Houston Botanic Garden Stormwater Wetlands

Contract 19-056-000-B090

Coastal Management Program Cycle 23

Final Report

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Prepared by:

Jessica Henry, Houston Botanic Garden

Christie Taylor, Texas A&M AgriLife Extension Service

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PROJECT OVERVIEW

The Greater Houston Area continues to experience wetland loss and degradation from urbanization and land development. Wetlands are a valuable coastal natural resource, serving to reduce flood impacts, provide habitat, and improve water quality. In collaboration with the Texas A&M AgriLife Extension Service program Texas Community Watershed Partners (TCWP), the Houston Botanic Garden (HBG) developed a Stormwater Wetland feature at its 132-acre site on Sims Bayou to not only control storm water related to flooding, but enhance water quality in Sims Bayou and educate visitors on the importance of coastal wetlands systems. This multiphase project enriches life through discovery, education, and the conservation of plants and the natural environment, contributing to Houston's network of green spaces and the collaboration of nearly 1,800 botanic gardens around the world.

Houston Botanic Garden used Coastal Management Program (CMP) Cycle #23 funding to design, construct, and plant approximately 2 acres at the Stormwater Wetlands, install interpretive signage explaining the functions and values of natural and constructed wetlands, and provide educational programming. The wetlands are designed to retain storm water for a minimum of 72 hours and treat no less than a 90th percentile storm. Basins were excavated and graded in accordance with the project design.

TCWP collected and propagated plant material from locations within a 50-mile radius, including drainage ditches and wetlands slated for fill. Approximately 5,000 plants will be propagated for each acre of wetland planting shelf created. TCWP and HBG identified and are actively managing invasive species as they appear and have completed wetland planting in accordance with an approved planting plan.

Interpretive signs have been installed highlighting the functions and values of natural and created wetlands and identifying the vegetation planted at the sites. Plant labels are being installed for each plant species. HBG hired a part-time Education Program Director to initiate educational programming. Finally, signage will be installed at the site acknowledging the use of CMP funding when the permanent signs arrive from CMP.

PROJECT PARTNERS

Houston Botanic Garden worked with many partners, contractors, vendors, and volunteers to complete this project. We would like to recognize them here:

- **Clark Condon Associates, Inc.**
  Landscape Architects, Planting & Soil Design

- **Harvey-Cleary Builders**
  General Contractor

- **Landscape Art, Inc.**
  Landscape Sub-Contractor

- **MSC Earthwork**

- **Texas Community Watershed Partners, Texas A&M AgriLife Extension Service**

- **Venturi Outcomes LLC**

- **Walter P. Moore Engineers**
  Civil, Structural, & Bridge Engineering

- **West 8**
  Prime Consultant, Landscape Architects

- And a special thanks to TCWP, Texas A&M AgriLife Extension Service Intern Rosemary E. Kline whom Houston Botanic Garden would like to dedicate the Stormwater Wetlands in memoriam.

TASK 1: DESIGN OF STORMWATER WETLANDS

HBG with assistance from the design team developed the design of the Stormwater Wetlands. HBG executed the contract with AgriLife TCWP group in February. The contracts were later extended in February 2020 and again in September 2020. The Stormwater Wetlands were designed to consist of three hydraulically connected basins to comply with the proposed project design of 1-5 hydraulically connected wetland sites. The initial schematic plan for the Stormwater Wetlands was submitted in January 2019.

Figure 1: Initial Stormwater Wetlands schematic.

The Stormwater Wetlands design plans were created in collaboration with West 8, Harvey Construction, Clark Condon Associates Inc., Texas A&M AgriLife Extension Service, storm water engineers, and storm water wetland program specialists. There was a coordination meeting held at HBG offices with the project partners on February 11, 2019. The Stormwater Wetlands are designed to retain storm water for a minimum of 72 hours and treat no less than an 90th percentile storm, with a 95th percentile storm as the ideal target, or about a 2-inch rainfall in Houston. Prior to bid solicitation, the GLO must review and approve the technical specifications, construction drawings, and bid documents. HBG solicited bids and selected a construction contractor to excavate and grade the basins. All necessary permits and environmental clearances were obtained prior to work beginning on site. An archeological survey was completed and submitted to the Texas Historical Commission prior to start of construction. An initial planting plan was developed for the

Stormwater Wetlands in April 2019. Depending on design development vegetation may be selected from various native plant palettes to include plants that thrive at various water and soil saturation depths.

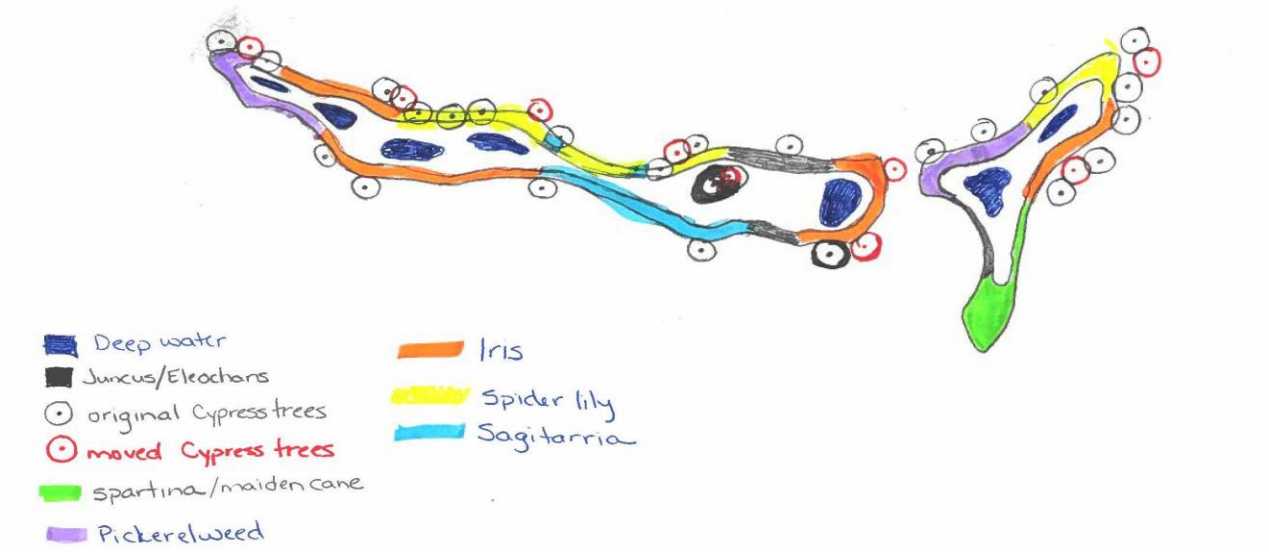

Figure 2: Initial Rough Draft Planting Plan 04/05/2019.

Design plans were modified in April of 2020 to include a secondary culverted land bridge. This allowed for fencing of the property up to the bank of Sims Bayou to mark the paid entry portion of the Houston Botanic Garden. Planting plans were revised to fit the new configuration and HBG removed any trees that were in the original planting zone for light specifications of wetland plants. After planting begun, the planting plan was modified a second time to mimic the rainbow theme of the HBG Susan Garver Family Discovery garden. The first basin to contain white and yellow flowering wetland plants leading to purple and white flowering wetland plants in the second basin and ending in a Marshhay cordgrass (*Spartina patens*) meadow with a mix of all the flowering plants combined in the third basin.

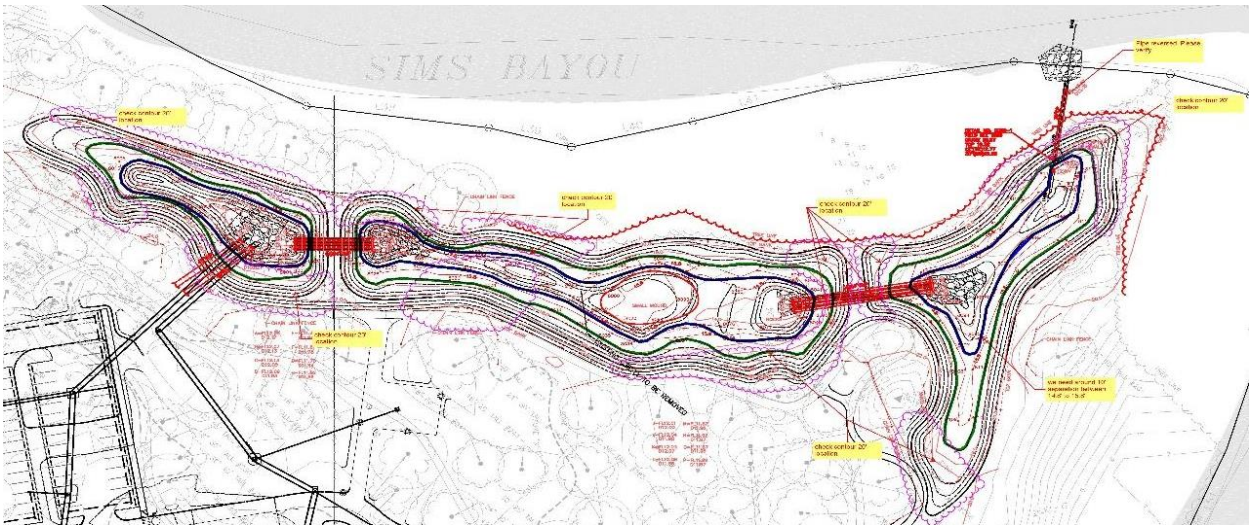

Figure 3: Revised Construction drawings from April 2020.

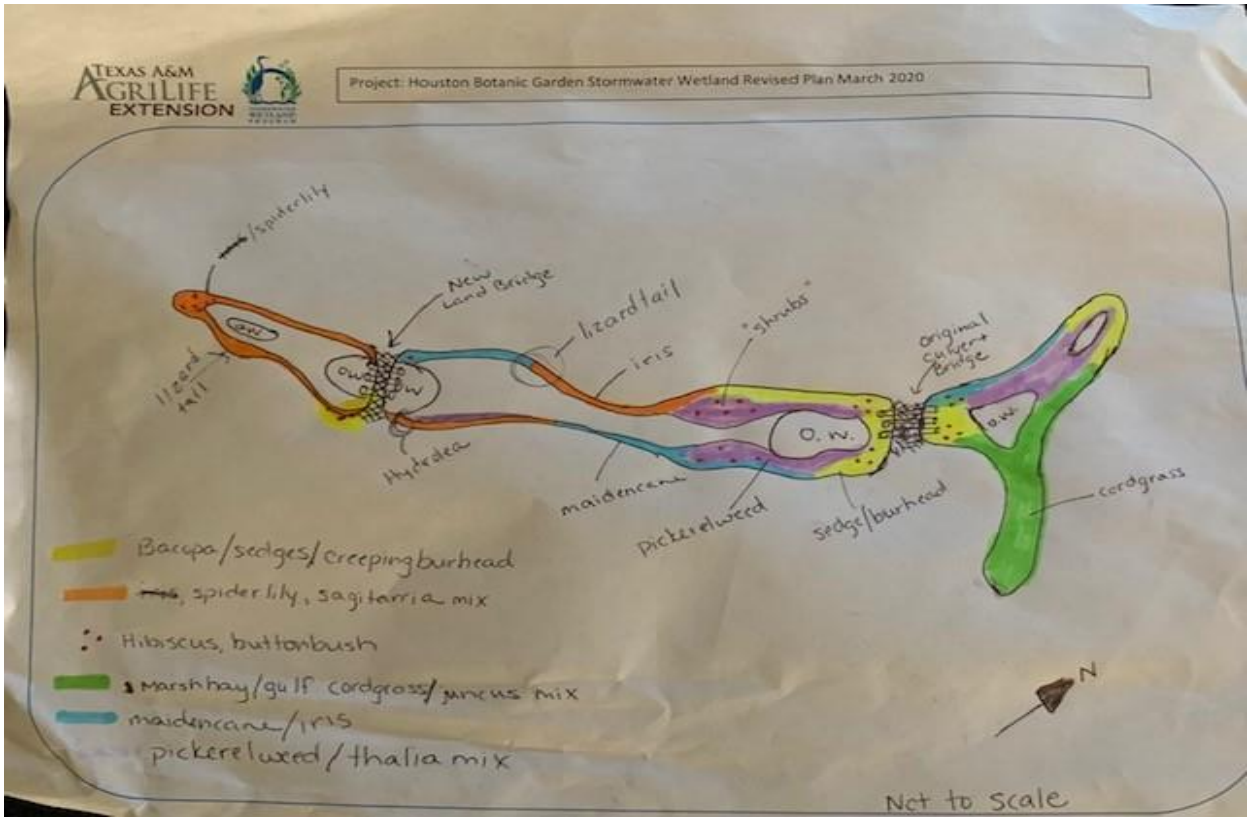

Figure 4: Revised planting plan based on new configuration and current plants.

TASK 2: CONSTRUCTION AND PLANTING OF STORMWATER WETLANDS

Harvey Construction contractors excavated and graded the basins using precision survey equipment to ensure conformance with the Stormwater Wetlands design.

Figure 5: Harvey Construction beginning excavation 05/07/2019.

Figure 6: Harvey Construction beginning excavation 05/07/2019.

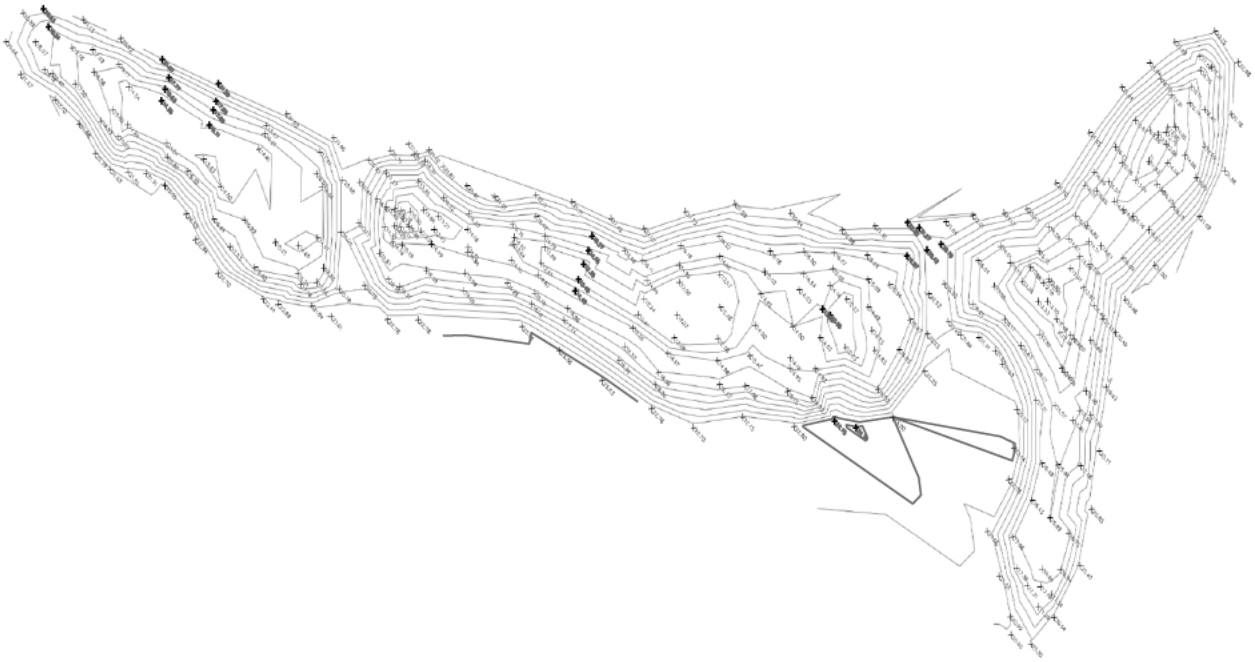

Figure 7: Final grading plan for the Stormwater Wetlands.

Figure 8: Final as built grading of the Stormwater Wetlands 04/22/2020.

Figure 9: Final as built grading of the Stormwater Wetlands 06/10/2020.

The Stormwater Wetlands were constructed with one inflow from the parking lot flowing into the first basin farthest west. Then the three basins are connected by culverts under the earthen bridges. Stone rip-rap was installed around the culverts to maintain steady water flow between basins and erosion control.

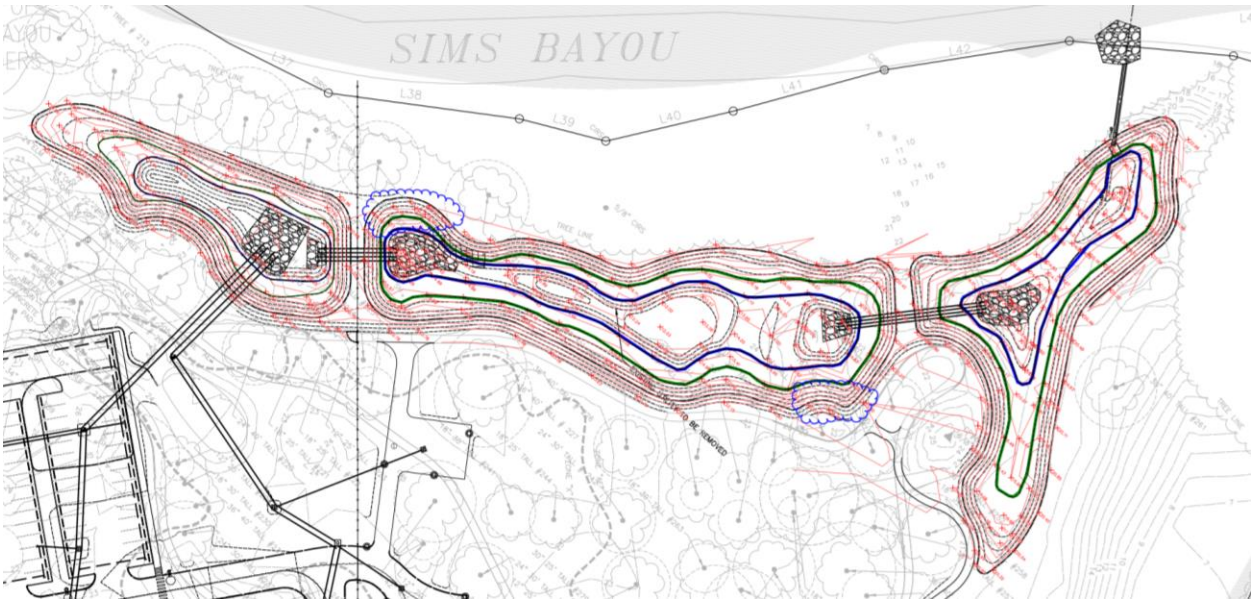

Figure 10: Final as built grading plan for Stormwater Wetlands depicting culverts, stone rip-rap, outfall, and parking lot inflow to first basin.

Figure 11: Culvert installed underneath the land bridge connecting basin 2 and 3.

The outflow to Sims Bayou is in the far northeastern corner of the Stormwater Wetlands in basin 3, depicted in the figures below. Below the water level there are smaller outflow drains to slowly and passively release water over time. When the basins are full of water the water level can overtop the structure above and flow to the outfall pipe through the cleaning grate structure. HBG has the capacity to actively lower the basins water level for release into Sims Bayou via opening the outflow drains manually. This will be done on a case by case basis associated with large storm events for flood control.

Figure 12: Looking northeast from the 4 culvert pipes that connect basins 2 and 3 toward the outfall structure connected to Sims Bayou.

Figure 13: Looking down into the first section of the outfall structure you see the control level opening and the overflow wall.

Figure 14: Cleaning grate at the outfall structure.

After the final grade was approved the site was flagged with colored flags to demark the planting zones. White flags were used to mark the permanent water line. Then pink flags were used to mark the upper wetland planting zone.

Figure 15: Photo depicting the pin flags marking the wetland planting zone prior to the water test.

After the basins were flagged, water was pumped into the basin from Sims Bayou to perform the outfall structure and water level testing to ensure everything was functioning as designed before planting began. After water level testing the slopes were hydro-seeded with Coastal Bermuda grass. HBG had the contractors also add strips of Bermuda grass sod to control erosion on the side slopes.

Figure 16: Coastal Bermuda grass sod around waterline of Stormwater basin.

Figure 17: Coastal Bermuda grass sod around waterline of Stormwater basin.

Most of the plants supplied for this project were propagated in two of TCWP wetland nursery sites at Exploration Green nursery in Clear Lake, Houston, Texas and the GCBO wetland nursery site in Lake Jackson, Texas. Plants had been previously collected from locations within a 40-mile radius of the project site, include drainage ditches and wetlands rescue sites; see Figure 18 for map of collection sites. No permits or permissions were needed for collection during this project.

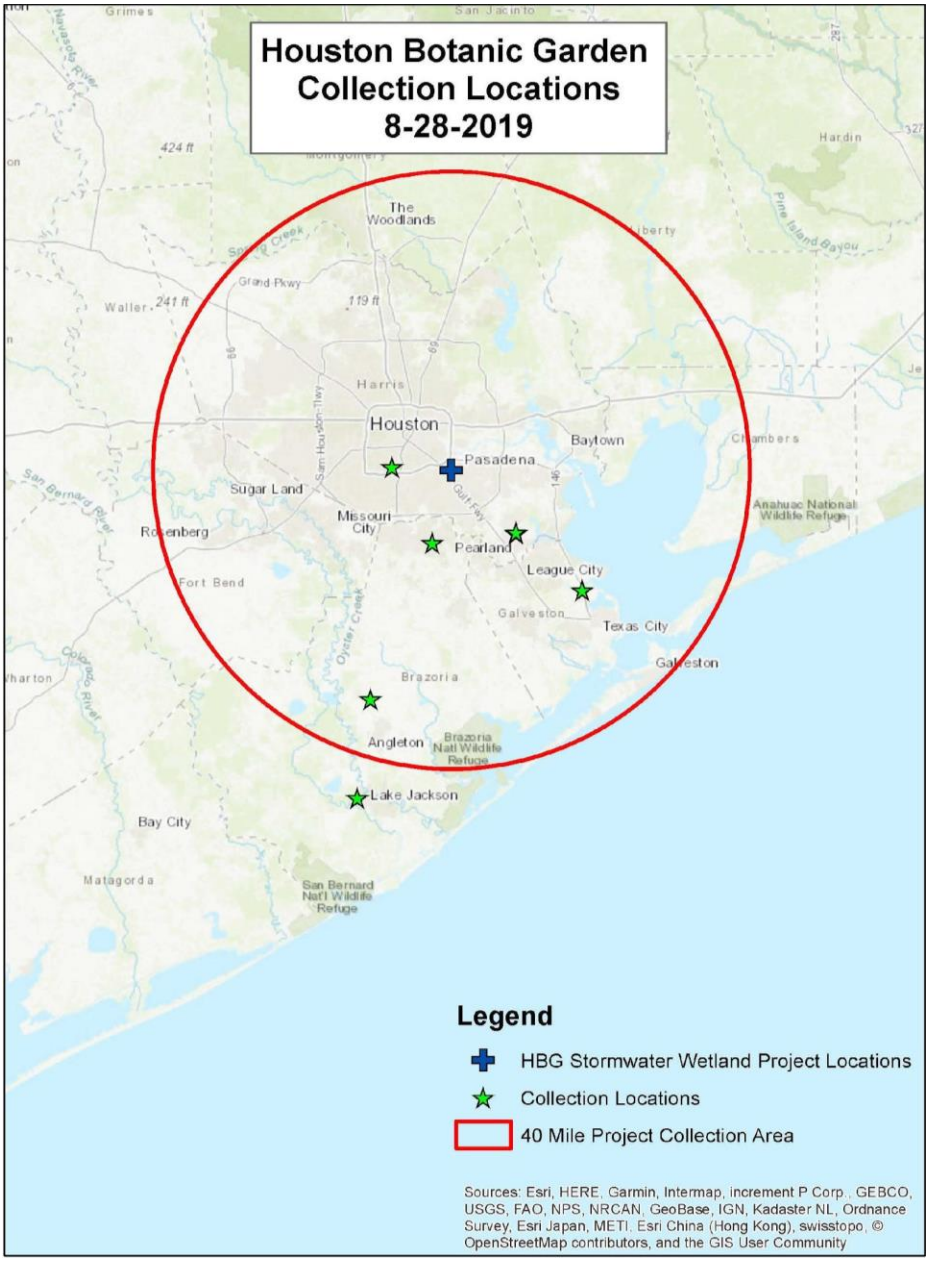

Figure 18: TCWP Wetland plant collection locations used to propagate stock for this project.

Figure 19: Exploration Green nursery location in Clear Lake, Houston, TX. Buckets are being staged for transport to Houston Botanic Garden for planting.

Figure 20: GCBO wetland nursery in Lake Jackson, Texas depicting two wetland nursery tanks.

The right tank, shown above, holds Irises (*Iris hexagona* and *Iris virginica*) grown specifically for Houston Botanic Garden and the left tank holds Spider lilies (*Hymenocallis liriosme*), Swamp lilies (*Crinum americanum*), Blue water leaf (*Hydrolea ovata*) and Hibiscus (*Hibiscus laevis* and *Hibiscus lasiocarpos*) that were transported to Houston Botanic Garden.

The majority of the plants for the Stormwater Wetlands were held and staged in the two TCWP wetland nurseries until they were ready to be planted due to the first tank of HBG's Aquatics nursery not being completed until June 2020.

The Houston Botanic Garden Aquatics nursery was designed similar to the two existing TCWP nurseries. TCWP AgriLife staff provided guidance to the construction of the tanks and HBG staff and volunteers visited the Exploration Green nursery facility for design ideas.

HBG's Aquatics nursery consist of on-grade tanks, 6-inches to 12-inches deep. Due to unforeseen circumstances (i.e. pandemics, increased price of materials, time constraints and available volunteers for construction) only one tank has been completed to date. The Aquatics nursery tank is located near the Tree nursery and maintenance area behind the Susan Garver Family Discovery garden across from the HBG administrative offices. This tank was completed as a Boy Scouts of America Eagle Scout Project; more tanks are planned to be constructed in the future by volunteers.

Figure 21: Initial framing of the on grade nursery tanks.

Frame posts are 8-12" above the ground anchored in concrete 16-20" below ground. Once concrete cures the sidewalls are installed to the post. The liner is installed and secured by the top

coping. The completed tank sections can hold roughly 950, 1-gallon sized potted plants. The finished tanks are depicted below.

Figure 22: Completed tank 1 with two sections will hold roughly 1900 plants.

Plant stock in the HBG Aquatics nursery tanks are being propagated and used as replacement stock for the Stormwater Wetlands and other wetland locations in the botanic garden.

Figure 23: Another view of the completed tank with initial plant stock to begin propagating on-site.

In July 2020, the Stormwater Wetlands basin construction and testing were complete and the site was ready for planting. TCWP AgriLife staff were trained by Harvey-Cleary Builders construction safety trainers to run the volunteer planting events whilst working in an active construction zone. TCWP AgriLife staff coordinated and tracked the volunteers for planting the Stormwater Wetlands via registration through the following Eventbrite link:

https://www.eventbrite.com/e/houston-botanic-garden-volunteer-wetland-planting-events-tickets-112690067024

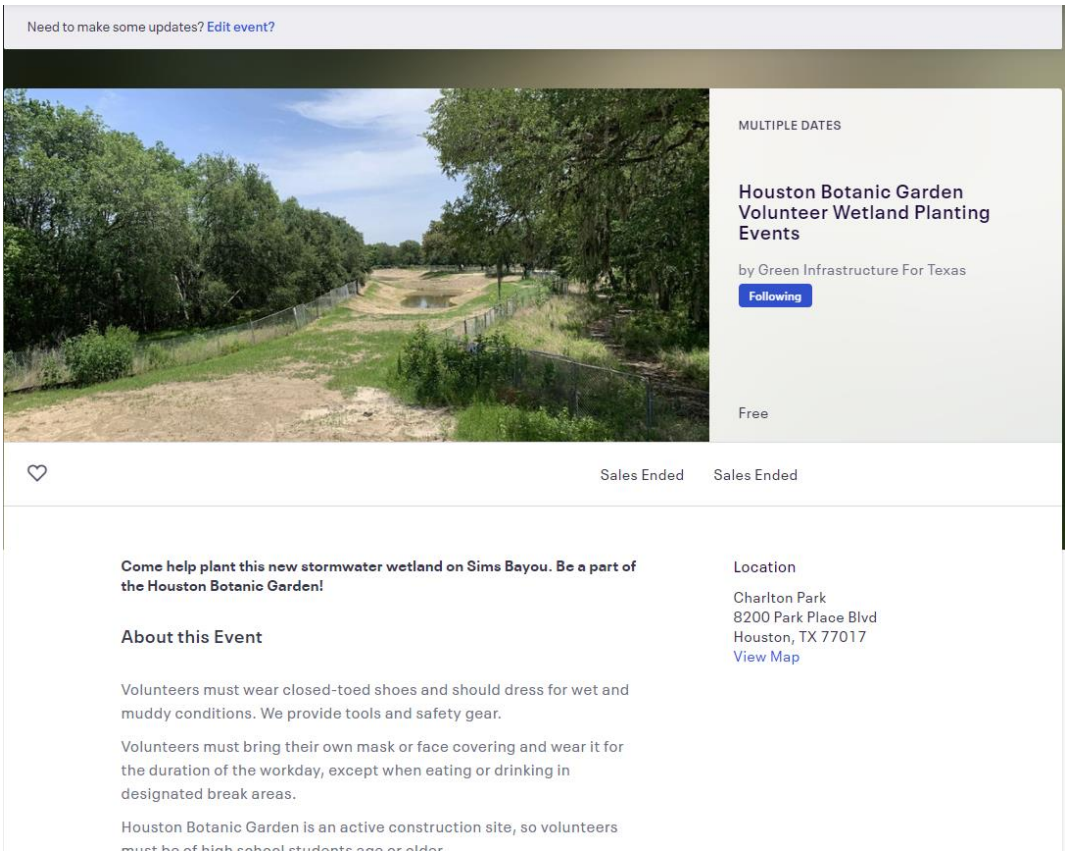

Figure 24: Screen shot of the Eventbrite link for volunteer registration.

Planting events were scheduled from July 25 – November 14 2020. Initially, we planted two days a week on Thursdays and Saturdays in July and August. In September up until the end of the project, planting events went to once per week either on Thursdays or Saturdays.

Volunteers were asked to wear a provided safety vest, rubber boots, gloves, and a face mask while volunteering. A brief construction safety overview was given prior to each planting event that occurred before mid-September, which was when full construction of HBG ended. Volunteers brought their own water bottles, and refills were provided by TCWP AgriLife staff along with individually prepackaged snacks.

Planting events were generally three hours in duration. TCWP AgriLife staff provided the tools for planting. Planting events involved checking in, unloading plants/materials, counting the deliveries prior to planting, staging the plants, and planting. Volunteers were asked to plant while socially distancing across the multiple basins at each of the planting events.

The plants which were delivered in buckets were staged around the wetland basins by volunteers under the direction of TCWP AgriLife and HBG staff. All the plants delivered each week were planted in that week's planting events. A few of the scheduled events were

cancelled due to weather and any plants delivered were planted at the follow planting event. Over the entirety of the project there was approximately 100 volunteers in total. This number is mostly volunteers that signed up on the TCWP EventBrite page and some who signed up to volunteer on HBG's website in response to our educational outreach.

Figure 25: First delivery of plants being off loaded by staff and volunteers.

Figure 26: Plants being moved from parking lot to planting area.

Figure 27: Jessica Henry counting plants by species prior to staging.

Figure 28: More shots of volunteers helping to count the plant deliveries prior to planting.

Figure 29: Buckets of plants separated by species staged after counting to be planted at next planting event.

Figure 30: Irises delivered in 1-gallon pots were staged at the top of bank along the sidewalk to be un-potted for planting.

Figure 31: Delivered buckets being staged by-basin along sidewalk.

Figure 32: Volunteers moving buckets to locations around the basins for planting.

Approximately 5,000 plants were propagated for each acre of wetland. Plants were counted and catalogued on spreadsheets both at the nursery and after they were delivered. Below are two tables of the plant counts, one from HBG staff and one from TCWP.

Table 1: HBG counts of total plants delivered by TCWP for Stormwater Wetlands

Scientific Name	Common Name	Total
Asclepias perennis	Aquatic Milkweed	25
Bacopa caroliniana	Lemon Bacopa	600
Bacopa monnieri	Waterhyssop	110
Canna glauca	Water Canna	9
Cephalanthus occidentalis	Buttonbush	18
Crinum americanum	Swamp Lily	29
Cyperus articulatus	Jointed flatsedge	69
Echinodorus cordifolius	Creeping burhead	172
Eleocharis montana	Mountain spikerush	640
Eleocharis montevidensis	Sand spikerush	485
Eleocharis quadrangulata	Squarestem spikerush	1348
Fimristylis autumnalis	Fimbry	46
Helianthus augustifolius	Swamp Sunflower	18
Hibiscus laevis	Smooth Rosemallow	4
Hibiscus lasiocarpus	Woolly Rosemallow	10
Hydrolea ovata	Blue waterleaf	112

Hymenocallis liriosme	Texas Spider Lily	126
Iris brevicaulis	Zig Zag Iris	27
Iris hexagona	Dixie Iris	532
Iris virginica	Virginia Iris	42
Juncus diffusissimus	Slimpod rush	116
Juncus effusus	Common rush	402
Juncus validus	Roundhead rush	109
Juncus sp.	Rush	118
Ludwigia octovalis	Mexican primrose-willow	5
Nymphea odorata	Fragrant Water-lily	2
Nymphaea mexicana	Yellow Water-lily	16
Panicum hemitomon	Maidencane	3008
Pontederia cordata	Pickerel-weed	177
Rhynocospora colorata	Starrush whitetop	47
Rhynocospora corniculata	Shortbristle horned beaksedge	51
Sagittaria graminea	Grass-leaved arrowhead	153
Sagittaria lancifolia	Bulltongue arrowhead	115
Sagittaria longiloba	Longbarb arrowhead	1
Sagittaria platyphylla	Broad-leaf arrowhead	254
Sagittaria sp.	Arrowhead	64
Saururus cernus	Lizards tail	120
Schoenoplectus pungens	Common Three-square Bulrush	2165
Schoenoplectus tabernaemontani	Giant bulrush	103
Spartina patens	Saltmeadow cordgrass	680
Thalia dealbata	Powderey Thalia	47
Xyris sp.	Yellow-Eyed Grass	4
TOTAL		12,179

Table 2: Total Plants delivered by TCWP for Stormwater Wetlands project

Houston Botanic Garden Wetland Plant Estimated Counts- Delivered by TCWP		
Species	Common name	Total
Iris hexagona	Dixie iris	532
Spartina patens	marshhay	680
Eleocharis montvidensis	sand spikerush	485
Hibiscus laevis	smooth rosemallow	2
Hibiscus lasiocarpus	wooly swamp mallow	10
Rhyncospora colorata	white-top sedge	47
Rhynocospora corniculata	horned beakrush	69
Pontederia cordata	pickerelweed	171

Thalia dealbata	powdery alligator flag	33
Panicum hemitomon	maidencane	3495
Nymphea odorata	white water lily	2
Hydrolea ovata	blue water leaf	112
Saururus cernus	lizard tail	155
Crinum americana	swamp lily	32
Helianthus augustifolius	swamp sunflower	19
Canna glauca	water canna	9
Asclepia perrenis	aquatic milkweed	25
Schoenoplectus (Scirpus) pungens	common three-square bullrush	2165
Echinodorus cordifolius	burhead	172
Eleocharis quadrangulata	square spikerush	1278
Eleocharis montana	montana spikerush	687
Ludwigia octovalvis	mexican yellow-primrose	5
Iris brevicalis	zig zag iris	33
Sagittaria graminae		5
Sagittaria lancifolia	bulltongue	147
Sagittaria longiloba		1
Sagitarria platyphylla	broadleaf arrowhead	465
Bacopa monerii	coastal water hyssop	110
Bacopa caroliniana	lemon bacopa/ blue water hyssop	400
Heteranthera limosa	blue mudplantain	19
Hymenocallis liriosme	spider lily	129
Cephalanthus occidentalis	buttonbush	23
Nymphea mexicana	yellow water lily	14
Cyperus articulatus	articlulated sedge	70
Juncus validus	round-headed rush	165
Schoenoplectus tabernarmontani	giant bulrush	59
Juncus effusus	Soft rush	402
Juncus diffusissimus	slimpod rush	180
Fimbistylis autumnalis	fimbry	46
Xyris caroliniana	yellow eyed grass	5
Total		12458

The planned wetland plants for the Stormwater Wetlands consists of native vegetation that was planted on 2-inch to 3-inch centers using plugs for grass, sedge and rush species, with larger species planted on 6-inch to 12- inch centers. Woody species such as Hibiscus, Buttonbush and Mexican primrose willow were planted on 2-foot to 3-foot centers on the upper edge of the wetland. Wetland planting pictures are included in this google drive.

https://drive.google.com/drive/u/1/folders/13eOks33Ggrubaow6x9roHJTD8xiTDQ-b

Figure 33: Marilyn Ventura, a Houston Botanic Garden staff member, planting *Panicum hemitomon*, Maidencane, in second basin.

Figure 34: Volunteers planting on banks of the second basin.

Figure 35: Another photo of volunteers planting the deeper water species in the second basin.

Figure 36: Volunteers planting in the third basin.

Figure 37: Volunteers planting in basin 1, behind a flowering *Canna glauca,* Water Canna.

TCWP and HBG will identify and remove invasive species at the project site. Invasive or aggressive species chosen for removal include Black willow (*Salix nigra*), Alligator weed (*Alternathera philoxeroides*), False daisy (*Eclipta prostrata*), and Water clover (*Marsilea vestita*). Groups of volunteers were trained to target a species and remove from the three basins on multiple occasions in November and December.

Figure 38: Alligator weed *(Alternathera philoxeroides)* to be removed as aggressive/ nonnative species.

Figure 39: Black willow (*Salix nigra*) being removed as aggressive/ nonnative species. These plants grow rapidly and will shade out the smaller wetland plants.

Figure 40: Volunteers removing nonnative and/or aggressive plant species from the edges of first basin.

Figure 41: Volunteers removing nonnative and/or aggressive plant species from third basin.

HBG requested that the GLO provide two permanent signs to install at the Stormwater Wetlands project site. These signs have been installed in the free portion off the parking lot near the west end of the first basin and in the paid portion of the garden on the southeast end of the third basin.

Figure 42: Grant project sign from the Texas GLO in the first basin.

Figure 43: Grant project sign from the Texas GLO along the pathway to the 2nd and 3rd basins.

TASK 3: EDUCATION AND OUTREACH

HBG installed interpretive signage explaining the functions and values of natural and created wetlands and identifying the native vegetation planted at the site.

Figure 44a and 44b: Samples of the interpretive signage installed at the Stormwater wetland.

Figure 45: Placement and location of signage along sidewalk.

Other examples of Stormwater Wetlands signage include moveable signs explaining the importance of the wetlands used at opening and other events.

Figure 46: Sample of moveable or temporary signage used at opening day and other events.

Plant labels are being developed and installed for each plant species in the wetland areas. Temporary plant labels were marked by bamboo poles with plant names written to mark placements for more permanent labels at a later date. Permanent signage is currently in the development process and is planned to be installed in 2021.

Figure 47: Photo showing temporary bamboo plant labels of *Pondetaria cordata,* Pickerelweed.

Houston Botanic Garden hired Ayanna Jolivet Mccloud, Director of Education and Public Programs to initiate educational programming. Her start date was August 30, 2019.

The Director of Education and Public Programs will schedule and implement education and outreach activities related to the Stormwater Wetlands. To date, she has launched docent training offering tours of the Stormwater Wetlands. An educational video on the Stormwater Wetlands has been recorded with Horticulture Assistant, Jessica Henry where she talks about the function and importance of natural ecosystems and storm water run-off facilities. The video will be available on our website, Youtube and social media in January 2021. A rough draft of this video is available here: https://vimeo.com/491708662 ([redacted]). Please note that this video is currently being edited and should not be publicized.

Other educational activities include planting events with Boy Scouts, the University of Houston, and corporate volunteer groups such as the Houston Bar Association, and collaborations with local organizations. HBG's neighbors at the Houston Audubon visit the garden one Thursday per month to study, track, and observe the bird populations as HBG

grows from golf course to botanic garden. An area of interest in this endeavor includes the Stormwater Wetlands.

Additionally, interpretation materials are currently in development including educational & interpretive signage, guides and scavenger hunts featuring the Stormwater Wetlands and other natural ecosystems.

Figure 48a and 48b: Boy Scouts from Troop 487 at volunteer planting events.

Figure 49: PTOT student group from University of Houston planting event.

Figure 50: Hallyu club from University of Houston second student group planting event.