

Galveston, Brazoria, and Harris County Stormwater Quality Improvement (Stormwater Wetland Pilot Projects)

Contract 582-12-22870 Final Report

Contractor: Texas A&M University

PI: John Jacob, PhD

Co-PI: Mary Carol Edwards

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Section 1: Project Overview

A. Executive Summary

During the course of this program (December 2012-May 2015), Texas A&M University (TAMU) established partnerships and initiated stormwater wetland projects with a number of entities in Galveston, Brazoria, and Harris counties. These projects reflect a variety of locations, project partners, basin types, and sizes. The diversity of projects can demonstrate to landowners tri-county target area the range of conditions in which stormwater wetlands can be applied.

Several stormwater wetlands were constructed during the course of the 582-12-22870 grant, while others are in stages of development. The stormwater wetland projects which are currently in process [Exploration Green Conservation and Recreation Area (Exploration Green) in Clear Lake City, Clear Creek Independent School District (CCISD) Education Village Outdoor Classroom in League City and the John Hargrove Environmental Complex in Pearland] are those that integrate into a master plan for a multifunctional site. These sites include amenities beyond the scope of this grant, such as jogging trails, upland park landscaping, and pavilions. While wetland engineering reports and initial phases of the stormwater wetlands have been completed, the full construction of the wetlands is based on the project partner's ongoing timeline for developing the site.

Throughout the development of each partnership and project site, TAMU has provided technical assistance to the project partners, and education to the general public on the use of stormwater wetlands for water quality improvements and other wetland benefits. Events where volunteers, students, and community members took a hands-on role in propagating plants or creating wetlands have been a critical part of the stormwater wetland program outreach. The establishment of a regular weekly workday with Texas Master Naturalists (TMN) from area chapters has been invaluable for preparing and propagating wetland plants and mentoring students and volunteers at wetland planting events. To further advance the stormwater wetland concept, activities were promoted with media such as newspaper, magazine, and blog articles, and information about stormwater wetlands distributed by fact sheets, a poster, newsletters, and interpretive signage.

Through the activities supported by the grant—education to the public, technical assistance to partnering entities, engineering analysis of project sites, preparations for stormwater wetland construction, and engaging the public in wetland activities—the concept and benefits of

stormwater wetlands have been more widely introduced to the Galveston, Brazoria, and Harris County area.

B. Introduction

The purpose of the project has been to demonstrate and advance the use of created multi-functional storm water detention basins as water quality improvement practices (WQIP) that will result in measurable storm water quality improvement. TAMU has assisted watershed communities in planning, designing, and installing stormwater wetlands to improve the quality of stormwater runoff. TAMU has directly participated in the completion of two or more stormwater wetlands in the target area of Galveston, Brazoria, and Harris Counties to demonstrate the stormwater wetland concept for local and regional governments.

Development triggers the construction of flood control basins to manage stormwater runoff from impermeable surfaces such as roofs and pavements. Typically this means a dry detention basin which gives minimal water quality improvements. Because this drainage infrastructure exists, the opportunity also exists to convert the standard single purpose dry detention basin to a multifunctional stormwater wetland basin. As urban and suburban development of existing agricultural lands in the tri-county area proceeds, runoff will increase accordingly, washing contaminants into waterways. In urban areas these contaminants generally include fertilizers, which contribute to algae blooms and fish kills; bacteria from pet waste, which can cause beach closures and bans on water recreation; sediment, herbicides, pesticides, and roadway compounds. Natural treatment of runoff in stormwater wetlands lessens these impacts downstream in the bayous and bays.

C. Project Significance and Background

Approximately 80% of the water bodies in the Galveston Bay Watershed are listed on the state's 2012 303(d) list of impaired waters due to high levels of indicator bacteria and low levels of dissolved oxygen. Additionally, southeast Texas historically contained several million acres of coastal prairie, wetlands and riparian bottomlands making for a unique biologically productive region of native and migratory wildlife and endemic plants. However, since settlement, little remains and some estimates put it at less than 1% of this natural habitat due to agricultural production and more recently, residential and commercial development.

Galveston, Brazoria, and Harris counties drain to the lower Galveston Bay watershed. Installing WQIPs in the region benefits the local receiving waters, providing an opportunity to remove

contaminants like bacteria, nutrients and sediments, and improve ecological services which wetlands are known to provide. This water quality improvement also protects those habitats downstream such as oysters on the recreational reefs and submerged aquatic vegetation (SAV) of Galveston and West Bays.

This project implements elements of the Galveston Bay Plan and the Coastal Management Program. By creating wetlands, supporting migratory and resident bird habitat, improving water quality, and increasing recreational opportunities, this project implements the management goals of both programs.

Section 2: Overview and Summary of Tasks

1. Grant Objective 1 – Project Administration

Task 1.1 Project Oversight. TAMU provided technical and fiscal oversight of project staff and/or contractor(s) to ensure Tasks and Deliverables were acceptable and completed as scheduled and within the budget. With the TCEQ Project Manager's authorization, TAMU secured the services of any subcontractor(s) necessary for technical support, repairs, or training.

Task 1.2 Project Work Plan. The TAMU provided a project work plan that provided complete detail to all major tasks to be performed and a time-line for all work. A copy of the work plan is included in the appendix.

Task 1.3 Quarterly Progress Reports (QPRs). TAMU submitted QPRs to the TCEQ in a timely fashion following the end of the state's fiscal quarter. The QPRs detailed all activities carried out during the quarter, using the template provided by the TCEQ project manager.

Task 1.4 Reimbursement Forms. TAMU submitted quarterly Reimbursement Forms [Form 20248, and Historically Underutilized Business Progress Assessment (HUB PAR) form] to the TCEQ by the 20th day of the month following each state fiscal year quarter.

Task 1.5 Agreement Communication. TAMU participated in a Post-Award Conference which was scheduled by the TCEQ Project Manager. TAMU provided a

summary of the Post-Award conference with the first QPR after the conference that includes the important items discussed and decisions made. A copy of the summary is included in the appendix.

Regular communication included a conference call with the TCEQ Project Manager each January, April, July, and October that was to be scheduled by the TCEQ Project Manager. TAMU provided a summary of the calls with the QPR that immediately followed the call; the summary included the important items discussed and decisions made. Additionally, during 2014 -15 TCEQ and TAMU implemented weekly phone calls to keep both parties updated on the grant's projects, billing, and administration.

Task 1.6 Contractor Evaluation. TAMU participated in an annual Contractor Evaluation scheduled by the TCEQ Project Manager. Copies of the available contractor evaluations are included in the appendix.

2. Grant Objective 2--Technical Assistance and Outreach

Task 2.1 Technical Assistance. TAMU met with local governments (e.g. municipal, municipal utility districts, drainage districts, reclamation and conservation districts, and county governments) to foster dialog and identify common needs/requirements/goals that support integrating stormwater quality improvements with flood reduction strategies; to garner support to implement selected projects; and to foster relationships to establish a regional watershed based strategy. Copies of attendee sign-in sheets for technical assistance meetings, where available, are included in the appendix. A chronological list of technical assistance meetings is also available in the appendix.

Task 2.2 Project Coordination. TAMU convened a task force of watershed practitioners, interested local government staff, industry, non-profit organizations and citizens to guide the continuation of the project. TAMU consulted with the task force to identify potential sites and prioritize future demonstration project sites based on key metrics (e.g. time, cost, size, feasibility, and benefits). A copy of the task force meeting attendee sign-in sheet and summary of discussion are included in the appendix.

Task 2.3 Stormwater Wetland Outreach Campaign. TAMU educated local groups, local officials, and local government staff on the feasibility, utility, and benefits of installing stormwater treatment wetland retrofits. TAMU coordinated outreach materials and events with the TCEQ GBEP outreach staff, and included existing materials and that coincide with the “Back the Bay” campaign. A chronological list of outreach campaign activities follows.

January 2013 :

TAMU's Texas Coastal Watershed Program (TCWP) Stormwater Wetland Program Coordinator Mary Carol Edwards (MCE) served as co-instructor in CCISD teachers' continuing education stormwater wetland workshop with 30 attendees. Participants were instructed on how stormwater detention and stormwater wetlands work, planting techniques, and plant identification.

February 2013:

MCE met with the Houston Parks and Recreation Department (HPARD) Bayou Greenways 2020 program outreach staff regarding proposed linear park system along the bayous. MCE posted an entry to the TCWP blog, *Texas Watershed*, on the Bayou Greenways 2020 program and TCWP stormwater wetland projects. The blog had 80 views in February. <http://wp.me/p2kSWg-4m>

April 2013:

MCE attended the Sea Grant advisory committee meeting in Port Aransas, Wetland Field Day at Sheldon Lake State Park, and the Watershed Steward Workshop at Carbide Park. The stormwater wetland program was referenced or introduced at each event to an approximate total of 120 attendees.

MCE developed one-page flyer to introduce the benefits of stormwater wetlands “at a glance”. See copies of flyers in the appendix.

May 2013:

MCE was a docent for stormwater wetland site visits to CCISD Education Village and Mason Park with staff from the US Environmental Protection Agency (EPA), the Texas Commission on Environmental Quality (TCEQ), and the Galveston Bay Estuary Program (GBEP). 10 attendees.

June 2013:

MCE posted an entry for the TCWP blog, *Watershed Texas*, concerning roadway runoff, stormwater wetlands, and a recent *Houston Chronicle* article on a proposed pedestrian bridge adjacent to a TCWP stormwater wetland site in Mason Park on Brays Bayou. <http://watershедtexas.org/2013/06/20/roads-and-lily-pads-is-there-a-connection/>

July 2013:

TCWP partnered with the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) landscape subcontractor to create a wetland in a 2200sf boggy site near NASA building 347. See attached photos. MCE posted an entry about the project in the TCWP blog, *Watershed Texas*: “Wetlands launched into (a new) space”. <http://watershедtexas.org/2013/08/06/wetland-launched-into-a-new-space/> The blog was viewed 320 times in July.

September 2013:

TCWP set up and attended a booth at the Native Plant Society of Texas annual workshop in Houston. The Stormwater Wetland Program and other TCWP programs were highlighted. The meeting had 220 attendees.

MCE posted an entry for *Watershed Texas*, the TCWP blog: "Floating a New Idea", about the upcoming floating wetland installation for CCISD. In September, *Watershed Texas* had 336 hits. <http://watershедtexas.org/2013/09/06/floating-an-new-idea/>

Change Magazine of the Bay Area published a story on the created wetland created by TCWP on the campus of JSC in the summer of 2013. A copy of the article is in the appendix.

November 2013:

Galveston Daily News ran a feature story on the CCISD floating wetlands project. A copy of the article is in the appendix. Photos and announcements of the project were available on the TCWP and Texas Sea Grant websites.

The CCISD floating wetlands project was circulated on social media as well: Facebook and the *Watershed Texas* blog at <http://watershедtexas.org/2013/11/21/the-floating-wetlands-project-is-off-the-ground-and-into-the-water/> MCE attended the following conferences and meetings and discussed the Stormwater Wetland Program with other attendees: Texas Society of Ecological Restoration annual conference, Native Plant Society of Houston monthly meetings, Bayou Preservation Association annual symposium, Keep Houston Beautiful annual awards banquet, and the Galveston Bay Council Water and Sediment Quality (WSQ) subcommittee quarterly meeting.

December 2013:

MCE posted an entry for the *Watershed Texas*, the TCWP blog: "What does a stormwater wetland look like, anyway?" showing three videos of stormwater wetlands in Washington State, North Carolina, and Australia. The blog will be an accessible visual reference for students and stakeholders unfamiliar with

stormwater wetlands. *Watershed Texas* had 278 visits in December. <http://watershedtexas.org/2013/12/04/what-does-a-stormwater-wetland-look-like-anyway/>

MCE attended the GBEP WSQ Subcommittee quarterly meeting and gave an update on the stormwater wetland program. Approximately 12 people attended.

January 2014:

MCE made a presentation at a meeting of the Exploration Green combined subcommittees, focusing on the benefits of the stormwater wetland and approximately \$200K+ in-kind contributions of the grant to the park's Phase 1 development. Approximately 50 attended.

MCE posted an entry for the *Watershed Texas*, the TCWP blog: "Oh rats! We have nutria", an update on the floating wetlands project, which lost most of its transplants to nutria predation. *Texas Watershed* had 381 visits in January. <http://watershedtexas.org/2014/01/28/oh-rats-we-have-nutria/>

February 2014:

MCE posted an entry for *Watershed Texas*, the TCWP blog: "Now showing: the floating wetlands on video", showcasing a video on the project just released by CCISD Office of Communications. *Texas Watershed* had 437 visits in February. <http://watershedtexas.org/2014/02/10/now-showing-the-floating-wetlands-on-video/>

The *Houston Chronicle* published an article (2/14) on the Floating Wetlands project: "Wetlands project pioneered at CCISD's Education Village". A copy is attached.

MCE participated in a panel of environmental professionals at River Oaks Elementary in Houston, and described her work with stormwater wetlands and wetland restoration to seven teachers and 126 fifth-graders.

MCE presented a segment on the TCWP's stormwater wetland contribution to Exploration Green at a "town hall" style public meeting in Clear Lake City. The meeting provided the public with updates on the park's progress. 198 attendees.

March 2014:

A presentation of the stormwater wetland program projects was given to the GBEP WSQ subcommittee. Approximately 20 were in attendance.

MCE' article about the interrelationship of habitat restoration and green infrastructure was published in the Texas Society of Ecological Restoration newsletter. "What can restoration science do for green infrastructure?" was developed into an Ecological Restoration Brief which is available at <http://chapter.ser.org/texas/files/2013/04/Ecological-Restoration-Brief-No9-Edwards.pdf>

MCE posted an entry for the TCWP blog Watershed Texas: "Kids have a part to play in the watershed", presenting ways that children can have a positive impact on their watershed. *Texas Watershed* had 355 visits in March. <http://watershедtexas.org/2014/03/27/kids-have-a-part-to-play-in-the-watershed/>

April 2014:

MCE was invited to give a presentation on wetlands to the Urban Harvest permaculture class at the University of Houston, followed by a planting demonstration. Approximately 30 attended.

A video about the CCISD project, "Another Floating Wetland Video Makes Waves in Outdoor Education," was released by TAMU AgriLife Communications Department. At the time of writing the video has been viewed 938 times.

<https://www.youtube.com/watch?v=Nv2ykKGpoMQ&list=UUqemYYBBFWG0vR5g3BLwgTA>

MCE posted an entry for the Watershed Texas, the TCWP blog: “Another Floating Wetland Video Makes Waves in Outdoor Education”, presenting a video on the project which was created by TAMU AgriLife Communications Department. *Texas Watershed* had 371 visits in April. <http://watershедtexas.org/2014/04/11/another-floating-wetlands-video-making-waves-in-outdoor-education/>

Exploration Green Conservancy held a groundbreaking event for the park. TCWP was invited to set up an information table about TCWP and the stormwater wetland program. Approximately 200 attended.

MCE presented a summary of the stormwater wetland program projects to the Texas Sea Grant Advisory committee at the annual meeting in Port Aransas. Approximately 40 attended.

May 2014:

Change Magazine of the Bay Area published an article on the CCISD floating wetlands project in the May issue. See appendix for a copy of the article.

MCE presented the stormwater program projects to the Houston Galveston Area Council’s Bacteria Implementation Group (B.I.G.) meeting. Approximately 40 people attended.

June 2014:

MCE was invited to present the stormwater wetland program to the Texas Parks and Wildlife Department’s annual meeting of Urban Wildlife biologists. 8 people attended.

MCE gave an invited presentation on wetland plants in urban settings to the Native Plant Society of Houston. Approximately 40 attended.

MCE posted an entry for the TCWP blog *Watershed Texas*: “Good News from Baltimore”, about an innovative program for collection floating debris before it

reaches the Baltimore Harbor. *Texas Watershed* had 325 visits in June. <http://watershедtexas.org/2014/06/30/good-news-from-baltimore/>

July 2014:

MCE made a presentation on the stormwater wetland program to the Board of the Cradle of Texas Chapter of TMN and received volunteer approval for Brazoria County projects. Approximately 20 attended.

MCE posted an entry for Watershed Texas, the TCWP blog: "A wetland plant nursery for Exploration Green is under way". <http://watershедtexas.org/2014/07/28/a-wetland-plant-nursery-for-exploration-green-park-is-under-way/>. *Watershed Texas* had 320 views in July.

August 2014:

MCE initiated and planned an Open House for the wetland and tree nurseries at Exploration Green together with the organization Trees for Houston. The Open House was held October 4, 2014.

October 2014:

MCE presented a talk "What can restoration science do for green infrastructure?" to the Texas Society of Ecological Restoration's annual conference at Sul Ross State University. The presentation uses stormwater wetlands as a model to make the case for ecologists and urban design professions more closely sharing their expertise. The conference had 101 registrants.

September 2014:

MCE contributed an article, "Take Part in Creating Stormwater Wetlands for Water Quality, Habitat, and Fun", for the Cradle of Texas Chapter of TMN newsletter. The article raised awareness of the stormwater wetland program among the Brazoria County public and volunteers. http://tmn-cot.org/Newsletters/Chapter_News_2014-09.pdf pages 8-9. A copy of the article is included with this report.

MCE posted an entry to the TCWP blog *Watershed Texas*: “Stormwater Wetland Thursdays Commence with a Little Rain”. The site had 257 views in August. <http://watershедtexas.org/2014/09/08/stormwater-wetland-thursdays-commence-with-a-little-rain/> Additional publicity for the Exploration Green wetland nursery effort comes from updates to the Exploration Green Conservancy's Facebook page, with 306 followers, and TCWP's Wetland Restoration Team weekly newsletter, with 120 recipients.

TCWP set up and attended an informational booth for TCWP and the stormwater wetland program at the Native Plant Society annual workshop at the Houston Zoo. The conference had approximately 200 attendees.

The Galveston Bay Area chapter of TMN published Mary Carol Edwards' article, “Creating Stormwater Wetlands” in their award winning newsletter, *The Midden*. A copy of the article is included with this report. <http://galveston.agrilife.org/files/2011/05/The-Midden-October-2014.pdf> Pages 3-4.

November 2014:

MCE published a post to the TCWP blog, *Watershed Texas* on the recent volunteer events around replanting the floating wetlands at CCISD's Education Village. <http://watershедtexas.org/2014/11/05/back-into-the-water-at-clear-creek-isd-schools/> The site had 286 views in November.

December 2014:

MCE published a post to the TCWP blog, *Watershed Texas*, on methods of natural mosquito control used in the wetland nursery at Exploration Green. The purpose is or general education and to make locals aware that mosquito control and wetlands are compatible and controllable. The site had 201 views in December. <http://watershедtexas.org/2014/12/11/natural-mosquito-control-in->

the-wetland-nursery/ A fact sheet of this information was also produced, and a copy is included in this report.

TCWP participated in partnership meetings with stormwater wetland program partners Galveston Bay Area Chapter of TMN and University of Houston at Clear Lake's Environmental Institute of Houston.

January 2015:

MCE was invited to present at the International Low Impact Development Conference held in Houston. Her presentation "Stormwater Wetlands for the Galveston Bay Watershed", describing the stormwater wetland program and lessons learned, had approximately 30 attendees, both local and national. A copy of the abstract is included in this report.

February 2015:

MCE gave an invited presentation to the Galveston Bay Area chapter of TMN a training course on natural and created wetlands, including stormwater wetlands. Approximately 40 attended.

MCE published a post to the TCWP blog, *Watershed Texas*, announcing the Pearland Wetland Awareness volunteer event. <http://watershedtexas.org/2015/02/26/pearland-wetland-awareness-day-offers-two-unusual-ways-to-plant-a-wetland/> The site had 289 views in February. Also, MCE announced the event at the Native Plant Society of Texas monthly meeting, with approximately 50 attendees and 10 sign-ups.

March 2015:

The Pearland Wetland Awareness event, held March 7, was the first implementation of stormwater wetlands at the John Hargrove Environmental

Complex lake, future home of the Pearland Nature Center. A video of the event was produced by Pearland staff: <http://youtu.be/tLuZXvuRtwM> A newspaper article was published by the *Pearland Journal*: http://www.yourhoustonnews.com/pearland/news/pearland-residents-team-up-with-parks-and-rec-to-plant/article_7f65bd08-34f6-5fa9-83bd-a735b3e0e379.html The volunteer sign in sheet and flyer are included with this report.

Exploration Green Conservancy invited TCWP to participate in the planned Earth Day, April 25. An article including the TCWP activities and a photo of the wetland nursery was published in the *Bay Area Citizen*. http://www.yourhoustonnews.com/bay_area/news/celebrate-earth-day-at-exploration-green-april/article_132f4153-a2cb-5320-aca5-bb8e1c7d2a4b.html Thunderstorms on the day of the event cancelled the Exploration Green Earth Day.

MCE published three posts to the TCWP blog, *Watershed Texas*, announcing current events: <http://watershedtexas.org/2015/03/11/new-wetlands-created-for-pearland/> <http://watershedtexas.org/2015/03/24/wetland-economic-benefits-on-the-upper-texas-gulf-coast-a-workshop/> <http://watershedtexas.org/2015/03/25/earth-day-at-exploration-green/> The site had 384 views in March.

April 2015:

MCE was invited to lead an aquatic plants class for Clear Falls High School Envirothon students. The class was held at the Education Village detention pond and included making and placing wetland plant balls. 6 attended.

May 2015:

TCWP donated and delivered wetland plants to Austin High School in Houston ISD for a class water quality study (7 attendees).

A fact sheet for the stormwater wetland program which was developed by Interpretive Insights graphic design was completed, printed, and distributed. A program logo was also developed, and the existing stormwater wetland program 1-page flyer was updated. The intention of these materials is to give the municipal staff, teachers, students, and the general public a basic introduction to stormwater wetlands and the objectives of the program.

3. Grant Objective 3--Constructed Stormwater Wetlands within Galveston, Brazoria, or Harris Counties

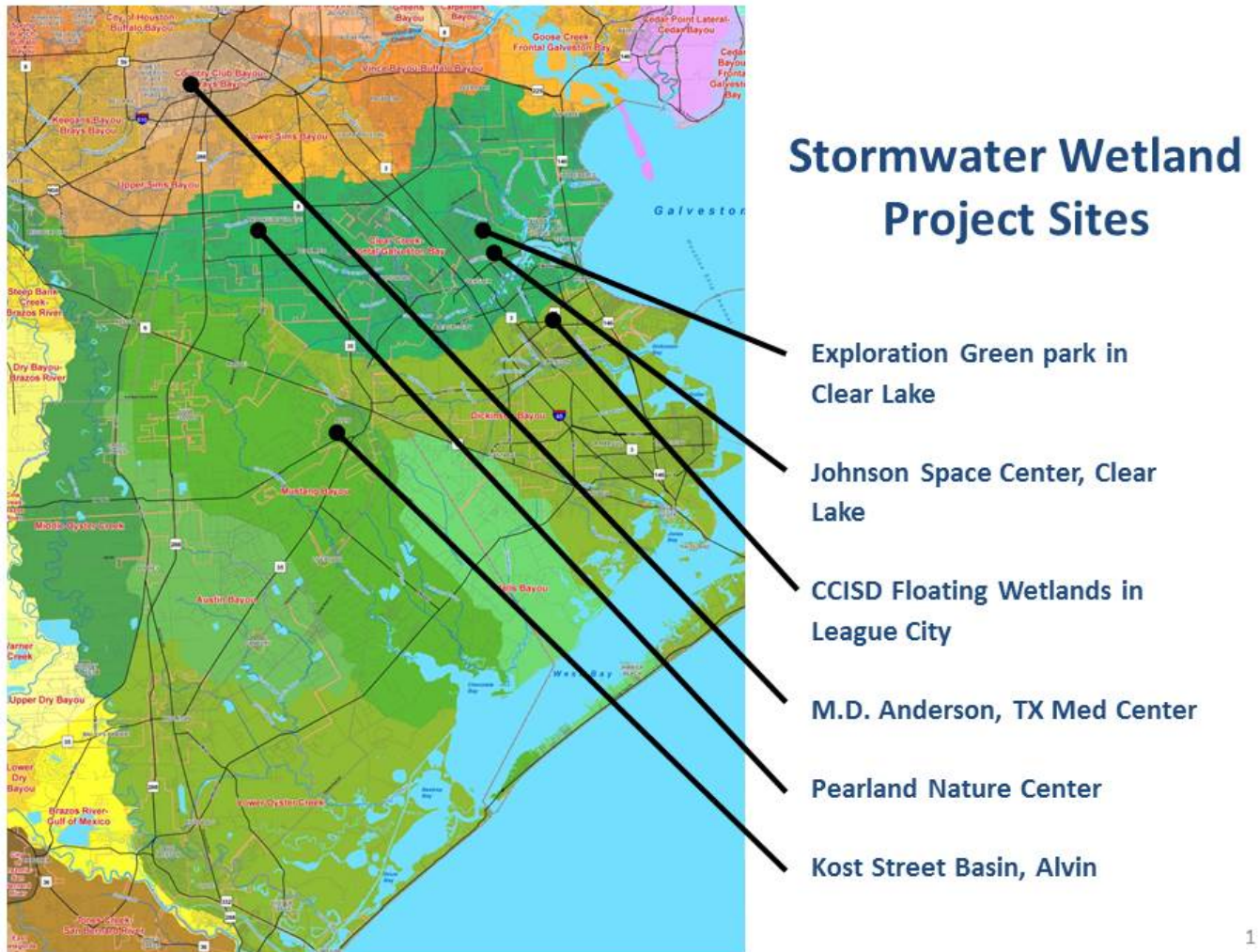
Goal: To create multi-functional storm water detention basins as water quality improvement projects (WQIP) that will demonstrate “proof of concept” for local and regional governments. A narrative of each project is available in Section 3: Results and Discussion, by Project Site.

Task 3.1 Site Selection and Design Specifications. TAMU initiated projects which could be a new or retrofitted detention basin, a community park, or a local governmentally owned property within the identified area. TAMU secured a Memorandum of Understanding (MOU) with each local partner to ensure support for the storm water wetland and commitment to future NPS projects. Copies of the fully executed MOUs will be found in the appendix. TAMU subcontracted (in accordance with Texas Government Code Section 2254.004) with an engineer to complete the necessary engineering documents. Copies of engineering and hydrology studies are found in the appendix.

Task 3.2 Permits and Construction. Using this Agreement’s available implementation funding, local contributions and any additional sources, TAMU partnered with local MS4s to construct storm water wetlands in local or regional detention basins. Stormwater wetlands were retrofitted into existing basins on University of

Texas MD Anderson Cancer Center campus in the Texas Medical Center in Houston, and the Lyndon B Johnson Space Center in Houston. The constructed wetlands were to be planted with seeds and plants from local sources and where possible, riparian and coastal prairie was to be planted on adjacent slopes. See the project descriptions for further information on the planning, development, construction, and outreach for these sites. TAMU coordinated and facilitated volunteer events and extended invitations to volunteers (e.g. TMN, local schools, and citizens) to participate in the plant sourcing, propagating and planting. See outreach events in the appendix for further information. Finally TAMU assisted participating MS4s to find resources to develop trails, boardwalks, and overlooks that include educational signs to communicate the importance of coastal natural resources and efforts to protect them. Letters of support from TAMU for partner's proposals for funding are included in the appendix.

Section 3: Results and Discussion, by Project Site



1. Exploration Green Conservation and Recreation Area



Master plan showing open water, wetlands, and reforestation of the five park segments.

Source: SWA Group Houston

Location: bounded by Bay Area Blvd, El Camino Real, Pineloch, Space Center Blvd. Clear Lake City, Houston (Harris County)

Watershed: Horsepen Bayou/Armand Bayou/Clear Lake

The 178-acre parkland will be a renovation of the former golf course into a multifunctional stormwater detention facility. The masterplan, produced by landscape architects SWA Group, includes trails for biking and walking, native plantings and a chain of excavated lakes containing stormwater wetlands for water filtration and habitat. The park will be developed in five phases with approximately 5-7 acres of wetland within the lake that will be excavated in each phase. The land is owned by project partners Clear Lake City Water Authority (CLCWA), managed by the Exploration Green Conservancy and the Galveston Bay Foundation which carries a conservation easement on the site.

TAMU provided

- 1) hydrological studies, weir specifications, and engineering consultation in order to improve the water quality function of the master plan's proposed wetlands. The engineering reports detail a system of weirs to detain 92% of all rain events, creating continuous--rather than margin-only--wetland plantings to insure the detained stormwater is treated by wetlands before exiting the system, and optimizing the elevation of wetland shelves in relation to groundwater levels. The reports were distributed so that the project engineers, LAN Inc, can incorporate the findings into their construction document set. A copy of the engineering report is included in the appendix.
- 2) Stormwater wetlands consultation, public outreach. Please refer to Task 3.2 in Section 2 for a list of public outreach activities.
- 3) TAMU developed the design of a wetland plant nursery with capacity for 30,000 plants, sufficient to plant 5 acres of wetlands on 3' centers. The nursery is a series of ten on-grade rectangular ponds divided into thirty tanks, created by a frame of treated 2x12s anchored with 4x4 posts, and holding UV-resistant EPDM pond liners. The water supply is provided by the former golf course irrigation system of reuse water, with a solar powered irrigation controller for 5 zones servicing the 10 tanks. A modular tool shed, heavy duty potting benches, canopy and fencing complete the site. A custom cedar composter, benches, and footbridge have been provided by Eagle Scout and TMN volunteers. Siting for the wetland nursery was made to allow continuous operation through four construction phases of Exploration Green. The construction of the nursery was bid by TAMU and awarded to Greenmark Environmental Inc and Hurricane Fence. Design, bidding, and construction documents for the wetland nursery are included in the appendix.
- 4) Operations and maintenance of wetland nursery from Sept 2014 to present, sourcing and propagating native wetland plants from the tri-county area to build up stocks in advance of the planting dates.

The construction of the wetland nursery was timed so that sufficient plant stocks could be built up in advance of the planting date for each phase. While the start date for excavation was prolonged due to protests against a waste water permit sought by CLCWA, TAMU provided approximately 3000 plants from the nursery for stormwater pilot projects in Pearland, MD Anderson Cancer Center, and CCISD. CLCWA has reported that the excavation start date for Phase 1 is late fall 2015.



Ponds in the Exploration Green stormwater wetland nursery are shallow on-grade tanks formed by a lumber frame supporting a pond liner.



TMN volunteers attend a weekly workday to collect and propagate wetland plants.

2. CCISD Education Village

Location: 4380 Village Way, League City (Galveston County)

Watershed: Gum Bayou/ Dickinson Bayou

TCWP has partnered with the CCISD to develop the 11-acre campus wet detention pond into a stormwater wetland and outdoor classroom. The Education Village campus includes Mossman Elementary, Brookside Intermediate, and Clear Falls High School. The school administration

and faculty generally recognize the value of an on-campus outdoor natural area for grade school curricula. The first objective in the development of the outdoor classroom has been to establish a wetland in the basin. TAMU's initial partnership with CCISD at this site was to develop a stormwater wetland through 319 funding in 2011. Full establishment of the 2011 wetlands was compromised by nutria predation and deep groundwater contributions. The subsequent phases of wetland development were supported by this grant. Floating wetland islands were used to demonstrate a new technique for adding wetlands to basins where water levels are too deep and fluctuating for most rooted wetland species. Floating wetlands are buoyant mats of recycled plastic fiber, with surface cavities for wetland plants to grow, extend roots into the water column, and develop pollution-treating biofilms.

In November 2013, three floating wetland islands as well as additional natural wetlands were installed by the school community and TMN, with over 600 volunteer hours to collect, propagate, grow, plant and launch the islands and shore plantings. This was the first public installation of floating wetlands in Texas. While the 240 sf feet of island would not measurably improve the water quality of the 6 acres of open water in the basin, it demonstrated a new technique for stormwater quality.

Again, nutria returned and compromised the outcome of the plantings, so replanting was planned using nutria-detering species in test plots. Plants known or suspected to be distasteful to nutria were planted on the islands and shore with a control of species eaten by nutria. Following the planting by volunteers in October 2014, students monitored the test plots and islands for nutria activity. A nutria has been observed in the basin. However the nutria-detering species established in the test plots, with the inconclusive exception of one species. The list of species not eaten by nutria is in the appendix. Use of these species is considered more practical for establishing a stormwater wetland where nutria are present than modifying the basin fence or hunting. Chicken wire fencing of two of the islands did not keep nutria out.

Wetland plants for the basin were sourced in part from CCISD's Ed White Elementary in El Lago. In 2013 and 2014, a Habitat Garden Day was coordinated by TAMU and partners to thin and collect species from the campus ponds as well as a general cleanup of the garden. The collected wetland species were propagated by students and TMN in the Education Village greenhouse (2013) and Exploration Green nursery (2014).

In the course of the project, magazine, newspaper, and blog articles were published, and videos were produced by TAMU and CCISD. Links to videos and blogs are given in Section 2, Task

3.2, and copies of other media are in the appendix. Outreach activities are listed in Section 2, Task 3.2.



Floating wetlands shortly after planting and launching in 2013.



Students ready a floating wetland for launch in 2014.



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Native wetland species planted in 2011 and 2013 have established on the margins of the CCISD stormwater basin.



Students replant the floating wetlands as a test of nutria-deterring species.



Students and community members collect wetland plants at Ed White Elementary for use in the Education Village wetlands, October 2014.

3. NASA's Lyndon B Johnson Space Center (JSC)

Location: JSC Building 347, Clear Lake City, Houston (Harris County)

Watershed: Horsepen Bayou/Armand Bayou/Clear Lake

TAMU consulted with the JSC Environmental Office on managing a landscape problem area created by stormwater runoff from a weather station building, parking lots, and a jogging trail. The site was often too wet to mow, but at about 2200 square feet, it was too large to be developed as a rain garden within the modest budget available. TAMU proposed the site be converted to wetland.

TAMU showed staff from NASA landscape subcontractor Prodyn EPES how to identify, collect, and plant twenty native wetland species growing in drainage ditches on the JSC campus itself. JSC prepared the site per TAMU, and the wetland was planted in late June 2013. In addition to improved control of stormwater runoff, the site immediately began attracting wildlife such as herons, plovers, and dragonflies.

A weir was not installed for this project, but could be added in a subsequent phase of enlargement. Evapotranspiration removes water through the plants as well as the surface of the wetland, reducing excess rainwater naturally.

The project sets a precedent for beneficial ways of managing excess rainwater at JSC. An entry about the project was posted in the TCWP blog, Watershed Texas: "Wetlands launched into (a new) space". <http://watershедtexas.org/2013/08/06/wetland-launched-into-a-new-space/>

This generated an article in the July 2013 issue of *Change Magazine*. A copy of the article is included in the appendix.



The wetlands, planted with species collected from ditches on the JSC campus, show signs of establishment one month after planting.



Preparation of the basin prior to planting.



Shortly after planting, the wetland, shown with the NASA space center buildings in the background, is attractive to wildlife.

4. City of Alvin Kost Detention Basin



Schematic plan for the Kost detention basin

Location: Kost Road at South St, Alvin (Brazoria County)

Watershed: M1 canal/ Mustang Bayou

The 15-acre “Kost Pond” received a preliminary design as a stormwater wetland basin. It is the first of three detention basins proposed by an independent drainage plan to control flooding of the M1 channel south of downtown. The site was originally conceived as a multifunctional stormwater detention park with trails and a pier, a solar fountain, sustainable materials, and strong educational ties to the five schools within a mile of the site. TAMU provided the stormwater wetland concept and technical assistance to City of Alvin staff. A wetland engineering report produced by TAMU and was the basis for the design of the approximate six acres of wetlands. In conjunction, Alvin’s subcontracted engineer firm Dannenbaum developed a construction document set to 70% completion. Designs for a supporting wetland nursery at the

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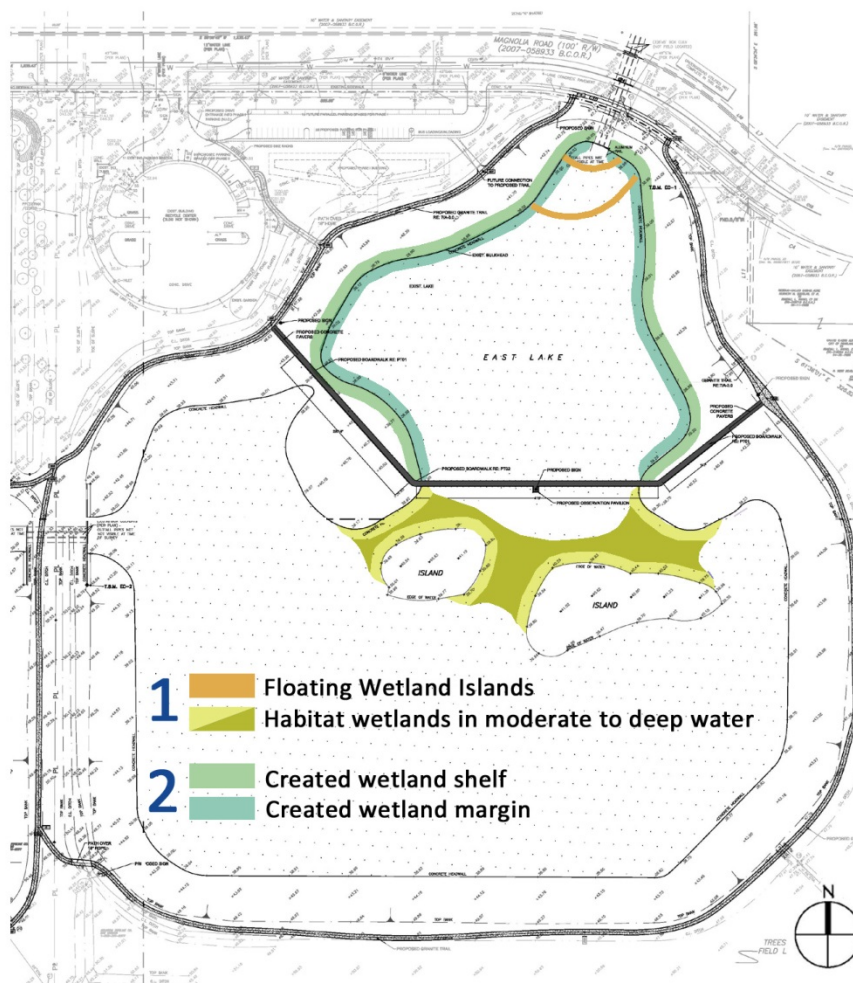
Alvin Waste Water Treatment Plant were prepared. Seeds collected by volunteers from the site, a high quality prairie, in order to replant the upland slopes with the same plant populations after construction.

The anticipated start was to be June/July 2014. Currently the project is shelved. April 2014 elections brought a new mayor and City Council, and interim City Manager, who were not familiar with the project. It emerged that the City Engineer preferred a dry detention basin and without the former (retired) City Manager to champion for the stormwater wetlands, the City Engineer brought opposition of the plan to the new City Council. TAMU publically advocated to the Council for the wetlands, and while the Council was generally receptive to the concept of treatment wetlands, they left the analysis for the decision to the City Engineer. The Kost basin is currently being excavated as a dry detention basin.



Volunteers collect prairie seeds for later reseeding of the Kost Pond site.

5. Pearland Nature Center



Schematic plan of the Phase 1 and 2 wetlands

Location: John Hargrove Environmental Complex, 4800 Magnolia Rd, Pearland (Brazoria County)

Watershed: Mary's Creek/Clear Creek/Clear Lake

The John Hargrove Environmental Complex contains an existing wet detention basin of approximately 30 acres, the Pearland Waste Water Treatment Plant, the Stella Roberts Recycling Center, and is the site of the proposed Pearland Nature Center. The basin was formerly the site of a sand quarry, and as a detention basin received a concrete curb at the waterline. As part of Pearland's effort to create more habitat and foster the environment of the

proposed Pearland Nature Center, the City entered a partnership with TAMU to provide stormwater wetlands at the site.

The site receives stormwater runoff from the complex's impermeable surfaces and via two culverts from adjacent neighborhoods. It also receives overflow from Mary's Creek in 10 year storm events, with inflow and outflow through the same structure at the northeast-most portion of the basin. Groundwater contributions are present. The waste water treatment plant does not currently contribute to the detention basin.

TAMU facilitated a hydrographic subsurface survey of the basin to determine depth, which ranges from 18" to six feet. An engineering study of the basin and its watershed was also provided. Based on the study, two initial phases were planned for the northeast portion of the basin. This area was chosen because it is 1) bounded to the south by peninsulas and two islands which will be crossed by a proposed modular boardwalk, 2) is close to the future Nature Center location, and 3) is where inflow and outflow are received from Mary's Creek.

The first phase included deep water wetlands (12" to 30" deep) for the areas between the islands and peninsulas, and chains of floating wetland islands for the open water. Floating wetlands provide a way to introduce wetland benefits to basins that are too deep, have widely varying water levels, or have sides too steep for natural wetland margins. The City opted for one chain of floating wetlands stretched across the inflow/outflow area, and ten individual islands scattered across the open water. Such an arrangement of individual islands has reduced water quality benefits in comparison to multiple chains of floating wetlands at the inflow/outflow.

Because the basin has a concrete curb and no margin, the majority of wetland species (which prefer 0-6 inches) will not establish in the 1.5'-6' depth. The second phase will be to create a wetland shelf and margin along the shore by cut and fill without disturbing the exiting concrete curb, and adding a weir to detain additional stormwater along the new margin.

Phase 1 was implemented in March 2014 with City coordination and volunteer participation. Chains and individual floating wetlands totaling 2400 square feet were mulched and planted with seven species that were found to deter nutria in the CCISD test plots. Volunteers also made 200 "plant balls" from bulrush, water lilies, and other deep water-tolerant species to create a continuous wetland zone between the islands and peninsulas. Plant balls are based on the "bulrush bombs" used by Armand Bayou Nature Center in areas too deep to plant with a shovel or dibble. Root balls are wrapped with burlap, wire and ballast and dropped from boats rather

than planted. Finally, volunteers made seed balls with native seeds collected in Alvin for replanting areas exposed by the upcoming trail and boardwalk construction. Pearland Parks and Recreation Department staff launched and anchored the floating wetlands the following week.

Plants on the continuous chain of floating wetlands have established well. Individual islands were colonized immediately by nesting terns, which removed almost all vegetation. These islands were replanted in June 2015. Record-setting rains in May 2015 resulted in the islands' anchors pulling loose from the substrate and allowing them to float freely. In subsequent phases, longer anchor cables will be attached and the anchors will be reset.

Monitoring of stormwater wetland sites for water quality improvements and habitat improvements from the installation and maturation of stormwater wetlands will be conducted in subsequent phases. In the meantime, Stream Team volunteers from the Cradle of Texas Chapter of TMN registered the site, selected sampling points at stormwater inflow and outflow locations, and have conducted monthly water sampling since September 2014. This effort provides some preliminary water quality information about the site prior to the addition of extensive wetlands. Likewise, TMN organized a team for bird surveys conducted quarterly to give a baseline for changes in bird habitation over the course of the stormwater wetland establishment. These volunteer monitoring efforts were begun in partnership discussions between the Chapter and TAMU.



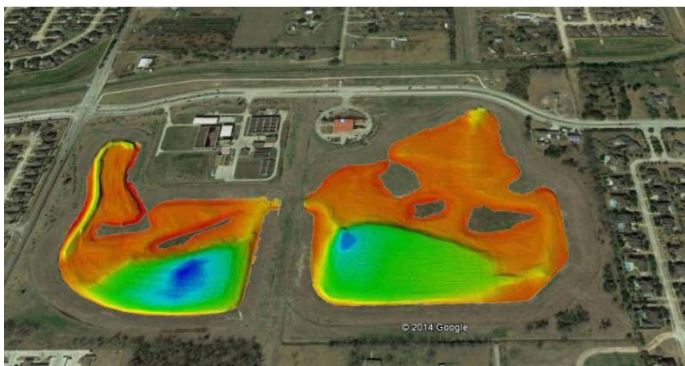
Volunteers plant nutria-resistant species on the floating wetlands, March 2015



Approximately 3000 seed balls with a mix of local prairie seeds were made for later use at the site.



The chain of floating wetlands shortly after planting.



Results of the hydrographic survey, showing the more shallow areas in red.

6. University of Texas MD Anderson Cancer Center

Locations: Radiation Outpatient Center (ROC) at Holcombe and South Braes Blvd; Medical Support Facility (MSF) at Bertner and Old Spanish Trail in the Texas Medical Center, Houston (Harris County)

Watershed: Braes Bayou

The MD Anderson property includes over 200 acres in the Texas Medical Center. The institution's Sustainability Initiative includes guidelines for campus outdoor space so that the focus on health extends to landscape planning and maintenance. MD Anderson considers onsite water quality improvement to be aligned with the healthy sites/healthy patients campus initiative. Demonstration projects for the initiative include stormwater wetlands facilitated by TAMU, vegetable gardens for healthy dining, urban prairie creation, low-water use gardens and other techniques supporting a healthy environment.

Two existing stormwater basins in high-profile locations were selected to retrofit with stormwater wetlands. The ROC basin has approximately 1000 sf of wetlands receiving runoff from a small watershed including the roof of the adjacent building, air handlers, and grounds. The MSF basin has approximately 2000 sf of wetlands, with an additional 1000 sf of landscaped uplands which demonstrate the use of native prairie varieties in landscaping. The basin receives runoff from the adjacent parking area and grounds.

TAMU produced an engineering study to characterize the watersheds of each site and develop weir specifications. A fine-grid survey of the sites was also produced. MD Anderson assisted in site preparations for the MSF wetland by relocating the inflow to the opposite end of the basin from the outflow, creating a useful flow pattern for stormwater within the wetland. The planting plans use a simple palette of native wetland plants emphasizing blooms, retaining some green in winter, and having strong foliage, so that the wetlands are perceived as gardens that integrate well with the surrounding landscape. This is important for the acceptance of wetlands in public, urban areas.

Planting of the two sites was completed in May 2015. Both sites were provided with interpretive signage which can be read from the adjacent sidewalks. These stormwater wetland pilot projects at MD Anderson will be observed as "proof of concept" for inclusion of stormwater wetlands in future master planning of an MD Anderson South Campus.



Planting of the ROC site by landscape crew.



The ROC site shortly after planting in May 2015.



The ROC site within the Texas Medical Center.

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Completed fine grading of the MSF site.

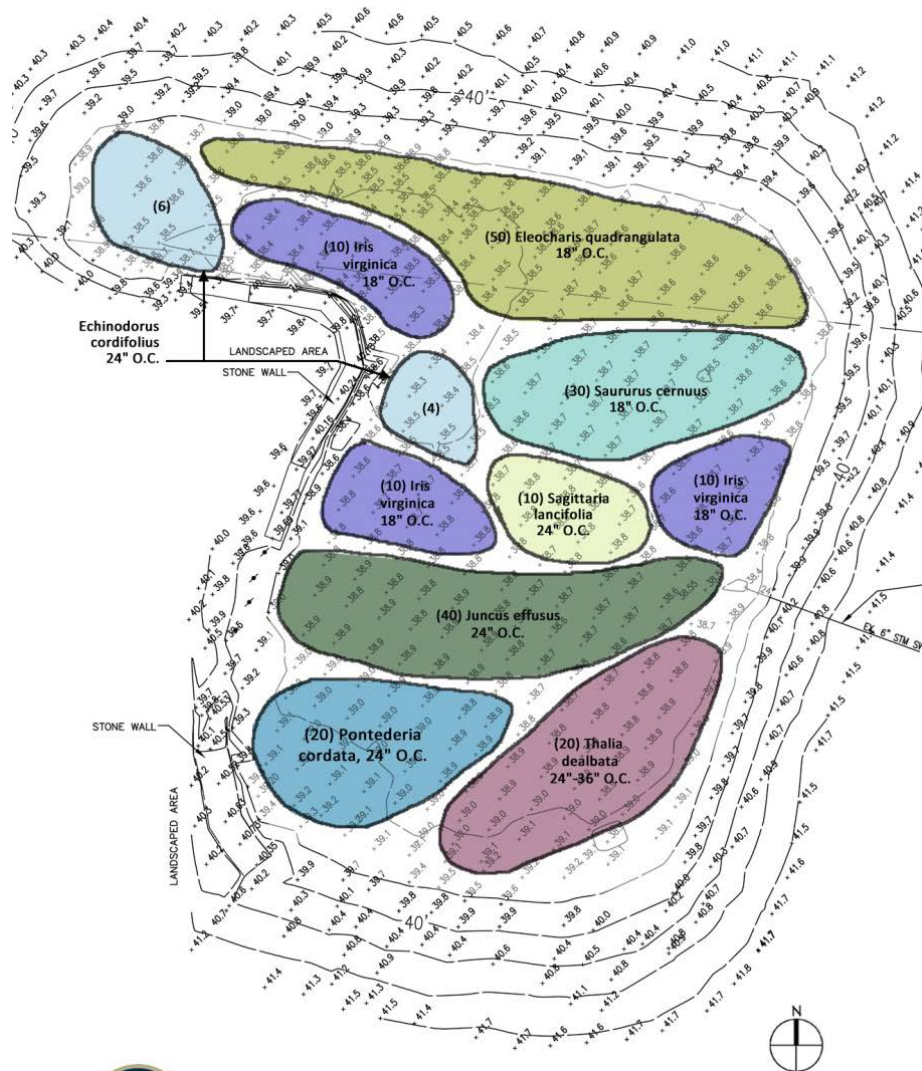


Weir installation at the MSF site.



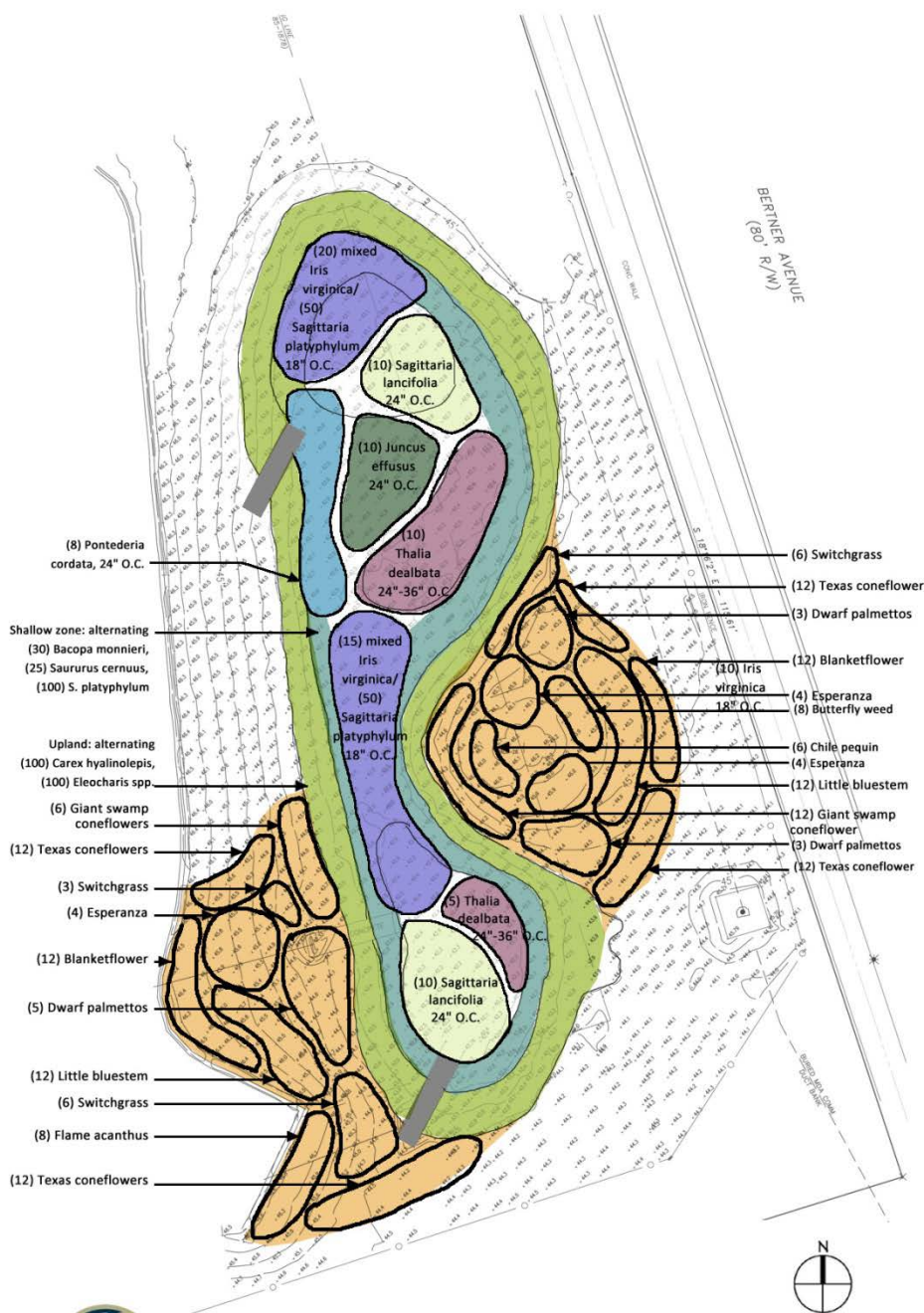
The MSF site during planting.

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Schematic planting plan for the ROC site.

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Schematic planting plan for the MSF site.

Section 4: Challenges and Successes

TAMU has been pleased with the reception the stormwater wetland concept has received in the general public. Through the course of the contract, several challenges and successes have emerged.

Matching the timeline of the contract to the timeline for partner's projects was generally a challenge. Fortunately, for smaller scale, "shovel ready" pilot projects, such as the wetlands at CCISD , Pearland Nature Center, MD Anderson, and NASA, the timeline was not an obstacle. These projects were conceived of as "Phase 1", ideally with larger and more impactful stormwater wetlands integrated into the design and planning of future construction for these entities.

However, where stormwater wetlands are a component of a program-rich masterplan, such as Exploration Green, the project has developed at a pace beyond the duration of the grant. This is an effect of the multi-functionality of the ideal demonstration stormwater wetland site as park space, including a trail system, upland planting, parking areas, etc. The returns on supporting these projects over the long term are great because the high profile, high use, and high impact of such sites can showcase the use of stormwater wetlands spectacularly and affect their acceptance.

While generally receptive, many entities contacted in the course of the contract projected their need for stormwater wetlands years into the future. The City of Manvel discussed the addition of stormwater wetlands to sites that are currently sand extraction pits with a projected five-to-ten-year operating life. The Houston Parks and Recreation Department is receptive to stormwater wetlands at Sylvan Rodriguez Park in Clear Lake City, but first must come to an agreement with Ellington Air Force Base regarding bird-attracting landscapes in the vicinity of the Ellington airways. The Pasadena Parks and Recreation Department is receptive to stormwater wetlands retrofitted into existing basins but does not have immediate plans to undertake new basin construction. However, in each of these contacts and others, TAMU planted the seed of future stormwater wetland use, through outreach and technical assistance.

In other instances, potential project partners had construction projects for which planning was largely completed, and re-planning to include stormwater wetlands proved unfeasible. This was the case for the Gulf of Mexico Foundation's new facility in Galveston, and Galveston County Parks Department's "64 Acre Park" in San Leon.

MD Anderson has demonstrated a conflict of construction schedules and priorities within the institution. The site of the ROC wetland, which was identified by MD Anderson Site Operations as a highest priority for landscaping in spring of 2015, was also identified by planners at the MD Anderson Operations and Facilities department as the only materials staging site available for upgrades to the ROC building. While it has recently become the staging area for the construction, negotiations to restore or replace the stormwater wetland site are underway.

Wetland skeptics were another challenge at some project locations. In Alvin, the City Engineer led the shelving of the Kost Pond project, believing that a standard dry detention basin will generate less maintenance complaints than a basin with a stormwater wetland. The construction of Exploration Green has been delayed by the landowner CLCWA's TPDES application being contested by a small vocal minority which objects to the plans, including the wetlands. In these two cases, unfamiliarity with wetlands in general, and stormwater wetlands in particular, plays a part in the rejection. TAMU addresses the concern with public outreach, such as holding wetland nursery open houses, presenting talks on the benefits of wetlands, and distributing information about natural mosquito control in the nursery. Befitting their urban or suburban settings, stormwater wetlands are tailored for a landscaped appearance, using more species that have prominent blooms, that remain green in winter, and are planted in large swaths. Fewer species are used than in a wetland restoration project, where diversity is the driver, and the plant selection is considered carefully.

Managing nutria, an exotic rodent which has developed large populations along the Gulf Coast, has become an ongoing effort in establishing robust stormwater wetlands at several project sites. The stormwater wetlands at Pearland and CCISD have been impacted by nutria repeatedly removing new vegetation before it can recruit. TAMU has responded by testing plant species nutria are reputed to avoid eating, and is developing a plant list of nutria-resistant species. Because of the widespread presence of nutria in the area, this plant list will be the core of plantings at all stormwater wetland sites.

Section 5: Next Steps for the Stormwater Wetland Program

TAMU plans to expand work with stormwater wetland “early adopters”—particularly regional school districts and Exploration Green. As the population on the Texas upper coastal plains expands, so do the school districts. CCISD has gone from being a system with two high schools

in 1985 to seven in 2015. Upcoming expansions and construction necessarily includes stormwater control. District teachers and science coordinators have recognized that the on-campus stormwater basins are an asset to the students' education, particularly when the water cycle and habitat functions are enhanced. Partnering with school districts such as CCISD is proving to be an expedient way to implement and demonstrate cutting-edge stormwater management techniques in this region.

Exploration Green is scheduled to break ground on Phase 1 at the end of 2015. Construction of the five phases is projected to take ten years. TAMU intends to continue providing technical assistance, outreach, and wetland plants for the duration of the project.

Rapid expansion on the Gulf Coast will lead to additional sites. Leads on potential sites and project partners, including a major chemical plant in Brazoria County and a new school in Houston, are being explored.

Additionally, TAMU will continue to introduce the stormwater wetland program to entities which have been less responsive to date—in particular, planned community developers and Drainage Districts. We believe both these groups can have great impacts on stormwater runoff quality if wetlands are routinely incorporated into their projects.

To continue the growth of the program, TAMU intends to expand the volunteer base and develop other staff positions supporting the program, such as a wetland nursery maintenance employee. Current funding for the program has been awarded by the Texas General Land Office through the Coastal Management Program, and additional funding is being sought.

Section 5: List of Appendices

Appendix files are arranged by the contract's task number and are given as separate files to this report.

1.0 Project Management Documents

2.1 Technical Assistance Meetings

2.2 Task Force Meeting Documents

2.3 Outreach: Event Flyers

2.3 Outreach: Media Coverage

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2.3 Outreach: Signs and Fact Sheets

2.3 Outreach: Volunteer Sign-In Sheets

3.1 Site Selection and Design Documents

3.1 Site Engineering Documents

3.1 Memoranda of Understanding

3.1 Surveys and Subcontracts

3.1 Volunteer Monitoring Projects