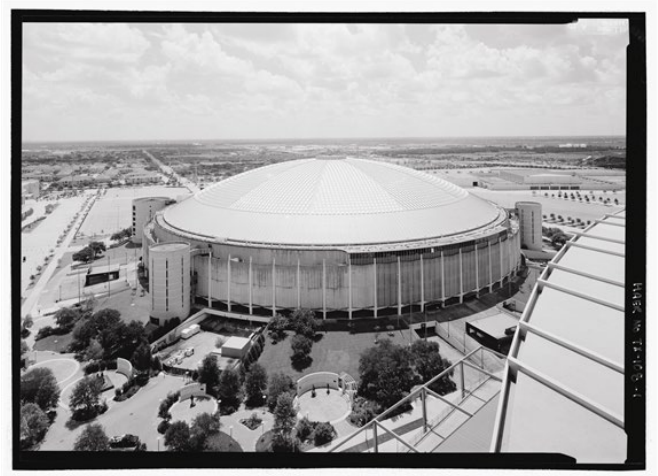
Harris County Domed Stadium (Astrodome)

1966 OCEA

The Harris County Domed Stadium (Astrodome) was the original large domed multi-sport arena. Capable of seating 42,217 for baseball and 50,000 for football at its opening in 1965, it became an instant must-see attraction. In fact, it became America's third most visited man-made tourist attraction (after Mt. Rushmore and the Golden Gate Bridge) and forever changed the way sports were experienced in the stadium and on the television. The stadium featured a retractable seat configuration and round design which allowed for multiple uses. It also featured a 710 ft. (outside diameter) lamella structures domed ceiling, equipped with lighting sufficient for color television coverage - another first.

The Astrodome was conceived by Judge Roy Hofheinz, who purchased the land it sits on, secured public funding for the project, and convinced the Texas Highway Department to build Loop 610 ahead of schedule for better access. Hofheinz named the stadium for his baseball team, the Astros, to honor the Manned Space Center that had opened in Houston two years earlier. The Astrodome was the first of its kind, including the first stadium to use an electronic scoreboard and luxury boxes. Modifications to minimize glare, making the stadium suitable for color television broadcasting, led to the invention of the artificial grass known as Astroturf - providing a grass field where there was not enough light for grass to grow. The Astrodome was the first innovative feat of civil engineering to receive the Texas Section Outstanding Civil Engineering Achievement (OCEA) Award.

Owner: Harris County, Texas
Engineers: Richard Pharr Doss (Harris County Engineer)
Walter P. Moore Associates, Houston (Structural)
I.A. Naman & Associates (Mechanical)
Architects: Hermon Lloyd & W.B. Morgan
Wilson, Morris, Crain & Anderson
Contractor: H.A. Lott Construction
Photo: Houston Astrodome; 8400 Kirby Drive; Houston; Harris County; TX.; Library of Congress



LBJ Freeway (IH-635), 1971 OCEA

The LBJ Freeway (IH-635) begins at I-20 (southeast Dallas), travels northward towards US80 and I-30, and then turns northwest near the border between Dallas and Garland. The road continues west at the Dallas North Tollway intersection and its origin, I-35E (Farmers Branch). It then veers to the northwest before arriving at its final terminus at the north entrance of DFW. The freeway was originally designated as a loop around east Dallas in 1959.

The first section of the LBJ Freeway that opened to motorists was from US 75 (North Central Expressway) westward to I-35E. However, the I-635 designation was subverted by the rerouting of I-20 south of Dallas to Terrell; the designation was removed from I-35E to its intersection with I-20. The additional westward expansion to the north entrance of DFW airport opened in the 1980s. In 2005, the completion of the Dallas High Five interchange (with US 75) also brought improvements such as the two added high-occupancy vehicle lanes, continuous frontage roads, and new left turn and U-turn lanes improve overall ease of use.

Photo Credit: Bob Smith, Photographer Environmental Protection Agency



Dallas-Fort Worth Regional Airport, 1975 OCEA

Dallas/Fort Worth Regional Airport (renamed "International" in 1985) had its first arrival, American Airlines Flight 341, on January 13, 1974. Political jockeying for location had been ongoing between the two cities since the 1930s with respect to a combined Dallas/Fort Worth airport. At one point, both cities were tenaciously competing for air traffic, each with their own airports (i.e. Greater Southwest International Airport and Dallas Love Field), only 17 miles apart. Finally, the Civil Aeronautics Board ordered the two cities to agree on a site or have one chosen for them unilaterally; ground was broken on the Dallas/Fort Worth Regional Airport in 1968, bordering the cities of Euless, Grapevine, and Irving.

The design for the airport specified 13 terminal buildings, a nine-mile parkway, 234 boarding gates, and up to 11 runways covering 27 square miles. Terminals were connected with the first automated transit system in the world, Airtrans, which could move 9,000 people and 6,000 bags per hour. Upon opening, DFW also featured a first-of-its-kind air traffic control tower, rising 232 feet, with a bank of equipment for visual and radar displays. Construction of the facility began in 1969 and was completed in 1973 at a total cost of $700 million.

Owner: the Cities of Dallas and Fort Worth jointly
Engineer:
Architect: Gyo Obata
Photo: Public Domain, FRED on wikimedia.org



McAllister Freeway, 1980 OCEA

The McAllister Freeway (North Expressway during development) is noteworthy for its rather long and controversial history. It is recognized as "Outstanding" for the resourcefulness with which its engineers met the many design challenges faced - providing a much-needed route while protecting and enhancing the neighborhoods, universities, parks, and precious natural features of San Antonio. All of those involved in seeing the project to completion are to be commended for their perseverance and fortitude in the face of many legal challenges and funding issues – rising to the occasion with extensive study, analysis, and an aesthetically pleasing design that incorporates multiple stakeholder input.

The need for a freeway to serve the rapidly expanding north-central part of the city was recognized in the mid-fifties, and a bond issue passed in 1961. However, opposition arose against the selected route, which would pass through the Olmos Creek Flood Basin and the City of Olmos Park, between the Sunken Garden Theater and the Alamo Stadium. The opposition included a 1967 filing of lawsuits against the City, State, and Federal Department of Transportation. Although the legal situation caused delays, bids were received on the sections not under contention and construction began. In response to concerns with the route as well as public insistence that it must be completed, changes were made to the original route and design e.g. the addition of a sound attenuation wall along the edge of Olmos Park and a change in route between the Sunken Gardens and Alamo Stadium. However, legal opposition caused delays in approval from the Federal Highway Administration to the extent that TxDOT agreed to fund it solely. Thus, a portion of the road is designated US Highway 281 and is not considered part of IH37. When the freeway finally opened, more than twenty years later in 1980, it was named one of the three "most attractive urban freeways" by the American Association of Highway and Transportation Officers and has facilitated the increasing development of north-central San Antonio (Average Daily Traffic is over 100,000).

Owner:	Texas Highway Department (Now TxDOT)
Engineer:	District Engineer, F.M. Davis
Contractors:	Killian-House Company
	H.B. Zachry Co.

Olmos Dam Modifications, 1982 OCEA

Considering a rapid increase in development in the Olmos Basin Area and vulnerability of the region to heavy rainfall, concern grew that the basin could overtop the dam. In fact, a study was conducted in 1973 which indicated that flood routings produced by severe storms would in fact overtop the dam, that the structure would be overstressed, and that it could fail. The modifications that followed included: post-tension cables that extended down through the dam and anchored into the solid limestone strata below, modification and/or replacement of the control gates, construction of a new control house, and relocation of the two-lane roadway from its original location across the top of the dam to a new location below the dam. Prestressing of the east and west non-overflow segments used a hard limestone layer (7-10 ft thick) 50 feet below the base of the dam as anchorage. Reconstruction of the roadway also included two bridges – one over the outlet channel and one to connect the new roadway to the remaining existing street, and replacement of the roadway on the west end with an ogee spillway.

One innovative method utilized during construction included the use of explosives to remove the upper portions of the dam, clearing the way for construction of the spillway crest. This type of demolition – partial removal of increments of an existing dam using explosives - had never been attempted before its use on the Olmos Dam Modifications. Engineers got the idea from pre-splitting techniques used in quarrying. This method saved considerable time and money and produced less shock to the structure than would have been inflicted by a hydraulic ram. The completion of the project in 1982 marked a great moment of relief for the community from the growing anxiety of an impending dam failure. Construction management and coordination of engineering was handled by the San Antonio River Authority (SARA), which recorded total cost of the project at $8,661,483.90.

Owner:	City of San Antonio
Project Manager:	San Antonio River Authority (SARA)
Engineer:	JV of W. E. Simpson Co. and Hensley-Schmidt Inc.
Contractor:	Clearwater Constructors Inc.
Photo:	©2014 ASCE, Texas Section



The Bullwinkle Project, 1989 OCEA

Upon installation, the Bullwinkle production platform was the world's tallest pile-supported platform, and tallest offshore platform for petroleum extraction in the world - with a base of 408ft by 487 ft, and height of 1,615 ft, weighing more than 75,000 tons. The Bullwinkle's structural design requirements included support of two drilling rigs during hurricane-produced wind and waves while maintaining a stable, functional, and livable site for its crew. Bullwinkle's jacket, made up of more than 40,000 tons of tubular steel, represents more than half of the structure's weight. During fabrication, sections of the jacket were built vertically, then turned horizontally and connected to the larger structure which was assembled lying on its side. This technique reduced the need for (and expense of) vertical lift in fabrication of the complete structure. Throughout the process, each movement was given its own separate structural analysis.

The complete structure was towed from Ingleside, Texas to its placement in the Gulf of Mexico (160 miles southwest of New Orleans, Louisiana) using what was, at the time, the largest barge ever built. The process of fabricating and towing the Bullwinkle in a single piece was not only a remarkable, never-before-achieved feat, but it eliminated the need for underwater welders to assemble structural pieces on-site and reduced installation costs. As a whole, the design, fabrication, and installation of the Bullwinkle were accomplished on a budget of $250 million. In recognition of the extraordinary complexity and magnitude of this project, it won the Texas Section OCEA Award in 1989, and also the ASCE National OCEA in the same year. The award plaque is on display at the One Shell Building Museum in Houston.

Owner:	Shell Offshore Inc.
Engineer:	Shell Oil Co.-Houston, Civil Engineering Group
Contractor:	Heerema Marine Contractors (installation), working as a subcontractor to Bullwinkle Constructors (fabrication), a subsidiary of Gulf Marine Fabricators, at Ingleside, TX.

Alamodome, San Antonio, 1993 OCEA

The success of the Alamodome is owed to its innovative and flexible design - maximizing usable square footage and accommodating mixed uses with the capability of accommodating over forty different types of events. The Alamodome features a 9-acre roof, which can be expanded or contracted independent of the concrete structure below and the largest retractable seating unit in the world – seating 72,000 people for large concerts and reconfiguring to 32,000 for basketball or hockey. It was also the first building in North America with two permanent ice rinks and the only domed stadium to have permanent ice sheets as part of its design.

The structural economy of the Alamodome is remarkable - a particularly valuable attribute for a stadium built during an economic downturn. Structural engineers were able to allow for the enormous flat roof expanses by supporting the roof structure with cable stays at each corner and utilizing two sets of tie-back cables for each column to transfer the load to the ground. This was an innovative technique which had never before been used in stadium design. Further contributing to structural economy of the building, a wind tunnel study provided support for the unusual design of the 378' long bowstring trusses, which use bridge cables for the bottom chord. The stadium is also remarkable for having been built on such a narrow site. In addition to contributing to the complexity of design consideration, the site is located between an expressway and a railroad, so it called for traffic engineering studies which helped to ensure the success of moving large crowds to and from events; the space constraints of the site also called for additional parking considerations such as shuttle and pedestrian walkway access.

Owner: City of San Antonio
Engineer: W.E. Simpson Company Inc (Structural and Civil)
Architect: HOK Sports Facilities Group
Contractor: Marmon Mok
Photo: Stanley J. Sarman, ©2013 ASCE, Texas Section



Auger Tension Leg Platform, Gulf of Mexico, Houston, 1994 OCEA

The Deepest Oil and Gas Production Platform in the World

The Auger Tension Leg Platform (TLP) was, when completed, the deepest offshore production facility in the world and only the fourth TLP ever built and installed. The project required development of new technology (resulting in 8 new patents) and stretched existing technology to its limits to construct an oil and gas drilling and production facility that stands in 2,860 feet of water. Upon construction, the Auger TLP was the tallest man-made structure in the world, measuring 3,280 feet. Two of the largest tug boats in the world were used with tandem submersible barges to transfer the hull from land skidways to its floating configuration.

Development of the $1.2-billion project included fabrication, installation, facilities, pipelines, development drilling, and incorporated contributions from over 900 separate vendors worldwide. Domestically, over 3,000 people worked on the project. Approximately 80% of the $1.2 billion cost of the project was incorporated into the US economy. Oil and gas produced by Auger will continue to have a positive benefit on the United States over its life, reducing dependency on foreign oil and improving the balance of trade. Total economic benefit of the project is in the order of $4 billion dollars. Multi-disciplinary collaboration over a six-year design, fabrication, and installation period, marked by innovative engineering and project management developments, reduced costs from the budget for this project and were made available to enable engineers to benefit future deep water projects.

Photo: Shell Oil Corp.



Santa Fe Alliance Intermodal Transportation Center, 1994 OCEA

The Santa Fe Alliance Intermodal Transportation Center, located 20 miles north of Fort Worth, was a groundbreaking project representing excellence in integrated industrial transportation and collaboration between private and public stakeholders. Construction of the new intermodal transportation hub consisted of three major components, including relocation of the main line of the Santa Fe Railway and construction of the Intermodal Facility (IMF) and the Consolidated Transportation Center (CTC).

The design of the project includes an innovative fuel accounting system that keeps a computer file register detailing how much diesel fuel goes into each locomotive and tracks how much goes into the day-service tank from the storage tank. It also includes fully-automated switching and closed-circuit television security. Engineers paid careful attention to aesthetics (a consideration which is not typically paramount for railroad facilities) in order to integrate the design of the IMF and the CTC with the unique and sophisticated design of the nearby Alliance development and airport. The Santa Fe Railway Intermodal Hub and Rail Complex has become a great asset to the cities of Dallas and Fort Worth, working together with Alliance Airport and Dallas Area Rapid Transport (DART) to dramatically expand multimodal transportation - promoting economic development through stronger trade ties with Canada and Mexico.

Owner: Santa Fe Railway
Engineer: Carter Burgess, Inc.
Contractor: Ragnar Benson, Inc.
Developer: Alliance Development Company

Fred Hartman Bridge, 1995 OCEA

The Fred Hartman Bridge design process was dominated by wind considerations, but for many, its unique double-diamond shaped towers leave the most lasting impression. Located east of Houston over the Houston Ship channel, the iconic Fred Hartman Bridge was built to replace the Baytown Tunnel and to improve capacity and traffic flow as the primary connection between the refineries of Baytown and LaPorte. The high winds experienced in the area became the primary concern of engineers, especially since the Fred Hartman is part of a main route for hurricane evacuations. The double-diamond tower configuration, while aesthetically pleasing, also serves to create "truss-action" that supports greater lateral stiffness for resistance against hurricane-force winds. The design also includes further support through inward-sloping cable planes which connect the upper tower legs with the deck to torsionally resist unbalanced dynamic loadings. The bridge supports two 78 ft wide decks, allowing for eight lanes of traffic with shoulders, and runs 10,475 feet in length.

The Fred Hartman Bridge was constructed at a cost of $91.3 million dollars, which was, at the time, the largest contract ever awarded for a single highway project in Texas. A joint venture between Williams and Traylor brothers, formed in 1986, completed the project in 1995, having overcome multiple obstacles including the bankruptcy of its steel supplier and complications in work processes. The anchor zones at the top of the towers, for example, were too complicated for steel panels and required carpenters to prefabricate wooden forms complete with rebar cages and technicians to calculate the weight of every rebar and piece of wood to ensure the crane could handle lifting these pieces to the top of the 60 ft towers. However, after all of the effort and money expended, those involved in its creation and those who admire it consider the Fred Hartman Bridge to be a tremendous success.

Owner:	Texas Department of Transportation (TxDOT)
Engineer:	Steve E. Simmons PE, Deputy District Engineer, TxDOT
Contractor:	JV of Williams and Traylor Brothers
Photo:	PA2 James Dillard, United States Coast Guard,



O.H. Ivie Water Supply System, 1996 OCEA

The O.H. Ivie Water Supply System consists of several structures and facilities in West Texas along the Colorado and Concho Rivers including the W.W. Freese Dam, the O.H. Ivie Reservoir, a 156-mile transmission line (pipeline), seven pump stations with a total static lift of 1,376 ft., a 100-million gallon terminal storage reservoir, a supervisory control center, seven electrical substations, and 30 miles of electric transmission lines. One of the challenges faced by project engineers - a zone of alternating limestone and shale in the spillway foundation - presented concerns about the size of the spillway training walls. However, resourceful engineers were able to solve this problem by designing a seepage gallery through the troublesome zone, allowing the problem rock to remain mostly in place and eliminating the expensive prospect of removing these strata or further altering the foundation.

Construction of the O.H Ivie Water Supply System was achieved with an estimated $5 million in savings to the Colorado River Municipal Water District (CRMWD), owing to very competitive bids, which resulted from a bid package that allowed contractors to bid on either concrete cylinder pipe or steel pipe or both, and gave the CRMWD the option to select the optimal combination - awarding contracts to one, two, or three contractors. Additionally, the use of heavy-duty trenching machines (which were specifically designed for the job of excavating the pipeline trench), special vibratory sieves for processing backfill, and a modified wide-track backhoe with twin compacting wheels (to compact the backfill) created significant gains in the cost-efficiency and progress of the project. The entire pipeline, which consists of 156 miles of 60-inch and 53-inch pipe, was installed in 28 months at a cost of $76 million. This project was a monumental undertaking and its completion ensures West Texas and its growing population will continue to be able to develop economically with the provision of a reliable water supply.

Owner:	Colorado River Municipal Water District (CRMWD)
Engineer:	Freese and Nichols
Photo:	Freese and Nichols



Sonny Carter Neutral Bouyancy Laboratory

1997 OCEA

The Sonny Carter Neutral Buoyancy Laboratory was built to facilitate training of NASA astronauts preparing for the assembly of the international space station. Serving as a simulated weightless training and testing center, it is the largest enclosed diving facility in the US, including a 6.2 million gallon, 40-foot deep tank - accommodating life-sized replicas of space hardware. The design includes special structural details in the tank floor, supported by its walls, to accommodate vertical and horizontal movements. Thousands of mechanical tension splices were made on horizontal and vertical reinforcements. To keep the water clear and moving at less than one foot per second, accommodations were made within the structure to embed piping for the elaborate filtration system into the pool's walls and foundation. Control offices and deck structures are supported by the pool walls, which include pool skimmers and sockets for portable jib cranes located around the perimeter.

For cost savings, the design of the facility called for conversion of an existing abandoned building. Innovative systems and methods as well as careful consideration of the proximity to existing building structural elements were used to achieve the 28.5-foot deep excavation and other aspects of the facility's conversion. The tank was designed to meet ACI "Environmental Engineering Concrete Structures" standards, and construction joints and concrete mix designs were given careful attention to minimize shrinkage-related cracking. Several waterproofing systems on the inside and outside of the tank minimize any leakage; the tank's cantilevered design serves to resist outward pressure when the pool is full and inward pressure when empty to allow for tank and water quality maintenance activities.



San Antonio River Flood Control Tunnel, 1998 OCEA

The San Antonio River Tunnel project (SART) - completed in 1998 - was designed to work with Olmos Dam Floodwater Detention to protect downtown San Antonio from damage. The project includes an inlet facility located at St. Josephine Street and the San Antonio River, a 24-foot diameter tunnel, and an outlet site at Lone Star Boulevard. The inlet and outlet sites were designed and landscaped to create a park-like setting, in keeping with the character of the adjacent neighborhoods and the city's popular tourist attraction the River Walk. The tunnel, capable of funneling over three million gallons of water per minute, was bored over ten years and one month and runs three miles long.

Soon after it was constructed, SART protected life and untold millions of dollars of property from flood damage when it passed the "flood of record" for the area in October 1998. An innovative alternative to river channelization, the project's tunnel concept minimizes disruption. Additionally, SART is beneficial in its reduction of environmental impact. One advantageous feature of the project, the recirculation of tunnel water, creates both higher water quality and conserves water, which had historically been pumped from the Edwards Aquifer to supplement river flow. The San Antonio Water System (SAWS) also implemented a treated effluent water recycling program so that the flow would be supplemented by recycled water at the tunnel inlet and in Brackenridge Park. This allowed the pumps, which had previously drawn water from the aquifer to supplement the base flow of the river, to be turned off. This project represents innovative and functional design and is a classic example of outstanding cooperative effort between local and federal government agencies.

Owner: City of San Antonio
Engineer: San Antonio River Authority, Chief Engineer, Steven Ramsey PE
Photo: William Fischer; Jr.of Fort Scott; Kansas, hmdb.org



Benbrook Pipeline Connection, 1999 OCEA

The Benbrook Pipeline Connection is a $52 million project which includes an eight-mile long 90-inch diameter pipeline, a four-mile long 126-inch diameter tunnel with a 90-inch carrier pipeline, two de-chlorination facilities, and supervisory control and communication systems. The pipeline, which went online in 1998, allows the Tarrant Regional Water District (TRWD) to utilize reservoir and transmission systems more efficiently, gaining an estimated $900,000 per year in power savings alone. The connection also provides drought backup for the West Fork of the Trinity River and redundancy in the water transmission facilities. The pump station was designed with special features in the structure, piping, systems and equipment, to allow for partial submergence during maximum flood levels, which provided significant cost savings in comparison to the prospect of elevating the station 46 ft. above the normal lake level. Innovative methods were also used in the reinforcement of a hill which made up part of the foundation of the road leading up to the pump station bridge. Instead of conventional retaining walls, drilled shafts were placed on two-foot centers to minimize excavation of the unstable hill and shafts were faced with cast-in-place concrete.

Additional innovations aided in the construction process, including a Tunnel Boring Machine (TBM) which was specifically designed to handle both soft ground and hard rock, capable of earth pressure balance operation and featuring mechanisms to install the two types of tunnel liner that were required for the project. Recommendations from ASCE's Committee on Resolving Disputes in Underground Construction and its *Geotechnical Design and Summary Report* were included in the contract specifications for the tunnel, which resulted in competitive bids and only .1% in change orders on the contract. Construction of the Benbrook Connection was completed six weeks ahead of schedule and on budget, saving the TRWD hundreds of thousands of dollars and solving a critical water supply shortage in Lake Arlington.

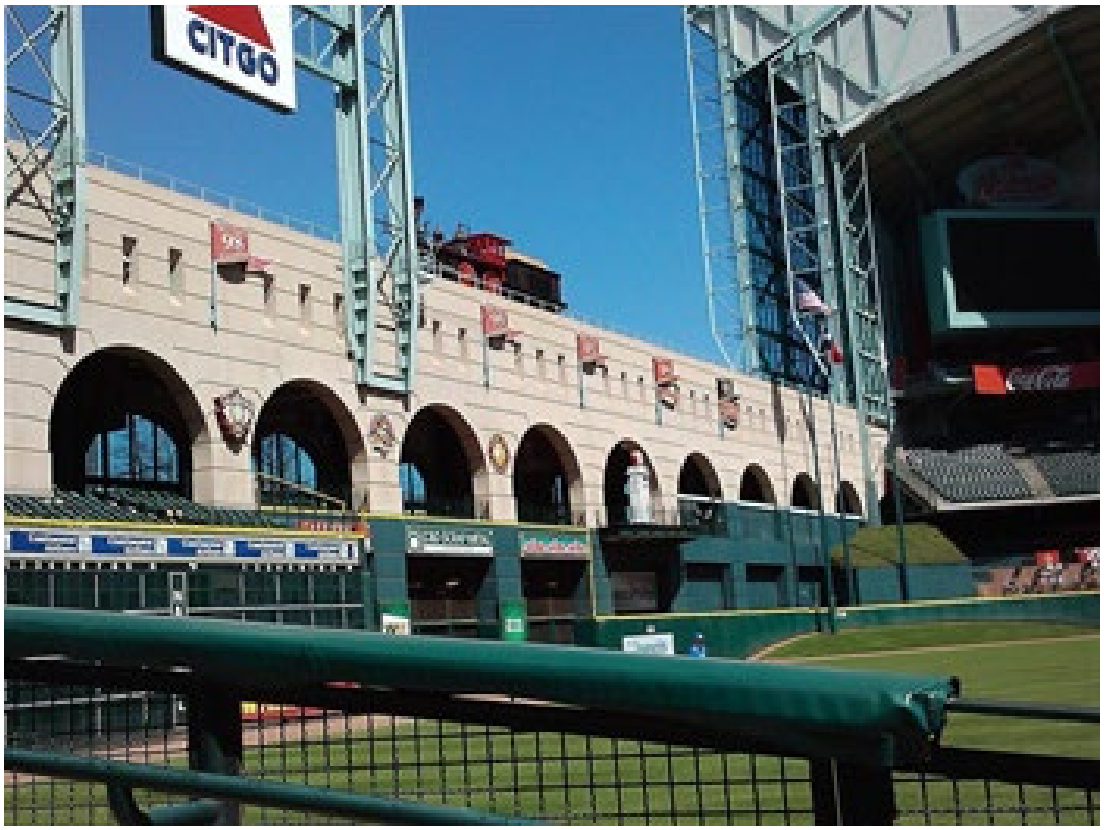
Owner: Tarrant Regional Water District
Engineer: Freese and Nichols Inc.
Contractors: Bar Constructors Inc.
Garney Construction Inc.
Archer Western Contractors Ltd.

Enron Field (Minute Maid Park), 2000 OCEA

Houston's 42,000-seat major league ballpark and first retractable-roof stadium, initially called Enron Field, and later renamed Minute Maid Park in 2002, was the fastest and most economically built retractable roof stadium ever developed, thanks to the creativity of the engineering and construction team. Compelling features include a landmark signature retractable roof, a renovated historic train station within the ballpark, the largest sliding glass wall in the world atop the left field wall, and a working locomotive that reminds fans of Houston's heritage.

The ingenious 6.5-acre roof structure utilizes a one-of-a-kind suspension wheel mechanism and computerized mechanization assembly with self-diagnostic abilities, allowing the operator to locate the exact wire, location, and circuit function in question with the click of a mouse. Enron Field has enhanced fan interest and set off the ongoing renewal of downtown Houston.

Owner: Harris County - Houston Sports Authority
Engineer: Walter P. Moore (structural)
Architect: HOK Sport
Contractor: JV of Brown & Root/Barton Malow/Empire
Photo: Mike Russell



Houston Gateway: US-59 Southwest Freeway, 2002 OCEA

The Houston Gateway is the single appellation given to the four identical tied-arch bridges, in close proximity, spanning one of Houston's major freeways - the US 59-Southwest Freeway. Engineers were able to achieve the unique, streamlined design of the overpasses by attaching the deck to the underside of the bridge support - increasing the clearance beneath the bridge without increasing the approach aprons. Fiber-optic lights were installed to enhance the striking singularity of the design.

Innovative features were also used in the construction of the project. The bridges that were to be replaced were used as support during construction and when the new bridges were completed, the old structures were demolished in a series of controlled explosions. This project represents the remarkable union of beauty and strength which has reinforced a sense of community cohesion in the Museum District and become a cornerstone of Houston's cultural development.

Owner: Texas Department of Transportation, Houston District
Engineer: Tensor Engineering Co.
Architect: Rey de la Reza Architects Inc.
Contractor: Williams Brothers Construction Company Inc.

North Central Expressway Reconstruction

2002 OCEA

The old Central Expressway, before reconstruction could easily be called a nightmare, with narrow lanes, nearly non-existent on-ramps, poor geometrics, and an extremely narrow right-of-way. The early 1980s brought TxDOT's tentative plans to build an elevated structure above the existing freeway. However, after further review, the decision was made to reconstruct the full length in a trench.

Reconstruction of the North Central Expressway (US75) was completed in November 1999 at a total cost of roughly $600 million. A minimum of eight continuous general-purpose lanes to facilitate the dense traffic. The building of the freeway in a trench (for six miles) on a narrow right-of-way while keeping the roadway open was a challenge, to say the least. The feeder roads are cantilevered over the main lanes in some sections because of the narrow right-of-way. When it opened in 2000, the project also included landscaping and architectural features at multiple cross streets which set a new standard of urban highway design.

Owner/Engineer:	Texas Department of Transportation (TxDOT)
Contractor:	Granite Construction Company
Photo:	Texas Department of Transportation (TxDOT)

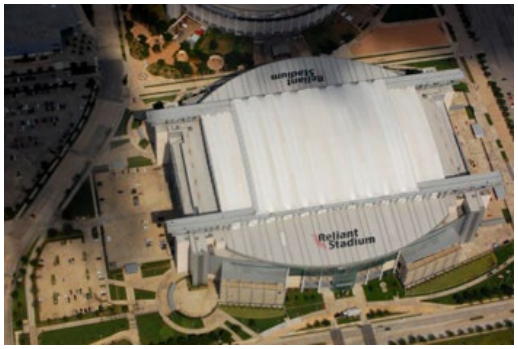


Reliant Stadium, 2003 OCEA

The $450 million Reliant Stadium was the first-ever NFL stadium with an operable roof. The stadium is unique in that it was designed to accommodate two very different tenants - the NFL's Houston Texans and the Houston Livestock Show and Rodeo (which conducts the world's largest stock show and rodeo each year). Reliant Stadium's groundbreaking design was a response to the Texan's founder, Robert McNair's, desire to have the football team play on grass under the open sky and the Houston Livestock Show and Rodeo's requirement of a closed roof for full show rigging and protection from the elements. The distinctive arched, fabric roof design that resulted became an instant architectural landmark and set new world standards for operable roof design, including unique two - wheel transporters, a first-of-its kind computerized system of electric motors, a new stress relief feature (the four bar linkage, an innovative inflatable rubber bladder system to seal key joints in the roof to keep rain out of the stadium), and computerized clamping system to keep the lightweight structure secure under high winds.

The construction of this ground-breaking design required the development of new methods such as the use of structural steel templates and stabilizing assemblies atop 150 ft. columns, and a "plug n' play" method of assembly, never before used for a retractable roof - which allowed the tri-chord trusses to be erected and assembled using a simple plug-in connection. Another unique feature of this stadium is its removable grass field, which is constructed of 3,000 lb. sod pieces in steel trays which can be removed so that a hard surface floor can be set up for certain events; the field can then be moved back into place for games. At its opening, Reliant Stadium was the NFL's largest stadium, covering more than 12 acres. It was also the largest air-conditioned space in Texas, and, outside of multi-terminal airports, the largest space for public assembly in the lone star state.

Owners:	Harris County
	Harris County Sports & Convention Corporation
Engineers:	Kellogg, Brown, and Root Inc (civil)
	Walter P. Moore and Associates Inc. (structural)
Architects:	Hermes Architects
	Lockwood, Andrews, Newman Inc.
	HOK Sport (now Populous)
Contractor:	JV of Manhattan/Beers
Photo:	Lonestar Mike, Wikipedia



Dallas/Fort Worth International Airport Capital Development Program, 2007 OCEA

The Dallas/Fort Worth International Airport Capital Development Program (CDP) was one of the largest undertakings in the U.S. in recent history. Over 122 professional firms contributed to its design and administration, and over 479 construction firms worked together to complete multiple stages of the project while keeping the airport fully operational. This extensive project consisted of a new international terminal, Hyatt Hotel, garage with smart parking technology, Skylink system linking all terminals, major expansion of the Central Utility Plant (CUP), major storm relief line, roadway improvements (including a major interchange to connect the existing roadway system to the new terminal), and airfield improvements to service the new terminal.

The design of this project is remarkable for its maximization of overall convenience and efficiency. Passengers are intuitively guided through the facility, including 99 ticketing positions, 14 passenger lanes for security screening, and a network of moving sidewalks, escalators, elevators, Skylink bridges, ramps, and elevated roadways for interior and exterior transit as well as a parking garage equipped with "Smart Parking Technology" to inform users of available parking capacity per level. The Grand Hyatt Hotel within Terminal D provides lodging and conference facilities, and the expanded Central Utility Plant provides conditioned water and air to the new CDP facilities for optimal passenger convenience and comfort. Structural components of the project include post-tension concrete to provide for cost-efficiency in spanning wide spaces. After the events of September 11, engineers heightened emphasis on security, and CDP components were designed using access control, closed circuit monitors, and secure area segregation methodologies to optimize structural and logistical security.

Owner:	the Cities of Dallas and Fort Worth jointly
Engineer/Contractors:	Kellog, Brown, and Root (KBR) Freese and Nichols Chiang, Patel, and Yerby Inc.
Photo:	Freese and Nichols



Westpark Tollway, 2006 OCEA

The Westpark Tollway has become a vital east-west corridor for the greater Houston area - home to the highest concentration of EZ TAG customers. The project called for 38 separate construction contracts, over 300 complex utility relocations, and the use of a General Engineering Consultant to manage more than 30 firms, representing practically all areas of civil engineering. The primary engineering challenge was maintaining cost-effectiveness within the restrictive confines of a very limited right-of-way and project specifications to allow for four lanes of traffic. Designing for limited right-of-way meant many ramps and connectors were constructed below natural grade to reduce expenses and numerous retaining walls were used to accommodate restrictions of depressed roadways.

In order to construct the project, engineers faced more than 300 utility conflicts for which accommodations had to be made, including placing conduits through bridges for utility companies, conduit installations between drill shafts, paving over existing utilities, and constructing common utility bridge structures to allow for use by multiple utility companies. Also, in some areas, sound walls had to be constructed on top of the concrete traffic rail because of the exceedingly constricted right-of-way in these areas; in many locations the right-of-way is one foot from the back of the traffic rail. The Westpark Tollway received the International Bridge, Tunnel, and Turnpike Association's Toll Excellence Award for Technology and its overall President's Award for its cashless (EZ tag) collection system.

Photo: Eric Slotboom



Arapaho Road Bridge, 2007 OCEA

The 1,575 ft. long Arapaho Road Bridge is the signature piece of a two-mile extension of Arapaho Road. It carries four lanes of traffic and is a model of innovation for standard pre-cast concrete and materials. The bridge's deck was constructed with pre-cast/pre-stressed U-beams and deck panels and is suspended by a series of steel rope hangers which attach to the arches and cast-in-place concrete diaphragms. The design is also notable for its use of round pipe for the arch rib, which was painted blue to tie the bridge into the town of Addison's most famous public art piece - a sculpture called "Blueprint of Addison." The use of round pipe was not only stylistically valuable, it also provides a high strength arch with good capacity against buckling and eliminates the need for lateral bracing.

Inventive methods of arch construction were utilized to mitigate traffic disruptions, which included construction of a temporary bent in the median of the road to allow the two free-standing 85-ft. long U-beam sections to be set in place. The steel pipes were fabricated using induction bending and the arch pieces were erected in two pieces overnight prior to being set and spliced together. Then, once the diaphragms and deck were cast, hangers were installed and stressed, lifting the bridge off of its temporary bent. Apart from occasional overnight road closures, traffic on Midway Road continued to flow unimpeded throughout construction of the main span. The cost of constructing the bridge and its lighting system was less than $6 million - to the satisfaction of Addison's budget. Completed in July of 2004 and open to traffic in January of 2006, the Arapaho Road relieves an estimated 11,000 vehicles per day from Belt Line Road without any additional congestion at the Midway Road intersection. The aesthetic theme of Arapaho Road Bridge unites the two areas of Addison and creates a striking gateway into the town's restaurant district.

Owner: City of Addison, Texas
Engineer/Contractor: URS Corporation

Lake Brazos Labyrinth Weir, 2008 OCEA

The Lake Brazos Labyrinth Weir was commissioned by the City of Waco to replace the Lake Brazos Dam, which had posed maintenance and operational problems and was unable to provide the stable lake levels that would be ideal for downtown development. Freese & Nichols refined the initial concept and were able to design the project in a way that eliminated the costly need to divert the river, empty the lake for construction, or to build downstream of the existing dam by constructing the weir in two phases over the foundation of the existing dam. The concept underwent extensive modeling to determine the most advantageous configuration and to develop optimal phased construction processes and river management practices. Ultimately, the design and construction of the weir was successful, allowing the City of Waco to benefit from reliable lake levels at nearly half the cost of earlier estimates.

In addition to minimizing cost, engineers were able to limit disruption to lake levels during construction through the phased construction process. Existing hydraulic gates remained operable while the left labyrinth was constructed and work started on the right labyrinth only when the left was completed and river flows were passed over it. Additionally, city-approved lake lowerings were accommodated at pre-determined times to facilitate specific work items. Although initial progress put the project five months ahead of schedule, heavy rains late in the construction process caused river flows to exceed 20,000 cfs and delayed completion of the right labyrinth weir, which had originally been scheduled for September, until October 2007. Despite the inconvenience, the floods in March and July offered a full-scale test of performance of the left labyrinth weir, which completely validated expectations while still in the construction phase. The weir has continued to perform as designed and has enabled city planners, developers, and businesses to look to downtown for events and development as steady lake levels have at long last become a reality in Waco.

Owner: The City of Waco, Water Utilities
Engineer: Freese and Nichols Inc.
Contractor: Archer Western Contractors Ltd.
Photo: Freese and Nichols Inc.



Cowboys Stadium, 2009 OCEA

The $1.15 billion, 3 million sq ft Cowboys Stadium, completed in 2009, represents an extraordinary triumph of engineering. Upon completion of the Cowboys Stadium structure, at least three structural engineering world records were established, including: "longest single-span roof structure," "largest center-hung high-def video display," and "largest operable glass doors." The single-span roof structure is supported by two 3,255-ton trusses that transfer 19 million pounds of thrust at each end into four concrete abutments. The first-of-its-kind, rack-and-pinion retractable roof was engineered with a very steep pitch (of 26°), mechanized, and features translucent fabric-covered panels that open or close within 12 minutes.

The stadium's design and engineering should also be commended for its extensive incorporation of green initiatives into materials use and management including the use of: more than 80% recycled reinforcing and structural steel content, at least 65% regional structural materials, and a translucent fabric retractable roof that provides substantially reduced power consumption through natural lighting. Cowboys Stadium's contemporary, streamlined design, efficient function, and exceptional engineering make it a truly one-of-a kind building that will capture the attention of Cowboys fans and the international community for years to come.

Owner:	City of Arlington, Texas
Engineer:	Walter P. Moore
Architect:	HKS Inc.
Contractor:	Manhattan Construction Company
Developer:	Blue Star Development/Dallas Cowboys Football Club
Photo:	Mahanga - Wikimedia.org, CC 3.0 Unported License



DART Green Line Light Rail Expansion

2010 OCEA

The DART Green Line Light Rail Expansion of 2010 is the longest light rail transit expansion in North America - consisting of 28 miles of double-track light rail, 5 aerial stations, and 15 at-grade stations customized to each local community. Engineers for this project worked closely with area stakeholders to determine the needs and preferences of the community. Engineers also collaborated with artists in the design of a large collection of public art to reflect the local culture at each station.

This $1.8 billion project expanded rail service across a highly populated metropolitan area with existing infrastructure, adjacent to active freight lines, two large medical districts, and a high traffic inner-city airport, while maintaining a tight schedule and budget, with minimal disruption to the public. The engineering and construction teams showed resourcefulness throughout the project such as in their fabrication of an at grade bridge to protect existing infrastructure and in the design of track elevation with minimal impact to the flooring pattern of flood plain areas.

Owner:	Dallas Area Rapid Transit (DART)
Engineer/Architect:	ACT21 (JV of STV, Jacobs, KAI-Texas)
Contractor:	Archer Western
Photo:	Elenaturner - Wikimedia, CC License



Margaret Hunt Hill Bridge, 2012 OCEA

The Margaret Hunt Hill (MHH) Bridge was designed as part of a broader collaborative development project between the Texas Department of Transportation (TxDOT) and the City of Dallas to revitalize the Trinity River floodplain. The MHH Bridge is the Woodall Rogers Freeway crossing over the Trinity River connecting Downtown and West Dallas; it has become not only a literal bridge between these two areas but also a figurative bridge over the economic chasm that exists between them, spurring urban planning and economic development aimed at revitalizing West Dallas. The bridge was the concept of renowned Spanish architect, artist and engineer, Santiago Calatrava. It instantly became an iconic city landmark for its singular design, whose signature features are a center arch pylon that rises 440 ft. above the floodplain - gracing the Dallas skyline with its unique, mesmerizing arrangement of cables.

The final realization of this incredible achievement was made possible by the perseverance and innovation of the construction team. The institution of new national levee requirements mid-way through the project's construction required the team to overcome new challenges and efforts to obtain the required 208 permit; this was achieved while staying on schedule and on budget. One of many process improvements - the use of a floating tension rig contained within the expansion sleeve in place of the larger, bulkier deviator installed inside an external guide pipe - improved the appearance of the arch and reduced construction costs and installation schedules. Upon completion, a three-day grand opening gala was held to celebrate the MHH Bridge. More than 40,000 people came out to participate in the weekend-long festivities culminating in a dramatic fireworks display - illuminating the Dallas skyline, highlighting its newest addition. Broader development plans for the Trinity River floodplain include three more Calatrava bridges, the second of which received funding approval from the Dallas City Council in January 2013.

Owners:	Texas Department of Transportation (TxDOT)
	City of Dallas
Architect/Engineer:	Santiago Calatrava LLC
Contractor:	Williams Brothers Construction Company Inc.

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Hamilton Pool Restoration, 2012 OCEA

Hamilton Pool is a natural swimming pool which has been a landmark natural feature in the Texas Hill Country and Austin area for centuries. In 2007, Hamilton Pool and its sources – Hamilton and Davis Creeks – were inundated with silt which had run off from an upstream residential development. To restore water quality, Espey Consultants was requisitioned to remove over 7,500 cubic yards of silt from the pool and contributing creek system. As Dr. Victoria Harkins PhD PE, Project Manager for the restoration, put it, "We are undoing years of sedimentation and silt that occurred in one summer." Dr. Harkins recommended and implemented a restoration plan which included a combination of water jetting and slurry extraction and a filtration system which was able to remove up to nine feet of silt from the bottom surface of Hamilton Pool.

During the restoration process, commercial underwater dive teams were contracted to suction the silt deposits, which were then pumped to a barge and up a 3,100 ft. cliff to a network of mix and filtration tanks. Once the water had been filtered, it was pumped back into Hamilton Creek, leaving both the creek system and the pool sediment free. Water clarity improved (from less than a meter to more than four meters) in less than a week. This outstanding feat of engineering was completed on time and approximately $100,000 under budget.

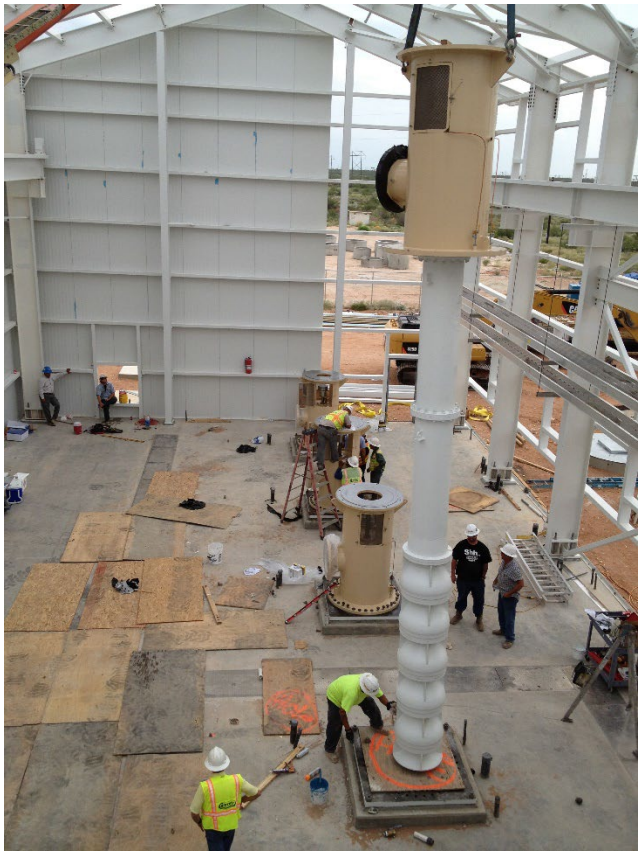
Owner:	Travis County
Engineer/Contractor:	Harkins Engineering Inc.
Photo:	Eric in SF - Wikimedia, CC License unchanged file



Ward County Water Supply Project, 2014 OCEA

The Colorado River Municipal Water District (CRMWD)'s Ward County Water Supply Project, implemented after the record drought of 2010-2011, supplies 30 million gallons of water a day to Odessa, Midland, San Angelo, Big Spring, Snyder and other water supply customers. Freese and Nichols, Inc. engineered the collection and water transmission system, which includes 21 groundwater wells, 66 miles of pipeline, four pump stations and other facilities. Daniel B. Stephens & Associates, Inc. (Albuquerque, NM) acted as civil engineering consultant for the well field expansion.

Four construction firms were contracted for the project, including Garney Construction (Kansas City, MO), who acted as the Construction Manager at Risk (CMAR); S.J. Louis Construction of Texas Ltd (Mansfield, TX); Oscar Renda Contracting (Roanoke, TX); and Hydro Resources (Sugar Land, TX). Because of emergency water needs, several innovative concepts were utilized in order to expedite the total project timeline, including resource scheduling, modular construction, CMAR delivery method, simplified equipment specifications and use of locally available materials. The project was designed and constructed in less than 18 months and completed two weeks ahead of schedule and $25 million (20%) under budget. Concurrent with one of the largest oil booms in decades, the timely completion of this water supply project was of critical importance to the vitality of West Texas and the nation's economy.

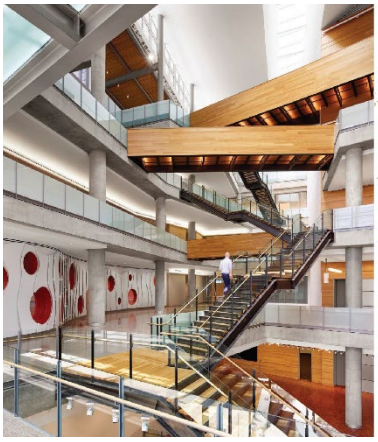


West 7th St Bridge (Fort Worth, TX)2015 OCEA

Union Station to Oak Cliff Streetcar Project (Dallas, TX), 2016 OCEA



Austin Central Library (Austin, TX), 2018 OCEA





Wichita Falls Direct Potable Reuse & Indirect Potable Reuse Project (Wichita Falls, TX), 2019 OCEA



US 290 Program, 2020 OCEA

"With a total project cost of $2.5 Billion, TxDot's strategy for reconstruction of 38 miles of US 290 in northwest Houston maximized and efficiently utilized innovative funding resources to deliver some portions of the corridor up to two decades earlier than originally planned." -Texas Transportation Commissioner Laura Ryan

The US 290 Program expanded economic opportunity by increasing transportation choices with a multi-modal approach that included a 50-ft environmentally cleared reserve for future High Capacity Transit, construction of a ten-mile extension of the US 290 HOV lane, and improved connectivity from I-610 and US 290 to the High Occupancy Vehicle (HOV) lane.

Program complexities included reconstruction and reconfiguration of the highly congested I-610/I-10/US 290 interchange to provide direct access between US 290 and I-10. The 2.5 mile-long direct connectors separate the traffic, reducing weaving movements, and resulting in significantly improved travel times and congestion ratings for both I-610 and I-10.

Accomplishing the May 2019 opening to traffic required innovative cost and time-saving solutions to overcome project challenges that included:

- Accelerated design and construction to accommodate funding changes and implement revised interim configurations due to changes in agency partnerships;
- Relocation of a steel processing plant, the State's largest relocation to date;
- Contractor default;
- Hurricane Harvey and tow other major storm events during construction, totaling 86 inches of rain in the Houston region;
- Phased implementation approach that deferred construction of the Hempstead Managed Lanes, Requiring an interim solution to accommodate HOV traffic on US 290.



Able Pump Station, 2021 OCEA

The Able Pump Station, located between two historic street viaducts, is designed to provide 100-year flood protection to approximately 3 square miles, including 171 acres of highly desirable land. The properties adjacent to the previous Able sump complex have experienced frequent flooding. The sump complex includes nine separate and interconnected ponds that store stormwater, as well as two existing pump stations, constructed in the 1930s and 1950s, with a current combined capacity of 220,000 gallons per minute. To help prevent the loss of life as a result of flooding, the City of Dallas hired HDR to design the new Able Pump Station, which increases the pumping capacity nearly fourfold, to 880,000 gallons per minute. It also lowers the 100-year flood elevation from 399.0 to a design elevation of 392.5 feet.
The new pump station utilizes 4,000 HP concrete volute pumps, the largest in the United States. The station has dual primary electric service and dual transformers to provide reliable service. The dual power provides an automatic switchover to a backup power supply in the event the primary power is lost during a flood. The secondary independent power feed enables the City of Dallas Flood Control to continue pumping flood waters into the Trinity River, preventing loss of life and any unnecessary damage to the adjacent properties. Dallas' pump stations protect about $13.7 billion worth of homes and businesses from flooding along the Trinity River — areas where about 200,000 residents live and work.



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Bagby Street Improvement Project, 2022 OCEA

Bagby Street in Downtown Houston is a street of parks and civic and cultural facilities. It is the first street on the west edge of the city near Buffalo Bayou and it serves as a welcoming gateway to downtown. Bagby is home to City Hall Civic Center, City Hall Annex, Barbara Bush Library, Sam Houston Park, The Hobby Center for the Performing Arts, Tranquility Park, Downtown Aquarium, and Bayou Place Entertainment District. Over time the streetscape deteriorated and needed upgraded facilities. The construction was part of the Plan Downtown initiative implemented by The Downtown Redevelopment Authority (DRA) and the Tax Increment Reinvestment Zone 3 (TIRZ3). The plan, completed in 2017, is a 20-year vision that outlines recommendations for development and design to improve visitor appeal, business climate, livability, and connectivity within and around Downtown Houston leading up to the city's bicentennial in 2036. As part of this plan, The Bagby Street Improvement Project was designed to re-imagine the west side of Downtown to better support core civic functions and establishes a framework for future mobility, government, commercial and residential redevelopment. The project spanned 10 blocks of Bagby, from Clay Street to Franklin Street, and included pedestrian enhancements, beautification elements, the addition of signature lighting and bike facilities, and an upgrade to the corridor's storm sewer and drainage system. With these improvements, Bagby Street was transformed into a corridor fitting its unique position.



Luce Bayou Interbasin Transfer Project, 2023 OCEA

Originally conceived in 1938, the Luce Bayou Interbasin Transfer Project (LBITP) is the most significant water supply project built in the Houston region in the last 50 years. To address the growing demand for surface water, while reducing dependency on groundwater, the LBITP will transfer up to 500 million gallons of water per day from the Trinity River in an adjacent water basin over Capers Ridge to Lake. At the time it was funded, the Texas Water Development Board rated the LBITP as its top-ranked project in the State. The $381 million LBITP consists of three primary components: Capers Ridge Pump Station (CRPS), Dual 96-inch Diameter Pipelines and Pig Retrieval Facility, and the Canal System. The Luce Bayou Interbasin Transfer Project (LBITP) was layered with multiple political, environmental, and engineering challenges in finding a solution to the City of Houston's (COH) growing water demand, abating regional subsidence, and ultimately reducing its reliance on groundwater. This could be accomplished only by increasing the supply of surface water by 500 million gallons per day (mgd). The entire water supply in the San Jacinto River basin was already claimed and Lake Houston does not have enough water to meet future water demands for the Houston area. The solution was to convey COH-owned water from the adjacent Trinity River basin to Lake Houston over 25 miles away.



Bois d'Arc Lake Program, 2024 OCEA

The **$1.6 billion** Bois d'Arc Lake program centers on Texas' first major reservoir in almost 30 years — a crucial new water source for more than 2 million people in more than 71 growing communities served by the North Texas Municipal Water District.

> Bois d'Arc Lake initially can provide up to **70 million gallons a day** of drinking water for North Texans, with expansions planned.
>
> The lake increases **recreational opportunities and economic development** for the area.
>
> **Ecological improvements across 17,000+ acres** to offset the reservoir's footprint mesh environmental resilience with infrastructure progress.

All the main elements were built simultaneously in 2018-2023: a dam and 16,641-acre reservoir; a treatment plant, two huge pump stations and 60 miles of pipelines; two major sites of forested and emergent wetlands, grasslands and stream restoration mitigation. Customers started receiving treated water from the system in Spring 2023.

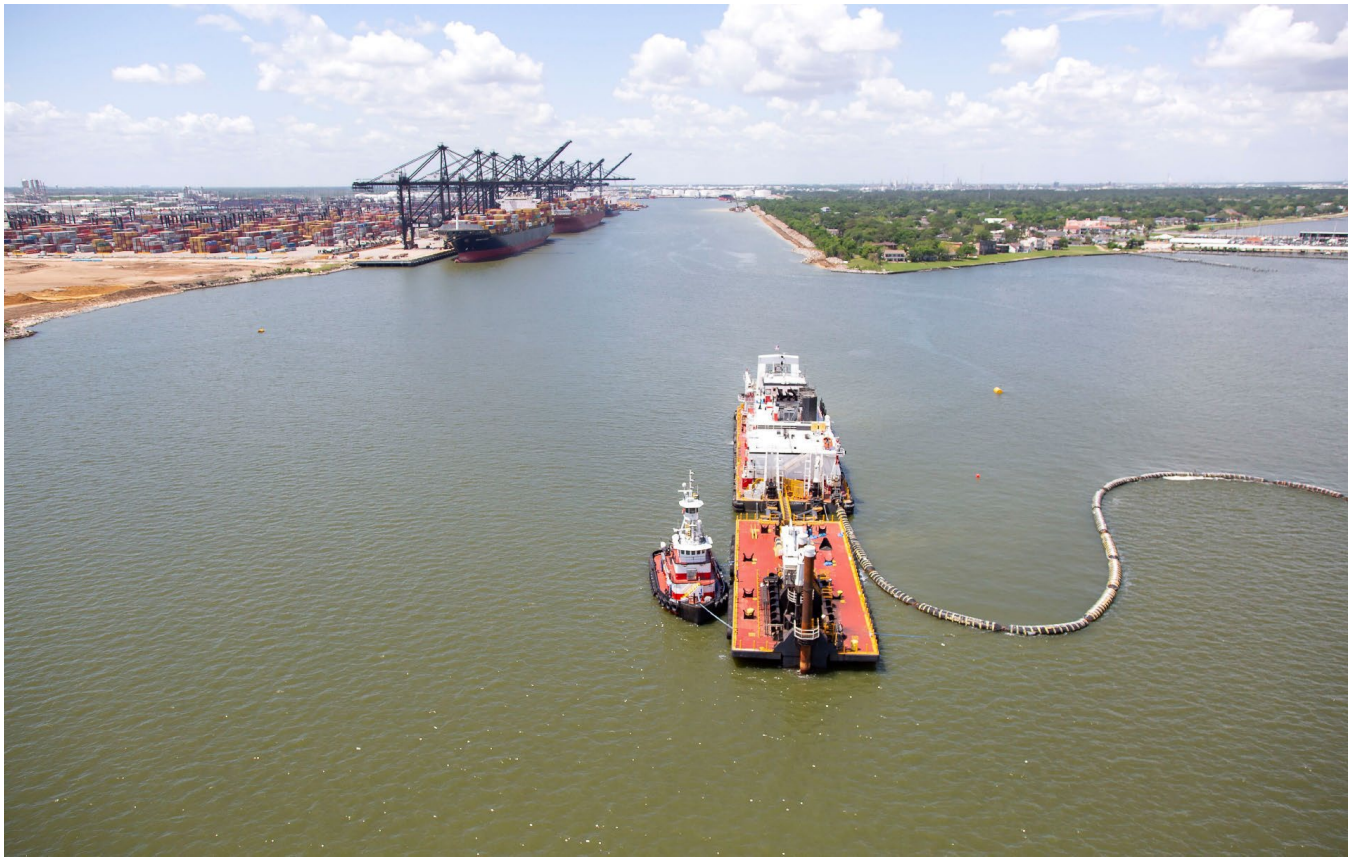
Delivering Bois d'Arc Lake required foresight, ingenuity, resourcefulness and extensive coordination involving a broad and dedicated array of partners. The team expertly navigated a myriad of challenges, and the final cost is expected to come within 1% of the target.



PROJECT 11: HOUSTON SHIP CHANNEL EXPANSION, SEGMENTS 1-2, 2025 OCEA

The Houston Ship Channel (HSC) is a federally authorized deep draft navigation channel, which serves the greater Houston region. Located in Chambers, Galveston, and Harris Counties, Texas, the HSC is a high-use channel and the busiest waterway in the U.S. with over 8,000 deep draft and 200,000 barge transits per year. The HSC provides access to Port Houston's eight public terminals and over 200 private docks and berthing areas. Combined, these areas provide the infrastructure for the #1 port for waterborne tonnage and #5 for TEUs in the U.S., support more than three million jobs, generate $906 billion in national economic benefits, and provide nearly $63 billion in annual tax revenue. As the non-federal sponsor of the HSC, Port Houston is preparing now for the future needs of vessels and businesses, and together with the U.S. Army Corps of Engineers-Galveston District (USACE-SWG), is accelerating the HSC expansion, also known as Project 11 (federally identified as the HSC Expansion Channel Improvement Project).

Project 11, the 11th major improvement to the HSC, includes widening the channel by 170 feet (from 530 to 700 feet) along its Galveston Bay reach, widening the Bayport and Barbours Cut Channels to 455 feet, deepening some upstream segments (up to -46.5 feet MLLW), making other safety and efficiency improvements, and constructing new environmental features including approximately 10-acres of bird islands, 276-acres of instant intertidal marsh, and 324-acres of oyster reefs, and over 600 acres or 12.4 million cubic yards of future Operation & Maintenance capacity.



The National Medal of Honor Museum, 2026 OCEA

The National Medal of Honor Museum in Arlington, Texas is defined by a bold and deeply symbolic architectural vision. Designed by Rafael Viñoly Architects, the museum's defining feature is a monumental 200-by-200-foot exhibition hall that appears to float 50-feet above the ground. This striking volume is supported by five massive precast concrete megacolumns, each representing a branch of the U.S. Armed Forces, transforming the structure into a powerful metaphor for service and sacrifice.

The lower-level houses event spaces, classrooms, and the Rotunda of Honor, a contemplative space crowned by a landscaped green roof that blends into the lakeside setting. A large oculus pierces the elevated hall, allowing natural light to cascade into the Rotunda, reinforcing themes of reflection and remembrance. The exterior is clad in a durable metal rainscreen system, providing a clean, contemporary aesthetic and long-term performance. Surrounding groves, lawns, and pathways soften the museum's monumental form and create a park-like environment for gathering and contemplation.

The museum also represents remarkable civil and structural engineering achievement. The megacolumns are engineered to carry 2,000 tons a piece while maintaining a minimal ground-level footprint, supporting one of the most complex structural systems of its kind. Engineers integrated long-span stability, wind resistance, storm resilience, and seismic considerations. Below grade, earth-sheltered spaces, retaining structures, waterproofing systems, and stormwater management were carefully coordinated with sensitive site grading around Mark Holtz Lake. Together, these solutions enabled the museum's dramatic architectural vision while delivering safety, durability, and environmental performance worthy of its national significance.

