

Levees in Texas – A Historical Perspective

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This paper describes a brief history of flood control levees that have been constructed in the state of Texas and some lessons that can be learned from these projects. Examples, photos, and discussions of historical levees will include: The Rio Grande levee system in the El Paso Valley (1920's and 1930's) and along the river to Brownsville; the Dallas-Fort Worth floodway (levees) system; Houston area levees; and the Port Arthur Levee System.

Some discussion of levee design and construction techniques will be included. Questions will be asked and discussed regarding the changing state and federal criteria and regulations. In addition, some comments regarding the ongoing certification process for levees under the FEMA and Corps of Engineers' programs will be included.

Background

After August 2005 because Hurricane Katrina and its impacts the New Orleans, levees have become major concerns to the general public. Texas was no exception. There are a number of levee systems in Texas. Levees were built by Federal and State agencies, citizens, cities, counties, and districts. One only needs to look at the history of levees to see that levees have and will have problems. An example of this was in December of 1913; levees along the Brazos River breached and caused flooding miles from the riverbed. The 1913 Flood received nationwide attention in an article published in Engineering News describing that the Brazos and Colorado Rivers became one floodplain near Hempstead, Texas. The same article also reported how the citizens of Bay City worked around the clock to avoid the levees in the area from breaching to avoid further flooding.

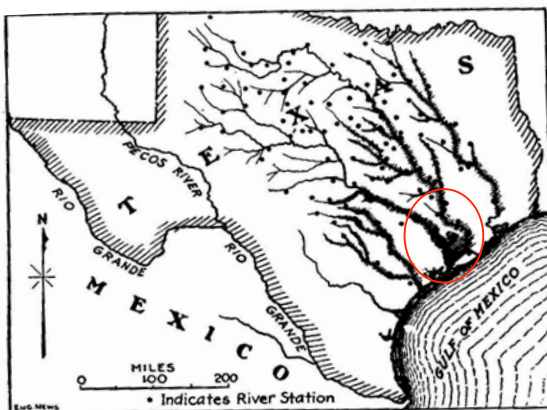


FIG. 1. MAP OF TEXAS, SHOWING FLOODED RIVERS

Figure 1

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The December Floods in Texas, B
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Note the dark area that joins the Brazos
and Colorado Rivers.

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While there are over 48 levee improvement districts registered with the Texas Water Commission (Now the Texas Commission on Environmental Quality), this paper focuses on five levee systems the Rio Grande levee system in the El Paso Valley (1920's and 1930's) and along the Rio Grande to Brownsville; the Dallas- Fort Worth floodway (levees) system; Houston area levees; and the Port Arthur Levee System.

El Paso Valley Levee system

The Rio Grande basin begins in Southern Colorado and runs through New Mexico, Texas/Mexico border to the Gulf of Mexico. The total area is 355,000 square miles with about 176,00 contributing drainage area. The portion inside of Texas is about 54,000 square miles of the basin. The Rio Grande serves as the 1,250-mile border between Texas and Mexico. With the building of Elephant Butte Reservoir (New Mexico) in 1906 provided some flood protection for El Paso. This caused the Rio Grande to have little to no flow at times that the river started silting up. In 1933, the Rio Grande Rectification project was proposed to relieve the silting situation and to protect the area from flooding. The plan called for a 50 feet wide normal flow channel lined by 7.5 miles of levees. The levees were designed to contain the 100 year flood with a two foot freeboard. The levees would also serve as roadways along the river. The Reclamation Project was completed in 1938 at a cost of 5 million dollars. The International Boundary and Water Commission (IBWC) maintain the system. Essentially the project straightened a meandering river from 155 miles to 86 miles. The American Dam was built to help distribute the water between the United States and Mexico. In this limited format, it is difficult to provide a map of the system. A map can be found on the IBWC site at <http://www.ibwc.state.gov/index.html>.

The Rio Grande Flood of 1958 was one of the floods that tested the levee system. The El Paso Valley Levee system held in 1958 but was subjected to an extreme test during the August 2007 Flood. The August 2006 flood revealed the deficiencies in the system and several areas had water overtop the levees and sections of the levee system on the Juarez, Mexico side were overtopped and failed. The Federal Flood Assessment Conference held in September 2006 brought together all the agencies in the area to share the lessons learned and data that was collected. The estimate to rehabilitate the levee system is being determined by IBWC, the US Army Corps of Engineers and FEMA. FEMA initiated a remapping effort of the area including El Paso County, Texas and Dona Ana County, NM. FEMA asked IBWC to certify that the Rio Grande levees could with stand a 100 year flood with 2 foot of freeboard. IBWC proposed that the Rio Grande levees must be raised to provide the required freeboard. The El Paso County and Dona Ana County remapping effort by FEMA must comply with FEMA's mapping procedures (Procedure Memorandums: 30 - FEMA Levee Inventory System; 32 – Levee Review Protocol; 34- Interim Guidance for Studies Including Levees; and Provisionally Accredited Levees, available on line at www.fema.gov) and the National Flood Insurance Program Regulations 44 CFR 65.10. Without levee certification, homeowners in the area will be mapped to be within the Special Flood Hazards Area (within the 1% or 100-year floodplain) and may be required to purchase flood insurance, as decertification of the levee system will place thousands of property owners into the floodplain. Federal funding is proposed to expedite design and construction of needed levee improvements..

Rio Grande Levee system (Along the River to Brownsville)

Major floods have passed through the lower Rio Grande in 1865, 1886, 1904, 1909, 1914, 1916, 1922, 1948, 1954, 1967 and 1988. Each time the area suffered damage.



Figure 2 – Soldiers doing repairs to the levees after the 1916 flood near Brownsville

Farmers and the military worked on the levees after the 1916 Flood, but the first organized effort to provide funding for a flood project were bond issues passed in 1924 and 1925 which raised 3 million dollars to build the Rio Grande levees from Donna to Brownsville. The system of levees started by farmers settling the area. The various floods clearly showed the citizens of the area that building levees along the US border would not protect the area from floods. The International Boundary and Water Commission (IBWC) recommended that 300 miles of levees be built on both sides of the river. The levees were built by the military, prison laborers and others, from 1933 until work was completed in 1951.

The levees were tested when Hurricane Beulah landed on the Texas coast in September 1967. The Mission Inlet, which runs just south of McAllen, had the flood channel overtopped causing flooding at the McAllen Airport. The Mission Inlet was later abandoned as part of the IBWC Floodway System and now maintained by Hidalgo Drainage District functions to carry local storm runoff. The diversion dike that split the floodwaters between the Arroyo Colorado (south floodway) and the North Floodway failed sending floodwaters. The next major flood event after Beulah was the flood of 1988 caused by Hurricane Gilbert.

Today the Lower Rio Grande Flood Control project is 158 miles along the main channel of the Rio Grande from Penitas in Hidalgo County to near the Gulf of Mexico. The infrastructure of the flood control project includes 284 miles of levees along the River. The IBWC Rio Grande System design flood is the 500 year flood or a flow rate of 250,000 cfs at the Rio Grande City

gage. This flow rate was arrived at with an agreement between the US and México as that coordination was needed to provide true flood protection. The system includes two diversion dams, Anzalduas and Retamal that serves to divide the waters into the US and México. The capacity of the floodway was increased after the floods of 1967.

Numerous studies have been performed for the flood protection system between 1995 and 2006. The most significant is the result of litigation in 2003 which is titled: “Hydraulic Model of the Rio Grande and Floodways within the Lower Rio Grande Flood Control Project”. The study evaluated the existing vegetation conditions to identify the impacts on conveyance of the channel and found that the 100-year flood was 250,000 cfs and the system would not provided protection from flooding along its entire length. In 2004, various projects were proposed to address problem areas where the levees will be overtopped. In November 2006, a Hidalgo County Bond Issue was passed to address the maintenance of the flood protection system at the cost of 125 million dollars. Construction is scheduled to be completed in 2008.

Dallas- Fort Worth floodway

The Trinity River has experienced floods in 1822, 1841, 1844, 1866, 1871, 1890, and 1908. After the flood of 1908, the citizens of the area looked to find a solution to the flooding.

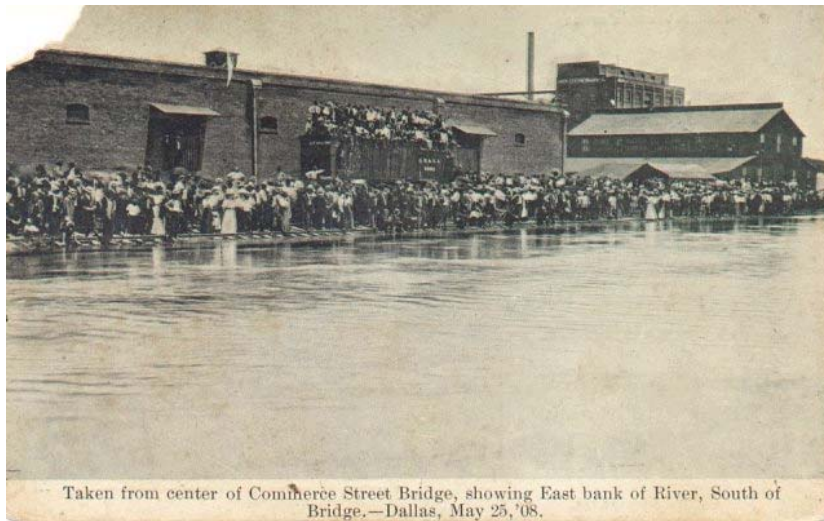


Figure 3 – Trinity River during the May 1908 flood

Planned improvements included construction of levees. Among these plans was the Kessler Plan. George E. Kessler, a landscape architect that had been working on plans to have the levees built. The plans called for the building of levees twenty-five (25) feet and thirty (30) feet in height. In 1919, the first levee district was created and called Dallas Levee Improvement District #5. The purpose of the District was to maintain the levee upstream of the Elm Fork. It was later dissolved and the City & county of Dallas Levee district created. A more detailed plan was proposed under the direction of Charles Ulrickson. A bond issue of 24 million was proposed.

The bond issue passed and the levees were constructed by Trinity Farm Construction Company with D Kerron as chief engineer. The levees were 156 feet width at the base with a 30 foot width

at the top. The 1908 Flood was the design flood with one foot of freeboard. With the crash of 1929, it made it financially difficult for the levees to be maintained. The 1942 Flood sent 111,000 cfs down the Trinity River at its peak and tested the levee system.

In 1948 a report stating that the levees were in bad condition was published by the Corps of Engineers which prompted creation of the Dallas County Flood Control District. Following work by the Corps of Engineers repaired the levee system and included internal drainage improvements.

In 2004, FEMA initiated remapping for both Tarrant and Dallas counties that included the Trinity River and the Dallas-Fort Worth Levee System.. In February 2007, the levees were declared by the Corps of Engineers as providing adequate protection from the 100 year flood. In May 2007, FEMA plans to publish Preliminary FIRMs showing the protection that the levees provide.



Figure 4 – Dallas Floodway today

Houston Area Levees

There are several levee systems in the area of Houston, Texas. These include: Texas City Hurricane Protection, the Galveston Seawall, Freeport Hurricane Protection system and numerous levees in the Fort Bend County area.

Texas City Hurricane Protection:

The Flood Control Act of July 1958 authorized a Corps of Engineers project to provide hurricane flood protection to Texas City, and La Marque, Texas, located on the southwest shore of Galveston Bay, about 9 miles northwest of Galveston, Texas. The project, as modified, provides for construction of about 1.3 miles of concrete walls and 15.7 miles of levees with crown elevations varying from 23 to 15 feet above mean sea level; related drainage and closure structures; railroad and highway ramps; tide control and navigation structure in Moses Lake; and two pumping plants. Construction began in 1962 and was completed in 1987. This system encircles approximately 50,000 residents and \$6 billion worth of property including BP, Marathon and Valero refineries and Dow, Sterling and ISP chemical plants.



Figure 5- Part of the
Texas City Hurricane
Protection system

Galveston Seawall:

The Galveston Seawall, constructed in 1902, is a seawall that was built after the Galveston Hurricane of 1900 for protection from future hurricanes. The Seawall has never been overtopped by a storm surge from hurricanes but waves from some storms have caused considerable damage to buildings that line Texas F.M. 3005, otherwise known as Seawall Boulevard along the wall, runs along the Seawall.

The seawall is presently 10 miles long, approximately 17 feet high and 16 feet thick at its base. The seawall was listed in the National Register of Historic Places in 1977.

Extension of the seawall in a southwesterly direction from 61st Street for a distance of 16,300 feet has been completed. Of that extension, 5,400 feet of Seawall was completed in 1953 with funds contributed by Galveston County, and the remainder was completed with Federal funds in 1962.



Figure 6 – The Galveston Seawall today

Freeport Hurricane Flood Protection:

The Flood Control Act of 1962 authorized a Corps of Engineers project to provide protection from hurricane tides and accompanying waves to Freeport, Texas, and vicinity, located in the southern part of Brazoria County on the Gulf of Mexico. Freeport is about 4 miles from the Gulf and about 43 miles southwest of Galveston, Texas.

The levee system, approximately 53 miles in length with a crest elevation of from 15 to 22 feet, encircles portions of the cities of Freeport, Lake Jackson, and Oyster Creek. The area is home to about 60,000 residents and nine industrial plants. The first levees were built in the 1940's and have been extended over the years by the Corps of Engineers and the Velasco Drainage District which is currently responsible for maintenance.

Fort Bend County:

There are twelve (12) major levees built by private developers in Fort Bend County that protect more than \$8.6 billion worth of Fort Bend property – nearly a quarter of the county's appraised value. Planned communities, including First Colony, Sienna Plantation, Pecan Grove, New Territory and Greatwood, simply would not exist without the levee systems meant to shield them from the Brazos River and its tributaries.

On occasions, where a flood is coming downstream and it is raining hard behind the levee as well, diesel-powered pumps can discharge storm water over the levees from the protected side.

Unlike the other Texas coastal levees, these levees were built by creating localized state government entities called Levee Improvement Districts, known as LIDs. LIDs issue tax-free bonds for construction that are repaid through special property taxes on everyone in the district.

Several LIDs have land use authority and are considered communities and participate in the National Flood Insurance Program. These LIDs regulate development, issue development permits and enforce the requirements of the NFIP.

Fort Bend County Commissioners Court appointed boards of directors, and the LIDs support a small cadre of specialty lawyers, engineers and maintenance/operations companies that keep the LIDs solvent and the levees inspected and mowed.

Port Arthur Levee System

The Port Arthur Levee project provides protection from hurricane flood tides to Port Arthur and vicinity, located in the extreme southeastern part of Texas on the west side of Sabine Lake, about 12 miles from the Gulf of Mexico. The system was constructed by the Corps of Engineers and consists of over 29 miles of earthen levee and 7 miles of floodwall with top elevations varying from 14 to 19 feet. There are gated gravity drainage structures that convey normal drainage from behind the flood protection system at various locations. In addition, five pumping plants provide interior drainage when gated drainage structures are closed during periods of high lake stage and high runoff. Behind the Hurricane Protection System is the Crane Bayou watershed which consists of 44.6 square miles with approximately 50 percent of its land developed. The area near Highway 73 between the Southern Pacific Railroad and the Hurricane Protection System is called the Lakeside watershed, and has a drainage area of 4.9 square miles. Construction was started in March 1966 and the project was essentially completed in 1984.

Maintenance of this system is currently the responsibility of Jefferson County Drainage District No. 7. The levees were last test in September 2005 when Rita made landfall between Texas/Louisiana Border. Before the storm made landfall, forecasters were calling for 15 to 20 storm surges. The surges were a lot less than those forecasted and the levees made it through without damage. Rain fall reports were 3 to 4 inches of rain per hour.

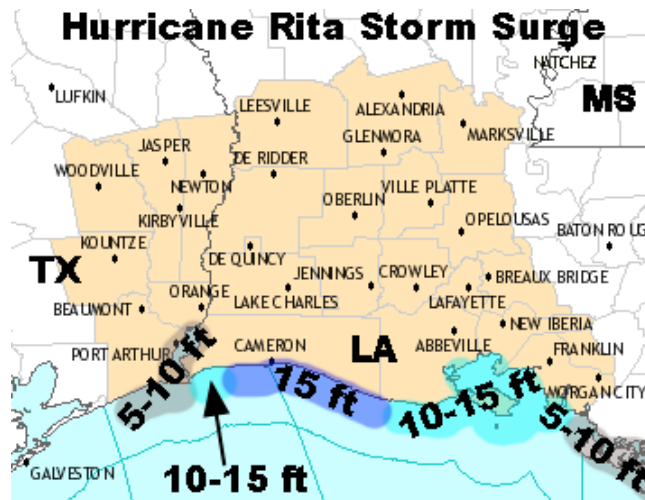


Figure 7 – NWS Storm Surge Information for Hurricane Rita

Conclusion

These levees have been tested over time some as recently as last year. For any levee there is no guarantee that they will not experience a flood that exceeds their design. Currently, levees are receiving some attention as FEMA re-maps the floodplains and will be in the public’s eye. Whether the levees are maintained by local, regional, state or federal agencies; located in arid areas or coastal areas in Texas, all the levees face the challenges of maintenance on limited budget. As citizens living in these various areas we must strive to understand the risks and challenges that the levees introduce into the areas we work and live. Congress is currently evaluating legislation to address levee safety both in the Water Resources Development Act and a national Levee Safety Act. Copies of these bills and White Papers addressing Levee Safety can be viewed on the Association of State Floodplain Managers (ASFPM) website www.floods.org.

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