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Financing Natural Infrastructure: Exploration Green, Texas

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PURPOSE: This technical note is part of a series collaboratively produced by the US Army Corps of Engineers (USACE)–Institute for Water Resources (IWR) and the US Army Engineer Research and Development Center (ERDC). It describes the funding process for Exploration Green, a large-scale community initiative that transformed a former golf course into a multipurpose green space with flood detention, habitat, and recreation benefits. It is one in a series of technical notes that document successful examples of funding natural infrastructure projects. The research effort is a collaboration between the Engineering With Nature® (EWN®) and Systems Approach to Geomorphic Engineering (SAGE) programs of USACE. A key need for greater application of natural infrastructure approaches is information about obtaining funds to scope, design, construct, monitor, and adaptively manage these projects. As natural infrastructure techniques vary widely by location, purpose, and scale, there is no standard process for securing funds. The goal of this series is to share lessons learned about a variety of funding and financing methods to increase the implementation of natural infrastructure projects.

BACKGROUND: Exploration Green is located in Clear Lake City, on the southeast edge of Houston, Texas. A short distance from NASA’s Johnson Space Center, the neighborhood surrounding Exploration Green was developed to house NASA employees, including some of the first American astronauts. Clear Lake City has an active history of flooding, with seven 100-year floods and five 500-year floods since 1979, not including Hurricane Harvey (FEMA 2018, 2). In 2004 the corporate owners of Clear Lake City’s public golf course announced their plans to sell the property for commercial development. Concerned about the impact of additional development on the area’s already high flood risk, the Clear Lake City Civic League (CLCCL) approached the Clear Lake City Water Authority (CLCWA) with the goal of finding an alternative solution. The CLCWA contracted an independent hydrology study for internal use, which recommended that the golf course be converted into a flood control area. Working together, the CLCWA and CLCCL created the vision of a natural infrastructure–based, flood-protection system that would offer a plethora of additional benefits to the community. The CLCWA acquired the golf course property in 2011, after a six-year period of community meetings and negotiations (FEMA 2018, 1).

After purchasing the property, the CLCWA initiated a master-planning process with extensive community input. As a result, Exploration Green’s primary purpose of reduced flood risk was

enhanced by design elements that also provide open green space, improve ecosystem health, offer an opportunity for environmental education, and create a gathering place for local events.

Exploration Green is retrofitting the 200 ac (81 ha)* golf course into a public park with five large ponds that serve as detention basins for floodwater during storm events (FEMA 2018, 1). The project was planned over a 15-year time horizon and is being implemented in five phases (Figure 1).

Phases 1, 2, and 3A are complete, with Phases 3B, 4, and 5 expected to finish by 2022 (EGC, “Construction,” [2018?]). In its entirety, Exploration Green will have a storage capacity of 500 million gallons (1.9 million metric tonnes), providing flood protection to over 30,000 residents living within a half mile (0.8 km) of the park.



Figure 1. Exploration Green’s five phases, showing construction progress as of 2021. (Map credit: Lockwood, Andrews, and Newman)

* For a full list of the spelled-out forms of the units of measure and unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52 and 345–47, <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

Exploration Green will also help address water-quality issues, which are an ongoing concern in the region. Stormwater runoff from the surrounding 2,000 ac (809 ha) flows directly into the project site through preexisting drainage ditches. Prior to the project, runoff from residential and commercial properties surrounding the golf course drained directly into Horsepen Bayou, before flowing into Armand Bayou, Clear Lake, and eventually Galveston Bay (Figure 2). The Texas Commission on Environmental Quality designated both Horsepen and Armand bayous as having impaired water quality (FEMA 2018). The wetlands at Exploration Green act as a natural filter for bacteria and other pollutants, improving water quality that flows downstream into the bayous. This improved water quality creates positive effects that extend far beyond the jurisdictional boundaries of the CLCWA.

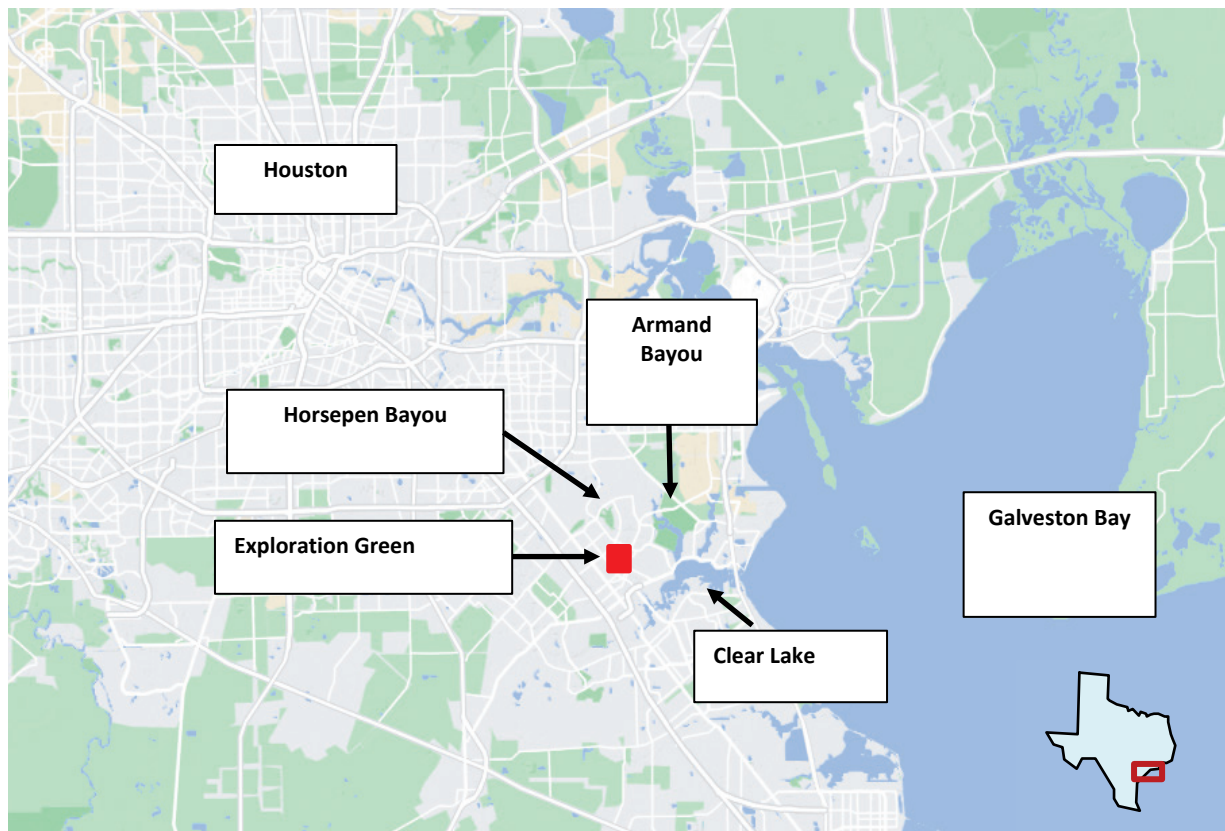


Figure 2. Location of Exploration Green within the Galveston Bay watershed.

Exploration Green has been carefully planned and adapted to create a functioning ecosystem that benefits residents and wildlife. Reestablishing 39 ac (16 ha) of native wetland habitat is a key aspect of the project's floodwater-retention capacity. The wetland areas are planted with trees, grasses, and wildflowers native to Texas, which also help remove pollutants carried by stormwater runoff. Since the site is located along the Central Flyway for migratory birds, bird islands were designed into each of the ponds. Vegetation planted throughout the project was carefully selected to provide adequate food and shelter for wildlife. Natural pest control comes from the addition of houses for swifts and bats as well as stocking the ponds with mosquito fish. Reuse water from a

nearby treatment plant is used to irrigate newly planted trees, maintain a constant water level in the ponds, and keep the pond water moving to prevent stagnation. Bubblers are used in the summer to maintain an acceptable oxygen level in the ponds, and spillways were installed to catch debris. Recreational facilities are another major part of Exploration Green, including over 6 mi (9.6 km) of bicycle and walking paths, park benches, picnic tables, athletic fields, and a visitor center (Figure 3).



Figure 3. An example of the native wetland habitat and recreational paths at Exploration Green. (Photo credit: SWA Group)

Development of Exploration Green was made possible by continuous collaboration among a strong network of institutions from across the public and private sectors. The CLCWA is the primary mover for the project, responsible for design and construction of the stormwater-detention aspects, with the support of their architect and engineering contractors. The Exploration Green Conservancy is a volunteer-driven nonprofit organization dedicated to the protection and enhancement of Exploration Green—their role is to support the creation, maintenance, and operation of habitat restoration and recreation facilities within the park. A wide array of additional partners has contributed to Exploration Green, including the Galveston Bay Foundation, Trees for Houston, Texas A&M AgriLife Extension Service, Texas Coastal Management Program, Texas Parks and Wildlife Department, Texas Parks and Wildlife Foundation, Texas Master Naturalist Program, Texan by Nature, City of Houston, Harris County, Galveston Bay Estuary Program, and the Texas Commission on Environmental Quality (EGC, “Partner Organizations,” [2018?]).

The Exploration Green project has generated broad and far-reaching positive effects. An early test of the project occurred in 2017, when Hurricane Harvey dropped record rainfall levels on the

Houston region. Although the first detention basin was only 80% excavated, it performed exactly as it should: a storage basin to keep an estimated 100 million gallons (378,541 metric tonnes) of floodwater away from 150 homes (Para 2017). In terms of future losses avoided, the CLCWA estimates that Exploration Green will prevent \$300 million in flood damage during every 500-year rain event (FEMA 2018). The aesthetics and amenities provided by Exploration Green also contributed to a \$120 million increase in property values for the community. The price per square foot for Clear Lake area homes increased from \$9 in 2016 to \$28 in 2018—much of which is attributed to the project (Ferguson 2020). Exploration Green has also boosted local biodiversity, with over 1,000 species of plants and animals recorded at the site (TBN 2020).

Funding process. Exploration Green shows how a local government agency can maximize the value of community engagement and multisector partnerships. This success is reflected in the variety of funding sources and in-kind contributions that support the project, which has an estimated implementation cost of \$48–\$50 million (Table 1). The largest portion of funding comes from \$45 million in local bond appropriations. Exploration Green has also been awarded \$2.8 million in grants, primarily from the Texas Parks and Wildlife Department and the Texas Coastal Management Program. In addition, \$300,000 has been donated by a plethora of local civic groups, corporations, and individuals. Another \$3.2 million of in-kind contributions have come in the form of native trees and wetland plants donated by Trees for Houston and the Texas A&M AgriLife Extension Service.

Table 1. Overview of funding sources for Exploration Green.

Source	Amount (USD)
CLCWA ^a bonds	45,390,676
State (Texas Parks and Wildlife)	1,950,000
State (Texas Coastal Management Program)	200,000
Local (Harris County and City of Houston)	680,000
Local (civic organizations)	33,000
Local (individual and business donations)	231,245
Local (corporate and foundations)	42,000
Local (Trees for Houston, Texas A&M AgriLife)	3,200,000 (value of in-kind services)
Total (as of 2021)	48,526,921

^a CLCWA—Clear Lake City Water Authority

Land acquisition. The CLCWA purchased the land for Exploration Green in 2011 for \$6.25 million, using reserve funds from existing bonds earmarked for drainage projects. However, the impetus for the project began six years earlier. The community was seeking a solution to mitigate severe seasonal flooding, which had been steadily increasing during the past 40 years of development practices. The CLCWA is the government agency responsible for water, sewer, and drainage services in the area—an authority delegated by the state of Texas when the Johnson Space Center was being constructed outside any existing city boundary (John Branch, president of CLCWA’s board of directors, web call, March 2021).



Late in 2004, the local golf course announced their closure and subsequent intent to sell the property for high-density commercial development. Residents, organized through the CLCCL, were concerned that the proposal would further exacerbate flooding. In response, the CLCWA contracted a hydrology study that assessed the entire 16,000 ac (6,475 ha) under their jurisdiction and made recommendations for the best way to reduce flood risk across the region. The study recommended that the CLCWA increase water detention capacity by purchasing the golf course property. The golf course was a practical and cost-effective site for a flood control project because it was centrally located within the drainage area, and water was already channeled to the property through existing drainage ditches. Hydrologic analysis also showed that a detention area at that site would reduce residential flooding and drain streets more quickly for evacuation routes and emergency response. The CLCWA approached the golf course owner about purchasing the property, but they were unable to negotiate a fair price. As a result, the CLCWA filed condemnation proceedings in 2006. The act of condemning a property occurs when a government entity uses the court system to exercise its power of eminent domain. *Eminent domain* is a constitutionally recognized power that allows the government to take ownership of private property for a public purpose, with just compensation to the property owner.* After a lengthy court process, the owner agreed to sell the land outright to the CLCWA in 2011 (Branch, web call).

Community-centered planning. From the beginning, the CLCWA embraced the concept of engaging the community in developing ideas for the project. Thus, planning for Exploration Green began with a series of town hall meetings led by the CLCWA and CLCCL. These meetings explained the flooding issue to residents, described how flood risk would be reduced by a natural water-detention system, and solicited public input on how the space could be used and enjoyed by the community. Early on, the CLCWA used operating funds to hire the SWA Group, an international landscape architecture firm. SWA offered valuable guidance on information gathering, which helped cultivate positive relationships with residents and generate high participation in the meetings. Together, the CLCWA and SWA emphasized actively listening to residents about what was most important to them as well as their concerns. Community interest groups were formed to make recommendations about different topic areas, such as recreational opportunities and use of native plants. The CLCWA also challenged community members to think creatively about methods and sources of funding to implement their ideas. SWA attended each of the meetings, recorded comments, and determined the feasibility of recommendations for the facility. The sum of this feedback directly informed the CLCWA's master plan for Exploration Green.

The master plan, issued in 2013, divided Exploration Green into five distinct phases—one for each of the detention ponds ([CLCWA?] 2013). The CLCWA decided to pursue tax-supported bonds to cover the \$45 million cost of excavating and constructing the detention ponds and sought to complete the project within a 15-year period to minimize negative impacts to the surrounding

* U.S. Const. amend. V. <https://constitution.congress.gov/constitution/amendment-5/>. See also *Kohl v. United States*, 91 U.S. 367 (1875), <https://tile.loc.gov/storage-services/service/l1/usrep/usrep091/usrep091367/usrep091367.pdf>, which affirmed the previously untested right of eminent domain, and *Kelo v. City of New London*, Connecticut, 545 U.S. 469 (2005), <https://www.supremecourt.gov/opinions/boundvolumes/545bv.pdf>, which affirmed economic development as a legitimate type of public use.

neighborhood. Exploration Green's extended time line for completion allowed the CLCWA to plan the sale of new bonds to coincide with the retirement of existing bonds, resulting in no net tax increase for residents. Because of this forethought, as well as strong community buy-in gained during the inclusive planning process, the CLCWA's bond measure passed by a wide margin.

Exploration Green Conservancy. To minimize costs to the public, the CLCWA and CLCCL sought alternative means of funding the additional design elements beyond detention-pond construction, such as habitat enhancements, walking trails, interpretive signage, and more (Figure 4). They met with the Houston Parks Board, a 501(c)(3) nonprofit organization that receives private and corporate donations for the purpose of purchasing land and building amenities to support existing parks and create new parks and trails for the city of Houston. Contributing to a nonprofit organization is attractive to private and corporate entities because it provides tax deductions, compared with donating directly to a government agency, which has no tax advantage. Inspired by the Houston Parks Board, the CLCWA and CLCCL established the 501(c)(3) Exploration Green Conservancy (EGC) in 2014. The EGC is set up to pursue partnerships, grants, and donations from a variety of sources to manage and fund the habitat and recreation aspects of the project. Conservancy status also opens eligibility for grants that are not available to government agencies like the CLCWA.

The EGC's mission is carried out by an executive board, which meets monthly. The Exploration Green Advisory Committee also lends advice as subject matter experts for specific issues. One full-time EGC staff member is funded by the CLCWA to handle grant management, but the rest are volunteers. The board initially focused on planning and prioritizing park amenities, identifying and applying for grant opportunities, and gathering a list of other potential contributors. In the two years before construction began, the EGC raised \$8 million in grant funding and donations to support future elements of the project (Para 2017). Their work also included creating a database of native plant species that would work best for the project site and developing a base plan for volunteer support. As construction began, the EGC's role evolved into coordinating volunteer events and ensuring that each phase of the project was ready for the public to use.

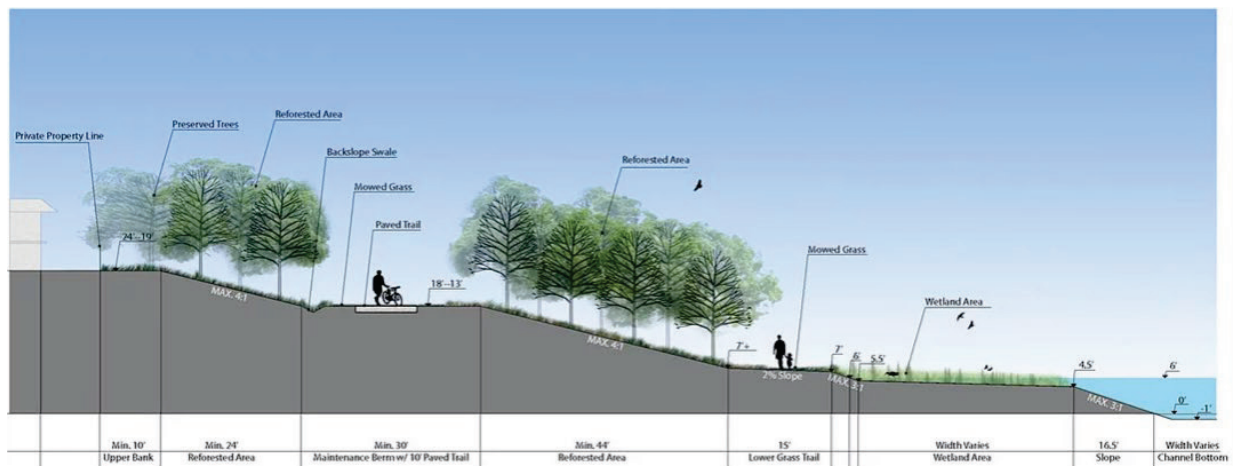


Figure 4. Cross section of Exploration Green from the master plan ([CLCWA?] 2013, 27).

Protecting and enhancing the investment. In 2014 the CLCWA and EGC worked with the Galveston Bay Foundation to establish a conservation easement—a voluntary agreement between a land trust and landowner to permanently restrict future uses on their property to safeguard conservation values (“Exploration Green,” 2015). The CLCWA is led by an elected board of directors, and they recognized that a future composition of board members could reverse the Exploration Green project and sell off the property for development. Now, the conservation easement for Exploration Green protects the land as open green space in perpetuity. The Galveston Bay Foundation was selected as the conservator because they are local to Clear Lake City and eager to expand their role as a land trust. They also helped train the newly formed EGC about the range of available grants and how to apply.

During the same year, key partnerships were formed with Trees for Houston and the Texas A&M AgriLife Extension Service. Trees for Houston, a nonprofit organization with the mission of planting and protecting trees within the region, developed an on-site nursery stocked with 1,000 native trees that could be planted on the property. Similarly, the Texas Coastal Watershed Program—a collaboration between Texas A&M AgriLife and Texas Sea Grant—established an on-site nursery that grows native wetland plants to support habitat creation and the filtration of stormwater runoff. The collective value of these contributions is estimated at \$2 million.

Construction. Phase 1 was completed during 2016–2018, with a total construction cost of \$3.9 million (Table 2). Phase 1 included the first 8 ac (3 ha) detention pond, a half-acre (0.2 ha) bird habitat island, 6 ac (2.4 ha) of wetlands, 1.1 mi (1.8 km) of walking and bike trails, athletic fields, and a main entrance plaza with parking (Figure 5). The CLCWA covered the \$3.5 million cost of design, engineering, and construction management using their bond funds. The EGC coordinated partnerships and approximately \$500,000 of funding for the other amenities, which consisted of grants, donations, and in-kind contributions. Grants were received from the Texas Coastal Management Program, while Harris County and the City of Houston donated funds for the walking and bike trails (FEMA 2018, 6). Local civic organizations also offered support, with the Space Center Rotary Club providing park benches for the perimeter of the pond and the CLCCL donating funds for irrigation. Overall, individual donations totaled more than \$40,000. The in-kind contributions included the 1,000 native trees from Trees for Houston as well as wetland plants from Texas A&M’s AgriLife Extension Service.

The Phase 1 detention pond was still being excavated when Hurricane Harvey hit in August 2017, bringing 45 in (114 cm) of rainfall to Clear Lake City. Although only 80% complete, the basin held an estimated 100 million gallons (378,541 metric tonnes) of water and prevented at least 150 homes from flooding (Para 2017). During previous storms, those same homes had been inundated by up to 10 in (cm) of floodwater. Seeing the project’s success during a massive storm event like Harvey raised community interest in accelerating Exploration Green’s overall completion date, and with the help of financial advisors, the CLCWA refinanced some of their outstanding bonds at a lower interest rate. The resulting savings allowed them to sell new bonds more quickly without raising taxes—advancing their goal to now finish the entire project by the end of 2022 (Branch, web call).



Table 2. Overview of Funding Sources for Phase 1.

Source	Project type	Amount (USD)
CLCWA bond	Design, engineering, construction	3,500,000
State (Texas Coastal Management Program)	Habitat, recreational trails	100,000
Local (Harris County, City of Houston)	Recreational trails	230,000
Local (Space Center Rotary Club)	Park benches	8,000
Local (Clear Lake City Civic League)	Irrigation	20,000
Local (individual and business donations)	Various	12,000 (includes value of in-kind materials)
Local (Trees for Houston, TexasA&M AgriLife)	Habitat	In-kind services (trees and plants)
Total		3,870,000



Figure 5. An aerial view of Phase 1. (Photo credit: SWA Group)

Phase 2 was completed during 2018–2020, with a total construction cost of \$6.5 million (Table 3). Phase 2 included a 5 ac (2 ha) detention pond, a half-acre (0.2 ha) bird habitat island, 9 ac (3.6 ha) of wetlands, and 1.3 mi (2.1 km) of trails. With a proven track record from Phase 1, Exploration Green obtained an additional \$200,000 in grant funding from Texas Parks and Wildlife to support pedestrian trails, site furnishings, native landscaping, and irrigation for Phase 2 (TPWD 2018).

These grants were distributed by the State of Texas, but the funds originally came from Deepwater Horizon oil-spill settlements and federal disaster relief after Hurricane Harvey. Texas Parks and Wildlife also donated two towers that provide chimney swift habitat, part of Exploration Green's natural mosquito control (Avery 2020). Harris County continued their support as well, committing an additional \$450,000 for multipurpose trails across Phases 2, 3, and 4. Local contributions also continued, with the Space Center Rotary Club providing more park benches and the CLCCL donating more funds for irrigation. Overall, individual donations totaled more than \$55,000. In-kind contributions included another 1,000 native trees from Trees for Houston as well as wetland plants from Texas A&M's AgriLife Extension Service.

Phase 3 was split into two subphases, as extra engineering was needed to ensure minimal impacts to a Harris County Flood Control District channel. Overall, Phase 3 will include an 8 ac (3.2 ha) detention pond, 6 ac (2.4 ha) of wetlands, a half-acre (0.2 ha) bird habitat island, and 1.3 mi (2.1 km) of trails. Phase 3A was completed during 2019–2020, with a total construction cost of \$7.3 million (Table 4). Phase 3B began construction in late 2021, with an estimated construction cost of \$5.6 million. A \$500,000 grant from Texas Parks and Wildlife supported the development of pedestrian trails, landscape and site restoration, and installation of irrigation systems for Phase 3A and contributes to Phase 5. A \$100,000 grant from the Texas Coastal Management Program was matched by an additional \$100,000 from the Galveston Bay Foundation to support prairie habitat restoration, multipurpose trails, and public-access features across the entirety of Phase 3. Phase 3 also received a \$12,000 grant from the Environmental Fund of Texas to support tree planting, which supplemented continuing in-kind contributions from Trees for Houston and Texas AgriLife. Overall, individual donations totaled more than \$70,000 for Phase 3.

Phase 4 began construction in 2020 and is expected to be complete in 2021 with a total cost of \$9.7 million (Table 5). This is the largest section, which will include a 10 ac (4 ha) detention pond, 11 ac (4.4 ha) of wetlands, a half-acre (0.2 ha) bird habitat island, and 1.5 mi (2.4 km) of trails. Phase 4 received an additional \$500,000 grant from Texas Parks and Wildlife to support multipurpose trails, habitat restoration, and installation of irrigation systems. Phase 3 also received a \$15,000 donation from the Apache Corporation to support tree planting, which supplemented continuing in-kind contributions from Trees for Houston and Texas AgriLife. Overall, individual donations totaled more than \$60,000 for Phase 4.

Phase 5 is expected to begin construction in 2021 and be completed in 2022, with an estimated cost of \$15.6 million (Table 6). Phase 5 will include a 7 ac (2.8 ha) detention pond, 7 ac (2.8 ha) of wetlands, a half-acre (0.2 ha) bird habitat island, and 1.2 mi (1.9 km) of trails. Texas Parks and Wildlife awarded Exploration Green a \$750,000 grant to support the development of more natural areas, trail facilities, interpretive signage, and a parking lot (Avery 2020). Trees for Houston and Texas AgriLife are continuing their in-kind contributions of native trees and wetlands plants, and individual donations for Phase 5 have surpassed \$38,000 so far.



Table 3. Overview of funding sources for Phase 2.

Source	Project type	Amount (USD)
CLCWA bond	Design, engineering, construction	6,152,646
State (Texas Parks and Wildlife)	Habitat, recreational trails	200,000
Local (Harris County)	Recreational trails	450,000 (also funds Phases 3A and 4)
Local (Space Center Rotary Club)	Park benches	2,500
Local (Clear Lake City Civic League)	Irrigation	2,500
Local (individual and business donations)	Various	55,800 (includes value of in-kind materials)
Local (Trees for Houston, Texas A&M AgriLife)	Habitat	In-kind services (trees and plants)
Total		6,491,858

Table 4. Overview of funding sources for Phase 3.

Phase	Source	Project type	Amount (USD)
3A	CLCWA bond	Design, engineering, construction management	7,072,719
	State (Texas Coastal Management Program)	Habitat, recreational trails	100,000 (also funds Phase 3B)
	State (Texas Parks and Wildlife)	Habitat, recreational trails	500,000 (also funds Phase 5)
	Local (Galveston Bay Foundation)	Habitat, recreational trails	100,000 (also funds Phase 3B)
	Local (Harris County)	Recreational trails	450,000 (also funds Phases 3A and 4)
	Local (Environmental Fund of Texas)	Trees	12,000
	Local (individual and business donations)	Various	32,100 (includes value of in-kind materials)
	Local (Trees for Houston, Texas A&M AgriLife)	Habitat	In-kind services (trees and plants)
	Total 7,312,724		
3B	CLCWA bond	Design, engineering, construction management	5,244,785
	State (Texas Coastal Management Program)	Habitat, recreational trails	100,000 (also funds Phase 3A)

Phase	Source	Project type	Amount (USD)
	State (Texas Parks and Wildlife)	Habitat, recreational trails	750,000 (also funds Phase 5)
	Local (Galveston Bay Foundation)	Habitat, recreational trails	100,000 (also funds Phase 3A)
	Local (individual and business donations)	Various	38,773 (includes value of in-kind materials)
	Local (Trees for Houston, TexasA&M AgriLife)	Habitat	In-kind services (trees and plants)
			Total 5,592,640

Table 5. Overview of funding sources for Phase 4.

Source	Project type	Amount (USD)
CLCWA bond	Design, engineering, construction management	9,014,526
State (Texas Parks and Wildlife)	Habitat, recreational trails	500,000
Local (Harris County)	Recreational trails	450,000 (also funds Phases 3A and 4)
Local (Apache Corporation)	Trees	15,000
Local (individual and business donations)	Various	60,700 (includes value of in-kind materials)
Local (Trees for Houston, TexasA&M AgriLife)	Habitat	In-kind services (trees and plants)
		Total 9,694,199

Table 6. Overview of funding sources for Phase 5.

Source	Project type	Amount (USD)
CLCWA bond	Design, engineering, construction management	14,406,000
State (Texas Parks and Wildlife)	Habitat, recreational trails	750,000 (also funds Phase 3B)
State (Texas Parks and Wildlife)	Parking lot	500,000 (also funds Phase 3A)
Local (individual and business donations)	Various	38,772 (includes value of in-kind materials)
Local (Trees for Houston, Texas A&M AgriLife)	Habitat	In-kind services (trees and plants)
		Total 15,565,000

Maintenance and monitoring. As the property owner, the CLCWA is responsible for properly maintaining Exploration Green. The CLCWA has developed a projected budget for annual maintenance of the flood-detention structures, which is funded by water rates paid by residential and commercial users within the district. In parallel, the EGC maintains ongoing fundraising efforts to support the maintenance of recreational facilities and amenities. To reduce taxpayer costs, the CLCWA and EGC have also developed plans for organizing volunteers to help with maintenance activities, such as checking the condition of vegetation and making minor repairs to park amenities. Community members and civic groups have already donated trailers, string trimmers, boats, and other items to assist with maintenance needs. When the project is complete, the CLCWA intends to hire a full-time employee to oversee and coordinate maintenance activities. An important partnership was also formed with the Harris County Flood Control District, which agreed to maintain the short strips of land that provide connecting channels between Exploration Green and Horsepen Bayou for the mutual benefit of both parties. In addition, Exploration Green is beginning to seek donations from local petrochemical companies, a core industry in the Houston area.

LESSONS LEARNED—ENABLERS: Several factors contributed to the successful funding of Exploration Green. These include the CLCWA’s dedication to community engagement throughout the project, the ability to attract and sustain volunteer support, and a host of innovative partnerships with civic and academic organizations.

Community engagement. Exploration Green’s status as an award-winning model for effective and creative floodplain management reflects how well the project embodies community values. From the earliest stages, CLCWA leadership consistently supported the interests of residents and worked together with grassroots neighborhood groups. The community was given a strong voice in the planning process, and the CLCWA followed through by holistically incorporating that feedback into the project’s design. When opposition was raised—primarily from business interests and residents whose property would be adjacent to construction—the CLCWA worked closely with them to address their concerns. The CLCWA’s investment of diligence and responsiveness paid off for Exploration Green, as it resulted in the community’s willingness to approve bond measures and further contribute their individual time, expertise, and monetary donations to the project. Exploration Green’s robust and thoughtful master plan also proved key to successfully meeting the requirements of different grant programs. The CLCWA’s approach to Exploration Green shows the ideal function of a local government agency—more effectively providing a public service (flood risk reduction) while reducing long-term costs with the added benefits of recreation and environmental sustainability.

Now that a significant portion of the project is complete and open to the public, the EGC continues to envision new ways of connecting Exploration Green with the community. The EGC organizes education initiatives with area schools and other groups to enhance the public’s understanding of local ecology, conservation, and the importance of wetlands for stormwater issues. One example is the annual Wetland Walkabout event, which includes guided tours, information booths, and eco-friendly giveaways from a long list of partners. The EGC also hosts regular wildlife viewing activities to observe the 600+ species of plants, animals, and insects that inhabit Exploration Green.



With regard to engaging the community in funding, the EGC has set up several processes to encourage individual donations. For instance, members of the public can purchase park benches, trees, and other amenities in memoriam of a loved one. The EGC also works to leverage large companies with foundations that match employees' end-of-year charitable donations. Using social media, like NextDoor and Facebook, the EGC asks residents employed by those companies to consider supporting Exploration Green.

Use of volunteers. An energized community is an excellent source of volunteers, who have played a key role in reducing the overall cost of Exploration Green. All the physical labor required for landscaping was performed by community volunteers of all ages (FEMA 2018, 9; Figure 6). Exploration Green has thus far mobilized over 1,000 individual volunteers, and more than 9,500 volunteer hours have been contributed to the project overall. The on-site tree and wetland plant nurseries are also maintained by volunteers year-round (DeLapp 2020). For people not as inclined to (or unable to) work outside, the EGC recruits volunteers to assist with fundraising efforts, communications, graphic design needs, and events planning (EGC, "Volunteering", [2018?]).



Figure 6. Volunteers at wetland (left) and tree planting (right) events during Phase 1. (Photo credits: CLCWA)

The EGC has developed creative methods for refreshing sources of volunteers to support this multiphase project. A particularly successful idea has been hosting events to attract guests that might not normally visit the site. Such events include a Halloween costume walk around the Phase 1 trail, a holiday luminary walk where the park stays open after dark, and a new effort called "Music On The Green" that will sponsor lawn chair concerts by the Clear Lake Symphony and Bay Area Chorus on the athletic fields (Lamkahouan 2019). Each of these events provide visibility and awareness of Exploration Green to different sectors of the community, leading to new donations and volunteers.

Innovative partnerships. Establishing a wide network of state, regional, and local partners has been key to successfully funding Exploration Green. One important factor is connecting with both public- and private-sector partners, which can fulfill different needs for the project. The diverse

range of partnerships involved with Exploration Green blossomed from strong community engagement, as the project team was introduced to potential partners through word of mouth from affiliated residents or because those organizations attended the CLCWA's public meetings. This influx of social capital was an important resource for both accelerating the project and generating funds. A few examples are described below.

Trees for Houston. The executive director of Trees for Houston lives in the neighborhood adjacent to Exploration Green and attended several of the initial town hall meetings. On learning about the project's ecological goals, Trees for Houston expressed interest in becoming a partner. Not only did Trees for Houston offer to provide 1,000 native trees per phase—up to 5,000 trees total—they also helped establish an on-site nursery to be a self-sustaining source of trees for the project's future needs (Figure 7). The initial value of this contribution was approximately \$1 million. Volunteers are trained to tend the nursery, grow the trees to planting size, and then plant them. Trees for Houston lends an augur to dig holes during planting events, so volunteers only have to pick up the trees, place them in the holes, and fill in soil. The combination of donating trees and enabling volunteer support generated a significant financial savings over hiring a landscape company to handle plantings.

Texas A&M AgriLife Extension Service. The CLCWA consulted with the AgriLife Extension Service at Texas A&M University to provide guidance on wetland habitat construction, particularly the appropriate species and distribution of plants. Through extension services, land-grant colleges and universities bring applied research and education about agriculture and natural resources to the public. More than 100 institutions nationwide provide extension services. Texas AgriLife is one of them, with a large, statewide network of professional educators, trained volunteers, and county offices. In addition to consulting, Texas AgriLife also set up an on-site nursery for native grasses and other wetland plants for use at Exploration Green—collectively saving the project more than \$1 million (Figure 7). The CLCWA pays half the salary of a wetlands specialist to help run the nursery and lead volunteers in planting events. The Texas Community Watershed Program, a part of AgriLife, also gave valuable advice on how to apply for state grants related to the Deepwater Horizon settlement and helps coordinate the wetland planting. Additionally, the Green Infrastructure for Texas, or GIFT, program, supported by AgriLife, held two field days at Exploration Green to educate residents about how natural infrastructure practices function and benefit the community.





Figure 7. Native tree (left) and wetland plant (right) nurseries at Exploration Green. (Photo credits: CLCWA)

Texas Master Naturalist Program. Exploration Green also derives substantial benefits from their connection with the Texas Master Naturalist Program, sponsored by Texas AgriLife and the Texas Parks and Wildlife Department. Master naturalist programs in every state develop a corps of knowledgeable volunteers to provide education, outreach, and public service dedicated to community-based conservation efforts. Texas master naturalists serve on the project's advisory committee, spreading awareness about Exploration Green among their large network, and continue to provide well-informed volunteers that help lead both planting and monitoring events.

LESSONS LEARNED—BARRIERS: Certain barriers have complicated the process of funding Exploration Green. These include grant time lines, environmental permitting, and issues related to operating in developed areas. They are described in turn below.

Grant-specification constraints. At times, the Exploration Green project team has found it challenging to fit the realities of implementing their project within the requirements of state grants. With many grant programs, several months elapse between when the grant is awarded and when the funds are available for use by the grantee. Additionally, most grant programs require that funds be used within a specified number of months or years after they have been awarded. These hard deadlines mean that if a permit is delayed, or it takes longer than expected for a government agency like the CLCWA to go through the competitive bid process for contractors, it hurts the project's ability to be delivered on time. These constraints can force project proponents to either make suboptimal decisions or lose the grant funds they have spent time and labor to win. The CLCWA noted that having a comprehensive master plan and dividing the project into phases has helped them manage some of these challenges.

Environmental permitting. It took three and a half years to get the project permitted by the Texas Commission on Environmental Quality (TCEQ) (FEMA 2018, 4). Permitting processes for natural infrastructure projects can often be challenging and lengthy, especially when regulatory agencies are considering unique design elements that may not have a precedent elsewhere in their

jurisdiction. In this case, the TCEQ required extra time to evaluate the use of reuse water to maintain a minimum water depth in the detention ponds to sustain wetlands during dry periods. In addition, the TCEQ has another layer of procedures that are triggered if there is opposition to a project. Early on, some community members expressed preferences for the golf course property to either be used for commercial development or left vacant. Before issuing a permit for Exploration Green, the TCEQ held a public meeting, reviewed concerns, and responded to them in writing. A preliminary opinion was then issued, followed by an appeals process. A specific time period is required for each of these steps, adding significant delay to the process.

Operating in highly developed areas. Exploration Green encountered a few unexpected issues that arose from working in an already highly developed area. For example, Phase 2 fell behind schedule because the project's proximity to Ellington Airport violated a Houston ordinance (Orozco 2018). The ordinance stated that any detention reservoir within 3.5 mi (5.6 km) of an airport must be a dry-bottom pond that drains within 72 hours of filling. The rule stems from Federal Aviation Administration guidance that considers birds, who are attracted to ponds that continually contain water, a potential flight hazard to nearby aircraft. However, data showed that the bird species most concerning for aircraft—such as snow geese and turkey vultures—are not regularly drawn to Exploration Green. All work on Phase 2 had to stop for two months until the project was granted a variance. Phase 5 has also been delayed because of concerns about a petroleum pipeline that crosses the project area. The CLCWA worked closely with the pipeline company, which has agreed to lower the pipeline to accommodate construction of the pond.

NEXT STEPS: After Phase 3B and Phase 5 are completed, Exploration Green will seek funding for construction of an entry plaza and environmental education center about how to use nature to solve problems in urban areas (Ferguson 2021). The CLCWA and EGC are interested in pursuing more funding from local petrochemical and aeronautical company foundations to support those aspects of the project.

Every year, the Texas Gulf Coast is faced with damaging storm systems, costing communities billions of dollars in repairs (Smith 2022). Exploration Green is the first of its kind in the region—an integrated, natural solution for catastrophic seasonal flooding that also serves as a nature preserve and recreation area. This project is an excellent example of how grassroots collaboration can achieve innovative flood mitigation that improves quality of life for the people and businesses in the surrounding community. As such, it has earned multiple prestigious national and regional awards. The success of Exploration Green and overwhelming community support for the project give it a favorable position to continue securing public and private funding.

ADDITIONAL INFORMATION: Project details were collected during a semistructured web call with Mr. John Branch, the president of the CLCWA's board of directors, in March 2021. This technical note summarizes the information he provided during the web call, through his comments on draft versions, with additional background research.

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BIBLIOGRAPHY

- “Amendment V.” 1791. *United States Constitution*. <https://constitution.congress.gov/constitution/amendment-5/>.
- Avery, Robert. 2020. “Exploration Green Gets \$750,000 Grant.” *Houston Chronicle*, September 14, 2020. <https://www.chron.com/neighborhood/bayarea/news/article/Exploration-Green-gets-750-000-grant-15565452.php>.
- [CLCWA?] (Clear Lake City Water Authority). 2013. *CLCWA Detention Facilities and Associated Open Space and Park Plan*. [Houston, TX?]: [Clear Lake City Water Authority?]. <https://www.clcwa.org/wp-content/uploads/CLCWAMasterplanWebsite.pdf>.
- DeLapp, John. 2020. “Exploration Green Planting Sessions Promise to Be Fun and Muddy.” *Houston Chronicle*, November 9, 2020. <https://www.houstonchronicle.com/neighborhood/bayarea/news/article/Exploration-Green-planting-sessions-promise-to-be-15714101.php>.
- EGC (Exploration Green Conservancy). [2018?]. “Construction Progress.” <https://www.explorationgreen.org/construction-progress>.
- EGC. [2018?]. “Partner Organizations.” <https://www.explorationgreen.org/partners>.
- EGC. [2018?]. “Volunteering at Exploration Green.” <https://www.explorationgreen.org/individual-volunteering>.
- “Exploration Green Protected from Commercial Development Forever.” 2015. *Bay Area Houston Magazine*, January 5, 2015. <https://www.bayareahoustonmag.com/exploration-green-protected-commercial-development-forever/>.
- FEMA (Federal Emergency Management Agency). 2018. *Exploration Green! A Case Study in Effective Floodplain Management*. Austin, TX: Federal Emergency Management Agency–Hazard Mitigation, Texas Recovery Office. <https://agrilife.org/gift/files/2019/09/Exploration-Green.pdf>.
- Ferguson, Colleen. 2020. “Exploration Green Provides Nature Center in Practical Space.” *Community Impact Newspaper*, March 3, 2020. <https://communityimpact.com/houston/bay-area/development/2020/03/03/exploration-green-provides-nature-center-in-practical-space/>.
- Ferguson, Colleen. 2021. “Exploration Green Development Continues; Traffic Increases amid COVID-19.” *Community Impact Newspaper*, February 2, 2021. <https://communityimpact.com/houston/bay-area/development/2021/02/02/exploration-green-development-continues-traffic-increases-amid-covid-19/>.
- Kelo v. City of New London, Connecticut*. 2005. 545 U.S. 469. <https://www.supremecourt.gov/opinions/boundvolumes/545bv.pdf>.
- Kohl v. United States*. 1875. 91 U.S. 367. <https://tile.loc.gov/storage-services/service/ll/usrep/usrep091/usrep091367/usrep091367.pdf>

- Lamkahouan, Carissa. 2019. "Tonight's 'Glow' Event a Trick-Or-Treating Opportunity at Exploration Green." *Houston Chronicle*, October 25, 2019. <https://www.chron.com/neighborhood/bayarea/news/article/Tonight-s-Glow-event-a-trick-or-treating-14562651.php>.
- Orozco, Yvette. 2018. "Work to Resume at Golf-Course Turned Reservoir Exploration Green after Pond Construction Delay." *Houston Chronicle*, October 3, 2018. <https://www.chron.com/neighborhood/bayarea/news/article/Work-to-resume-soon-at-Exploration-Green-after-13279073.php>.
- Ozment, Suzanne, Kara DiFrancesco, Todd Gartner, and the International Water Association. 2015. *Natural Infrastructure in the Nexus*. Monographic series 1. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources. <https://doi.org/10.2305/IUCN.CH.2015.NEX.4.en>.
- Para, Jen. 2017. "Former Golf Course to Protect Thousands of Bay Area Homes from Flooding." *Houston Business Journal*, September 28, 2017. <https://www.bizjournals.com/houston/news/2017/09/28/formergolf-course-to-protect-thousands-of-bay-area.html>.
- Para, Jen. 2018. "Houston-Area Flood-Mitigation, Green Space Project Finishes First Phase." *Houston Business Journal*, April 20, 2018. <https://www.bizjournals.com/houston/news/2018/04/20/houston-area-flood-mitigation-green-space-project.html>.
- Roy, Dimple. 2018. "The Multiple Benefits of Natural Infrastructure." *Insights*. August 27, 2018. <https://www.iisd.org/articles/insight/multiple-benefits-natural-infrastructure#:~:text=Natural%20infrastructure%20can%20be%20considered,resilience%2C%20clean%20water%20and%20biodiversity>.
- Sharifi, Ayyoob. 2020. "Co-Benefits and Synergies between Urban Climate Change Mitigation and Adaptation Measures: A Literature Review." *Science of The Total Environment* 750 (January): 141642. <https://doi.org/10.1016/j.scitotenv.2020.141642>.
- Smith, Adam B. 2022 *Billion-Dollar Weather and Climate Disasters, 1980 - Present* (NCEI Accession 0209268). Data set. Asheville, NC: National Oceanic and Atmospheric Administration–National Centers for Environmental Information. <https://www.doi.org/10.25921/stkw-7w73>.
- TBN (Texan By Nature). 2020. "2020 Conservation Wrangler: Exploration Green Conservancy." <https://texanbynature.org/projects/exploration-green/>.
- TWCP (Texas Community Watershed Partners). [2017?]. "Welcome." <https://tcwp.tamu.edu/>.
- TMN (Texas Master Naturalist Program). "Home." Accessed June 19, 2021. <https://txmn.tamu.edu/>.
- TPWD (Texas Parks and Wildlife Department). 2018. "Texas Parks and Wildlife Commission Awards \$8.7 Million in Local Park Grants to Texas Communities." News Releases. March 22, 2018. <https://tpwd.texas.gov/newsmedia/releases/?req=20180322b>.

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APPENDIX A: ABOUT THE NATURAL INFRASTRUCTURE FINANCING CASE STUDY

SERIES: This research effort is a collaboration of the Engineering With Nature® (EWN®) and Systems Approach to Geomorphic Engineering (SAGE) initiatives, undertaken in response to an identified information gap about how to secure the funds necessary to scope, design, construct, monitor, and adaptively manage natural infrastructure.

The project development team identified initial case studies through team members' professional networks. Projects must include natural infrastructure features, have progressed at least partially through construction, and have a knowledgeable point of contact willing to communicate relevant details about the project and financing process. For the purpose of this effort, *natural infrastructure* is defined as an area or system that is naturally occurring, naturalized, or constructed to mimic naturally occurring features and then intentionally managed to enhance ecosystem value and provide social and economic benefits (DiFrancesco et al. 2015; Roy 2018). Examples include river floodplains, setback levees, forested water-supply watersheds, freshwater and coastal wetlands, living shorelines, dune and beach systems, living breakwaters, and reefs. Natural infrastructures are dynamic, with landscape-level interactions occurring among different features as well as in tandem with conventional infrastructure (Sharifi 2020).

For each case study, a semistructured interview of the project's point of contact was conducted to obtain pertinent information about the project, with emphasis on the process for securing funding for each stage. The project team developed a questionnaire to elicit information about a project's time line, funding sources and how they were obtained, and the barriers and enablers of successful financing. The standardized questionnaire will help facilitate consistent collection of pertinent information and potentially independent authorship of case studies for inclusion in the evidence base for natural infrastructure.

The library of case studies will increase as additional projects are identified by the EWN-SAGE team or are nominated by the network surrounding the project or by natural infrastructure practitioners themselves. Practitioners can nominate projects by contacting the project leads, Bari Greenfeld (bari.n.greenfeld@usace.army.mil) and Margaret Kurth (margaret.h.kurth@usace.army.mil). The project intends to showcase a diversity of project types and funding and financing mechanisms.

EWN is developing the science and practice of intentionally aligning natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative processes. EWN is led by the US Army Engineer Research and Development Center, or ERDC, and brings together a growing international community of practitioners, scientists, engineers, and researchers from a wide range of disciplines to understand how best to harness the power of nature to innovate, solve problems, and create sustainable solutions. More information can be found at www.engineeringwithnature.org.



The SAGE community of practice advances coastal community, ecosystem, and shoreline resilience by promoting a spectrum of green (natural and nature-based) and gray (structural) techniques. Organizations across many different sectors are investing in the research, development, and implementation of natural infrastructure solutions. The SAGE community of practice improves coordination among these entities and provides a forum to share information and collaborate on innovative projects. Through SAGE, the Institute for Water Resources, or IWR, engages with a diverse suite of multidisciplinary partners, including federal and state agencies, nongovernmental organizations, academic institutions, and the private sector. More information can be found at www.sagecoast.org.

