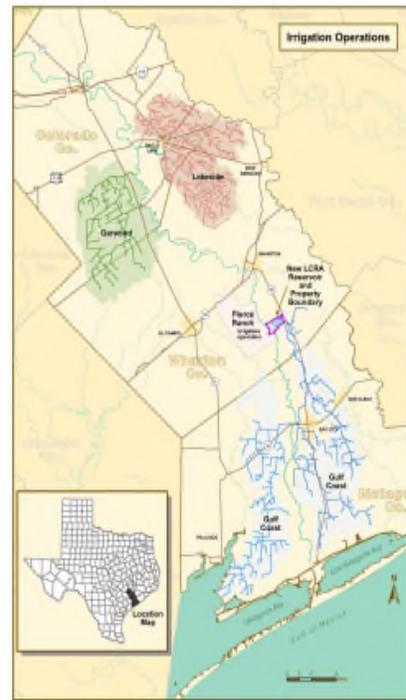


**RE: Response to Proposal From Non-Federal Interests for Proposed Feasibility Studies and Proposed Modifications to Authorized Water Resources Development Projects for Feasibility Studies for Inclusion in the U.S. Army Corps of Engineers (USACE) Annual Report – Feasibility Study for Brackish Groundwater Augmentation for the Mouth of the Colorado Project.**

1. **Non-Federal Interest:** Lower Colorado River Authority, P.O. Box 220, Austin, TX, 78767-0220. Attention John Hofmann, [john.hofmann@lcra.org](mailto:john.hofmann@lcra.org). (512) 473-3200 or (800) 776-5812 ext. 7083.
2. **Feasibility Study for Brackish Groundwater Augmentation for the Mouth of the Colorado Project, Matagorda County, Texas.**
3. **Project Purpose.** LCRA is a steward of the Colorado River and the Highland Lakes. It provides clean water for more than a million people, and businesses, industries and the environment in the lower Colorado River basin including Matagorda Bay. Like most Texas estuaries, freshwater inflows to Matagorda Bay are highly variable in proportion to the extremes of the harsh regional climate. Native species have adapted to survive and even flourish in this environment. For example, the oyster responds to stressed environmental conditions, by increasing the release of juvenile spat to improve the odds of survival.

Historically the bay has been stressed both by extreme flooding events and extended wet periods which have driven salinity down to near freshwater levels. However, tidal influences and sea water intrusion eventually return the bay to a varied saline environment. Similarly, extended dry periods, such as occurred during the 1950's drought and more recently the ongoing drought since 2008 to present, have also stressed the bay.

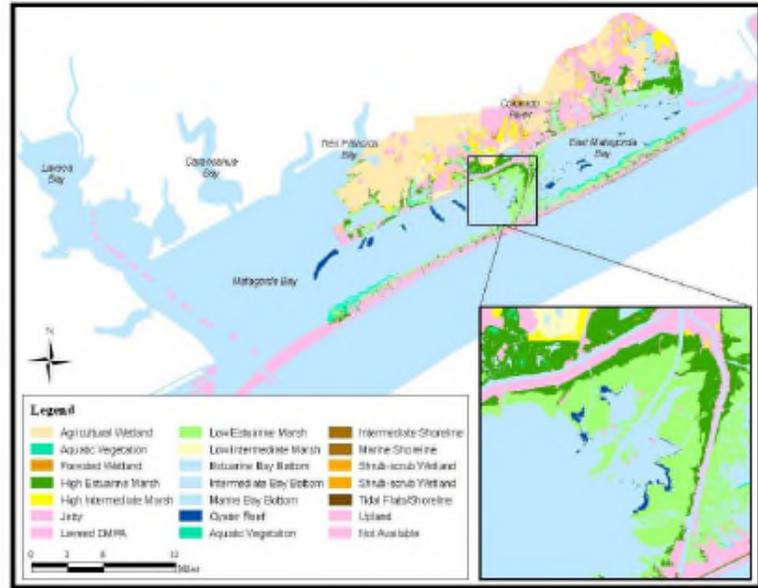


**Figure 1  
Lower Colorado River and  
Matagorda Bay**

The Lower Colorado River has been experiencing extreme drought since 2008. As a result LCRA cut off Highland Lakes water to most downstream interruptible water customers in 2012, 2013 and 2014. LCRA is also required to release some water from the lakes to meet the critical environmental needs of the river and Matagorda Bay during the drought. During the ongoing drought, high heat, low precipitation, and record evaporation have occurred. Portions of the bay reached hyper-saline (> 32 parts per thousand - ppt) conditions that summer.

Freshwater flow needs to the bay can be met by Lavaca and Colorado River flows in addition to coastal basin run-off. However the Eastern Arm is freshened almost exclusively by the Colorado River. Texas Parks and Wildlife has designated and posted the most eastern half of the Eastern Arm of Matagorda bay, shown in Figure 2, as a marine life nursery. Commercial

fishing in this part of the bay has been prohibited under penalty of fine. Additionally, the Colorado Diversion delivers freshwater flows from the Colorado Basin directly into this region of the bay. LCRA maintains a monitoring station named West Tripod in this region. From this sanctuary the finfish and shellfish species, particularly oysters, can recover from low inflows and high salinity conditions to repopulate the Matagorda Bay when normal weather conditions return.



**Figure 2. Matagorda Bay Habitat.**

The geomorphology of the Colorado River delta was significantly altered by construction of the Mouth of the Colorado River Project (diversion project) by the U.S. Army Corps of Engineers. The diversion was completed in 1991 but required major maintenance in 1992 due to flooding damage. The period of 1991 to 1992 was therefore a transitional period. This project largely diverted the flow of the Colorado River into the Eastern Arm of Matagorda Bay by an artificial cut, called the Diversion Channel, in the river delta as shown in Figure 1. The old river channel was dammed to prevent a direct outlet of the Colorado River into the Gulf of Mexico. Additionally, Tiger Island Cut (also called Parker's cut), a water exchange pass in the delta between the Gulf and Matagorda Bay, was artificially closed to prevent intrusion of sea water from the Gulf of Mexico directly into the Eastern arm of Matagorda Bay.

Historically, stored water in the distant Highland Lakes has been vital for providing more reliable water for rice farming in the Coastal Bend region and helps support the environmental benefits provided by Matagorda Bay. When other freshwater flows are not available to help meet these needs, LCRA often releases stored water from the Highland Lakes, which is located 300 river miles upstream of the coast. The distance results in one to two weeks of delivery time to Matagorda Bay and causes river transport losses of 10 to 15 percent, or more in extreme drought conditions.

Brackish groundwater augmentation to Matagorda Bay would consist of drilling wells in the brackish zone of the Gulf Coast Aquifer and pumping the water into the lower reaches of the Colorado River or directly into nursery areas of Matagorda Bay. The groundwater has the potential to offset needed releases from surface water supplies that could otherwise be used for industry, municipalities, and agriculture. It also provides a more drought proof supply for the Bay than surface water supplies. The salinity of the brackish water is less than 5 ppt which is significantly less than the typical bay salinity thus providing a valuable dilution in salt concentration. Approximately 12 to 32 wells could be constructed to provide 24,000 to

64,000 gallons per minute (gpm) of groundwater to meet these environmental needs. This initial feasibility will result in a proof of concept for coastal health management. To achieve this goal, the following general process will be applied:

- a) Perform field reconnaissance to collect detailed water quality data and map the Colorado River Delta. Estimated cost = \$25,000
- b) Modeling would estimate effects of brackish water augmentation at proposed delivery locations. Estimated cost = \$15,000
- c) Identify most ecologically beneficial sites the delta for direct augmentation with brackish water. Estimated cost = \$5,000
- d) Identify sites with suitable subsurface and access to support groundwater well development. Estimated cost = \$20,000
- e) Select three sites for demonstration studies which have suitable access for drilling and operation, and are likely to provide positive ecological benefits. Estimated cost = \$10,000
- f) Design demonstration studies. Estimated cost = \$10,000
- g) Drill and operate three test wells. Wells are stainless steel construction and would be designed to operate as production wells in the complete project. Total cost includes drilling monitor wells, obtaining temporary permits, generators & fuel, manpower. Estimated cost = \$9,500,000.
- h) Conduct demonstration study. Estimated cost = \$150,000
- i) Evaluate demonstration study costs and benefits for consideration of more wide scale application. Estimated cost = \$15,000

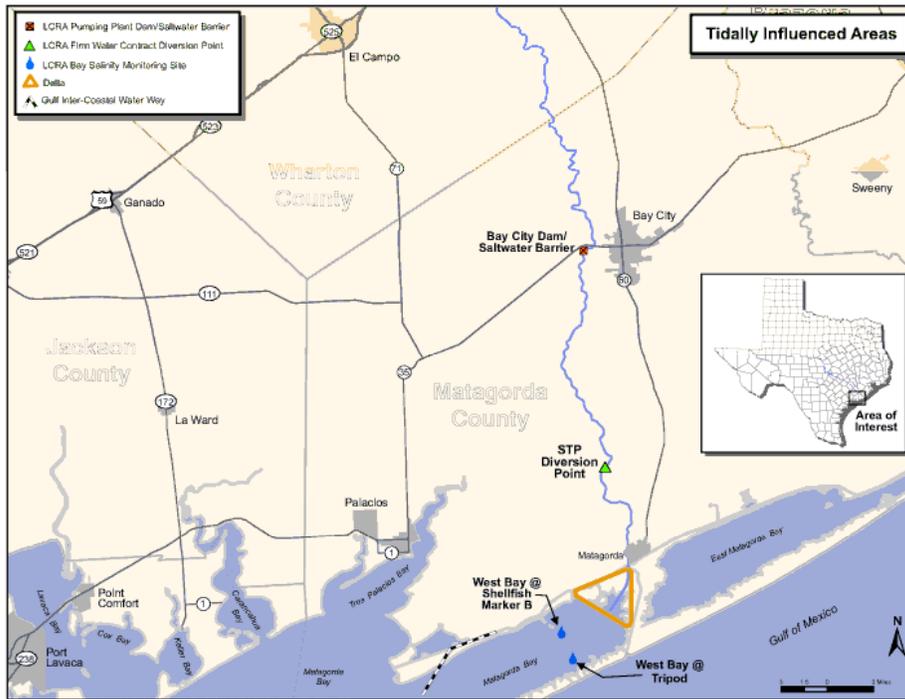
Feasibility Study Total Cost = \$9,750,000

If feasibility studies demonstrate that full implementation is beneficial, the complete project could involve:

- a) Brackish wellfield located within the Matagorda Bay Delta, delivers 1-3 ppt groundwater to the Delta using 12 wells at depths up to 1,200 feet (ft). Replaces releases from Highland Lakes storage.
- b) Peak rate 3,150 ac-ft/mo potentially feasible with the wellfield shown, depending on results from recommended future subsidence study.
- c) Equivalence of brackish water to achieve the same effect as a volume of released stored water is a function of the brackish & river Total Dissolved Solids (TDS) values, the effectiveness of delivery directly to the lower marsh as opposed to delivery through the channel, and the amount of released water that reaches the bay. It is possible that a given volume of brackish water delivered to the right location may be more effective than the same volume of water released from storage.
- d) Assumptions
  - a. Well spacing of at least 2,000 ft. assumed
  - b. Without a site visit, it is assumed that the higher elevations in the marsh will allow mobilization of construction equipment without having to construct access channels

4. Initial feasibility project construction is anticipated to cost about \$9,750,000. Full project construction is anticipated to cost about \$36,800,000 (approximately \$27,300,000 in addition to the feasibility study cost) and would require four years to complete.
5. Anticipated Benefits. Brackish water has the potential to help marshland and marine-life habitats in and around Matagorda Bay. Matagorda Bay provides a nursery and feeding area for many species of finfish, shrimp, shellfish and shorebirds. Forty-seven species have been identified in the bay including brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), blue crab (*Callinectes sapidus*), Gulf menhaden (*Brevoortia patronus*), Atlantic croaker (*Micropogonias undulatus*), spotted seatrout (*Cynoscion nebulosus*) red drum (*Sciaenops ocellatus*), and Eastern oyster (*Crassostrea virginica*).

Matagorda Bay is comprised of open bay, wetlands and marsh habitats covering approximately 200 acres. The mainland interior marshes are generally located within local drainage basins which drain the surrounding rangeland and rice fields. The hydrology of these watersheds is affected by the use of the surrounding lands. In the case of the rice fields, irrigation and rice growing practices, such as the timing and frequency of inundation and



draining of rice fields, impact the wetlands within their watersheds. Salinity in the Matagorda Bay system can range from near zero ppt after a major flooding event to near 50 ppt in the open bay during severe drought conditions with high temperatures and evaporation rates. While freshwater inflows to the entire bay

**Figure 3. The Delta Region of Matagorda Bay**

complex are quite large in comparison to the project, opportunity exists for freshwater supplementation during droughts to create a refuge in the Colorado River Delta to maintain tolerable oyster reef health, benthic character, and habitat conditions of 27 to 29 ppt.

Bays and estuaries are critically important to the well-being of most marine shellfish and finfish species on the Texas coast and are vital to the state's commercial and sport fishing industry. Between 75 to 80 percent of the fishery species in the Gulf of Mexico are dependent upon estuaries during some portion of their life cycle. Many species are not permanent residents of the estuaries but migrate to them during different times of their lives.

These migrations occur seasonally and are usually related to spawning cycles. Larval and juvenile organisms move from the ocean into estuarine marsh lands to find food and to seek the protection of lower salinity water. The young of many fishery species can tolerate lower salinity than their predators and parasites. When they mature to young adults, the individuals migrate back to the Gulf.

The life cycles of estuarine-dependent species require differing seasonal migratory patterns. Redfish, for example, spawn in the fall, and the young migrate into estuarine marshes shortly afterward to feed and grow. Estuaries are the permanent homes for many indigenous species that do not migrate. The most well-known of these is the oyster. The juveniles anchor upon natural reefs or other solid objects and remain in the same spot through their adult lives. This lack of mobility makes the oyster particularly susceptible to changes in water conditions. Oysters cannot tolerate freshwater (i.e. less than 5 ppt salinity) for more than a few days. On the other extreme, very salty water (i.e. over 25 ppt) for a prolonged period of time combined with high temperatures allows parasites (*Perkinsus marinus*) and oyster drills (*Thais haemostoma*) to attack the oysters, often destroying entire oyster reefs.

Many complicated interactions govern the biological productivity of Texas bays and estuaries other than the quantity of freshwater inflows. However, freshwater inflows and their associated nutrients and sediments are recognized by most estuarine biologists as one of the primary factors in estuarine productivity. Studies have demonstrated that these contributions from the freshwater inflows allow economically important fish and shellfish species to survive, grow and reproduce abundantly (LCRA, 1997). Researchers have also discovered that periodic river floods inundate delta marshes, transport nutrients and other organic materials (food sources), and remove or limit many pollutants, parasites, bacteria and viruses harmful to estuarine-dependent organisms (LCRA, 1997). However, too much freshwater can stress or even severely damage these living coastal systems if their environment loses its marine character.

At approximately 350 square miles, the Matagorda Bay system is the second largest of Texas' seven major bay systems (Galveston Bay is the largest; other significant bay systems include Sabine Lake, San Antonio Bay, Aransas/Copano Bay, Corpus Christi, Nueces Bay and Upper and Lower Laguna Madre). This system is also known as the Lavaca-Colorado estuary, and its largest single body of water is Matagorda Bay. Major secondary bays in the estuary include Lavaca, East Matagorda, Keller, Carancahua, and Tres Palacios. The current health and productivity of Matagorda Bay is good, according to TPWD studies and observations. The bay, with its estuaries nourished by freshwater inflows from the Lavaca and Colorado rivers as well as numerous, smaller streams and creeks, has been described as a "mother dynamo of sea life production." (Jim Anderson, "The Ocean's Nursery," TPWD, *The Outdoor Magazine of Texas*, July 2002)

The abundant production of finfish and shellfish make this environmentally sensitive area important not only as an ecological resource, but also as a source of economically significant commercial and sports fisheries (Loeffler and Balboa, "Colorado Quandary," TPWD, *The Outdoor Magazine of Texas*, July 2003). Palacios calls itself "The Shrimp Capital of Texas," and is the home port to more than 400 shrimp trawlers. The Gulf of Mexico produces more

than 40 percent of the total U.S. seafood harvest, and commercial boats based around Matagorda Bay bring in a major portion of the bounty, generating about \$63 million annually. *Id.* The booming sportfishing industry on the bay generates \$115 million annually. *Id.* “It’s a healthy, diverse system now,” according to Bill Balboa, who is Sea Grant’s Marine Extension Service agent for Matagorda County. “The menhaden [a key forage fish] are thriving, shellfish surveys are up and new wetlands have formed.” *Id.*

The economic importance of estuaries is shown in the value of estuary-dependent fish and shellfish. Commercial fishermen in Texas landed an estimated 95.2 million pounds of fish, shrimp, crabs and oysters in 1999. Shrimp are the most valuable resource along the Texas coast, accounting for 81 percent of the harvest and 88 percent of the dockside value in 1999 (Auil-Marshalleck et al., 2001). The dockside value of the shrimp catch was worth an estimated \$219 million (in 1999 dollars). The economic impact of the industry is estimated at \$330 million annually, which supports 30,000 full-time jobs (Texas Center for Policy Study, 2002).

Matagorda Bay has an important role in commercial fishing among Texas bays, especially with regard to shrimp. Commercial shrimpers in the Matagorda Bay system landed one-fourth of the total shrimp catch from all Texas bays, representing 27 percent of the dockside value, on average, from 1995 to 1999. Commercial crab landings from the Matagorda Bay system accounted for about 15 percent of the statewide catch and value. Gulf landings from ports located in the Matagorda system are important to the local and state economies. Palacios and Port Lavaca have gained major port status with the National Marine Fisheries Service. Major port status is assigned to a port with more than 5 million pounds of seafood landings per year. Palacios, in particular, has consistently been classified as a major port and ranked second among Texas ports for shrimp landings in 2000.

Texas A&M University modeled economic output for several Texas bays in 1995. The A&M study estimated that the statewide impact from commercial fishing (Gulf and bay) for the Matagorda system was 1,847 jobs and \$71.86 million in total output (Tanyeri-Abur et al., 1998). Increases in landings and value data indicate that this impact has grown over time. For example, Palacios landings recorded 6 million pounds of seafood worth \$21 million in 1995; by 2002 that number increased to 15 million pounds worth nearly \$31 million. Estuaries also provide important recreational benefits. The Texas coast provides abundant opportunities for fishing, wildlife and bird watching and other nature recreation. Marsh wetlands surrounding the estuaries are vital habitat for migrating waterfowl. The U. S. Fish and Wildlife Service estimated that expenditures for wildlife-related activities in Texas were \$5.4 billion in 2001 (Underwood, 2003). Fishing and other nature tourism are dependent on healthy estuaries with adequate freshwater inflow.

6. **Local Support:** LCRA is the local sponsor.
7. **LCRA Financial Ability.** The Lower Colorado River Authority provides a multitude of vital services to Texans. Whether it's contributing reliable power to the Electric Reliability Council of Texas market, making sure that power is delivered through our more than 5,150

miles of transmission lines, or working to increase and preserve the water supply for more than a million people, LCRA's goal is to provide excellent service day in and day out.

LCRA, established by the Texas legislature in 1934, is a unique, nonprofit political subdivision of the state. LCRA receives no state tax revenues, but operates by selling electricity, electric transmission and water services at cost. It does not levy taxes or receive specific appropriations from the government. As a conservation and reclamation district of the state of Texas, it is generally exempt from paying taxes, though its affiliates, LCRA Transmission Services Corporation and GenTex Power Corporation, pay property and sales taxes.

LCRA water responsibilities include dam operations, river and water supply management, and irrigation operations. Water-related revenues in 2013 and 2014 were \$32 million per year. Water revenues are from firm and interruptible raw water sales, and domestic use contracts. Water and wastewater utilities also contributed to water revenues a minimal amount in those years, although LCRA now has sold most of its water and wastewater utilities. Water-related expenses and debt service, not including depreciation, interest payments or corporate support, were \$25 million in 2013 and \$23 million in 2014.