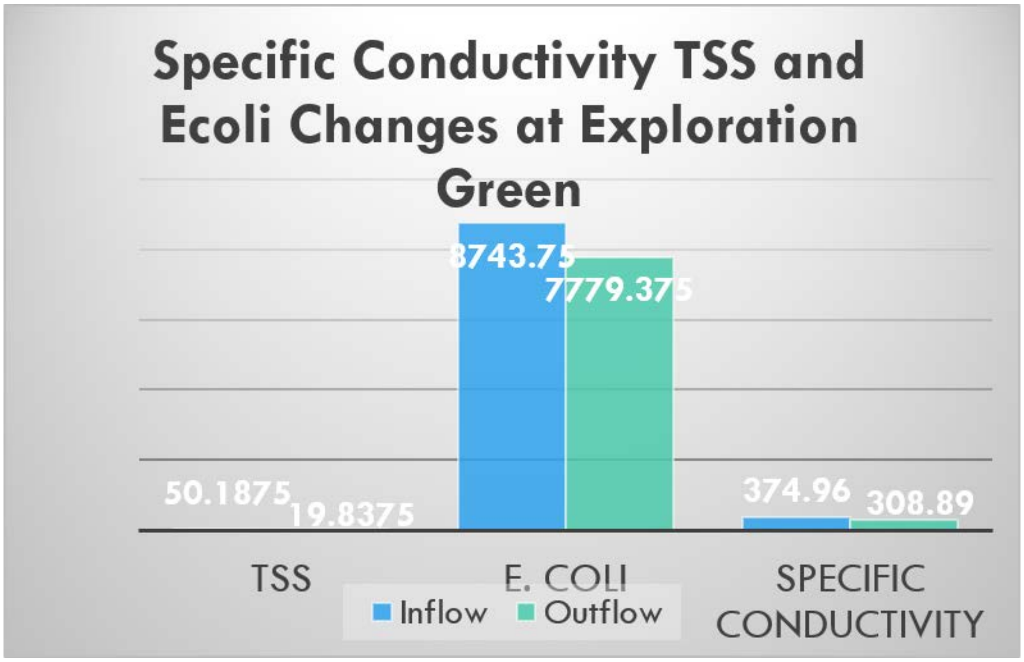

Figure 1.13 Changes in specific conductivity, total suspended solids and E. coli levels at Exploration Green

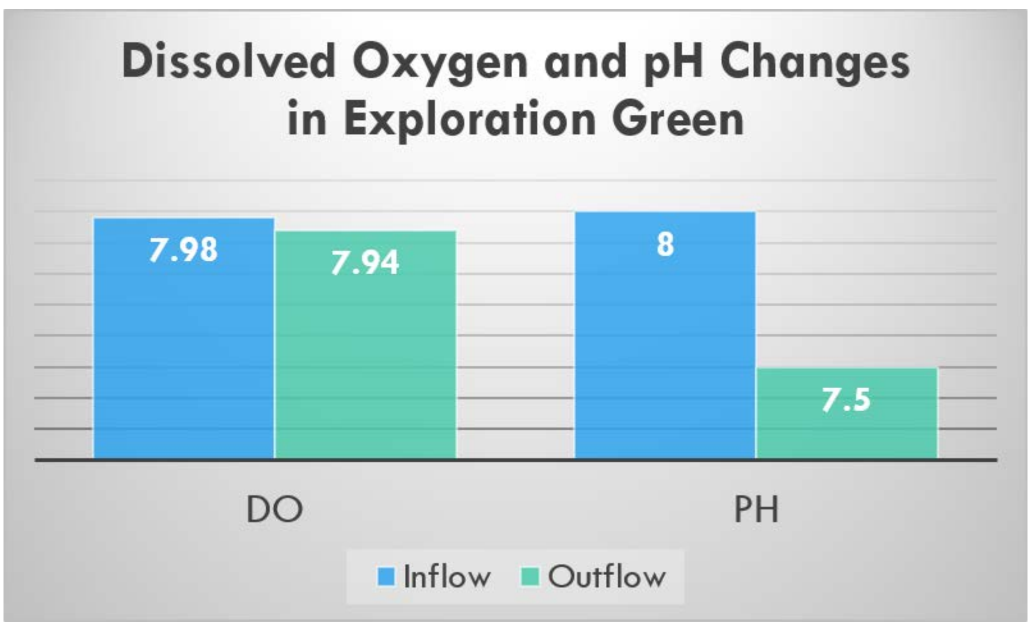

Figure 1.14 Changes in dissolved oxygen and pH at Exploration Green

Table 3.3: Initial Analysis of data from Proton Therapy Wetland Basin site locations

Mean Values	DO	Specific Conductivity	pH	Water temp.	NO2 & NO3	NH3N	E. coli	TSS	Total Phosphate	Arsenic	Barium	Chromium	Lead
Inflow	7.62	141.32	8.54	24.98	2.51	0.1	444.8	3314	0	0.00159175	0.0227375	0.0020775	0
Outflow	8.02	133.94	8.426	25.3	0.642	0.02	3314	17.6	0	0.0016425	0.031575	0.0040925	0.0003935
Difference	-0.29	7.38	0.114	-0.32	1.87	0.08	-2869	3296	0	-0.00005075	-0.0088375	-0.00202	-0.000394

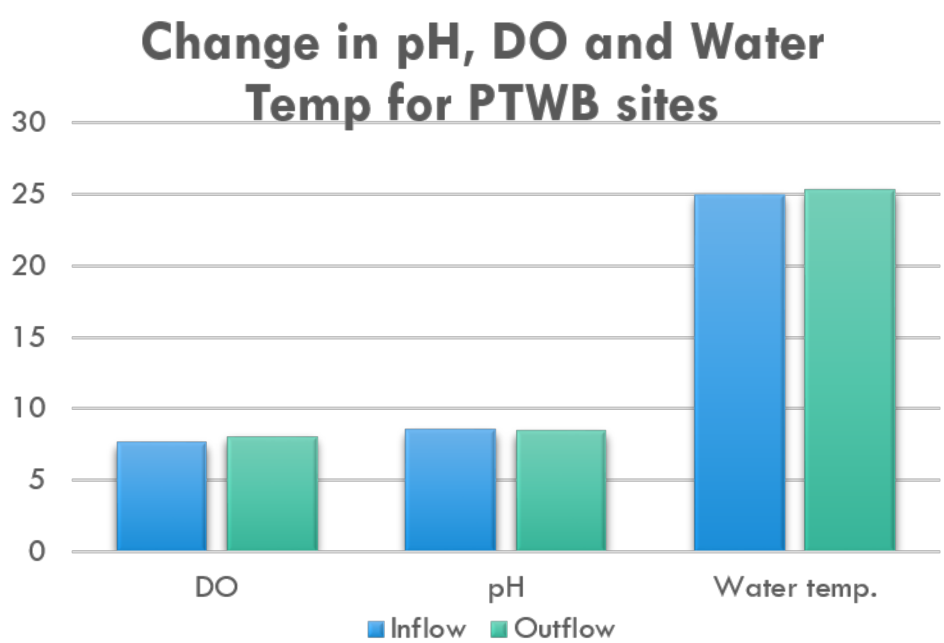

Figure 1.15 Changes in pH, DO, and water temp at PTWB

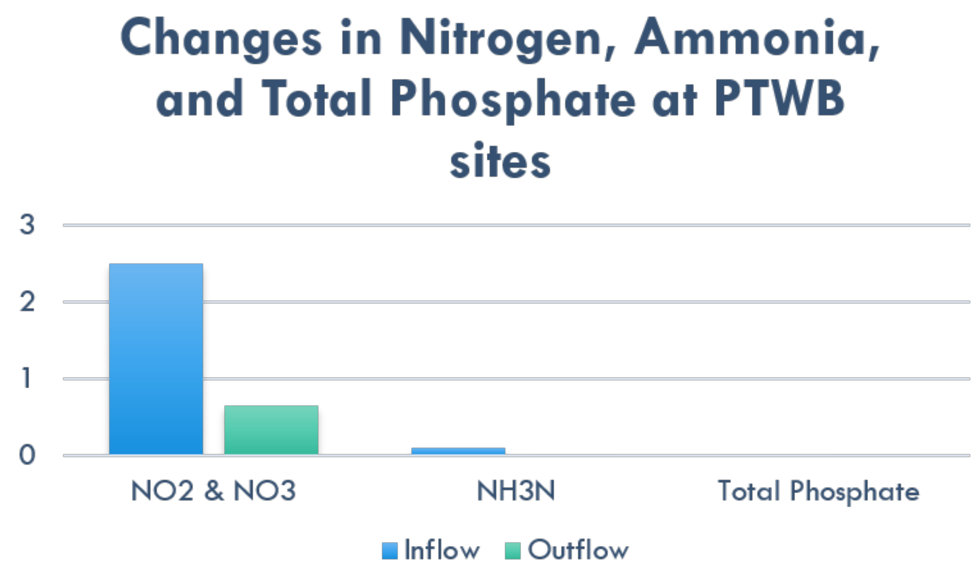

Figure 1.16 Changes in nitrogen and phosphorous at PTWB

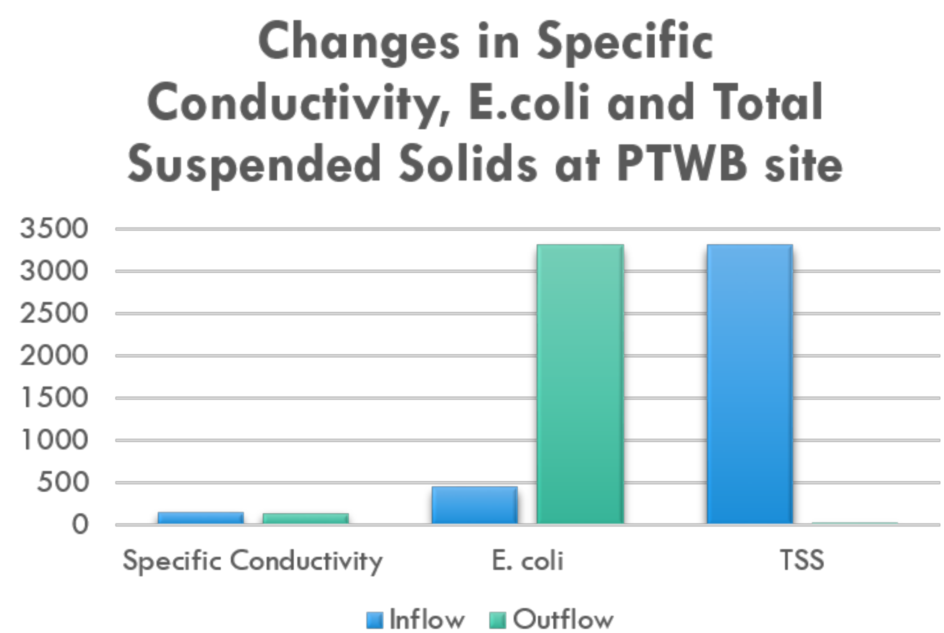

Figure 1.17 Changes in specific conductivity, E.coli, and TSS at PTWB

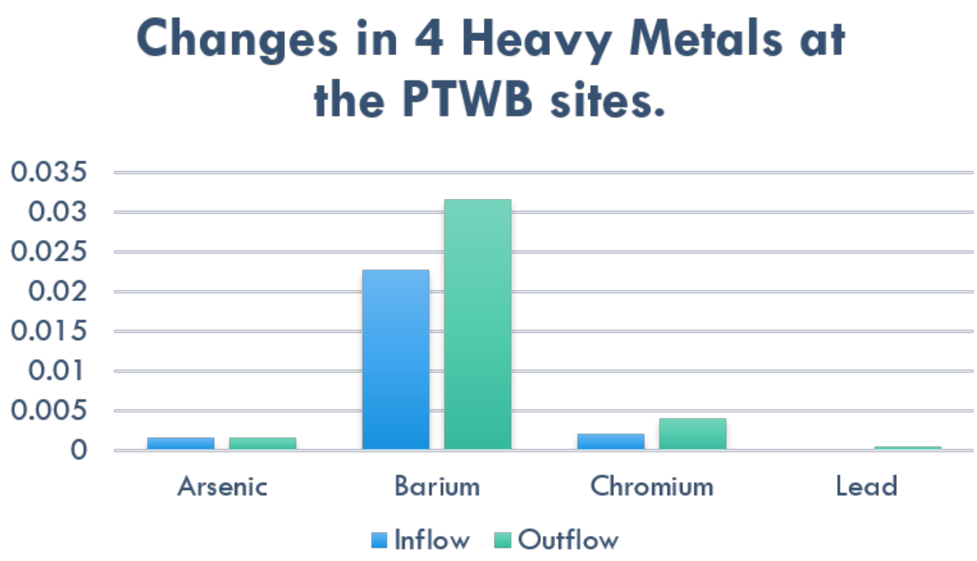

Figure 1.18 Changes in heavy metals identified at the PTWB site

Further analysis of the data was done by conducting paired t-test for each of the parameters identified in the previous tables combining all the results from the three project sample locations, two project sample locations for the heavy metal parameters. The results for the paired t-test with an *alpha =0.05* and a 95% confidence level are reported in the following Tables 3.4-3.12. These tests show no significant change in any of the parameters identified.

Table 3.4 Analysis of DO:

	Inflow	Outflow	difference
average	9.0793103	8.772414	0.306897
t-test	0.3485493		
t-crit	2.048		

Table 3.5 Analysis of Specific Conductivity:

	inflow	outflow	difference
average	219.8714	217.6214	2.25
t-test score	0.889651		
t-critical	2.052		

Table 3.6 Analysis of pH:

	inflow	outflow	difference
average	8.053333333	7.624762	0.428571
t-score	0.00004577348		
t critical	2.086		

Table 3.7 Analysis of TSS:

TSS:	Inflow	Outflow	Difference
sum	513.8	273.1	240.7
mean	25.69	13.655	12.035
t-test	0.095284		
t-crit	2.093		

Table 3.8 Analysis of E. coli bacteria data

E. coli	Inflow	Outflow	Difference
sum	72363	83290	-10927
mean	3618.15	4164.5	-546.35
t-test	0.792677		
t-crit	2.093	Accept H0: no change	

Table 3.9 Analysis of Phosphate:

Phosphate	Inflow	Outflow	Difference
sum	1.128	1.0985	0.0295
mean	0.125333	0.122056	0.0032778
t-test	0.817973		
t-crit	2.306	Accept H0: no change	

Table 3.10 Analysis of Ammonia:

Ammonia	Inflow	Outflow	Difference
sum	1.4	5.9	-4.5
mean	0.0875	0.36875	-0.28125
t-test	0.294446		
t-crit	2.131		
	Accept H0: no change		

Table 3.11 **Analysis of Nitrogen:**

Nitrogen	Inflow	Outflow	Difference
sum	19.24	8.21	11.03
mean	0.962	0.4105	0.5515
t-test	0.308727		
t-crit	2.093	Accept H0: no change	

Table 3.12 Analysis of heavy metals data:

Lead	sum	mean	t-test	t-crit
inflow	0.00273	0.00034125	0.805643	2.365
outflow	0.002217	0.000277125		
difference	0.000513	0.000064125		

Arsenic	sum	mean	t-test	t-crit
Inflow	0.010142	0.00126775	0.325361	2.365
Outflow	0.008033	0.001004125		
Difference	0.002109	0.000263625		

Barium	sum	mean	t-test	t-crit
Inflow	0.14776	0.01847	0.011817	2.365
Outflow	0.2297	0.0287125		

Difference	-0.08194	-0.0102425

There were 8 heavy metal parameters tested, only four parameters gave any results over the reporting limit the other parameters were not reported by the lab. Also, there were no incidences of TPH reported for the samples tested at either of the locations.

Conclusions

In conclusion AgriLife found that this is a good start to some baseline information on constructed stormwater wetlands in the Lower Galveston Bay Watershed. We found trends to improving water quality in all three project locations, not dependent on the size or establishment of the stormwater wetland. We saw decreases in specific conductivity, pH, TSS, phosphate, nitrogen, chromium, lead, arsenic. While these are promising improvements, the t-test results do not let us reject the null hypothesis, no change between the inflow and outflow samples. We saw increases in ammonia levels. While no definitive causes were identified, this could be due to increased habitat and bird activity in stormwater wetlands. We also saw an increase in E. coli bacteria at the outflow locations. This could be a result of the longer hold times in stormwater sampling from the traditional 8 hours for water quality to 24 hours for our stormwater samples. Most samples were test I well under the 24- hour limit. We know bacteria can live longer on sediment and other surfaces so if there are more significant decreases in TSS the bacterial amounts may also decrease, but the data from this study show bacteria are not closely correlated to the amount of suspended solids. It is also thought that animals typically do not use the restroom on the concrete parking lot surfaces, the sources of the runoff in the inflow pipes. So it is thought that the increases are from surface flow off the grass areas rather than the inflow pipes. We saw increases in barium from the two sites that were tested for heavy metal parameters. We do not know why this is the case but it could be tied to location, being in the medical center. Maybe there are more sources we are unaware of in this location. These findings make a case for more sampling to be added in these and other stormwater wetland projects in the area over a longer duration to try to identify differences seasonally and prove the trends merit more of these types of green infrastructure projects.

APPENDICES

Appendix A: Field Data Recording Sheet

Field Data Recording Sheet

Date: ____________________ Collected By: ____________________

Location: ____________________ Event #: ________________

Site ID:		Rainfall Amount		Air Temp.		Water Temp.		DO		Specific Conductance		pH		24 Hr.	48 Hr.		Bottle Collected #:

Field Observations:

Appendix B: Chain of Custody

EASTEX ENVIRONMENTAL LABORATORY, INC.

P. O. Box 1089 * Coldspring, TX 77331 | P. O. Box 631375 * Nacogdoches, TX 75963-1375
(800) 525-0508 * FAX (936) 653-3172 | (936) 569-8879 * FAX (936) 569-8951
www.eastexlab.com

REPORT TO:	INVOICE TO:
① Company	② Company
Address	Address
Attn.	Attn.
Phone #	Phone #
Fax #	Fax #
	P.O. #
Sampler's Name (please print)	Sampler's Signature

Project Number	③ Project Name	⑦ Containers

Remarks:

⑧ ANALYSIS REQUESTED

Order ID	④ Sample ID	Date	Time	⑤ C/G	DO	PH	Cl2	Flow	Temp	⑥ Matrix	#Con	Size	Type	Pres										

Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received and/or Checked In By: (Signature)	Date	Time	Received Iced: Yes / No

LAB USE ONLY Sample Condition Acceptable Yes / No	Temp °C	* Therm ID	Logged in By: (Signature)	Date	Time	White Copy-Follows Samples Yellow Copy-Laboratory Pink copy-Client Copy
Alternate Check in (Signature) Date Time						SEE BACK FOR INSTRUCTIONS

Chain of Custody Revision 2: 03/24/17 — * Thermometer has 0.0 factor and recorded temperature is actual temperature. — Eastex Environmental Laboratory, Inc.

INSTRUCTIONS

Please be complete and accurate when filling out the Chain-of-Custody sheet, as all Information will be printed on the final lab report.

1 REPORT TO:	Name of company, address, #'s, and where you want the report sent.
2 INVOICE TO:	Name of company, address, #'s, and where you want the report sent.
3 PROJECT NAME:	What you will call this sample.
4 SAMPLE ID:	How you will refer to this sample.
5 SAMPLE TYPE:	C3=3pt Comp. C6=6pt Comp. C12=12hr Comp. C24=24hr Comp. G=Grab
6 MATRIX:	DW=Drinking Water WW=Wastewater SO=Soil/Sludge OL=Oils FL=Filter LE=Leachate SD=Solid RE=Resin OT=Other
7 CONTAINER(S)	
SIZE:	1=Gallon 2=1/2 Gallon 3=Quart/Liter 4=Pint 5=1/2 pt (250 ml) 6=125 ml/4 oz. 7=60 mls/2 oz 8-Vial 9=Other
TYPE:	P=Plastic G=Glass T=Teflon S=Sterile
PRESERVATIVE:	C=Chilled S=Sulfuric Acid N=Nitric Acid B=Base/Caustic Z=Zn Acetate H=Hydrochloric Acid ST=Sodium Thiosulfate O=Other
8 ANALYSIS REQUESTED	Please be as specific as possible when listing which samples get what results.

Appendix C: Eastex Lab Bid and Requirement Specifications

Eastex Environmental Laboratory PO Box 1089 Coldspring, Texas 77331

Christina Taylor
Extension Program Specialist
Stormwater Wetlands Program
Texas Community Watershed Partners
Texas A&M AgriLife Extension Service

March 6, 2018

Response for Bid – Texas Community Watershed Partners Stormwater Quality Project
Grant Award Number NA18NOS4190153

Thank you for the opportunity to bid on your analyses.

Eastex Environmental Laboratory is very familiar with the analysis requirements for this task. We are an approved Clean River Program Laboratory and have been meeting the bacteriological holding times for these projects in the Houston/Galveston area. We have 3-4 Field Technicians in the Houston/Galveston area daily and coordinate sample pick-up for similar tasks regularly.

We are TNI accredited, HUB Certified laboratory and have been servicing the Houston/Galveston area for the past 32 years meeting our clients analytical needs. Eastex Environmental performs all items in the tasks at our facilities under our scope of accreditation. All analytical procedures will be conducted according to NELAP procedures, EPA Standards, AWWA and TCEQ guidelines. The procedures include the following, as a minimum requirement: comparisons against known standards in each run; one in ten sample duplicates and a monthly review against known spiked samples. Detection Limits will be our normal reporting limits unless otherwise specified by project requirements. The price includes sample bottles, pick-up, coolers as needed and delivery of data.

Enclosed you will find the following:

Section 1 – Bid Documents

Bid Specification with Scope of Services,

Section 2 - HUB Certificate,

Once again, thank you for this opportunity. If you need any additional information or any further assistance, please feel free to call me at 936-653-3249 or 1-800-525-0508. You may also visit our website at www.eastexlabs.com .

Respectfully,

Kathleen Harrott

Kathleen Harrott, Technical Director, Eastex Environmental Laboratory, Inc.

Appendix D: Eastex Laboratory NELAP Accreditations

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 08, 2018

CERTIFIED MAIL 9485 5090 0527 6008 6739 69

Ms. Tiffany Guerrero
Eastex Environmental Laboratory, Inc. - Coldspring
P. O. Box 1089
Coldspring, TX 77331-1089

Re: Amendment application

Dear Ms. Guerrero:

Based on the amendment request submitted on April 05, 2018, I am enclosing an updated NELAP accreditation certificate and Fields of Accreditation listing. They replace the previous ones issued on November 01, 2017.

Please review the enclosures for accuracy and completeness. Your laboratory's accreditation is valid until the expiration date on the certificate and scope, contingent on continued compliance with the standards for accreditation and requirements of the state of Texas.

Please let me know if I can provide any additional information regarding this matter. You may also contact me at (512) 239-1990 or *ken.lancaster@tceq.texas.gov*.

Sincerely,

Kristy M. Beaver
for Ken Lancaster
Manager, Laboratory & Quality Assurance Section

Enclosures

P.O. Box 13087 • Austin, Texas 78711-3087 • 512-239-1000 • tceq.texas.gov
How is our customer service? tceq.texas.gov/customersurvey

Appendix E: LAB REPORTS

See the lab report links at the follow website
https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

https://tcwp.tamu.edu/files/2020/02/UTRP101-1.pdf

https://tcwp.tamu.edu/files/2020/02/UTRP102-1.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-8.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-9.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-10.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-11.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-12.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-3.pdf

https://tcwp.tamu.edu/files/2020/05/EG-201-4.pdf

https://tcwp.tamu.edu/files/2020/05/EG201-5.pdf

https://tcwp.tamu.edu/files/2020/06/Eg-201-6.pdf

https://tcwp.tamu.edu/files/2020/06/EG-201-7.pdf

https://tcwp.tamu.edu/files/2020/07/EG-201-8.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-3.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-4.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-5.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-6.pdf

https://tcwp.tamu.edu/files/2020/05/EG202-7.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-8.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-9.pdf

https://tcwp.tamu.edu/files/2020/07/EG-202-10.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-301-1.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-2.pdf

https://tcwp.tamu.edu/files/2020/06/PTWB-301-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-301-5.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-302-1.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-302-2.pdf

https://tcwp.tamu.edu/files/2020/06/PTWB-302-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-302-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-302-5.pdf