APPENDIX G: FINAL INTENSIVE ENGINEERING INVENTORY AND ANALYSIS OF THE DALLAS FLOODWAY, DALLAS, TEXAS
(November 2010)

Prepared by TEC, Inc. for the U.S. Army Corps of Engineers

FINAL

INTENSIVE ENGINEERING INVENTORY AND ANALYSIS OF THE DALLAS FLOODWAY, DALLAS, TEXAS

November 2010

Prepared for United States Army Corps of Engineers

Technical Report

INTENSIVE ENGINEERING INVENTORY AND ANALYSIS OF THE DALLAS FLOODWAY, DALLAS, TEXAS

November 2010

THIS STUDY FULFILLS THE USACE REQUIREMENT TO IDENTIFY HISTORIC AND CULTURAL RESOURCES UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT.

Dallas Skyline

Executive Summary

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EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) is preparing the Dallas Floodway Project Environmental Impact Statement (EIS) for all of its related proposed undertakings within the Dallas Floodway in Dallas, Texas. The Dallas Trinity River Floodway (Dallas Floodway) includes levees, the river channel, six pumping plants, seven pressure sewers, and numerous gravity sluices, and extends from the Loop 12 crossings of the West and Elm Forks of the Trinity River to the existing Atchison, Topeka & Santa Fe Railroad Bridge. The Dallas Floodway Project EIS describes the potential environmental consequences resulting from the implementation of proposed levee remediation, flood risk management, ecosystem restoration, recreation enhancement, and other proposed projects in and around the Dallas Floodway. Although the projects have not been completely defined at this point, they would involve modifications to the floodway, levees, and interior drainage systems and have the potential to adversely impact historic resources within and adjacent to the floodway. As a result, an intensive engineering cultural survey was conducted of the Dallas Floodway for the purpose of identifying and evaluating cultural resources in order to assess cultural impacts under the National Environmental Policy Act (NEPA).

Section 405 (a) of the 2010 Supplemental Disaster Relief and Summer Jobs Act (Public Law 111-212) states that the Army is not required to make determinations under the National Historic Preservation Act for the Dallas Floodway project. USACE Implementation Guidance dated 19 October 2010 directs the Fort Worth District not to make determinations under the National Historic Preservation Act (NHPA) and to examine the Dallas Floodway Project as a engineering system with a discussion of the cultural resource's significance without making explicit references NHPA eligibility criteria. This study fulfills the USACE requirement to identify historic and cultural resources within the context of the scope of impacts that must be analyzed under NEPA.

This report is a cultural inventory and evaluation of the engineering components associated with the Dallas Floodway Project. It includes a historic context of the floodway as a flood control system and as the outgrowth of community planning. The historic context investigates the Dallas Floodway as a part of the larger Dallas Trinity Reclamation Project (1908–1959). This context is then used to identify the appropriate structural components of the floodway, record the current condition of each component, and evaluate the collective historical significance of these components and the floodway system as a whole.

A total of 55 engineering resources comprising 10 different types of hydraulic physical features (levees, diversion channels, overbanks, pumping plants, pressure sewers, outlet gate structures, intakes, sluices, sumps, and emergency control structures) associated with flood control were recorded. The research and field data for each resource were recorded according to Texas Historical Commission standards. Additionally, this survey meets the Federal Highway Standards for Uniformity for Non-Archaeological Survey.

Based on an analysis of the field and research data, the Dallas Floodway, as a single engineering system for flood control and reclamation, is a historic and cultural resource with locally significant historical associations with flood control and the history of city planning and community development in Dallas, and is a significant statewide example of an engineering system designed for flood control and development enhancement. The period of significance of the Dallas Floodway spans from 1928, when floodway construction started, to 1959, when the project was completed. The essential physical features of the Dallas Floodway are the levees, diversion channels, and overbank. The Dallas Floodway retains all its essential physical features and its ability to convey its significance to the observer.

The Dallas Floodway meets the NEPA definition of a significant historic and cultural resource that must be considered in assessment of environmental impacts as required under CEQ regulations Part 1502.16.

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ACRONYMS AND ABBREVIATIONS

ASCE	American Society of Civil Engineers
AT&SF	Atchison, Topeka & Santa Fe
ca.	circa
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	corrugated metal pipe
CPIL	City Plan and Improvement League
C.S.G.	Control Gate Structure
DART	Dallas Area Rapid Transit
DCLID	Dallas County Levee Improvement District
DMN	*Dallas Morning News*
DPOA	Dallas Property Owners Association
EIS	Environmental Impact Statement
ER	Engineering Regulation
FHWA	Federal Highway Administration
gpm	gallons per minute
H&TC	Houston & Texas Central
HAER	Historic American Engineering Record
HRSR	Historic-Age Resource Survey Reports
IH	Interstate Highway
KPA	Kessler Plan Association
N/A	Not applicable
NEPA	National Environmental Policy Act
NYT	*New York Times*
RCP	reinforced concrete pipe
SHPO	State Historic Preservation Officer
SPF	Standard Project Flood
TxDOT	Texas Department of Transportation
THC	Texas Historical Commission
USACE	United States Army Corps of Engineers

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Baker Pump Stations, Levee and Pressure Sewers 2009

Introduction

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CHAPTER 1. INTRODUCTION

1.1 INTRODUCTION

The United States Army Corps of Engineers (USACE) is preparing the Dallas Floodway Project Environmental Impact Statement (EIS) for all of its related proposed undertakings within the Dallas Floodway (Figure 1-1). The Dallas Trinity River Floodway (Dallas Floodway) includes levees, the river channel, six pumping plants, seven pressure sewers, and numerous gravity sluices, and extends from the Loop 12 crossings of the West and Elm Forks of the Trinity River to the existing Atchison, Topeka & Santa Fe (AT&SF) Railroad Bridge. Between 1928 and 1932, the Dallas County Levee Improvement District (DCLID) originally constructed levees to protect the city of Dallas from riverine flooding (Figure 1-2). The DCLID relocated the confluence of the West and Elm Forks and either filled the remnant channel or set it aside for sump storage. To reduce flooding the USACE made significant improvements to the levees and the interior drainage system in the 1950s. Twenty-two bridges constructed between 1911 and the present also cross the floodway providing transportation corridors between downtown Dallas and west Dallas.

Section 405 (a) of the 2010 Supplemental Disaster Relief and Summer Jobs Act (Public Law 111-212) states that the Army is not required to make determinations under the National Historic Preservation Act for the Dallas Floodway project. USACE Implementation Guidance dated 19 October 2010 further directs the Fort Worth District not to make determinations under the National Historic Preservation Act (NHPA) and to examine the Dallas Floodway Project as a engineering system with a discussion of the cultural resource's significance without making explicit references NHPA eligibility criteria. This study fulfills the USACE requirement to identify historic and cultural resources within the context of the scope of impacts that must be analyzed under NEPA. The USACE Implementing Guidance on Public Law 111-212 and the subject section of the law is contained in Appendix G.

Any project within the Dallas Floodway potentially could affect historic and cultural resources defined under NEPA. This study fulfills the USACE requirement to identify historic and cultural resources under NEPA; the USACE will consider the project's impacts on historic resources in a separate report. This investigation will analyze whether the Dallas Floodway is an important historic and cultural resource by considering four types of significance. As part of this consideration, it is appropriate that the floodway system be considered holistically rather than through a piecemeal approach. To this end, this evaluation encompasses the entire Dallas Floodway system, including all physical features.

This report is a cultural inventory and evaluation of engineering components associated with the Dallas Floodway. It includes a historic context of the floodway as a flood control system and as the outgrowth of community planning. The historic context investigates the Dallas Floodway as a part of the larger Dallas Trinity Reclamation Project (1908–1959). The Dallas Trinity Reclamation Project was a massive public works project that changed the landscape of the city of Dallas. Conceived in the early part of the twentieth century, it moved the Trinity River, reclaimed swamplands for private commercial and industrial

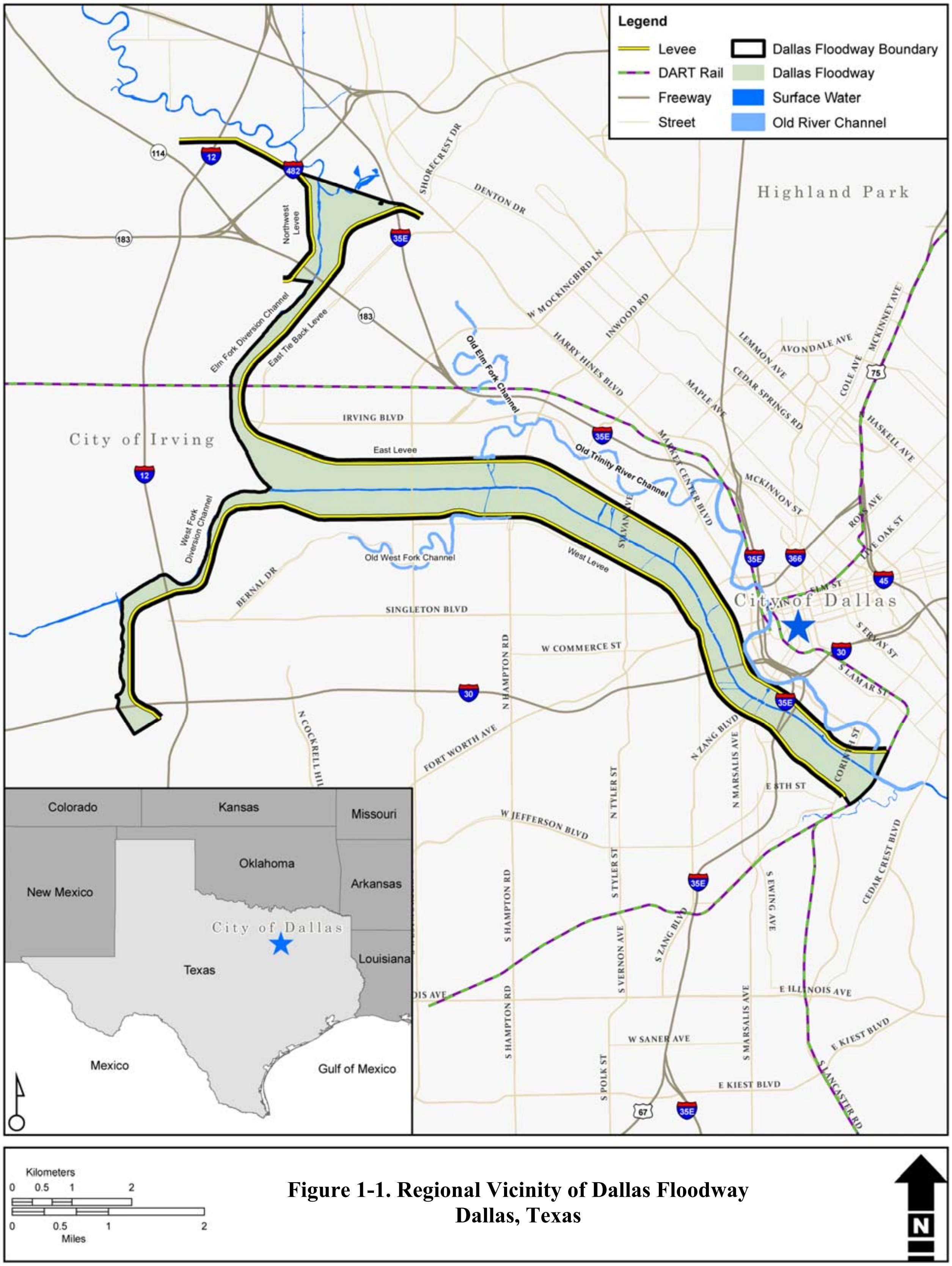

Figure 1-1. Regional Vicinity of Dallas Floodway
Dallas, Texas

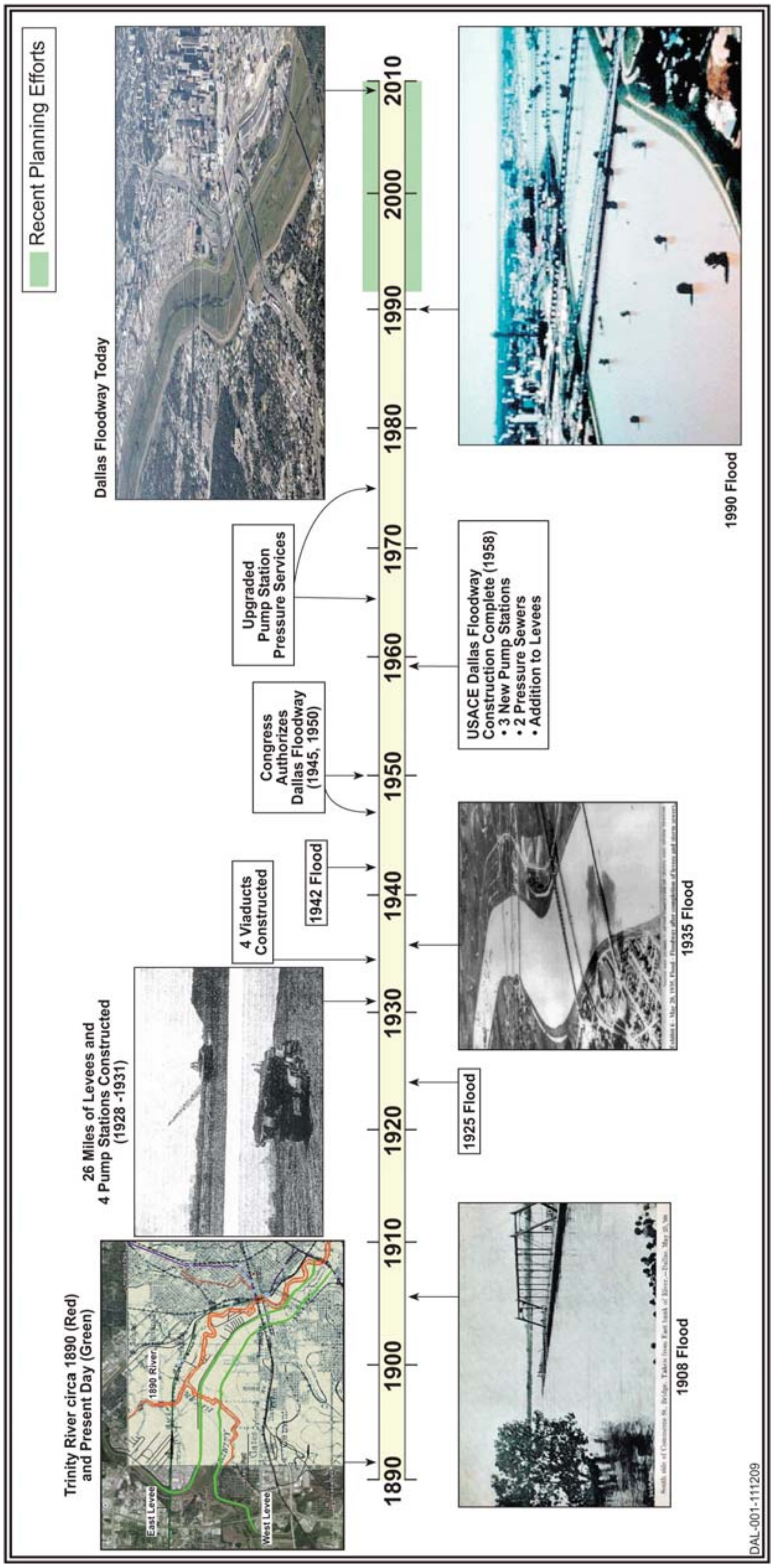

Figure 1-2. History of the Dallas Floodway

development, and provided flood control that played a significant role in creating modern Dallas. Constructed in the late 1920s and early 1930s, it was one of the largest public works projects in the country at that time. The major components of the Reclamation Project are the Dallas Floodway and its system of levees, pump stations, sluices, and pressure sewers.

This context is then used to identify the appropriate floodway's hydraulic physical features, record the current condition of each hydraulic feature, and evaluate the collective historical significance of the features and the system as a whole according to four types of significance. Although other historic contexts could be constructed, such as the history of transportation and the evaluation of bridges and roadways in the area, this report will concentrate on the features associated with flood control and the importance of taming the Trinity River to the development of the city of Dallas.

1.2 ORGANIZATION OF THE DOCUMENT

This report is organized into seven chapters and seven appendices. Chapter 1, Introduction, discusses the purpose for the intensive inventory. Chapter 2, Project Setting, describes the physical and cultural setting of the survey area. Chapter 3, Research Design, puts forward the goals and objectives, the previous investigations in the area, and the archival, survey, and evaluation methods used in the study. A detailed historic context of the development of flood control systems and community planning for the Dallas Floodway is presented in Chapter 4. Chapter 5, Survey Results and Evaluation, presents the physical features of the Dallas Floodway with descriptions of physical features, materials, construction, character-defining features, and current conditions. These resources are evaluated according to four types of significance and whether they retain the ability to convey significance to an observer. The Conclusions and Recommendations, Chapter 6, present the findings and recommendations. References are presented at the end of the main body of the report. The appendices include panoramic photographs of the Dallas Floodway from March 2010 (Appendix A), the report preparers and contributors (Appendix B), the May 1960 USACE Fort Worth District Operation and Maintenance Manual for the Dallas Floodway (Appendix C), 1929 construction drawings of the Dallas Floodway (Appendix D), the National Historic Civil Engineering Landmark Nomination Form for the Dallas Floodway (Appendix E), the historic and cultural resource inventory form on the floodway (Appendix F) and the Implementing Guidance and Section 405 (a) of Public Law 111-212 (Appendix G).

View of Downtown Dallas from the Levees

Project Setting

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CHAPTER 2. PROJECT SETTING

This chapter provides the environmental and historical setting for the Dallas Floodway. It includes discussion of the physical setting of the Dallas Floodway, current components of the floodway system, physical characteristics of the Trinity River, the levees, and the interior drainage system, and a general history of the development of the city of Dallas. Specific details of the historic development of flood control and community planning associated with flood management are presented in the historic context in Chapter 4.

2.1 ENVIRONMENTAL SETTING

The city of Dallas is located in north-central Texas, bisected by the Trinity River. The Dallas Floodway includes the area bound by the Loop 12 crossing of the Elm Fork and the Interstate Highway (IH) 30 crossing of the West Fork (river mile 505.50) to the AT&SF Railroad Trestle crossing over the Trinity River (river mile 497.92) (see Figure 1-1).

2.1.1 Trinity River

The Trinity River is 715 miles long and flows entirely within the state of Texas. It originates in extreme north Texas, a few miles south of the Red River, and empties into Galveston Bay, just east of Houston. Within the project area, the Trinity River channel has an average depth of 25 feet and an average bottom width of 50 feet, providing a maximum design conveyance capacity of 13,000 cubic feet per second (cfs). Flows above this level spill out of the defined channel and into the Dallas Floodway.

Flows measured in the Trinity River range from the record low flow of 4,540 cfs (1978) to the record high flow of 184,000 cfs (1908). The total drop in river elevation in the Dallas Floodway is approximately 3 feet. At the confluence of the West and Elm Forks of the Trinity River, the Trinity River watershed is approximately 6,100 square miles. Upstream of Dallas, 15 reservoirs regulate the flow of the Trinity River (City of Dallas 2008a).

The Trinity River has experienced dramatic change over the past century, as regional authorities have relocated, channelized, and managed it. In addition, the watershed has experienced significant changes in land cover and land use, resulting in changes to river hydrology. The most rapid and extensive changes occurred during the construction of the original Dallas Floodway in the late 1920s, and then again during the subsequent USACE floodway strengthening in the mid- and late-1950s.

The Trinity River has produced significant flooding in Dallas, most notably in 1822, 1841, 1866, 1871, 1890, 1908, 1925, 1935, 1942, and 1990. The flood of 1908 resulted in the loss of five lives and $2.5 million in damage and was the impetus for initial efforts to control the Trinity River through the city of Dallas.

2.1.2 Dallas Floodway

The Trinity River was vital to the early development of Dallas (Figure 2-1). However, numerous large floods, including the catastrophic 1908 flood, led the city and county of Dallas to seek protection from the Trinity River. Between 1928 and 1931, the DCLID constructed levees to protect Dallas from riverine flooding. The DCLID relocated the confluence of the West and Elm Forks and either filled the remnant channel or set it aside for sump storage. In the mid-1940s, major storms, compounded by continued urbanization in the watershed, resulted in severe flooding in the project area.

To reduce the riverine flood risk within Dallas, Congress authorized the flood control project termed the "Dallas Floodway" in 1945, and again in 1950. The USACE built the authorized Dallas Floodway project between 1953 and 1959, which included significant improvements to the levees. The 1950s efforts constitute the Dallas Floodway as it exists today, even in light of the repair and improvement activities performed by the USACE and city of Dallas since 1959. Currently, the Dallas Floodway includes the levees, river channel, six pumping plants, seven pressure sewers, and numerous gravity sluices.

The Dallas Floodway provides flood damage reduction benefits to the Dallas' Central Business District and West Dallas. Specifically, the Dallas Floodway currently protects approximately 10,000 acres of residential and highly developed commercial and industrial property that account for approximately 17 percent of the Dallas tax base. The failure of the Dallas Floodway would result in approximately $8 billion in damages and the inundation of over 10,000 structures, including residences, businesses, schools, and churches.

2.1.3 Levee System

The Dallas Floodway contains 25.4 miles of earthen levees located along both sides of the main stem of the Trinity River and along the Dallas side of the West and Elm Forks of the Trinity River (refer to Figure 1-1).

The downstream end of the 11.7-mile long East Levee is located near the Dallas Area Rapid Transit (DART) Bridge. The upstream end of the East Levee begins at the Union Pacific Railroad embankment near Harry Hines Boulevard and crosses the embankment of IH-35E. The East Levee travels downstream along the Elm Fork, past the confluence of the West and Elm Forks, and down to the DART Bridge. The East Levee terminal section extends perpendicular to the river to high ground directly beneath and alongside the DART Bridge.

The upstream end of the 10.9-mile long West Levee begins at the high ground adjacent to the Loop 12 Walton Walker Boulevard southbound service road south of IH-30 in the Mountain Creek floodplain. The West Levee extends downstream along Mountain Creek floodplain to the confluence of the Elm and West Forks, then southeastward along the main stem of the Trinity River. The West Levee terminal section ties to high ground located approximately 600 feet upstream of the DART Bridge.

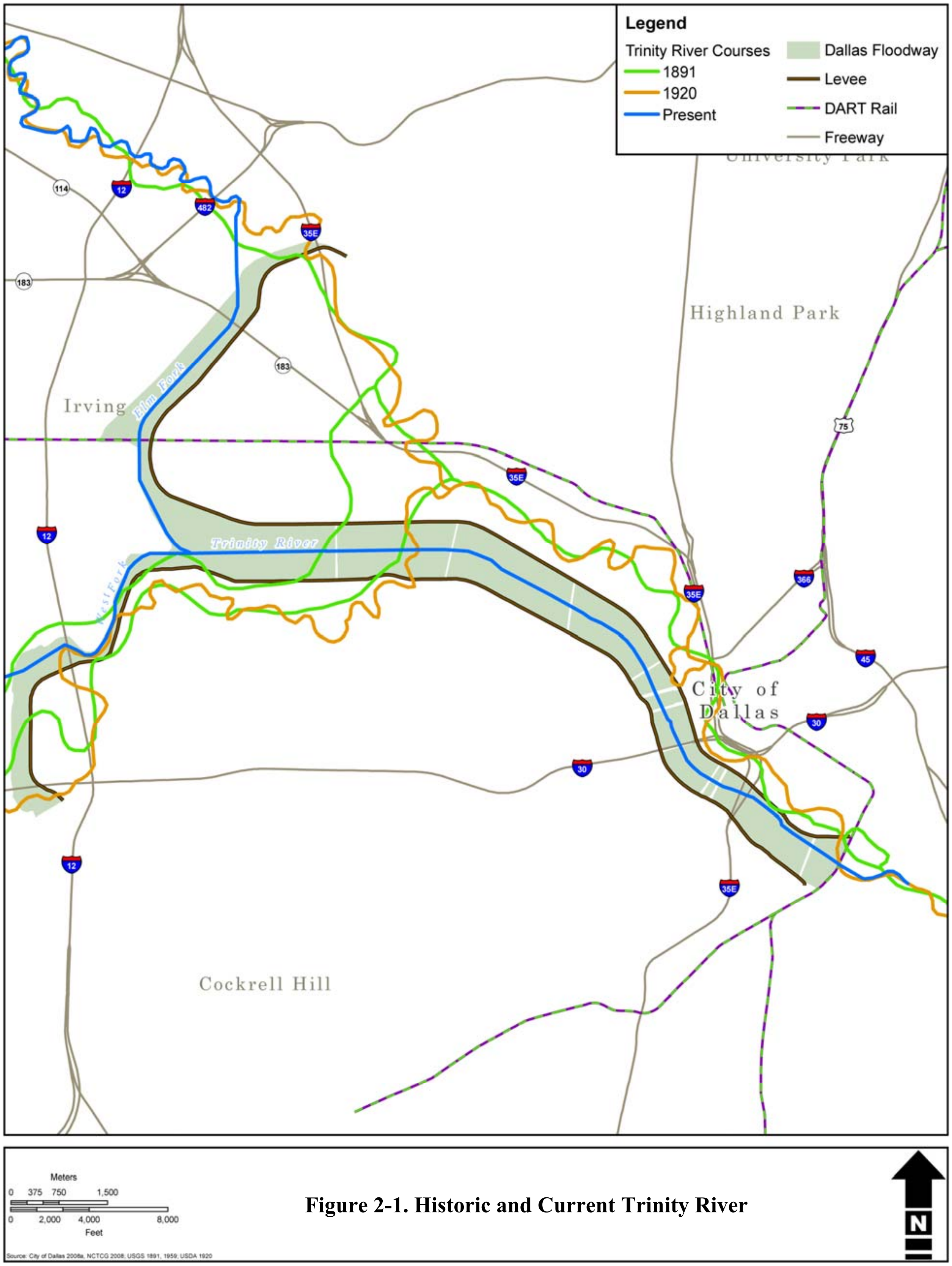

Figure 2-1. Historic and Current Trinity River

The 2.8-mile-long Northwest Levee curves around the city of Irving's eastern edges at the extreme northwest portion of the Dallas Floodway system. The levee wall is located across from the East Tie Back Levee at the west overbank of the Elm Fork diversion channel. Although not part of the Dallas Floodway, it was part of the original Dallas County Levee Improvement District's Plan of Reclamation.

2.1.4 East and West Levee Interior Drainage Systems

The same levees that protect the city of Dallas from Trinity River flooding also block local stormwater runoff from the interior (developed) side of the levee from reaching the Trinity River. Thus, the city of Dallas manages interior drainage by allowing the stormwater runoff to pool in sumps (low areas) in interior areas before pumping or gravity feeding it into the Dallas Floodway. The old Trinity River channel also functions as part of the interior drainage. For the last 75 years, the city of Dallas (in cooperation with the USACE) has employed this strategy for managing stormwater in the East and West Levee Interior Drainage System.

2.2 CULTURAL SETTING

Dallas is the third largest city in Texas in both population and land mass; 1,210,390 people live in an area of 384.7 square miles. Although today Dallas is a well-known metropolis, when the first Spanish explorers visited the area in 1542, only nomadic Native American tribes sparsely populated the region.

2.2.1 Early History of Dallas and the Beginnings of Transportation (1830–1865)

Since 1500, six different governments have claimed Texas: Spain, France, Mexico, the Republic of Texas, the Confederate States of America, and the United States. As early as 1519, a Spanish explorer mapped the Texas coastline, and in 1542, the first Spanish explorers entered the area now known as Dallas. The Spanish founded their first mission near present day El Paso in 1682. In 1813, the Spanish government allowed a U.S. citizen, Moses Austin, to form a colony of Anglo-Americans within Texas. The Spanish laid claim to Texas until Mexico won its independence in 1821. Upon seizing control of Texas, Mexico agreed to allow Stephen F. Austin, the son of Moses Austin, to bring 300 families to Texas. Due to the increasing numbers of non-Mexican settlers moving to Texas, by 1830 the Mexican government passed a law precluding any American citizen from settling in Texas without the express written permission of the government.

The Texas Revolution, a result in part of Mexican policies of immigration, began in 1832, although full-fledged violence did not break out until the battle at Gonzales in 1835 when Mexican troops attempted to retrieve a canon they had placed at Gonzales to help with the defense of the settlement from Native American raids. The Anglo settlers declared independence in 1835, establishing Texas as an independent country and allowing for further settlement of the area by U.S. citizens. One settler, John Neely Bryan, followed the old Indian Trail from Arkansas to the Trinity River, stopping around the Three Forks area sometime around 1839. Due to the size of the river, Bryan, a land speculator, believed he found the perfect location for a trading fort that would have a navigable waterway with access to the Gulf of Mexico.

Bryan returned to Arkansas to gather supplies for his trading fort and upon returning to the area learned that the Republic of Texas had removed the Native American tribes he intended to trade with from the area. The trading fort was no longer a viable option, thus Bryan turned his focus toward creating a town. Nearby settlers were invited to move to this new town, and five people chose to take Bryan up on his offer. The Texan Emigration and Land Company contracted with the Republic of Texas to bring 600 families to settle on a land grant encompassing areas in present-day Dallas, Denton, Cooke, Collin, Grayson, Ellis, and Wise counties (Cliff et al. 1999). Known as Peter's Colony, this area north of Dallas, was settled and occupied until 1852 when settlers took up arms to keep the title to their lands.

Following the official annexation of Texas to the U.S. in 1846, settlers in the Dallas area joined other Texans and the U.S. military in fighting in the Mexican-American War over land disputes in Texas. The next year, Dallas County was divided from a larger county, with Bryan's settlement as its county seat. In 1849, the California Gold Rush boomed, and Dallas became a base for those trying to cross the Trinity River on their way to the gold fields of California. Dallas' selection as county seat in 1850 was critical to the growth of Dallas and its becoming the dominant town in the county. The courthouse was a center of activity for the county.

By the 1850s, businesses and industry (on a small scale) were developing in Dallas' largely agricultural region. The first factory in Dallas was opened by a French immigrant and made carriages and wagons. A general store, picture gallery, hotel, insurance agency, a boot and shoe shop, a milliner, two brickyards, and two saddle shops were also opened at this time (Hazel 1997).

Dallas' business leaders in the 1850s were the Cockrells. Alexander Cockrell built a covered toll bridge over the Trinity River. He also built a steam sawmill at the foot of Commerce Street. The need for buildings and the availability of sawn lumber created a demand for contractors, mechanics, carpenters, and masons. All of this activity brought business to hotels and boarding houses, general stores, and saloons. In 1855 the two-room log courthouse was replaced with a two-story brick structure.

During the 1850s, the city of Dallas was separated from nearby settlements by the Trinity River because of the inability to safely and easily cross the waterway. As such, in 1855, the first permanent wood bridge was built across the Trinity River near the current-day Commerce Street Viaduct. This bridge, constructed by Alexander Cockrell and the Dallas Bridge and Causeway Company, allowed the people of Dallas to have easy access to their counterparts on the eastern banks of the river. This bridge was replaced in 1872 by an iron bridge, which the city of Dallas purchased in 1882, making it the first free bridge across the Trinity (Federal Highway Administration [FHWA] et al. 2008).

French, Belgian, and Swiss immigrants colonized a settlement known as La Reunion in 1855. Located three miles west of Dallas along the West Fork of the Trinity River, this new settlement did not prosper and was officially disbanded in 1867, with many of the residents moving to Dallas (Shanabrook et al. 2001). Slavery was another issue in Dallas during the mid-1800s. Many of the settlers in the region were southerners and supported slavery, leading to Texas's decision to secede from the United States in 1861. Although a number of Texas residents joined the Confederate Army, no battles occurred in Dallas.

Additionally, due to the lack of newsprint, which forced the *Dallas Herald* to stop publishing the news, residents of the Dallas area did not hear of the emancipation of 1863 until the Union Army occupied the area in 1865 (Shanabrook et al. 2001).

In 1860, twenty-five buildings in Dallas burned down including the stores, the hotels, the *Dallas Herald* office, and the post office while the brick courthouse was spared. Rebuilding began immediately. The people of Dallas envisioned more substantial stone or brick (preferably fireproof) buildings. Between 1860 and 1890 hundreds of Italianate commercial structures were built in Dallas. Some of these buildings can still be seen in parts of downtown Dallas. In the late 1880s and early 1890s the Romanesque style of architecture became popular for commercial construction.

2.2.2 Trinity River and the Development of the Railroads (1866–1890)

Bryan's idea that the Trinity River could allow for sea traffic from the Gulf of Mexico to Dallas remained in the minds of Dallas residents. In 1866, the state legislature chartered the Trinity Slack Water Navigation Company to improve the Trinity River for smooth navigation between Galveston and Dallas. Although the project did not begin construction, a seven-month-long journey from Galveston to Dallas, undertaken by Captain J. M. McGarvey, showed that while the Trinity River was superior to the upper Red River and upper Mississippi River, regular river service was not a practical endeavor. Despite this, the steamer *Sallie Haynes*, constructed in Dallas, made three trips downriver prior to being sunk; however, no data exist showing the *Sallie Haynes* traveled to Galveston (Cliff et al. 1999).

In the years following the Civil War, Dallas grew in size and prominence due to its location near cattle trails and railroad lines. The Houston & Texas Central Railroad (H&TC, formerly the Galveston and Red River Railroad) reached Dallas in 1872, providing easy access to Dallas from the southern reaches of the state. In 1873, the Texas & Pacific Railway arrived in Dallas, providing travel to the eastern extents of the state. These important rail lines allowed Dallas to acquire the benefits of a large metropolis including a water distribution system, gas lighting, a private telegraph company, telephones, and electricity (Cliff et al. 1999). Population and land value increased, especially near the rail lines. More than 700 buildings were built in a single year during this era, which was dominated by the railroads. The railroad governed the growth pattern of Dallas at this time, and there were few building codes, street designs, or any sort of municipal planning. The H&TC railroad was situated a mile east of the courthouse. Eighty percent of the population lived in a narrow band between these two poles (McDonald 1978). Cotton became the region's main cash crop with its market centered at Elm Street in Dallas. By 1900 one-sixth of the world's cotton was grown within a 150-mile radius of Dallas, and the city was also a leader in the manufacture of cotton gin machinery (Fitzgerald 2001).

When merchants realized that Dallas would be the dominant city for all of north Texas, many built stores in Dallas similar to the department stores of today. New jobs were created for store clerks, bank tellers, and teamsters, and Dallas began to experience a new diversified economy (Hazel 1997). However, despite this diversification the first city directory continued to list more saloons than any other business. An important enterprise in Dallas during the 1870s was the Todd Flour Mills at the corner of Pacific and

Broadway. Founded by Sarah Cockrell and her son, it was the first mercantile mill in Dallas to buy raw wheat from local farmers and market the flour via the railroad for transport (McDonald 1978).

In the 1870s and 1880s the arrival of the railroads created a period of great migration into the city of Dallas, both from people from other parts of the United States and foreign immigrants. Dallas' industries began to increase in size and number. In 1879 the Howard Oil Company built a large cottonseed oil mill at Polk Street. Several other factories and mills were constructed including two more steam flouring mills and two steam-driven corn mills, several broom-making plants, a barrel manufacturer, and several cement plants and brick kilns.

In 1886 a group of Dallas business men received a charter to hold the Dallas State Fair and Exposition. The state fair attracted large numbers of people from throughout the state to the Dallas area and brought business to Dallas' barbers, livery men, saloon keepers, hand and express drivers, restaurants, hotels, and boarding houses. The city purchased the fairgrounds in 1904.

2.2.3 Urbanism and Suburbs (1890–1910)

By 1890 Dallas has most of the features of a major urban center: public utilities, public schools, daily newspapers, and the State Fair (Hazel 1997). Dallas finally had an organized fire department in 1871 (Fitzgerald 2001). The spatial configuration of Dallas was changed with the development of the streetcar. Communities known as The Cedars, Highland Park, and Oak Cliff developed in areas surrounding Dallas. The development of these outlying suburbs, serviced by streetcars, led to a fairly large expansion of the geographic boundaries of Dallas. Dallas encompassed 23 square miles by 1920. Streetcars were especially important during the gas rationing times of World War II. Dallas also changed with the introduction of the automobile, as traffic increased through the city because it was centrally located in the growing national highway system.

The growth Dallas experienced in the 1870s and 1880s as a result of the railroads came to a halt in 1893 with an economic depression that came to be known as the Panic of 1893. Financial credit markets were destroyed, devastating the industrial sectors of the economy. Banks lacked the capital to loan money for any purpose including street railway car and real estate development in Dallas. Cotton prices dropped significantly. For the first time in its history Dallas actually saw a reduction in its population, as some residents left to seek their fortunes elsewhere.

In the early 1900s Dallas was the country's largest distribution center for farm machinery. About 1900, several farm implement dealers began to build warehouses and showrooms north of the courthouse near the intersection of Elm and N. Jefferson. Today this area is known as the West End Historic District.

Dallas' first skyscraper, the fifteen-story Praetorian Building, was built in 1907 and the first Neiman-Marcus store opened in 1907. By the turn of the century, Dallas was the leading book, drug, jewelry, and wholesale liquor market in the Southwest. Dallas was a major printing center in the early twentieth century and published magazines and newspapers distributed throughout the South. The 1910s also brought progress to Dallas. White Rock Lake was constructed and the city's water reservoir and water filtration plant was built in 1911, while Southern Methodist University opened in 1915 (Hazel 1997).

Although Dallas residents began embracing new forms of transportation and business, they continued to attempt to make the Trinity River navigable. In 1899, a plan to construct 37 locks and dams along the river between Dallas and the Gulf of Mexico to allow traffic flow along the river for eight months each year was suggested (Shanabrook et al. 2001). Several other attempts to create successful businesses using the Trinity River ensued before the USACE determined that any efforts to make the Trinity River navigable were impractical.

After the city of Dallas purchased the old Commerce Street Bridge in 1882, the city went on to build two new bridges, one near present-day Cadiz Street, and a second on Zang Boulevard near the present-day Houston Street Viaduct. These three early bridges were designed in a manner that made them susceptible to flooding; even during moderate flooding events bridges and their approaches were submerged. Between 1822 and 1908, the Trinity River flooded seven times, including the devastating flood of 1908. Inundated with water from storms upstream and still saturated from a flood the month before, the floodway was not able to handle the drenching rains that started on May 24, 1908. A three-day period of rain inundated the Trinity River watershed, leading to a flood gage reading of 52.6 feet in Dallas on May 26 (Furlong et al. 2003). Between five and eleven deaths were blamed on the flood and roughly 4,000 people were left homeless. Considered the largest flood ever recorded in Dallas, this single event caused over $2.5 million in damage (the equivalent of $55 million today). Estimates put the Trinity River at two miles wide during the flood, and left Dallas without telephone, telegraph, and rail services, while nearby Oak Cliff was only accessible by boat. The flood's destruction was the driving force behind the decision local business owners made to focus on a flood plan for the city and reduce the possibility of another flood event.

2.2.4 Community Planning and Flood Control (1900–1950)

Located across the Trinity River from Dallas, the town of Hord's Ridge, later renamed Oak Cliff, was established in 1845. The Dallas, Cleburne, and Rio Grande Railway came to the area in 1880 and in 1887 Thomas L. Marsalis and John S. Armstrong purchased several hundred acres to develop into the residential area of Hord's Ridge. Once Marsalis and Armstrong began work on their new community, they renamed the settlement Oak Cliff. The partners intended to turn Oak Cliff into a resort community, but before this could occur, Marsalis and Armstrong ended their partnership. Following the dissolution of the partnership, Marsalis continued to plan the expansion of Oak Cliff and Armstrong went on to form the Highland Park neighborhood. Oak Cliff incorporated into a city in 1890 and had a population of 2,470, a 150-acre park, and the Marsalis Park and Zoo by that time (Nall 2009).

The population growth of Oak Cliff stagnated and plans for the town to become a resort community ceased during the depression of 1893. By the early 1900s, Oak Cliff's population began to expand with an influx of middle and working class families. The citizens of Oak Cliff voted for annexation to the neighboring city of Dallas as early as 1900, and Dallas officially annexed Oak Cliff in 1903. The Flood of 1908 made it apparent to city officials that a permanent all-weather bridge linking Dallas and Oak Cliff was necessary.

Support from local businessmen helped set into motion plans to construct a permanent bridge between Oak Cliff and Dallas. Well-known publisher of the *Dallas Morning News*, George Bannerman Dealey, gathered a group of businessmen and sought the community's help in passing a bond issue to construct a viaduct at Houston Street. Although Dealey's proposal was met with resistance from members of the community who objected to the bridge's $609,797 estimated cost, the bond passed. Construction began on the Dallas-Oak Cliff Viaduct in October 1910. The bridge was completed in February 1912 at a cost of $675,000 (Jackson 1996). With the bridge completed, the city began to develop plans for the river floodway.

Determined to initiate the Dallas Floodway plan, Dealey contacted German born, former Dallas resident, and landscape architect George E. Kessler in 1910. Hired by Dealey to design the State Fairgrounds in 1907, Kessler had worked on several bridge projects in Kansas. Kessler designed a plan for the city that included a levee system for the Trinity River.

The outbreak of World War I delayed any actions concerning the recommended levee system. In 1918, the city asked Kessler to revise and improve his original plan, which would result in a widening of the levees near downtown Dallas and raising the levee height (Furlong et al. 2003). Additionally, Kessler's plan for the city included the creation of two parkways, the purchase of five municipal parks, and the construction of a series of boulevards.

Prohibition in the 1920s put approximately 220 saloons and beer parlors in Dallas in addition to twelve wholesale liquor houses and a brewery out of business. Bootleggers quickly started profitable businesses. The African American population of Dallas grew in the 1920s and housing was in short supply. African Americans established a community, known as North Dallas, located just north of the area around Central Elm Street, which was known as Deep Ellum (Hazel 1997). North Dallas started as a freedmen's community and developed on either side of the H&TC tracks. Deep Ellum was a commercial/social area (Peter et al. 2000). Elm Street was theatre row in the 1920s with dozens of vaudeville houses and moving picture palaces. Dallas pursued the benefits of commercial air transportation in 1927 when they purchased the Army airfield known as Love Field.

During the 1920s, the city continued to work on the floodway project, and in 1925 the city appointed, the Ulrickson Committee to work on a more detailed version of the Kessler Plan with a focus on flood control. This committee submitted its final report to the city in 1927. The report included a financial plan to build dozens of civic improvement projects, including a levee system and floodway to control 10,500 acres along the Trinity River and establish storm sewer systems, water works, traffic ways, and additional beautification (Furlong et al. 2003).

After purchasing the necessary property for the levees, the city began construction on the Dallas Floodway in July 1928. The undertaking became one of the largest projects in the country during that year (Furlong et al. 2003). Completed in 700 working days, the levee project entailed the relocation of utilities, streetcars, oil and gas lines, water lines, and sewer lines for the 26-mile total length of the new levee system. As part of the levee construction, the confluence of the Trinity River was moved three-and-one-half miles west of its original location and the Trinity River channel was straightened as part of the project, necessitating an additional expenditure of $100,000 to strengthen the sidewalls and rails of the Houston Street Viaduct (Jackson 1996). The levee's infrastructure included four pump stations, and three pressure sewers.

Four new viaducts were constructed using Dallas County funds to span the floodway and connect Dallas with Oak Cliff and other communities located on the west side of the Trinity River. These four viaducts were the Corinth Street, Cadiz Street (now the eastbound side of the IH-35 Bridge), Commerce Street, and the Lamar-McKinney (now the Continental Street). Constructed by Dallas County, all four viaducts were designed by consulting engineer Francis Dey Hughes. Although Hughes had no formal education in engineering, he began working as an engineer as early as 1897 (Jackson 1996). Shortly after moving to Dallas in 1928, the city awarded Hughes the contract for the four viaducts on the Trinity River in Dallas. Although Hughes' four new viaducts were not identical, they are very similar in style as each features a reinforced concrete-and-steel framework and identical light standards.

While the floodway was being constructed, Dallas' skyline was also growing. The 29-story Magnolia building was completed in 1921. Downtown streets became lined with multi-story bank and office buildings. Construction of the levee system opened up thousands of acres for new development in Dallas along the Trinity River, an area which became known as an industrial district.

Dallas, like many American cities was impacted by the Great Depression. The city undertook a number of projects to create jobs, including the construction of the viaducts over the Trinity River and the development of land reclaimed by the levee project (Hazel 1997). Although no oil was ever discovered in Dallas County, Dallas benefited by the discovery of oil in East Texas in 1930. The city was a convenient location for the headquarters of oil producers, investors, promoters, contractors, and corporations. By the early 1940s, 18 to 20 percent of those living in the Dallas area depended on the oil industry for their income (Hazel 1997).

In 1936 Dallas hosted the Texas Centennial Exposition, celebrating the state's 100 years of Texas independence from Mexico. Fair Park, the location of the State Fair, was transformed over a period of 18 months as laborers and artists began constructing or remodeling 77 buildings, including museums. Six million visitors passed through Dallas for the exposition. This undertaking gave a substantial boost to the local economy.

In 1946, the Dallas County Flood Control District was established to protect state resources (highways, bridges, government buildings and facilities) and control the maintenance of the levees (Furlong et al. 2003). During this same time, the United States Congress authorized the USACE to help repair and reconstruct the Dallas Floodway in response to a 1948 report by the USACE that cited the levees poor condition and a need for improvements. The Dallas County Flood Control District advised the USACE to follow the original 1932 levee plans in order to abate the possibility of high costs and delays in the schedule.

The 1949 flood of the Trinity River led to Congress commissioning a new USACE District in Fort Worth, which opened in 1950. The new flood control district controlled all levee projects in Dallas and Fort Worth, and oversaw reservoir projects in the surrounding areas. The district produced six project reports detailing plans to strengthen components of the Dallas Floodway. Construction of the USACE's project for the Dallas Floodway began in 1953 and was completed in 1959. The project included building three new pump stations and two new pressure sewers. Additionally, the river channel was moved 100 feet to the west of its original path between the Belleview Pressure Sewer and the Cadiz Street Viaduct. Construction reduced the levee width by 30 feet and was accomplished by adding four feet of new fill to the riversides of the levees (Furlong et al. 2003).

2.2.5 World War II and Urbanization (1940–present)

During World War II many of Dallas' minorities joined the armed forces, and factories, such as the Ford Motor Plant, converted to war time production and began to hire women (Hazel 1997). The postwar period was a time of rapid growth for Dallas. Between 1940 and 1960 Dallas' incorporated land mass nearly doubled to 90 square miles. From 1945 to 1955, 151,000 new jobs were created in Dallas, resulting in the construction of 105,000 dwellings, 350 churches, 36 schools, and 25 major office buildings. During this era of new growth, Dallas experienced a dramatic change in the course of history. On November 22, 1963, the motorcade carrying President John F. Kennedy came under fire as it turned down Elm Street at Dealey Plaza. President Kennedy was assassinated during the attack, and Dallas was labeled the "city of hate" and had a marked stigma due to the assassination (Hazel 1997).

As Dallas grew, Dallas and Irving took control of the responsibilities of the Dallas Floodway upon the expiration of the Dallas County Flood District in 1968. Each city became responsible for the portion of the floodway within their city boundaries, while the USACE retained its oversight and inspections of the entire length of the floodway.

By 1980 continued migration to Dallas increased its population to 904,078. Dallas dramatically expanded its boundaries to include 378 square miles. Farmland that surrounded Dallas was transformed into suburbs. Much of Dallas' historic architecture was lost to modern development, although the West End warehouse district on the edge of downtown was revived by historic preservationists and Deep Ellum became an eclectic mix of galleries, clubs, and dining spots (Hazel 1997).

Today Dallas' economy is dominated by electronics and other high-tech industries (Fitzgerald 2001). Most of the downtown businesses have been replaced with high-rise office buildings. Interstate highways have replaced railroads as the prime mover for goods and people in the Dallas area.

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Research Design

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CHAPTER 3. RESEARCH DESIGN

This chapter presents the research design developed for this intensive-level survey. The research design sets forth the objectives of the survey and describes the activities undertaken to accomplish the survey goals. The scope and nature of this survey was based upon knowledge of the survey area's properties; therefore, the research design also describes previous research and survey efforts involving the cultural resources of the Dallas Floodway.

3.1 OBJECTIVES OF THIS INVESTIGATION

The purpose of this survey is to provide information for compliance with NEPA. The goal of this survey is to identify, document, and evaluate whether the engineering resources in the Dallas Floodway meet the definition of a historic and cultural resource as defined by NEPA so that environmental impacts of the Dallas Floodway Project may be assessed.

3.2 PREVIOUS HISTORICAL/ARCHITECTURAL INVESTIGATIONS

TEC conducted a search of the USACE files in November 2009 to identify previously recorded cultural resources within the floodway. Additionally, the Texas Archaeological Sites Atlas Database was searched to identify archaeological sites within and near the project. The search parameters encompassed the entire floodway system, including the east and west levees. The search identified 19 previously undertaken surveys (Table 3-1) and a total of 33 previously recorded sites (Table 3-2).

The 33 previously identified cultural resources within the floodway include the pumping plants, pressure sewers, levees, and sluices associated with the water control features of the floodway. Additionally, one prehistoric and eight historic archaeological sites have also been identified through survey in the floodway.

Table 3-1. Previous Cultural Resources Surveys of the Dallas Floodway

Authors	*Title*	*Date*
Cliff, Maynard B., Steven M. Hunt, Marsha Prior, Steve Gaither, and Whitney Autin.	Archaeological Architectural, and Geoarchaeological Investigations of the Proposed Dallas Floodway Extension Project, Dallas County, Texas	1998
Burson, Elizabeth and Maynard B. Cliff	Cultural Resources Survey of the Proposed Environmental Restoration Areas Along the Old West Fork of the Trinity River, Dallas County, Texas	1999
Cliff, Maynard B., David Shanabrook, Steven M. Hunt, Whitney Autin, and Marsha Prior	Buried Archaeological Site Potential in the Dallas Floodway Project Area	1999
Buysse, Johnna L.	An Evaluation of Sites Within the Proposed Dallas Floodway Extension Project, Dallas County, Texas	2000
Norman Alston Architects	Cultural Resource Review for the Environmental Impact Statement Areas of Potential Effect of the Trinity River Parkway, Dallas, Texas	2000
Norman Alston Architects	Historic Resource Survey of the Building Displacements of the Trinity River Parkway, Dallas, Texas	February 2001

Table 3-1. Previous Cultural Resources Surveys of the Dallas Floodway

Authors	*Title*	*Date*
Shanabrook, David, Duane E. Peter, and Steven M. Hunt	Geoarchaeological Investigations of Wetland Cell D within the Dallas Floodway Extension Project Area, Dallas, Texas	2001
Skinner, Alan S.	The Trinity River Parkway Archival and Archaeological Evaluation Report	2003
Huhnke, Marie, Edward Salo, and Duane E. Peter	A Cultural Resources Assessment of the Potential Impact and Interpretive Potential of the Trinity River Interpretative Center and Associated Facilities, Great Trinity Forest, Dallas County, Texas	2003
Green, Melissa M., and Duane E. Peter	Assessing the Potential for Intact Archaeological Deposits Within the Pegasus Project: Reconstruction of the IH-30/IH-35E Corridor (Canyon/Mixmaster/Lower Stemmons) in Dallas County, Texas	2003
Texas Department of Transportation, Dallas District	Project Pegasus Historic Resources Survey Report	March 2004
Carter and Burgess	City of Dallas, Interior Levee Drainage Study – Phase I, Volume 1 of 2 – Report	September 2006
Frederick, Charles D., Lance K. Trask, and Alan S. Skinner	Archaeological Testing for the Trinity Parkway	2006
Skinner, Alan S.	Draft Archaeological Testing Report for the Trinity Parkway	2006
Sundermeyer, Scott A. and Charles D. Neel	Intensive Archaeological Resources Investigations of the Santa Fe Trestle Trail Borrow Pit, Dallas County, Texas	2007
Trask, Lance K., Jesse Todd, and Alan S. Skinner	Archaeological Testing of Site 41DL441 for the Trinity Parkway in Dallas, Dallas County, Texas	2008
Federal Highway Administration	Supplemental Draft Environmental Impact Statement & Draft Section 4(f) Evaluation, Trinity Parkway from IH-35E/SH-183 to US-175/SH-310 Dallas County, Texas	October 2008
Thomas P. Eisenhour, Ecological Communications Corporation	Non-Archaeological Historic-Age Resource Reconnaissance Survey Report Trinity Parkway: From IH-35E/SH 183 to US 175/SH 310 Dallas County, TxDOT Dallas District	October 2009
Shanabrook, David, and Melissa M. Green	Analysis of Geotechnical Core Samples for the Sylvan Avenue Bridge Replacement over the Trinity River (CSJ 0918-45-669), Dallas, Dallas County, Texas	2009

Table 3-2. Previous NRHP Evaluations of Cultural Resources of the Dallas Floodway

Resource	*Date Built*	*Previous Evaluation*	*NRHP Eligibility*
All Levee Sides	1929	FHWA/Pegasus Project 2004	Not Eligible
East Levee	1929–1932; 1954	USACE 2009a (made prior to PL 111-212)	Eligible (Criterion A - Association with Events)
West Levee	1929–1932; 1954	USACE 2009a (made prior to PL 111-212)	Eligible (Criterion A - Association with Events)
Pumping Plant A (Able)	1929	FHWA/North Texas Tollway Authority 2009	Not Eligible
Pumping Plant A (Able)	1956	FHWA/North Texas Tollway Authority 2009	Not Eligible
Pumping Plant B (Baker)	1929	Norman Alston Architects 2001; FHWA/North Texas Tollway Authority 2009	Eligible (Criterion A and C - Associations with Events and Design)
Pumping Plant B (Baker)	1975	USACE 2009a (made prior to PL 111-212)	Not Eligible
Pumping Plant C (Charlie)	1929	FHWA/North Texas Tollway Authority 2009	Not Eligible

Table 3-2. Previous NRHP Evaluations of Cultural Resources of the Dallas Floodway

Resource	*Date Built*	*Previous Evaluation*	*NRHP Eligibility*
Pumping Plant C (Charlie)	1956	FHWA/North Texas Tollway Authority 2009	Not Eligible
Pumping Plant D (Delta)	1929	FHWA/North Texas Tollway Authority 2009	Not Eligible
Pumping Plant D (Delta)	1956	FHWA/North Texas Tollway Authority 2009	Not Eligible
Pavaho Pumping Plant	1954	FHWA/North Texas Tollway Authority 2009; USACE 2009a (made prior to PL 111-212)	FHWA –Not Eligible; USACE –Eligible (Criteria A and C Associations with Events and Design)
Pavaho Pumping Plant	1975	FWWA/North Texas Tollway Authority 2009	Not Eligible
Hampton Road Pumping Plant	1956	FHWA/North Texas Tollway Authority 2009	Not Eligible
Hampton Road Pumping Plant	1975	FHWA/North Texas Tollway Authority 2009	Not Eligible
Elm Fork Sluice*	1928–1931	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Turtle Creek Pressure Sewer*	1953	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Dallas Branch Pressure Sewer*	1932	FHWA/North Texas Tollway Authority 2009*	Not Eligible
East Bank Interceptor*	1950s	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Belleview Pressure Sewer*	1928–1931	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Eagle Ford Sluice*	1928–1931	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Canada Drive Sluice and Dike*	1950s	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Coombs Creek Pressure Sewer*	1928–1931	FHWA/North Texas Tollway Authority 2009*	Not Eligible
Lake Cliff Pressure Sewer*	1952–1955	FHWA/North Texas Tollway Authority 2009*	Not Eligible
41DL64	Unknown	Unknown	Not Eligible
41DL220	Historic – Well and House Site	Tom Jamison 1981	Not Eligible
41DL320	Historic – Dump Ground	ARC Cultural Resource Recovery 91-6 1991	Not Eligible
41DL323	Historic – Proctor Street Bridge	OAS Stewards 1991	Not Eligible
41DL370	Historic – Well and Refuse Dump	AR Consultants 1995	Not Eligible
41DL371	Historic – Refuse Dump	AR Consultants 1996	Not Eligible
41DL414	Historic – Santa Fe Bridge	TASN, Dallas Arch. Soc. 2000	Eligible(Criterion C - Association with Design)
41DL440	Historic – Trash Dump	Skinner 2006	Unknown
41DL441	Prehistoric – Hearth	Skinner 2006	Unknown

** Individually named sluices, pressure sewers, dikes, and interceptors were evaluated collectively in the 2009 report by FHWA/North Texas Tollway as part of one resource called "Associated sluices, sluice gates, pressure sewers, and interceptors."*

Pegasus Project

The Pegasus Project, completed in 2004 by qualified historians for the Texas Department of Transportation (TxDOT) in coordination with FHWA, evaluated the East and West Levees, but no other physical features of the Dallas Floodway system. It was determined at that time, and concurred by the Texas State Historic Preservation Officer (SHPO) that the levees were not eligible for inclusion in the NRHP. The survey found that the 1950s alterations compromised the integrity of the original levees. The report concluded that both levees were ineligible due to the 1950s USACE modifications to the original levees since, at the time of the Pegasus Project, the 1950s work was not 50 years old and did not meet the criteria for exceptional significant.

Norman Alston Architects

Architectural resources located within the survey area were evaluated between 2000 and 2009 for their eligibility for inclusion in the NRHP. In 2000 and 2001, Norman Alston Architects conducted a number of surveys of the Trinity River floodway area. It was determined that Pumping Plant B (Baker) was eligible for nomination under Criterion A for its contribution to historic events and Criterion C for architectural merit. This finding was concurred by the Texas SHPO in 2009 following a secondary report completed by Joseph Murphey of the USACE Fort Worth District prior to passage of PL 111-212.

Non-Archaeological Historic-Age Resources Reconnaissance Survey Report

The remaining architectural resources were evaluated in the *Non-Archaeological Historic-Age Resource Reconnaissance Survey Report* by the North Texas Tollway Authority and FHWA in October 2009. This survey upheld the previous eligibility determinations and recommended that the remaining Pumping Plants A, C, D, Hampton, and Pavaho are not eligible for nomination to the NRHP. Additionally, this report states that all associated sluices, pressure sewers, and interceptors are not eligible for nomination to the NRHP.

Although the three previous investigations above resulted in determinations that certain components of the Dallas Floodway system are ineligible for inclusion in the NRHP, in a letter dated November 13, 2009, the Texas SHPO expressed objections to these determinations in the FHWA's *Non-Archaeological Historic-Age Resources Reconnaissance Survey Report* (Eisenhour 2009). The SHPO requested reconsideration of the Dallas Floodway by defining its period of significance and evaluating the integrity of the system's components, particularly the levees, and requested the further development of the floodway's mid-century historic context in a reevaluation of the floodway's historic significance and eligibility to the NRHP. The SHPO also requested that the entire Dallas Floodway system, including the levees, open spaces between the levees, diversion channels, pumping plants, pressure sewers, sluices, and interceptors, be included in the reevaluation in order to address the entire floodway as a whole (Texas Historical Commission [THC] 2009).

Previously identified historic and cultural resources within the Dallas Floodway include historical wells, refuse dumps, and bridges. Twenty-two bridges cross the Trinity River within the Dallas Floodway (Table 3-3). Nineteen of these bridges are dedicated to vehicular travel and three are railroad bridges, the

AT&SF, the Union Pacific (formerly the Southern Pacific), and the DART. The AT&SF Railroad Trestle is currently closed to railroad traffic and is not in use.

Table 3-3. Previous Assessments of Bridges over the Dallas Floodway

Site Description	Date of Construction	Eligibility for the NRHP
AT&SF Railroad Trestle	1926	Eligible under Criterion C
DART Bridge	1992	Not Eligible
Corinth Street Viaduct	1931	Eligible under Criterion A
Cadiz Street Viaduct (eastbound side of IH-35E/U.S. 67/U.S. 77)	1929–1931	Not Eligible
IH-35E/U.S. 67/U.S. 77 Westbound Bridge	Circa (ca.) 1956	Not Eligible
Jefferson Viaduct	1975	Not Eligible
Houston Street Viaduct	1911	Listed on the NRHP (August 9, 1984)
IH-30 (Tom Landry Hwy) Bridge	Ca. 1960	Not Eligible
Commerce Street Viaduct	1930	Eligible under Criteria A and C (2001)
Union Pacific Railroad Bridge (formerly the Southern Pacific Railroad Bridge)	Pre-1930	Eligible under Criterion C
Margaret Hunt Hill Bridge	Under construction	Not applicable (N/A)
Continental Street Viaduct (formerly the Lamar-McKinney Viaduct)	1934	Eligible under Criteria A and C s (2001)
Sylvan Avenue Bridge	1958	Not Eligible
Hampton Road Bridge	Currently undergoing reconstruction	Not Eligible
Westmoreland Road Bridge	1990	Not Eligible
SH 356 Bridge	1963	Not Eligible
Chicago, Rhode Island, and Pacific Railroad Bridge/DART Bridge	Ca. 1930s; later alterations	Eligible under Criterion C
Proctor Street Bridge	Ca. 1930s	N/A (Demolished in mid-1980s; remnants only)
SH 183 (J. W. Carpenter Fwy) Bridge (over West Levee and Northwest Levee)	1959	Not Eligible
Stemmons Fwy/U.S. 77 Bridge	Ca. 1959	Not Eligible
SH 482 (Storey Ln) Bridge (over Northwest Levee)	1942, 1982	Not Eligible
Loop 12 (Walton Walker Blvd) Bridge (over West Levee and Northwest Levee)	1969	Not Eligible

Seven of the 22 bridges have been previously evaluated and determined eligible for inclusion to the NRHP. One of these seven bridges, the Houston Street Viaduct, is currently listed on the NRHP. The seven historic bridges are the AT&SF Railroad Trestle, Union Pacific Railroad Bridge, Houston Street Viaduct, Commerce Street Viaduct, Corinth Street Viaduct, Continental Street Viaduct, and Chicago, Rhode Island, and Pacific Railroad Bridge/DART Bridge. Thirteen bridges have not been evaluated for their NRHP eligibility. One bridge, the Proctor Street Bridge, has been demolished, and one bridge, the Margaret Hunt Hill Bridge, is currently under construction.

3.3 METHODS

The goal of this investigation is to conduct an intensive-level survey and significance evaluation of the Dallas Floodway as required by NEPA to identify historic and cultural resources. Four tasks were required to achieve the project objectives: 1) literature review, 2) archival research, 3) field survey, and 4) data analysis. A literature review of secondary sources was conducted to gain an understanding of the development of the project area. Archival research was conducted to identify changes to the floodway since its construction and to develop the historic context for the evaluation of floodway. The field survey collected information on the design, materials, construction, and condition of the floodway as a whole system and its individual structural components. The archival and field data were then synthesized and analyzed to evaluate the historic significance of the floodway as required under NEPA to assess environmental impacts.

3.3.1 Literature Review

To understand the development of the project area TEC staff reviewed secondary sources on the history of Dallas. The *Handbook of Texas Online* gave researchers an overview of the history of the area. Other resources consulted included the *Dallas Morning News*, *Dallas Then and Now*, *A History of the Big 'D',* and *Dallas Rediscovered: A Photographic Chronicle of Urban Expansion 1870–1925*. This review revealed that commerce, industry, transportation, and urban planning were dominant themes in the development of the project area. Based on this background research, historians developed basic historic contexts of the project area, summarized in Chapters 2 and 4. These chapters also incorporate historical information and data set forth in the "USACE Section 106 Compliance Efforts for the Dallas Floodway," developed in November 2009 (USACE 2009b).

3.3.2 Archival Research

During the initial site visit to the project area on December 16–19, 2009, archival resources at the Dallas Public Library were reviewed. Joseph Murphey, Historic Architect, USACE Fort Worth District, and Don Lawrence, Systems Analyst, City of Dallas Flood Control District, were interviewed to obtain information about alterations and other changes to the structures in the floodway. Archival research was undertaken to develop a historic context to aid in the evaluation of the floodway.

During the week of December 14–18, research of primary and secondary source materials was undertaken at the Dallas Public Library and the USACE offices in Fort Worth. Floodway histories, newspaper articles, maps, historical photographs, and inspection reports were consulted. Additionally, the research gathered numerous records and materials about floodway development that are available on the internet.

Additional documentary research was conducted during the field survey in order to obtain additional resource-specific information. As-built drawings of selected floodway structures from the USACE were reviewed, as were operations manuals. These records provided information on the original construction and design of the hydraulic physical features, and aided in evaluating their ability to convey significance to the observer.

3.3.3 Survey Approach

The field survey of the Dallas Floodway was conducted on December 16–19, 2009, and included all visible hydraulic physical features within the floodway, listed in Table 3-4. The survey was limited to exterior inspections of the pumping plants. Field notes were taken on the current use, materials, alterations, setting, and existing condition of each floodway component. All components surveyed were identified according to existing information regarding the construction of the floodway.

Table 3-4. Dallas Floodway Hydraulic Physical Features Surveyed

Resource	*Date Built*
East Levee	1929–1932; 1953
West Levee	1929–1932; 1953
Northwest Levee	1929; 1974
Parallel Levee Channel	1929–1932; 1960s
Trinity River Diversion Channel	1932
Old Trinity River Channel	1929*
Overbank	1932
Pumping Plants A (Able)	1929 and 1953
Pumping Plant A (Able) Outlet Gate Structure	1953
Pumping Plants B (Baker)	1929 and 1975
Pumping Plant B (Baker) Outlet Gate Structure	1956
Pumping Plants C (Charlie)	1929 and 1956
Pumping Plant C (Charlie) Outlet Gate Structure	1956
Pumping Plants D (Delta)	1929 and 1956
Pumping Plant D (Delta) Outlet Gate Structure	1956
Hampton Road Pumping Plants	1956 and 1975
Hampton Road Pumping Plant Outlet Gate Structure	1956
Pavaho Pumping Plants	1954 and 1975
Pavaho Pumping Plant Outlet Gate Structure	1954
“New” Pump House (Northwest Levee)	ca. 1995
“Old” Pump House (Northwest Levee)	1974
Belleview Pressure Sewer	1928–1931
Belleview Pressure Sewer Outlet Gate Structure	1950s
Old Coombs Creek Pressure Sewer	1928–1931
Old Coombs Creek Pressure Sewer Outlet Gate Structure	1989
Dallas Branch Pressure Sewer	1932
Dallas Branch Pressure Sewer Outlet Gate Structure	1950s
Lake Cliff Pressure Sewer	1952–1955
Lake Cliff Pressure Sewer Outlet Gate Structure	1955
Turtle Creek Pressure Sewer	1953–1957
Turtle Creek Pressure Sewer Outlet Gate Structure	1953–1957
Woodall Rodgers Pressure Sewer	1979
Woodall Rodgers Pressure Sewer Outlet Gate Structure	1979
Coombs Creek Pressure Sewer	1957
Coombs Creek Pressure Sewer Outlet Gate Structure	1957
Elm Fork Sluice Outlet Gate	1960s
Coombs Creek Intake	1957
Lake Cliff Intake	1950s
Turtle Creek Intake	1955–1956
Eagle Ford Sluice	1928–1931
Elm Fork Sluice	1928–1931
Ledbetter Dike C.S.G.	1950s

Table 3-4. Dallas Floodway Hydraulic Physical Features Surveyed

Resource	*Date Built*
Northwest Levee Sluices	1928 and 1974
Grauwyler C.S.G.	1950s
60-inch Emergency Control Structure	1950s
East Bank Interceptor	1950s

**Although the Old Trinity River Channel is a naturally occurring feature, it became a part of the Dallas Floodway's hydraulic system when the creation of the Diversion Channel relocated the Trinity River and converted the old river bed into a drainage feature of the Dallas Floodway.*

The survey supplemented the written data with photographs of each physical feature. The photographs record principal views, architectural or structural details, or other notable features that were deemed relevant to the historical evaluation of the resource. The photographs were mapped and logged.

The research and field data for each physical feature in the project area were recorded according to Texas Historical Commission standards. Additionally, the survey meets FHWA Standards for Uniformity for Non-Archaeological Survey.

3.3.4 Evaluation

The objective of the survey and evaluation was to determine whether the floodway and its component structures meet the definition of a historic and cultural resource under NEPA.. The survey and evaluation categorize the Dallas Floodway as one structure consisting of 55 hydraulic physical features. The definition of a structure is "to distinguish from buildings those functional constructions made usually for purposes other than creating human shelter". The floodway comprises an array of engineered physical features (10 different types of hydraulic features, as described in Chapter 5) that were designed and configured as one system to prevent floods. The components of the floodway function collectively to drain, collect, and contain water. Thus, this report evaluates the floodway as one large structure made up of numerous interconnected structural components related by function and physical development.

Focused research questions included the following:

1) The Plans of Reclamation were a series of comprehensive plans involving flood control, transportation and urban development of the reclaimed land. What is the relationship between these aspects of the plan and can they be evaluated individually?
2) What constitutes the physical and spatial boundaries of the Dallas Floodway?
3) What are the physical features of the Dallas Floodway? Which are hydraulic physical features and which are non-hydraulic physical features?
4) Where do viaducts (bridges and railroad trestles) that cross over the floodway fit within the analysis of the floodway system?
5) If the resource is a historic and cultural resource in terms of NEPA, what are the character-defining features of the Dallas Floodway so that impacts may be assessed?
6) If the resource is a historic and cultural resource in terms of NEPA, what are the essential physical features of the Dallas Floodway?

7) If the resource is a historic and cultural resource in terms of NEPA, have the various repairs and changes to the Dallas Floodway's hydraulic physical features, or the presence of the non-hydraulic physical features, diminished the floodway's ability to convey its significance to an observer?
8) Is the Dallas Floodway a collection of objects united by plan and physical development or it a single unified engineering entity designed to contain and direct floodwater?

Consideration of Question #8 during the project resulted in an evaluation of the Dallas Floodway as one single unified engineering entity that is, in effect, a flood control machine. The floodway's physical features, such as levees, pumping plants, and pressure sewers, are the engineering components that make it operate in unity. As a machine to control floodwater and bypass urban Dallas, it operates as a unified entity. The Dallas Floodway would operate regardless of the presence of the bridges, which are not engineering elements of the floodway. Therefore, although an evaluation of a potential historic district could apply to the collective physical features of the Dallas Floodway, this evaluation categorizes it as a single interconnected engineering structure because of the nature of the floodway's numerous underground components. Moreover, the Dallas Floodway's buried features extend from the floodway in the form of sluices, culverts, and pressure sewers buried underneath the city of Dallas. They are not visible and cannot physically accommodate an observer. If this evaluation resulted in a significant historic district, the delineation of the district boundary using a vertical section (y-axis from sky to earth), as drawn on a map, would inadvertently include all of the aboveground buildings and structures that are physically located over the buried floodway components. This survey's single-resource evaluation is rather a selective intensive survey of the floodway as one contiguous entity that includes all of its underground and aboveground components as one engineering system working in concert.

To reiterate, the Dallas Floodway is one engineering structure consisting of contiguous engineered aboveground and underground components. For this survey, however, the underground components were not assessed because they are not experienced by the observer of the floodway, and thus, cannot effectively convey their significance.

The cultural significance of a cultural resource can be determined only when it is evaluated within its historic context. Historic contexts are "those patterns or trends in history by which a specific occurrence, property, or site is understood and its meaning (and ultimately its significance) within history or prehistory is made clear." Historic contexts compile information about the time period, the place, and the events that created, influenced, or formed the backdrop to the historical resources. A single property may represent more than one historic context, and conversely, numerous property types may represent a single historic context.

A cultural resource must demonstrate significance within its historic context. To be considered a historic and cultural resource under NEPA, this study establishes four types of significance to define a historic and cultural resource:

An association with events that have made a significant contribution to the broad patterns of American history;

Association with the lives of persons significant in the past;

Embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant or distinguishable entity whose components may lack individual distinction; or

Have yielded, or may be likely to yield, information important in prehistory or history.

The Dallas Floodway and the structural components in this survey were evaluated within the framework of the historic context for the level (i.e., local, state, or national) and type of significance and for their ability to convey significance. As a floodway system, the evaluation considered all the components necessary to carry out flood control and stormwater drainage, such as the overbank and diversion channel, in addition to the levees and other structures. Information relevant to the history of the Dallas Floodway, its land use, and the history of the floodway structures was included in the evaluations, based on the types of significance defined above.

The final step in the evaluation process is to determine whether the resource conveys its period of significance. This is based on why, where, and when a cultural resource is significant. The ability of a cultural resource to convey significance depends upon defining the *essential physical features* that must be present for a resource to represent its significance, and determining, based on the essential physical features and the type and level of significance, which aspects are particularly vital for the resource to convey its significance. Essential physical features are "those features that define both *why* a resource is significance and *when* it was significant. Except for archaeological sites, significant historic and cultural resources require visible essential physical features to convey their significance. The underground (non-visible) features of the floodway do not help to identify the floodway system, and thus, were not analyzed.

There are seven aspects, or qualities, that define the ability of a resource to convey significance to an observer. A resource that retains its ability to convey significance will embody several, and usually most, of these seven aspects:

1) *Location* is the place where the historic and cultural resource was constructed or the place where the historic event occurred;
2) *Design* is the combination of elements that create the form, plan, space, structure, and style of a historic and cultural resource;
3) *Setting* is the physical environment of a historic and cultural resource;
4) *Materials* are the physical elements that were combined or deposited during a particular period of time and in a particular patter or configuration to form a historic and cultural resource;
5) *Workmanship* is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory;
6) *Feeling* is a resource's expression of the aesthetic or historic sense of a particular period of time; and

7) *Association* is the direct link between an important historic event or person and a historic and cultural resource.

An assessment of the ability to convey significance considers the degree to which a historic and cultural resource retains original fabric and design elements and the impact of changes made to the property. It is used to evaluate the extent to which a resource can convey its significance in relationship to its period of significance. Due to the function and technical nature of the Dallas Floodway, the floodway components often are continually repaired and upgraded with the latest technology and, as a result, may no longer retain those qualities or physical features that convey their significance. For example, if a component is significant for its association with a defined period or specific event, modifications made after-the-fact may have compromised its ability to convey significance. Alternatively, if a component significant to the period of significance continues to perform its original function, later modifications may illustrate the evolution of the physical feature.

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McKinley Street 1908

Historic Context

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CHAPTER 4. HISTORIC CONTEXT:FLOOD CONTROL DEVELOPMENT ALONG THE TRINITY RIVER IN DALLAS, 1908-PRESENT

The following developmental historic context discusses the Dallas Floodway primarily within the historical themes of civil works and community planning and development.

The Trinity River bisects the city of Dallas geographically, separating the downtown to the east from Oak Cliff and West Dallas to the west. Flooding and potential flooding have guided urban development and affected Dallas geographically, politically, economically, and socially throughout its history, resulting in repeated efforts to tame the Trinity River. At the epicenter is the debate over the relationship of public works with private development which, through study of the Dallas Trinity River Reclamation Project, forms a textbook example of twentieth century American city planning.

4.1 BACKGROUND – THE TRINITY RIVER AND THE EARLY DEVELOPMENT OF DALLAS

The area that would become the center of Dallas was first settled in November 1841 by John Neely Bryan, an Arkansas land speculator, who built a cabin to serve as a trading post on the east bank of a promising ford across the Trinity River. A permanent community soon developed. The easy crossing of the Trinity River in Dallas increased traffic and trade to the area, and the town quickly became a commercial and transportation center. Manufacturing concerns, eagerly sought, played a subordinate role (Texas Department of Transportation [TxDOT] 2004, 2–3, 6–7; Wilson 1989, 254).

The Trinity River was initially thought to be a great benefit to the city of Dallas as a steamboat link to the Gulf of Mexico. However, several attempts to make the river navigable failed. It proved to be unsuitable for navigation because of its shallow depth, narrow banks, and frequent floods (TxDOT 2004, 9).

Although the idea of creating a navigable waterway between Dallas and the Gulf of Mexico was one which resonated with Dallas residents, the reality of the situation was not lost on the city. During the 1850s, the city of Dallas was separated from nearby settlements by the Trinity River because of the inability to safely and easily cross the waterway. As such, in 1855 Alexander Cockrell and the Dallas Bridge and Causeway Company built the first permanent, wood bridge across the Trinity River near the current-day Commerce Street Viaduct. This bridge provided Dallasites access to the western bank of the river. The bridge, however, survived only a few years before it was washed away in one of the Trinity River's frequent floods. It was replaced in 1872 by a toll bridge, which the city of Dallas purchased in 1882, making it the first free bridge across the Trinity River (FHWA et al. 2008). The city later built two new bridges, one near present-day Cadiz Street, and a second on Zang Boulevard near the present-day Houston Street Viaduct. These three early bridges were designed in a manner that made them susceptible to flooding, even during moderate flooding events, which submerged the bridges and their approaches.

In the years following the Civil War, the railroads reconfigured the landscape of Dallas and put the city on the map as one of the region's largest shipping ports. The Houston & Texas Central Railroad (H&TC, formerly the Galveston and Red River Railroad) reached Dallas in 1872, and the next year, the Texas & Pacific Railway arrived in Dallas. These important rail lines provided Dallas access to southern and eastern Texas and allowed the city to acquire the benefits of an urban area including modern utility and communication systems (Cliff et al. 1999).

Dallas residents had a number of significant problems to confront, however, in expanding the city. The Trinity River was the most menacing problem in Dallas as it separated the city from neighborhoods on the south and west and inhibited growth within its 10,000-acre floodplain. Due to flooding of large areas near the downtown area, farming was the predominant use of the land to the west of the city along the Trinity River bottoms rather than commercial and industrial development (Wilson 1989, 254).

The first major flood in newly established Dallas occurred in 1844 when the river rose to a gauge height at Commerce Street of 50.7 feet. The highest flood of the Trinity River in the history of Dallas occurred in 1866. Although the official flood gauge reading was 49.2 feet, the waters rose in some areas to 56.5 feet, cutting Dallas off from all communication and causing the city to become an island. During a flood five years later, the flood level reached 47.4 feet. Another flood in 1890 submerged 200 homes as it spread the width of two miles (Furlong et al. 2003, 1; TxDOT 2004, 9). On Easter Sunday, April 19, 1908, another major flood measured 39.4 feet and overran the river banks flooding all the way down to the Commerce Street Bridge (TxDOT 2004, 9).

4.2 PLANNING THE FLOODWAY AND RECLAMATION, 1908–1931

4.2.1 The 1908 Flood and the Push for Civic Improvement

The modern city of Dallas was born from the great flood of 1908 (*Dallas Morning News* [*DMN*] 2008). A storm during the weekend of May 23, 1908, dumped 10- to 15-inches of rainfall in the Dallas-Fort Worth area over a three-day period. The run-off of the rains north and west of Dallas caused the Elm Fork and the West Fork to swell so much that when they merged just north of Dallas, the water began to spread beyond the banks of the Trinity Rivery (Figure 4-1). In 1908, the Trinity River meandered much closer to the western edge of the downtown area, near the present location of the Triple Underpass. The Trinity River swelled to two miles wide near downtown, flooding parts of it and inundating Oak Cliff and West Dallas. The floods caused the city to lose water, electricity, streetcar service, and rail service and cut Oak Cliff off from Dallas and city services for more than a week. By May 29, the waters of the Trinity River had started to recede from 52.6 feet, the second highest level in its recorded history. The flood killed between five and eleven, displaced more than 4,000 people from their homes, and caused more than $2.5 million in property damage (Furlong et al. 2003, 2; TxDOT 2004, 10).

Figure 4-1. 1908 Flood

Restoring transportation connections to Dallas was the first major rebuilding effort after the flood. First, the Santa Fe, Southern Pacific, and Missouri-Kansas-Texas railway bridges were replaced. The next immediate need was to reestablish a permanent connection between Dallas and Oak Cliff. The well-known publisher of the *Dallas Morning News*, George B. Dealey, gathered a group of businessmen and sought the community's help in passing a bond issue to construct a viaduct at Houston Street. Although Dealey's proposal was met with resistance from members of the community who objected to the bridge's $609,797 estimated cost, the bond passed. Construction of the Dallas-Oak Cliff Viaduct began in October 1910 and was completed in late 1911 (Figure 4-2). The reinforced concrete, high-level bridge was billed as the longest concrete structure in the world when it was opened (Jackson 1996; Payne 1994). Today it is known as the Houston Street Viaduct. With bridge construction under way, the city government turned its attention to long-term issues (Eisenhour 2009, 30).

Figure 4-2. Dallas-Oak Cliff Viaduct, 1912

Dallas also had several other problems to address besides the Trinity River in order for the city to prosper. The city had five different railroad stations and their tracks crossed congested, unorganized downtown streets. It also lacked large-scale arterial roadways (Eisenhour 2009, 32). Furthermore, Dallas was not a visually attractive place to live. There were no impressive vistas, boulevard system, park system, or large nearby recreational areas. The city was choking on its own growth. At the turn of the twentieth century, the president of the Dallas Civic Improvement League stated, "there is scarcely a more slovenly community in the United States" (Wilson 1989, 257).

Prior to the flood, city planning in Dallas was a piecemeal affair with no comprehensive plan. George Dealey was intent to change that, and emerged as a leader in the struggle for a better city. George Bannerman Dealey (1859–1946) is perhaps best known as the publisher of the *Dallas Morning News*. He started as an office boy at the *Galveston News*, became business manager of the *Dallas Morning News* when the newspaper was founded in 1885, and worked his way up to president in 1919. Dealey used his position, influence, and at times, his newspaper, to advocate city planning for Dallas. His role in helping to secure financing for the Dallas-Oak Cliff Viaduct is an example of his civic activism for Dallas. Dealey was also responsible for donating most of the right-of-way for the Triple Underpass (Perez 2009; Hunt

1991). Another of his important contributions to city planning in Dallas was his crusade for improvements to the Trinity River corridor.

According to Dealey, during the winter of 1902, he walked onto the Commerce Street Bridge. With nothing particular on his mind, he smoked a cigar while gazing at the Trinity River bottomland before him. Suddenly the realization came to him that the worthless land adjacent to the downtown business district could become highly prized if the Trinity River was moved. He secretly began to buy land in the area as it became available (Payne 1994, 29).

After reading a pamphlet on the City Beautiful Movement, Dealey became immersed in this urban planning movement. As a committed citizen activist, he would later become a man some called "the father of planning in the southwest" (Fairbanks 1996, 190; Wilson 1989, 258). The City Beautiful Movement was a nationwide, turn-of-the-twentieth-century (1890–1920s) trend in urban planning to rectify the decay and demoralization of communities through the beautification of the city. Urban areas across the nation were growing exponentially, and leaders increasingly realized the critical importance of community planning, not only in sustaining urban growth but also for the continued health and safety of residents and visitors. Proponents of the City Beautiful Movement believed that by beautifying an urban area with wide, elegant avenues, carefully planned landscape designs, and opulent, usually Beaux Arts style buildings, the pride of the city would be restored, and inner cities would maintain their central position within the expanding community (Wilson 1989).

Embracing the role of citizen activist, Dealey in 1909 led efforts to organize the Dallas City Plan and Improvement League (CPIL) and in January 1910 launched a civic improvement series in the *Dallas Morning News*,. An adjunct of the Chamber of Commerce, the CPIL was designed to study the needs and possibilities of the city and develop a city plan. It was made up of 38 prominent citizens, including Dealey (TxDOT 2004, 11; Wilson 1989, 260).

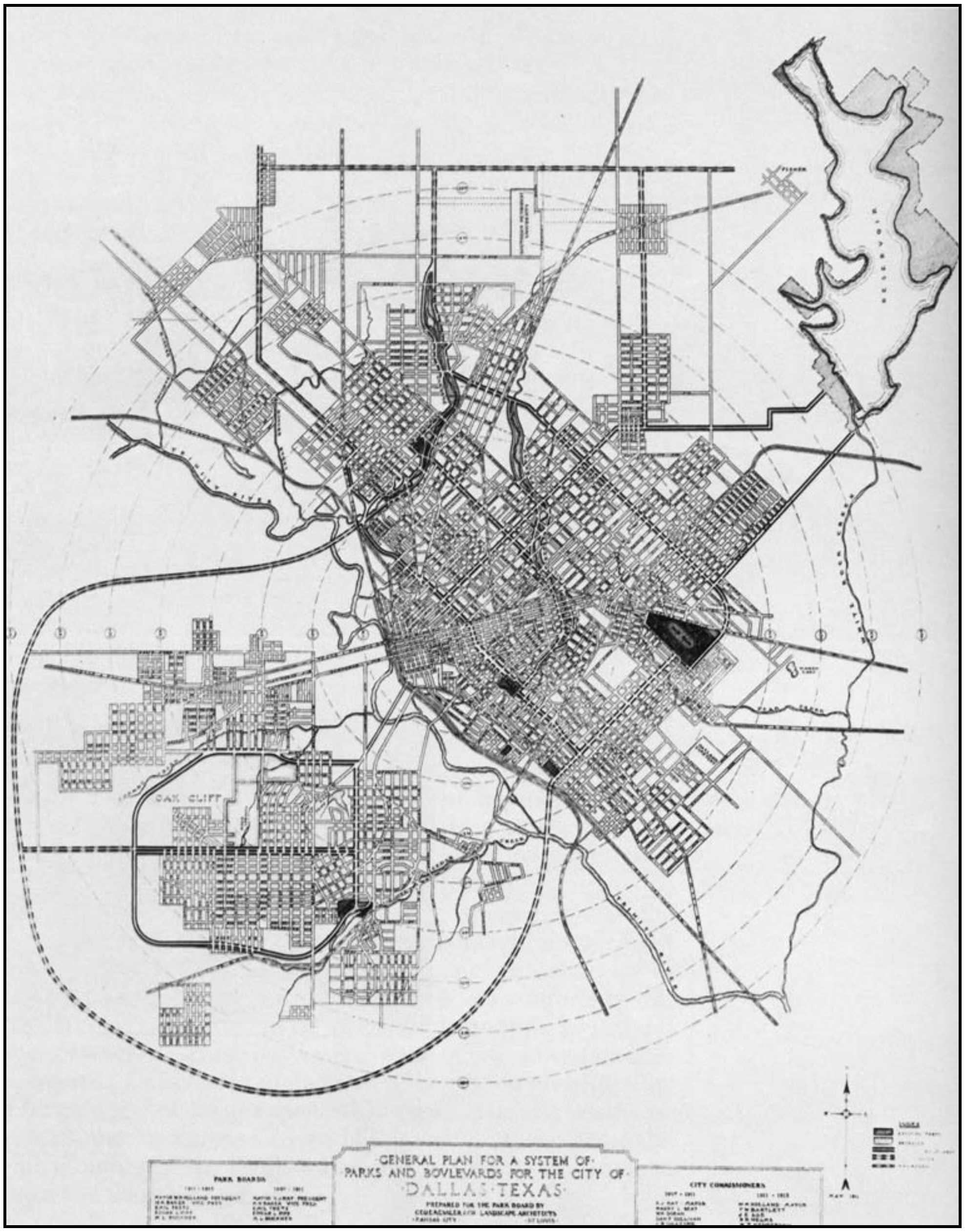
4.2.2 Development of the Kessler Plan

The CPIL sought the expert advice of George E. Kessler, a nationally renowned landscape architect and city planner, to develop a city plan (Fairbanks 1996, 190). Kessler, who lived in Dallas as a young man but settled in St. Louis, had previously worked in Dallas in 1904 to redesign the State Fair Grounds (Fair Park) (Payne 1994, 29). Kessler was one of the leading proponents of the City Beautiful Movement (Wilson 1989). He designed Kansas City's park-boulevard system, and city plans for Cincinnati, Cleveland, Indianapolis, Denver, El Paso, and Syracuse (Maxwell 2009a). Kessler participated in a joint conference with the mayor, the city commissioners, the Park Board, and members of the CPIL. As a result of the meeting the city officials agreed to employ Kessler to develop a 25-year plan to help guide Dallas.

Kessler's 40-page *A City Plan for Dallas* was published in 1911. The Kessler Plan, as it was commonly known, noted planning deficiencies in Dallas and provided specific solutions to correct them. The plan was essentially a City Beautiful blueprint for Dallas (Payne 1994, 30) (Figure 4-3). The Kessler Plan proposed directing urban growth with large-scale infrastructure improvements, establishing arterial roads, separating rail lines, creating recreational areas and greenbelts, and preventing flood damage by moving the Trinity River and constructing a floodway. To accomplish these objectives, Kessler specified nine proposed improvements:

- Levees: a levee system to protect the city from floods and to reclaim river bottom land for industrial use by moving and straightening the Trinity River channel;
- Belt Railroad: a beltway railroad line with two loops, one around the city proper and the other around Oak Cliff and West Dallas;
- Union Station: a union passenger station along the belt railroad in the central business district;
- Freight Terminals: separate rail freight terminals;
- Civic Center: one civic center adjacent to the Union Station;
- Grade Crossing: elimination of railroad grade crossings in downtown;
- Street Openings: widening and extension of numerous downtown streets to improve traffic flow;
- Parks, Parkways and Boulevards: building a comprehensive system;
- Playgrounds: building additional playgrounds (Kessler 1911, 9)

In his first recommendation, levees to contain the Trinity River, Kessler noted that the river, together with the railroads on the west bank, constituted a development barrier to the central business district of Dallas (Kessler 1911, 7). The river should be moved to the west and channeled, opening up a large strip of developable land. Kessler felt this undertaking was essential to the continued growth of the city (Foley 1931, 9).



Source: Kessler 1911

Figure 4-3. Kessler Plan

The specifics of this plan consisted of moving the Trinity River westward towards Oak Cliff, and confining the new channel within 25-foot-tall levees spaced 1,200 feet apart. To build the eight miles of levees, the earth between them would be dredged. The channeled river would be designed to include a lock, dam, and turning basin to accommodate barge traffic in a Trinity River capable of navigation. Kessler envisioned an industrial area with loading faculties and railroad tracks (Kessler 1911, 9, 10).

Regarding the reclamation of the Trinity, Kessler stated it "will command attention throughout the United States and will attract many men interested in other reclamation projects in other parts of the country who will come here to learn the 'Dallas' way of doing big things" (*DMN* 1933d). From Kessler's statement, it can be construed that the Dallas Floodway project would be an early step in putting the "Big D" in Dallas.

Kessler's proposal perfectly aligned with Dealey's vision for industrial development. Dealey wrote to Kessler: "As I understand your ideas, the one great project necessary for the proper development of Dallas is the reclamation of the Trinity River bottoms and all that will follow." To drum up public support for the Trinity floodway project and the proposed citywide civic improvements, Dealey regularly printed excerpts of Kessler's plan in the *Dallas Morning News* (Payne 1994, 30).

With the Kessler Plan, the city had its first comprehensive plan, but officials carried it out in a piecemeal and haphazard fashion. Citywide supporters rallied around the projects that had a clear direction and that could be accomplished quickly, such as the Union Station, which opened in 1916; a parkway along Turtle Creek; and the widening and extension of several downtown streets (TxDOT 2004, 12). Furthermore, the Park Board had boosted park acreage from 150 acres in 1908 to more than 650 acres by 1923 (Wilson 1989, 276).

No immediate action was taken on the major components of the plan. The more costly proposals, such as the levee/reclamation project, lacked a clear vision on how to proceed and suffered from a lack of city support. Initially city leaders ridiculed the construction of levees for the Trinity River and moving of existing rail lines. The railroads were not initially amenable to adjusting the rail lines to accommodate potential competition from Trinity River navigation. Opposing parties wanted opinions of other engineers and offered an alternate proposal to dam the Trinity River and create a town lake for beauty and recreation purposes. The City Council subsequently retained William B. Parsons, a hydraulic engineer, to study the proposals. The engineering studies corroborated the Kessler Plan and the unstable soil conditions proved unsuitable for the lake (*DMN* 1933e; Foley 1931, 10; Furlong et al. 2003, 2). Thus, the Kessler Plan lay largely dormant. Contributing to the lack of action was the severe national economic downturn of 1913–14, and later, the advent of World War I.

By 1918, the CPIL was essentially defunct (Wilson 1989, 275). George Dealey spearheaded the formation of another improvement association the next year. Called the Dallas Property Owners Association (DPOA), this group urged the reclamation of the Trinity River bottoms, adjacent to the property owners' part of town in the once fashionable West End that was deteriorating. A different group of downtown businessmen, in the Central Improvement League, promoted parts of the Kessler Plan that helped the east end of downtown, but opposed public financing of reclamation of the Trinity River bottoms because they felt it disproportionately helped the West End property owners (Fairbanks 1996, 192). These opposing groups accomplished little but set the stage for the Metropolitan Development Association, a branch of the Chamber of Commerce. DPOA remained independent, specifically to improve the West End and to create a reclamation district in 1920 to straighten the Trinity River and reclaim land. The effort stalled when the cost of the project was revealed (Fairbanks 1996, 195).

Following several years of rapid growth, city officials asked George Kessler to update his plan in 1919. Kessler issued a revised plan in 1920 that blended aspects of the City Beautiful and City Practical concepts of planning. Kessler's revised plan recommended removing the H&TC railroad tracks and developing the right-of-way with a 10-mile-long boulevard from the southern city limits near the Trinity River to Mockingbird Lane. Embodying the City Beautiful concept of a city parkway, Kessler envisioned Central Boulevard as a 200-foot wide parkway consisting of a 70-foot wide center park space, 40-foot roadways on either side of the park, and 25-foot parkways on either side of the roadways (TxDOT 2004, 12).

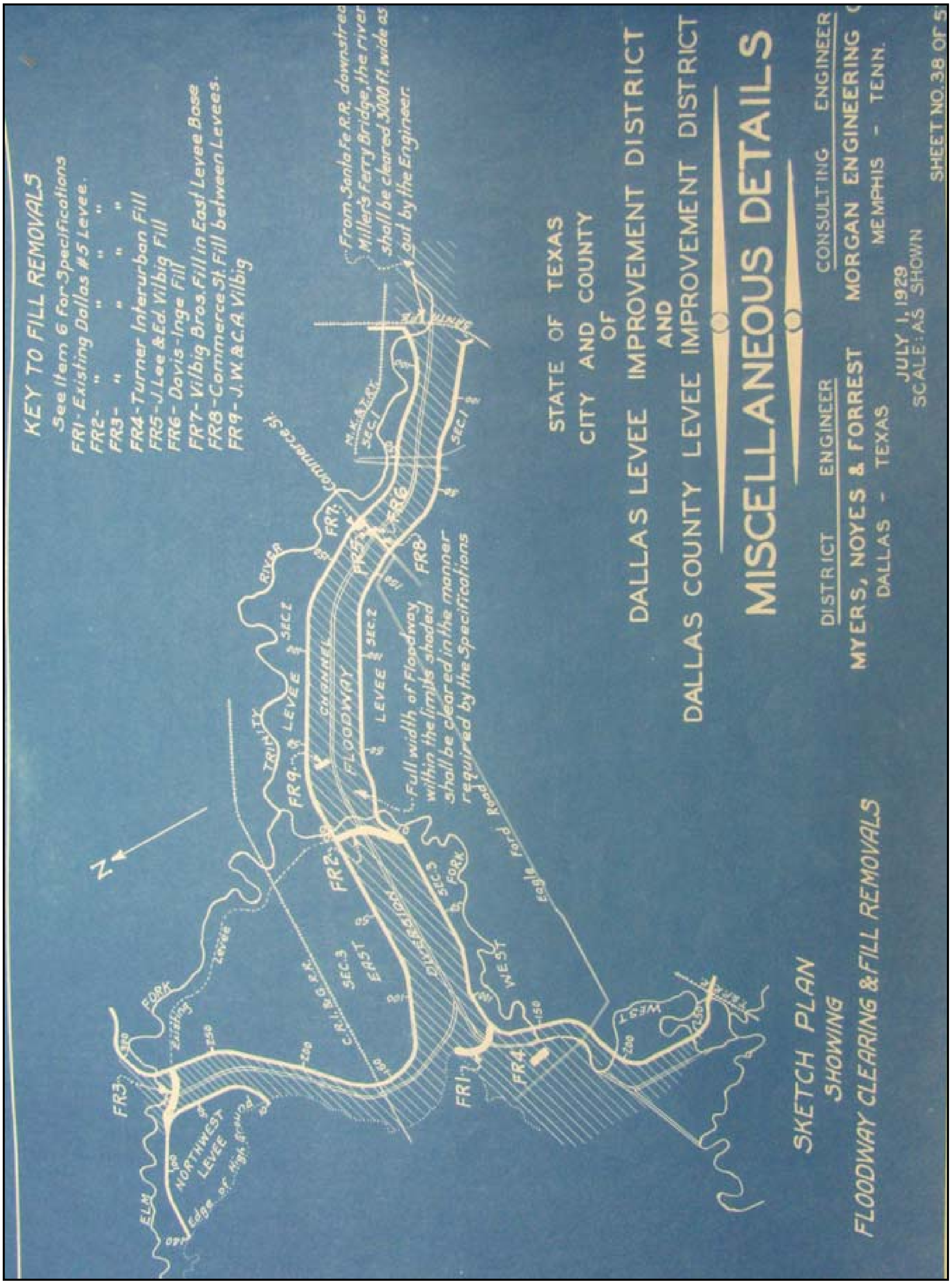
Kessler also revised the specifications for building levees along the Trinity River. The revised Kessler Plan increased the levee height from the original 25 feet to 30 feet and the floodway width between the levees from 1,200 feet to 2,000 feet (Texas Section American Society of Civil Engineers [ASCE] 1989; Wilson 1989, 261). With these revisions, approximately 4,500 acres of land adjacent to the confluence of the Elm and West Forks of the Trinity River would be protected (Texas Section ASCE 1989).

The DPOA and other improvement associations were unable to build interest for the revised Kessler Plan in each of their respective geographic areas, let alone generate a broad appeal. Members of DPOA believed a citywide planning organization would resolve the problem, and thus, in 1924 formed the Kessler Plan Association (KPA). The new KPA promoted citywide comprehensive planning through promoting the Kessler Plan plus its revisions, and civic unity through education and public participation, in the hope of eliminating planning by special interest groups (Fairbanks 1996, 197; Wilson 1989, 269–271). The thinly veiled attempt at unity would prove to be short lived. Accusations soon arose that the KPA was in the shadow of one man, George Dealey, and the organization's "sole purpose is to develop the Trinity River and the west business district" (Wilson 1989, 273).

4.2.3 The Ulrickson Committee and Final Plans of Reclamation

The Dallas County Levee Improvement District No. 5 was formed in 1919 to construct the levee system proposed in the 1919 update of the Kessler Plan (Texas Section ASCE 1989). This levee district consisted of a 4,500-acre footprint located adjacent and upstream of the confluence of the Elm and West Forks of the Trinity River. The Trinity Farm Securities Company owned about 90 percent of the land. By the mid-1920s, levees were constructed in these areas (Figure 4-4) to protect against ordinary floods and allow agriculture, but it did not constitute reclamation in a manner that would lead to organized development (Fry 1929, 805).

In 1926, Myers and Noyes (later to become Myers, Noyes and Forrest) Engineers of Dallas developed a modified plan of levees that amended the plan of levees for the Levee Improvement District No. 5 and added levees outside of its limits (Texas Section ASCE 1989). The City and County of Dallas Levee Improvement District (Levee District) was created in July 1926 for construction of the levees downstream of the Dallas County Levee Improvement District No. 5 to the AT&SF Bridge. The property owners in this



Source: Supplement to the Plan of Reclamation, 1929

Figure 4-4. Original Dallas Floodway Design, 1929

area agreed to unite to create the Levee District. Leslie Stemmons and the Trinity Farm Securities Company owned the largest amounts of land within the Levee District (Furlong et al. 2003, 3). Leslie Stemmons and John J. Simmons, both prominent local businessmen, were appointed the supervisors of the district. Stemmons was president of Atlas Metal Works (located in West Dallas and flooded in 1908) and the Southwestern Loan Association (Fairbanks 1998, 62). He had supported the Kessler Plan from the beginning. Simmons held no land in the District (Foley 1931, 15; Baker 1988, 46).

In November 1926 the Dallas County Levee Improvement District No. 5 and the Levee District filed the Joint Plan of Reclamation. This plan encompassed the entire levee system and floodway, but went well beyond flood control and included all the basic elements needed to develop reclaimed land. The plan provided for 7,217 acres of reclamation for the Levee District and 3,336 acres of reclamation for the Dallas County Levee Improvement District No. 5. Thus, the Joint Plan of Reclamation included 10,553 acres (approximately 17 square miles) to be reclaimed along the Trinity River (Furlong et al. 2003, 3; Texas Section ASCE 1989). The geographical boundaries of the two districts roughly coincided with the limits of the 1908 flood and covered not only the proposed floodway, but also included what would become an industrial corridor along Industrial Boulevard. Protection for the Houston Street viaduct where it intersects the levee was also detailed (Myers, Noyes and Forrest Engineers 1926).

A financing plan for the floodway and reclamation project, as well as other citywide improvements, was provided in the 1927 report “Forward, Dallas!” by the city’s Ulrickson Committee. Mayor Louis Blaylock had appointed Charles E. Ulrickson in 1925 to lead a committee to determine the best course for dealing with urban improvements, including the flood control issue (TxDOT 2004, 13). The Ulrickson Committee recommended a $23.9 million bond issue to fund a nine-year capital improvements program. Of this total, a little more than $13 million was the cost of implementing flood control measures and land reclamation in the Trinity River floodplain. The remaining $10 million was for infrastructure and economic development improvements behind the Trinity River levees (Furlong et al. 2003, 3). The latter included the street improvements, development of Central Boulevard, schools, parks, a downtown auditorium, improvements to Love Field, construction of a triple underpass at the western edge of downtown, and four viaducts to span the Trinity (Ulrickson Committee 1927).

The core of the Ulrickson Committee improvements program was flood control drainage systems along the Trinity River. The flood control plan protected approximately 10,500 acres. The levees would be approximately 13 miles long on each side of the river, 30 feet high (9 feet higher than the 1908 flood), 156 feet wide at the base, and 6 feet wide at the crown. Interior drainage would entail seven gravity flow sluiceways, four pumping plants, and five pressure sewer lines. This floodway system would have the capacity to carry 2.5 times the volume of the Trinity River flood of 1908 (Furlong et al. 2003, 3). The Ulrickson plan was the basis of what would eventually be constructed.

The KPA endorsed the Ulrickson financing proposal and touted the benefits for the city to straighten the Trinity River and levee, reclaim the river bottoms, and provide new viaducts that would link Dallas to Oak Cliff. Through the KPA’s efforts, the Ulrickson Committee report was approved and bonds were authorized by election (Fairbanks 1996, 200; Furlong et al. 2003, 3).

By December 1927, the comprehensive improvement program, aligned with the 1926 Joint Plan of Reclamation, coordinated private property owners (united together as the Levee District), the city, the county, railroads, and utilities in the nearly $24 million effort to create the floodway and development improvements to streets, utilities, schools, and recreation (Fairbanks 1998, 62).

The 1926 Joint Plan of Reclamation was updated in 1928 with even greater detail and explanation of the purpose of the project, which now described both the public and private improvements within the two districts (Morgan Engineering 1928). Five entities—the city, the county, private landowners, utility corporations and railroads—would move the river, channel it, and reclaim lands for industrial development in a single, unified plan. The plan stated "the betterment plans of Dallas and Dallas County [e.g., construction of Industrial Boulevard, viaducts, and sewer improvements] are so closely interlocked with the plan of reclamation of the Levee Districts…they will be valueless unless the plan of reclamation is carried out" (Morgan Engineering 1928).

The 1928 Joint Plan of Reclamation reached 10 conclusions that outlined the creation of both a floodway and infrastructure for industrial development from reclaimed lands. Central among the conclusions were many references to the importance of industrial development resulting from the reclamation (Morgan Engineering 1928):

- **Industrial District** – Create a new area adjacent to the railroad and downtown business district "well suited for the commercial and industrial expansion of Dallas" (Figure 4-5, No. 13). Grading and filling of sections of the old river channel with hydraulic fill as part of the plan "should aid materially in making that area attractive to prospective purchasers of commercial and industrial sites." The city would pay for the sewers, the property owners for the fill.
- **Triple Underpass** – Approaches to the reclaimed area on the East Levee by street improvements and underpasses beneath the railroad tracks skirting the bluff (now known as the Triple Underpass near Dealey Plaza) would connect them with "the city proper in a manner that should contribute to their early development" (see Figure 4-5, No. 14).
- **Four Bridges** – Construction of four bridges (Corinth, Commerce, Lamar [now Continental], and Cadiz) would provide needed links to Oak Cliff (see Figure 4-5, No. 11, 12, 14, and 17).
- **Industrial Boulevard** – A "hard surfaced highway" that will "transverse the entire length of the eastern protected area" and will "aid in developing district lands" (see Figure 4-5, No. 6).

The essential floodway components of the plan were as follows (Morgan Engineering 1928):

- **Levees** – 24.5 miles of new levees, paid for by the property owners in the levee district (see Figure 4-5, No. 36).
- **New River Channel** – In a direct line down the center of the floodway. Elm and West Forks are to be diverted into this new channel at a new confluence. The diversion channels also would be paid for by the property owners in the levee district (see Figure 4-5, No. 36).

- **Floodway** – The newly created floodway was to be kept in an unobstructed condition and "assume ultimately, a park like aspect. They may even become so attractive, that the city will make them public recreation grounds, thereby strengthening the likelihood of perpetual maintenance in a smooth condition."
- **Interior Drainage System** – Funded by a combination of property owners and the city, the system was needed to drain the reclaimed valley lands using the remnants of the old river channel. The interior drainage system was intentionally under designed, with less sluiceway and pump capacity than would be needed in the future and as industrial development occurred. These additional floodway components could be financed through taxation. "This condition is likely to arise after the reclaimed lands have become so far developed that additional costs will not be burdensome."
- **Hydraulic Fill Area –** Paid for by the property owners in the levee district, this area consisted of approximately 600 acres immediately adjacent to downtown, from Commerce Street to what is today Turtle Creek Boulevard, and was the heart of the newly created Trinity Industrial District. The Property Owners Map (Figure 4-6) shows the reclamation project in an overlay with the street layout of the Trinity Industrial District. Within this area, the old channel of the Trinity River was to be filled in with 3 million cubic yards of earth borrowed from the floodway and graded by the district. The city would provide a stormwater system for the interior drainage. The city would also pave Industrial Boulevard as part of the reclamation plan. The area was to be "improved in a manner to make it immediately attractive as an extension of the Dallas business and industrial districts" (see Figure 4-5, No. 13).

Figure 4-7 shows the essential floodway components of the 1928 reclamation plan. The figure also shows the Hydraulic Fill Area where the Trinity River was to be filled from "X to Y," roughly from Turtle Creek Boulevard to Commerce Street and from the East Levee to present-day Stemmons Expressway.

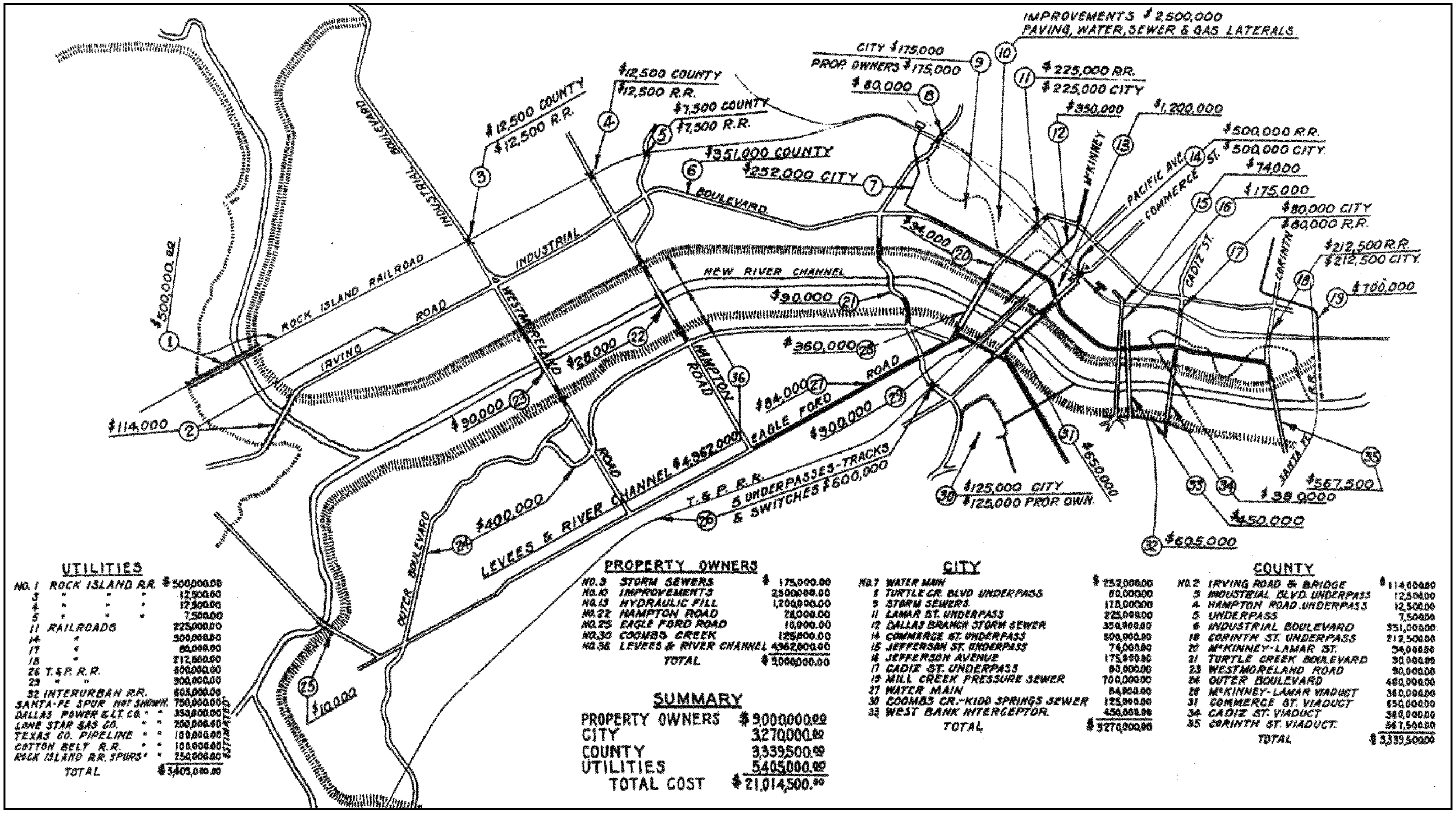


Figure 4-5. Physical Features of the Reclamation Plan and Distribution of Expenditures

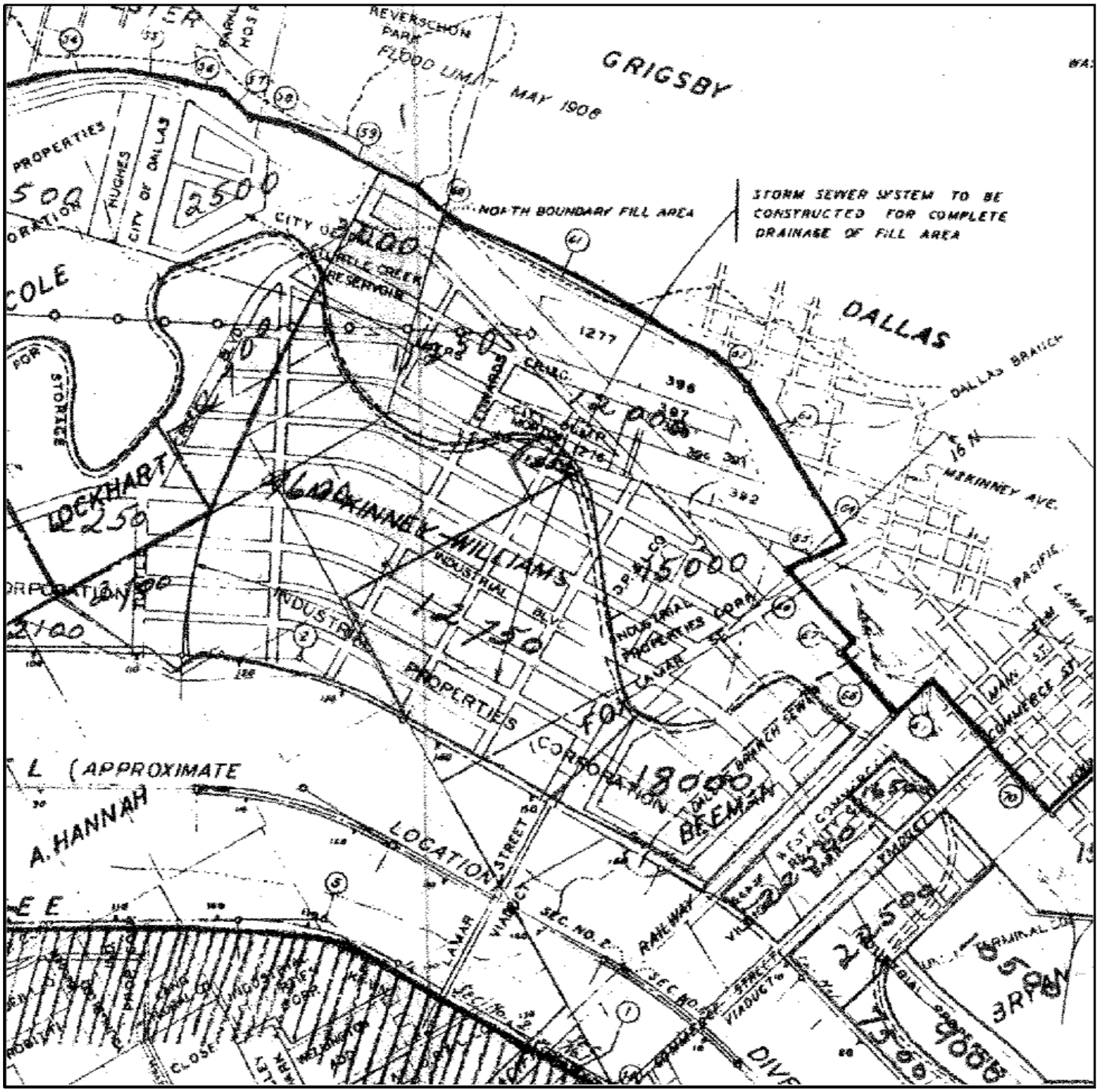
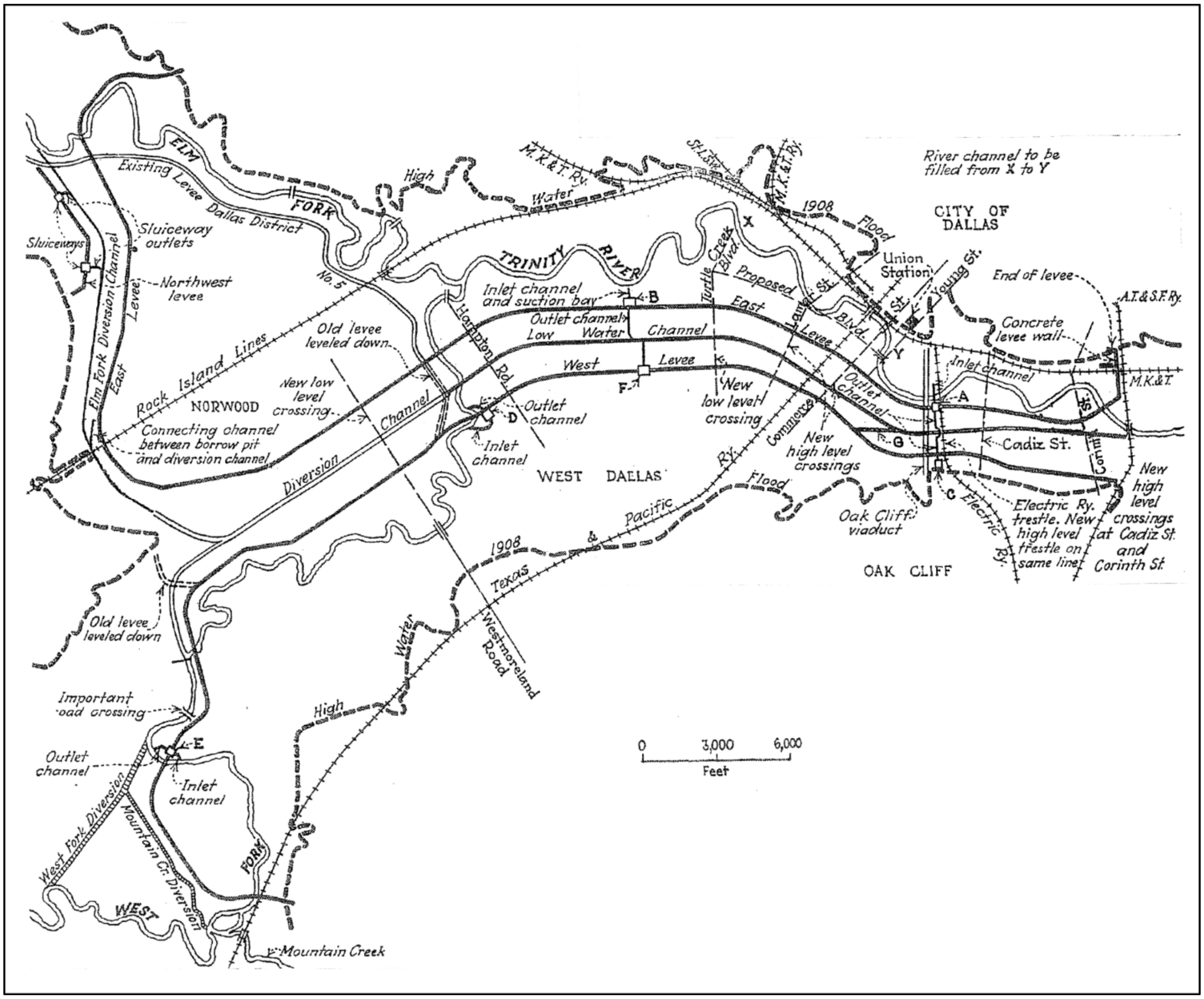


Figure 4-6. Hydraulic Fill Area and Planned Trinity Industrial District



Source: Fry 1929

Figure 4-7. Dallas Floodway and Reclamation Project (November 1929)

The city moved rapidly on many of the improvements including initiation of the Trinity floodway project, construction of the Triple Underpass, and relocation of railroad tracks (TxDOT 2004, 13). The property owners within the Levee District sold bonds against their properties for $6 million in April 1928 to relocate the river and build the levees. The Dallas County Levee Improvement District No. 5 also sold bonds to contribute $500,000 for this joint effort. In addition, the city of Dallas and Dallas County also sold bonds for a little more than $3 million each to participate in the immediate phase of the Trinity River project, while the railroads (Rock Island and the Texas and Pacific) and utility companies dedicated about $1 million to the Trinity project. Meanwhile, Dallas County provided funds (less than $2 million) to construct the four viaducts across the Dallas Floodway as well as one viaduct (Irving Road Viaduct) across the Elm Fork. Besides the five major viaducts, four minor crossings were also constructed along various parts of the Trinity River. Each of the four new viaducts across the Dallas Floodway was constructed with a 150-foot center span to accommodate the river channel and enough clearance for the bridge decks to be above the levees (Furlong et al. 2003, 3).

The Hydraulic Fill Area of the reclamation and floodway project was immediately attractive to Levee District supervisors Leslie Stemmons and John Simmons. Even though the Ulrickson bond package was approved by voters, when it came time for the Levee District to sell bonds for its portion of the Trinity Reclamation Project, opponents led by the railroads (who initially saw the levees as a step toward navigation of the Trinity River) threatened to file an injunction to stop the bond sale (Baker 1988, 46).

Simmons and Stemmons organized a subset of the property owners in the Levee District: landowners in the reclaimed area closest to the river downtown were united to form the Industrial Properties Corporation, whose goal was to initially develop the 1928 Joint Plan of Reclamation's Hydraulic Fill Area and eventually expand with successful development. The property owners that formed the Industrial Properties Corporation controlled 75 percent of the 10,500 acres to be reclaimed at an estimated worth of $52 million (Fairbanks 1996, 202). In 1928, the city gave the Industrial Properties Association a charter to develop the reclaimed land as the Trinity Industrial District (TxDOT 2004, 11).

Instead of a public offering of bonds, Stemmons and Simmons arranged a secret, private sale to a Chicago brokerage house. The two men had $6 million in bonds printed in Galveston and sent to Austin for approval by the Attorney General. Signed and then stuffed into eight suitcases, the bonds were driven to Dallas by Stemmons and Simmons at such a high speed that the car caught on fire. Both men were met in Dallas by an armed escort who took the car to Union Station, where Leslie Stemmons put his 90-year-old mother aboard a train with the suitcases to "visit relatives in Chicago." The bonds were then sold in Chicago in a private sale at the highest price to date for levee bonds in Texas. As soon as word arrived that the bonds were sold, Stemmons and Simmons revealed a petition signed by the majority of the landowners in the district and immediately awarded the contract for construction to the Trinity Farm Construction Company, a subsidiary of the largest landholder in the district (*DMN* 1933b). Construction could now commence.

In a 15-part series on the Trinity Reclamation Project by columnist Lynn Landrum in 1933, the *Dallas Morning News* devoted one part to describing the secret sale entitled "The Runaway Bonds." Landrum later reported in Part IX, "Getting the Job Done," that "there are numbers of sincere and reputable people in Dallas who insist there is something 'crooked' about the contract" (*DMN* 1933d). The injunction suit to stop the project was never filed.

These actions by the two Levee District supervisors (one of them, Leslie Stemmons, was also the leader of the newly organized Industrial Properties Corporation) raised the question among many members of the community of how much the city should be helping private developers. This and other business practices by the Levee District were widely perceived to run counter to the idea of a bond program operated for the benefit of the city as a whole and was widely seen as catering to special interests. The distrust threatened the consensus the KPA had hoped to create for effective comprehensive city planning.

However, George Dealey threw the weight of the *Dallas Morning News* behind the reclamation project and intensely lobbied city officials on its behalf. the *Dallas Morning News* contained a special eight-page supplement promoting the reclamation and industrial development. Opponents pointed out that Dealey owned property in the bottom lands and would personally benefit.

An angry and bitter battle played out in the local press. George Dealey's *Morning News* was in full support, while the rival *Times Herald* was convinced Leslie Stemmons was "a swindler." The two papers "fought like Tigers." The *Times Herald* would publish accusations, such that as the Levee District Supervisors were not following the Ulrickson Plan or that the city and the Levee District only followed the plan when it was favorable to the District. The *Morning News* would counter with full page sections on the Trinity Industrial District such as the 12 October supplement, reporting it "will be the most exclusive district in the world…a great boulevard nine miles long and 130 feet wide will be available…twenty million dollars were expended by the city and county of Dallas, private landowners in the district, public utilities and railroads to make this paradise for industry." The battle of the two papers would last years and was still smoldering as late as 1935 (Baker 1988, 47–48).

4.2.4 Floodway Construction and Project Cutbacks

Actual construction of the floodway began in July 1928, with George Dealey as the keynote speaker at the dedication ceremony. He told the crowd that the realization came to him in 1903 (it was actually 1902) when he suddenly understood the possibilities inherent in reclamation (i.e., expanding the business district to the west), and the groundbreaking event was "one of the most important in its potential effects" that he had seen in his then 43 years in the city. He then stated, "A blot on the landscape near the heart of Dallas will be removed and a great industrial development will follow." In his dedication speech, Dealey, in the spirit of the City Beautiful Movement, went on to envision a future floodway that would "become an urban park with wildflowers on the levee slopes and sunken gardens, baseball fields, polo grounds, golf courses, bridle paths, archery ranges, trapshooting spaces, winding drives and a two mile long lake with a Coney Island atmosphere" (Payne 1994, 156).

By the time of the dedication, the City Beautiful Movement was on the wane and the emphasis on beautification, aesthetics, and social issues gave way to the City Efficient Movement. This new movement focused less on the big sweeping plans of monuments, boulevards, and parks, and placed emphasis on practicality, stabilization of land values through zoning, separation of urban land uses, and accommodating the automobile (Talen 2005, 117–140).

The Morgan Engineering Company from Memphis, Tennessee, was the consulting engineer on the Dallas Floodway project. Myers, Noyes and Forrest Engineers from Dallas performed additional engineering. As previously described, the Trinity Farm Construction Company was awarded the construction contract as a private letting. The company contractually agreed to complete construction with the available money regardless of any unanticipated circumstances that might arise. To manage the construction effort, the Levee District appointed a three-person Board of Supervisors led by Leslie Stemmons (Furlong et al. 2003, 3, 4).

The Dallas Floodway project was the second largest flood control project in the nation during its time; only the flood control project along the Miami River in Dayton, Ohio, was larger (Furlong et al. 2003, 4).

More than 1,000 men worked around the clock seven days a week for nearly two years to build the Dallas Floodway project (North Texas Public Broadcasting and KERA 2009).

The amount of earth moved to move the river one-half mile west (22 million cubic yards) was five times the volume of the Great Pyramid of Giza and one-tenth the size of the Panama Canal. No deaths occurred during the construction (*DMN* 1933d; Furlong et al. 2003, 4). Figure 4-8 shows the floodway and downtown Dallas before the floodway construction began and Figure 4-9 shows the floodway under construction in late 1929.

Figure 4-8. Downtown Dallas and the Trinity Floodplain Before Reclamation, ca. Early 1920s

Figure 4-9. Dallas Floodway Under Construction, 1929

The Great Depression intervened in October 1929 and greatly affected the project. By 1930, the mayor announced he would have to raise taxes if he sold all the bonds for pressure sewer development needed by the floodway design. The levee supporters needed $1.1 million to complete the reclamation effort to build the sewer system required. A protest movement ensued, charging the reclamation was a private undertaking and not deserving of more public money. Also of concern was the diversion of bond money for storm sewers from areas of the city that continually flooded to finance sewers for the yet undeveloped Trinity Industrial District (the hydraulic fill area) controlled by the Industrial Properties Corporation (Fairbanks 1996, 203).

The battle for the Trinity River bottoms raged on because the reclamation project had been sold to the public as a better way to link downtown to Oak Cliff, protect the city from flooding, and open land for industrial development, leaving many concerned over what they viewed as a huge public subsidy for a private real estate venture (Fairbanks 1996, 202). Many groups wanted a more even distribution of the bond money spread around the city instead of the city paying for interior drainage for yet undeveloped land controlled by private interests (i.e., property owners of the Levee District and Industrial Properties Corporation).

The public debate over the relationship between public works and private development ultimately ended in a compromise. The compromise provided storm sewers for the rest of the city that was considered neglected, but eliminated several of the interior drainage components and expensive pressure sewers (e.g., Turtle Creek Pressure Sewer) for the reclamation area controlled by the Industrial Properties Corporation, effectively stalling the effort to develop the area as an industrial district (Fairbanks 1996, 207).

In December 1931, the Board of Supervisors and the State Reclamation Engineer approved an amended Joint Plan of Reclamation. The amended plan, prepared by Myers, Noyes and Forrest, reflected the changes to the interior drainage that resulted from the Depression budget and political compromise over the drainage (Myers, Noyes and Forrest Engineers 1931). To appease the citizens of areas of Dallas that were flooding, the city delayed the construction of storm sewers in the Hydraulic Fill Area, rendering it useless for development, and shifted the bond money to fix areas that were flooding (*DMN* 1933c). It was futile for the Industrial Properties Corporation to fill in the area and then taxpayers later pay for it to be re-excavated for storm sewers.

Other significant design changes were made to save costs. The original design for the levees called for a three to 1 (3:1) slope, which was changed to 2.5:1, and in places, 2:1. While all four pump stations in the 1928 Joint Plan of Reclamation were constructed, not all of the interior drainage works were completed. Five of the seven sluiceways were constructed, and only three of the five planned pressure sewers were built (Furlong et al. 2003, 5).

A construction progress report was issued on April 1, 1931, with estimated completion of the now almost $21 million project set at 60 percent. The cost of the project was divided as follows:

Property Owners	43 percent
City of Dallas	14 percent
County of Dallas	17 percent
Railroads and Utilities	26 percent

The flood control works (levees, pump stations, and sluiceways) were essentially complete; however, only $200,000 of the funding remained, while storm sewers and improvements to the Corinth, Commerce, and Continental Street viaducts were not complete. Significant work on the Hydraulic Fill Area and the paving of Industrial Boulevard by the County of Dallas also remained.

Construction of the project as outlined in the Amended Joint Plan of Reclamation of 1931 was essentially accomplished in late 1932 with the completion of the Dallas Branch Pressure Sewer. The lack of adequate drainage, the Great Depression, and World War II combined to insure the reclaimed hydraulic fill area left from the straightening of the Trinity River remained undeveloped until the mid-1940s (Fairbanks 1996, 209).

The KPA in 1932 fragmented under the dual impact of the Great Depression and a bitter dispute over the disposition of storm sewer bond funds from the Ulrickson Plan. KPA urged spending some of the monies in residential areas, while Dealey wanted no monies to be diverted from storm drainage construction in the Trinity River bottoms (Wilson 1989, 275).

The Dallas floodway and reclamation project polarized the city of Dallas, and full completion of the construction as originally planned was delayed for decades (Fairbanks 1996, 205). Kessler's 1919 statement that "The Trinity River Project is the biggest problem you have today in Dallas" was still true.

4.3 Floodway Management, 1932–1959

The project was completed in 1932 but even though the levees were in place with four pump stations on line, there were no funds available during and immediately following the Depression for the maintenance of the floodway or operation of the equipment and facilities used as an integral part of floodway management (Texas Section ASCE 1989). The Levee Districts did not have the funds to maintain the levees because the property owners that comprised the districts were not able to pay taxes. The Levee District bonds went into default several times during the depression years (Baker 1988, 49). This, coupled with the interior drainage issues, led to an overall degrading of the system throughout the 1930s. Meanwhile, development occurring elsewhere in the city increased runoff and demand on the system.

Major floods occurred in Dallas in 1935 and 1942. The 1942 flood produced the largest peak flow along the Trinity River since the 1908 flood. The levees held for the 1942 flood, but they were in poor condition and becoming worse (Furlong et al. 2003, 6–7).

4.3.1 The U.S. Army Corps of Engineers (USACE) Completes the Joint Plan of Reclamation

Through the efforts of John Stemmons, son of Leslie Stemmons, the Texas Legislature created the Dallas County Flood Control District in 1945. This new flood control district was the response to the major flood of 1942. It essentially replaced the previously created flood control districts because of their default on the bonds issued for the construction of the original floodway. The new flood control district acted to repair and maintain the levees and operate the pump stations (Texas Section ASCE 1989). Operations and maintenance of the levees and other floodway components was funded by $25,000 in annual state taxes, which were collected from the property owners within the boundaries of the district (Furlong et al. 2003, 7).

The departments of Agriculture, Commerce, and War conducted several surveys on the development of the Trinity River. In the 1944 Flood Control Act, Congress authorized a program of water and soil conservation, and in the 1945 River and Harbors Act (amended in 1950), Congress authorized deepening the Trinity River channel nine feet from the river mouth to Liberty, strengthening the levees at Dallas and Fort Worth, and building new reservoirs on the upper branches of the river (TxDOT 2004, 28). The USACE was charged with carrying out this public works program.

The USACE began to study expanding and raising the levee system. The Dallas County Flood Control District advised the USACE that the strengthening project "needed to adhere as close as possible to the latest version of the Joint Plan of Reclamation that was the basis to the original Dallas Floodway project completed in 1932" (Furlong et al. 2003, 7). Deviations from the plan would otherwise need to be approved by the two original levee districts. The USACE's strengthening of the system complied with the Joint Plan of Reclamation in its last amended form in 1931, adding features that the two levee districts foresaw would be needed as development occurred and increased runoff put greater demand on the system. The floodway, levee alignments, and overall design concept from the 1930s remained unchanged. When the USACE finished with the floodway in 1959, it included upgrades in the original design and the completion of the components that had been removed because of the Great Depression and the compromises from the political battle over public works and private development. Figure 4-10 shows the exact same view of the Dallas Floodway in 2009 as the 1929 view shown in Figure 4-9. The primary change in the two photographs is the successful development of the reclaimed lands made possible by the floodway as envisioned by the 1928 Joint Plan of Reclamation.

Source: Google Maps

Figure 4-10. Dallas Floodway, 2009

The USACE strengthening began in January 1953 and was completed in April 1959, 31 years after the first earth was moved for the Dallas Floodway. Rather than obscuring work done earlier in the 1930s, the USACE efforts allowed completion of the floodway and reclamation project by restoring essential features compromised in the original plan (e.g., pressure sewers) and creating components (e.g., additional pump stations) that were needed as runoff from development increased. Nonetheless, the latter components were envisioned in the 1928 Joint Plan of Reclamation. Robert Fairbanks, in his article in the compilation of American planning history titled *Planning the Twentieth Century American City*, states, “Only after the Army Corps of Engineers…committed more than $8 million to strengthen the levees and to develop the pumping plants and pressure sewers for the area, did the last chapter in the Trinity River reclamation begin” (Fairbanks 1996, 209).

Continuation of those efforts resulted in portions of the original Trinity River bottoms being reclaimed as dry land, and development of what became known as the Trinity Industrial District began in 1947. Over the next 15 years, industrial and commercial interests built warehouses, stores, and related support buildings along Industrial and Irving Boulevards.

The city of Dallas and the city of Irving took control of the responsibilities of the Dallas Floodway upon the expiration of the Dallas County Flood District in 1968. Each city became responsible for the portion of the floodway within their city boundaries, while the USACE retained its oversight and inspections of the entire length of the floodway. This division of the floodway's management has allowed the city of Dallas to improve the capabilities of its pumping stations and sumps when needed. In 1963, the city upgraded two pumps at the Delta Pump Station and at the Charlie Pump Station. Additionally, two pumps at the Able Pump Station were upgraded in 1967, and a pump was added to the Hampton Pump Station in 1969 (Furlong et al. 1993, 8).

In 1975, the city constructed a second pump station at both the Hampton and Baker locations. In 1979, it added one pump each to the large Able Pump Station, Charlie Pump Station, Pavaho Pump Station, and Delta Pump Station to increase the capabilities of these locations. The city also constructed the Woodall Rodgers Pressure Sewer as part of the project for the Woodall Rodgers Freeway in the 1970s. The 1980s were a slow time for the levee system, and the city undertook few improvements to the floodway, including six 10- x 10-foot box culverts at the Baker Pump Station (Furlong et al. 1993, 9).

The Irving Flood Control District No. 1 was created in 1971 to maintain the Northwest Levee. In 1974, the district constructed a stormwater pump station and related facilities and enlarged the levee from its 2:1 slope, as built between 1928 and 1932, to a 3:1 slope, as was specified in the original levee design. The levee was also heightened (Fennell 2010). A second stormwater pump station was added in 1995. The district owns and maintains all the flood control structures in the city of Irving, including the Northwest Levee, and has over time, made periodic improvements to them (Skipwith et al. ca. 2007, 6).

4.4 Urban Growth and Community Development

From 1900 to 1920, the city limits of Dallas grew exponentially and the population boomed. In 1900, Dallas was a city of 42,639 people. By 1910 the population was 92,104 and grew to 158,976 by 1920. This growth was precipitated by the movement of people from the rural farms of north Texas to the urban center growing at Dallas and Fort Worth. During this time, Dallas annexed Oak Cliff, bringing Dallas across the Trinity River.

The growth Dallas experienced in the early 1900s was in part, a result of the expansion of the railroads. The first railroad came to Dallas in 1872 and began the early period of development of the city as crops from the surrounding countryside were brought to market in the cities. Following the Panic of 1893, the railroad industry slowed its expansion until the economy could recover. By the early 1900s, the railroads were once again growing as the city moved away from agriculture toward machinery. As of 1902, Dallas led the region in publishing, drug manufacturing, jewelry fabrication, and wholesale liquor distribution (McElhaney and Hazel 2009).

Dallas' new found urban role was challenged by the constant flooding of the Trinity River. The downtown district continually flooded as the river overflowed its banks, damaging businesses, disabling utilities, and cutting off all communication and travel between Dallas and Oak Cliff. Although the city knew the Trinity River would be a constraint to expansion, the flood of 1908 proved to be a turning point in the way the city dealt with the river. By 1912, the permanent bridge between Dallas and Oak Cliff was completed, with plans to expand the number of bridges between the two areas in the works. While cotton continued to be the dominant agricultural endeavor in Dallas County, farmers in the area also contributed to the agricultural industry with large-scale wheat and corn production. As agricultural production in the region surrounding Dallas expanded, so did the emphasis on mechanizing the process of harvesting and transporting the crops. This continued spotlight on agriculture led to Dallas being one of the leading agricultural transit centers in the region, and guided the city to focus on mechanization.

The financial world began to notice Dallas in the late 1800s when William Henry Gaston arrived in the area. Gaston and his partner Aaron C. Camp began the Gaston and Camp Bank of Dallas which allowed commerce and industry to develop. Due to the continued growth of Dallas, city leaders, supported by George B. Dealey of the *Dallas Morning News,* contacted well-known landscape architect George Kessler to formulate a city plan. Although features of the city plan included the creation of two parkways, the purchase of five municipal parks, and the construction of a series of Boulevards, the most drastic aspect of Kessler's plan was the creation of a levee system to control the flooding of the Trinity River. The implementation of Kessler's levee system did not occur quickly, and took the creation of the 1927 Ulrickson Committee to be fully implemented.

During the 1920s, financial speculations in the stock market and land development led to increased personal wealth for those involved in industrial expansion. During this era of growth and development, the new wealthy elite began leading the way in roadway advancement. The 1916 Federal Aid Road Act stated that each state must have its own highway department to be eligible to receive federal funds for roadway construction. While Texas struggled to implement a highway system, individual community leaders such as Leslie Stemmons continued to push for Dallas' roadway system.

Also during the 1920s, industry became the leading employer in Dallas. This move from an agricultural to an industrial economy pushed the focus of development in Dallas toward the plans supported by men such as Leslie A. Stemmons and George Dealey.

4.4.1 Industrial Properties Corporation

The 1928 Joint Plan of Reclamation, which came out of the Ulrickson Committee, called for the recovery of a large area of land beside the Trinity River, known as the Hydraulic Fill Area. Although this proposal was passed by voters with a $23.9 million bond issue, opponents of the bonds led by the railroads, continued to threaten to file an injunction to stop the bond sale (Furlong et al. 2003, 3; Baker 1988, 46).

Two of the Levee District supervisors, Leslie A. Stemmons and John Simmons were interested in the development of the Hydraulic Fill Area and organized a group of property owners within the Levee District into the Industrial Properties Corporation. The main goal of the corporation was to develop the

Hydraulic Fill Area and continue to expand in that region. The original property owners who formed the Industrial Properties Corporation in 1928 controlled 75 percent of the 10,500 acres set to be reclaimed (Fairbanks 1996, 202). As explained earlier, Stemmons and Simmons arranged a private bond sale and awarded the construction contract for the Dallas Floodway as a private letting.

The actions taken by Stemmons and Simmons laid the groundwork for the way in which Industrial Properties Corporation would take control of the Hydraulic Fill Area and the urbanization of this area of Dallas. Many community members questioned the amount of help the city should give to private developers as a result of the actions taken by Stemmons. The actions taken by the Dallas Levee Improvement District were believed to run opposite to the idea of the bond program which was meant to operate for the benefit of the city as a whole while the district appeared to operate for the benefit of the landowners. Despite these questions, George Dealey supported the reclamation project and lobbied city officials on its behalf. Dealey went so far as to publish a special eight-page supplement in the *Dallas Morning News* promoting the reclamation and industrial development led by Stemmons. Dealey's support came under fire; however, because he owned property in the bottom lands set to be reclaimed and would personally benefit from the project. The Trinity River Reclamation Project polarized the city and led to a delay in the completion of the project for decades (Fairbanks 1996, 205).

Due to the controversy over private development and public works as well as the Great Depression, the Trinity River Reclamation Project entered into a period of disregard. The mayor of Dallas announced that a tax increase would be needed if he sold all of the bonds for the pressure sewer development portion of the floodway design, leading to a protest movement against the project. The opposition argued that the floodway development was not a public issue, but instead a private undertaking that would benefit the Industrial Properties Corporation and large landowners. Also of concern to community members was the diversion of bond money for storm sewers from areas of the city that continually flooded. The bond money was instead utilized to finance sewers for the yet undeveloped industrial area (the hydraulic fill area) controlled by the Industrial Properties Corporation (Fairbanks 1996, 203). The battle for the Trinity bottoms raged on because the reclamation project had been sold to the public as a better way to link downtown to Oak Cliff, protect the city from flooding, and open land for industrial development, leaving many concerned over what they viewed as a huge public subsidy for a private real estate venture (Fairbanks 1996, 202). Many groups wanted a more even distribution of the bond money spread around the city instead of the city paying for interior drainage for yet undeveloped land controlled by private interests (i.e., property owners of the Levee District/Industrial Properties Corporation).

The eventual compromise between the city and the Industrial Properties Corporation resulted in the completion of storm sewers for the portion of the city that was considered neglected, but the elimination of sewers for the Industrial Properties Corporation lands (Fairbanks1996, 207). The lack of adequate drainage, the Great Depression, and World War II combined to insure the reclaimed hydraulic fill industrial area left from the straightening of the Trinity River remained undeveloped until the mid-1940s (Fairbanks 1996, 209).

Delayed by financial troubles of the Levee District, drainage issues, and World War II, development by the Industrial Properties Corporation began in 1947, and George Dealey's 1902 vision of the private development of the reclaimed lands became a reality.

Plans that had been mothballed for twenty years were updated. Officials visited industrial districts around the country and drew up a list of things not to do in the District (Baker 1988, 49):

- Don't lay out narrow streets.
- Don't get a district too far away from the residences of employees or public transportation.
- Don't overlook the parking problem.
- Don't construct tracks so that a small parcel of land cannot be served.
- Above all, don't do anything that will keep you from maintaining flexibility. Be sure any industry can have the type, shape and size tract suiting its particular needs.

The District acquired its first tenant in 1947, Continental Trailways quickly followed by the Texas and Pacific Freight House and the International Harvester Company (Baker 1988, 51). These companies opened in the south end near Continental Street, where interior drainage worked the best. The Corporation's plan included the development of a large area of land in the Hydraulic Fill Area. This land would then be subdivided and sold for a profit (Baker 1988, 53).

Three railways served the district, the Texas and Pacific, the Rocky Island, and the Cotton Belt making the area attractive to industrial companies that needed to ship their goods across the nation (Baker 1988, 53). By 1953, the Trinity Industrial District included 310 buildings. During this era of growth between 1946 and 1953, Industrial Properties Corporation was under the leadership of John Stemmons, the son of Leslie A. Stemmons. John and his brother Storey had begun working for the Industrial Properties Corporation in the early 1930s under the guidance of their father. Upon Leslie Stemmons' death in 1939, John took control of the corporation. John Stemmons was appointed the President of the Industrial Properties Corporation in 1945 and his brother Storey became the Vice President and General Manager of the corporation in 1946 (Baker 1988, 51).

4.4.2 Trammell Crow and the Stemmons Brothers

A rising Dallas businessman, Trammell Crow, began his association with the Trinity Industrial District in 1948 when he constructed a warehouse for the Ray-O-Vac company. When Ray-O-Vac decided to move to larger quarters, Crow put together his first real estate deal. He acquired loans from an insurance company and a local bank to build a warehouse on land he had bought from Mr. Stemmons. He leased half the building to Ray-O-Vac and soon found a renter for the rest. With this success, he realized he wanted to continue and obtained an option for the remaining lots on Cole Street within the Trinity Industrial District. He ultimately built over fifty warehouses and two million square feet of industrial space in the Trinity Industrial District (Baker 1988, 57; *New York Times* [*NYT*] 2009).

Crow partnered with the Stemmons brothers in the early 1950s. Through this partnership, the Industrial Properties Corporation would lease land to Crow who would in turn obtain a mortgage for constructing a building on the property. In order to accomplish this goal, a corporation was created between the Stemmons brothers and Trammell Crow as equal partners in the corporation. The partnership between Crow, Stemmons, and the Industrial Properties Corporation, resulted in the development of properties in the Trinity Industrial District that changed the face of Dallas.

The first success of this partnership was the Decorative Center which opened its doors in 1954. Built to serve the many decorators in Dallas, the Decorative Center was a repository for fine furniture, materials, and antiques that was only open to decorating professionals. When the building opened in 1954, it had 71,335 square feet of space for display. The Decorative Center proved lucrative and the building was enlarged to 130,680 square feet.

Shortly after the success of the Decorative Center, the Furniture Mart (1956) was completed. Then the partnership constructed the Trade Mart (1959), which was double the size of the Furniture Mart; Stemmons Towers (1961), a series of four buildings; and Market Hall (1963). When Market Hall was completed in 1963, it served a civic need for the city of Dallas. In 1962, the executive Vice President of the Dallas Chamber of Commerce approached Trammell Crow with the idea that the city needed a larger space to house traveling groups. While the 1925 Municipal Auditorium was a good venue for many groups, Dallas' appeal was bringing in larger meetings than the auditorium could hold. Crow took the idea for a new meeting hall to the Stemmons brothers and the deal was made.

The next large-scale project Trammell Crow and the Stemmons brothers undertook was the Apparel Mart. Upon completion, the Apparel Mart was four stories tall with a large atrium and 1,800,000 square feet of display space. During the 1960s, the four Marts constructed by Crow and the Stemmons brothers continued to increase in occupancy and they went ten years without a vacancy.

The partnership between Crow and John Stemmons ended in the early 1970s when Crow approached Stemmons about building a World Trade Center in Dallas. John Stemmons, who did not believe in being in debt, did not want any part of the World Trade Center deal and chose instead to have Crow, buy him out of the deal. Crow hoped to further Dallas' standing as a financial center and was determined to complete the deal.

While Trammell Crow moved on to large-scale projects such as the Anatole Hotel, Wyndham Hotel, and the Infomart, the Industrial Properties Corporation led by John Stemmons began to look outside Dallas to expand its holdings. During the 1970s, the Industrial Properties Corporation sold the four Stemmons Towers to the Manufacturers Life Insurance Company of Canada and the Market Center to Trammell Crow.

Forbes in 1971 and *The Wall Street Journal* in 1986 called Mr. Crow the largest landlord in the United States. The *Journal* said the company he founded was then the nation's biggest developer (*NYT* 2009).

4.4.3 Stemmons Expressway

In the early 1950s, the district engineer for the State Highway Department approached John Stemmons about the need for a north-south expressway through Dallas and a corridor through the Trinity Industrial

District. To get Stemmons' attention, the state engineer had an artist draw double-decking on Industrial Boulevard as a suggested way to provide the corridor, bypassing Stemmon's properties. Stemmons went into a rage and pledged to fight it until "hell freezes over." Stemmons agreed to donate land that would become Stemmons Expressway (named for his father) in the mid-1950s. One condition of the donation was the creation of access ramps to the Trinity Industrial District from the newest addition to the emerging interstate highway system. It was a move that exponentially increased the value of land held by the Industrial Properties Corporation. The freeway opened in December 1959 (Baker 1988, 55).

4.4.4 Community Growth

The development of Dallas is directly tied to the growth of commerce, industry, and real estate. As families began moving from the rural countryside into the urban core, Dallas moved toward a heavily industrialized city. While agriculture remained a leading source of income in the late 1800s and early 1900s, industry took the forefront after 1920. In the years between 1920 and World War II, industry was the leading employer in Dallas County. This growth in industry led to a growth in real estate. While Trammell Crow and the Stemmons brothers would lead the way in industrial real estate, Leslie A. Stemmons led the way in residential real estate. Stemmons was influential in the development of several neighborhoods within Dallas including the Miller-Stemmons addition, Winnetka Heights, Rosemont Crest, Sunset Hill, Sunset Annex, Sunset Summit, Sunset Heights, and Sunset Crest (TxDOT 2004, 22).

Following World War II, the migration from the country to the city continued in north Texas, leading to an increased population in Dallas. Between 1940 and 1990, the population of Dallas tripled from 294,734 to 1,006,887 and saw a marked diversification of commercial and industrial pursuits. As a result of these growing industries, residential areas in Dallas continued to expand and several areas were annexed into the city limits. The commercial development of the downtown Dallas area began to overrun the early residential areas and forced many people to the newly developed suburbs.

Additionally, the oil and defense industry boom of the 1950s and 1960s helped lead Dallas' focus on a car culture. During that era, personal automobiles became the preferred method of travel and allowed workers to live outside of the city core and still travel to work. This ability to travel to the workplace by private vehicle created an impetus to move to the suburbs and thus led to the creation of a patchwork of freeways. This movement led to the sprawling metropolitan area of the modern-day Dallas-Fort Worth metroplex.

4.5 Physical Development of the Floodway

4.5.1 Original Dallas Floodway Construction, 1928–1932

Construction of the Dallas Floodway began in July 1928. The project was designed to confine a flood of about 2.5 times that which occurred in 1908 (Furlong et al. 2003, 5). Doing so involved moving the Trinity River channel one-half mile west into the middle of the floodplain, and building a series of levees. To move the river channel, the confluence and channels of the Elm Fork and West Fork were moved 3.5 miles west. In total, approximately 15 miles of new river channels were excavated. The main floodway was formed by two parallel levees built along each side of the new channel. The land in the floodplain between the new channel and levees, called the overbank, was cleared of brush, timber, and all other obstructions. The East and West Levees extended approximately seven miles upstream from the AT&SF Railroad Bridge. The floodway then divided into two separate floodways for Elm Fork and West Fork (see Figure 4-7). The length of the East and West Levees, including the Elm Fork and West Fork channels, was 11.9 miles and 10.9 miles, respectively. The total length of the Northwest Levee was 2.8 miles. Each levee was 30 feet tall and on average, 156 feet wide at the base and six feet wide at the crown (Furlong et al. 2003, 4).

Four pumping plants, called A, B, C, and D, were constructed. Pumping Plant A includes two pumps at 20,000 gallons per minute (gpm) capacity and is located at the East Levee just downstream from the Houston Street Viaduct (formerly the Dallas-Oak Cliff Viaduct). Also at the East Levee is Pumping Plant B, which includes four, 52,000-gpm-capacity pumps. This plant is located upstream of Sylvan Avenue. At the West Levee are Pumping Plants C and D. Both of these plants each contain two pumps at 60,000 gpm capacity. Plant C is located just downstream of the present-day Houston Street Viaduct, and Plant D is upstream of the Hampton Road Bridge. Pumping Plants A, B, C, and D became Able, Baker, Charlie, and Delta, respectively, in the 1950s when the USACE added pumping plants and strengthened the levees (Furlong et al. 2003, 4–5).

Floodway construction also included gravity sluiceways in the main floodway and one at Eagle Ford along the West Fork. In all, two miles of auxiliary channels were constructed (Furlong et al. 2003, 5).

Three pressure sewers were constructed to carry interior drainage through the levees to the river. The Mill Creek Pressure Sewer (later known as the Belleview Pressure Sewer) has more than 2.6 million gpm in capacity. It is located at the East Levee upstream from the Corinth Street Viaduct. The Dallas Branch Pressure Sewer is located at the East Levee downstream from the Continental Avenue Bridge, and has a capacity of 256,731 gpm. At the West Levee, upstream from the Houston Street Viaduct, is the Coombs Creek Pressure Sewer. Its capacity is a little more than 3.1 million gpm (Furlong et al. 2003, 5).

The old river channel was retained to provide storage for interior drainage, but a specific section from Turtle Creek Boulevard to Commerce Street was to be filled in by the property owners (the city would provide the storm drainage) with hydraulic fill. This was done specifically to create the area for the planned Trinity Industrial District. A dredge floating in the river pumped over the levee to fill the low places and “make it as level as any other part of business Dallas” (*DMN* 1933d).

As explained earlier, the Great Depression and the political battle between public works and private interests resulted in significant design changes to the Dallas Floodway during construction to save costs. The original design for the levees called for a 3:1 slope, but the side slopes on the riverside were changed to a steeper 2.5:1 slope. The slope of the Northwest Levee was 2:1 (Fennell 2010). While all four pump stations were constructed as planned in the 1928 Joint Plan of Reclamation, not all of the interior drainage works were completed. Only five of the seven sluiceways were constructed as planned, and only three of the five planned pressure sewers were built (Furlong et al. 2003, 5).

Construction was nearly complete on the Dallas Floodway in February 1932. The last component to be finished was the Dallas Branch Pressure Sewer in late 1932 (Furlong et al. 2003, 6). Upon completion, the floodway protected 20 districts and reclaimed 10,650 acres of land; 7,317 acres to the west and 3,333 acres to the east (Furlong et al. 2003, 4).

4.5.2 USACE Strengthening, 1953–1959

The USACE was mandated by Congress through passage of the River and Harbors Act in 1945 (Public Law 14-79) and as amended in the Flood Control Act of 1950 (Public Law 81-516) to complete various flood control works along the Trinity River, including the Dallas Floodway. After studies documented the poor condition of the levees, the USACE Fort Worth District developed detailed plans and specifications for strengthening and enhancing the Dallas Floodway. Construction began in January 1953 (Furlong et al. 2003, 7, 8).

The USACE as-built drawings of the levee strengthening (Figures 4-11 and 4-12) show that all the original levees were retained, but additional fill was placed on the river side to change the slope of and enlarge the East and West Levees; the USACE did not strengthen the Northwest Levee (Skipwith et al. ca. 2007, 5; USACE 1956a, 1956b). Fill was added as a cap to thicken the levee system on the river side; the land side levee toe was unchanged. The additional fill increased the average height of the levee to 28 feet and extended the width of the levee crown to 16 feet and its side slopes to 3:1 as specified in the original design. The fill used to strengthen the levees came from the material that was removed from the riverside crown of the existing levees and from excavation of existing and new sumps. The additional fill on the riversides of the levees reduced the width of the Dallas Floodway by approximately 30 feet. Ironically, the four feet added by the USACE in the 1950s is today reduced back to its near original 1929 design height in some areas due to settlement, soil creep, or lack of maintenance. The following excerpt from Volume VI of the *Definite Report on Dallas Floodway* (USACE 1955, 4) provides a detailed description of the levee strengthening:

> "In general, the alignment for the strengthened levee has been set by retaining the existing location for the landside toe of the levee. The new centerline of the levee will be riverward an average distance of about 20 feet. The landside slope of the levee will vary from 1 on 3 to 1 on 4, depending upon soils conditions, and the riverside slope will be 1 on 3 throughout the floodway…The crown of the levee will be increased in width from 6 feet to l6 feet and will be paved with 12 inches of flexible base material and double bituminous surface treatment. Riprap will be placed on the riverside slope of the levee under the floodway bridges.
>
> Prior to placement of the embankment materials, the side slopes of the existing levee and the necessary additional base area for the enlarged levee will be stripped. Suitable material will be placed in 8-inch layers and rolled with at least 6 passes of a tamper type roller. Where portions of the existing levee extend beyond the slopes and the top of the proposed levee section, the material will be removed and used for the levee strengthening work. All usable material from sump and channel excavation will be placed in the levee. All borrow material taken from the floodway will

be obtained by enlargement of the river channel above ground water level. Waste material from stripping operations and sump and channel excavation will be placed in riverside borrow ditches and low spots in the floodway."

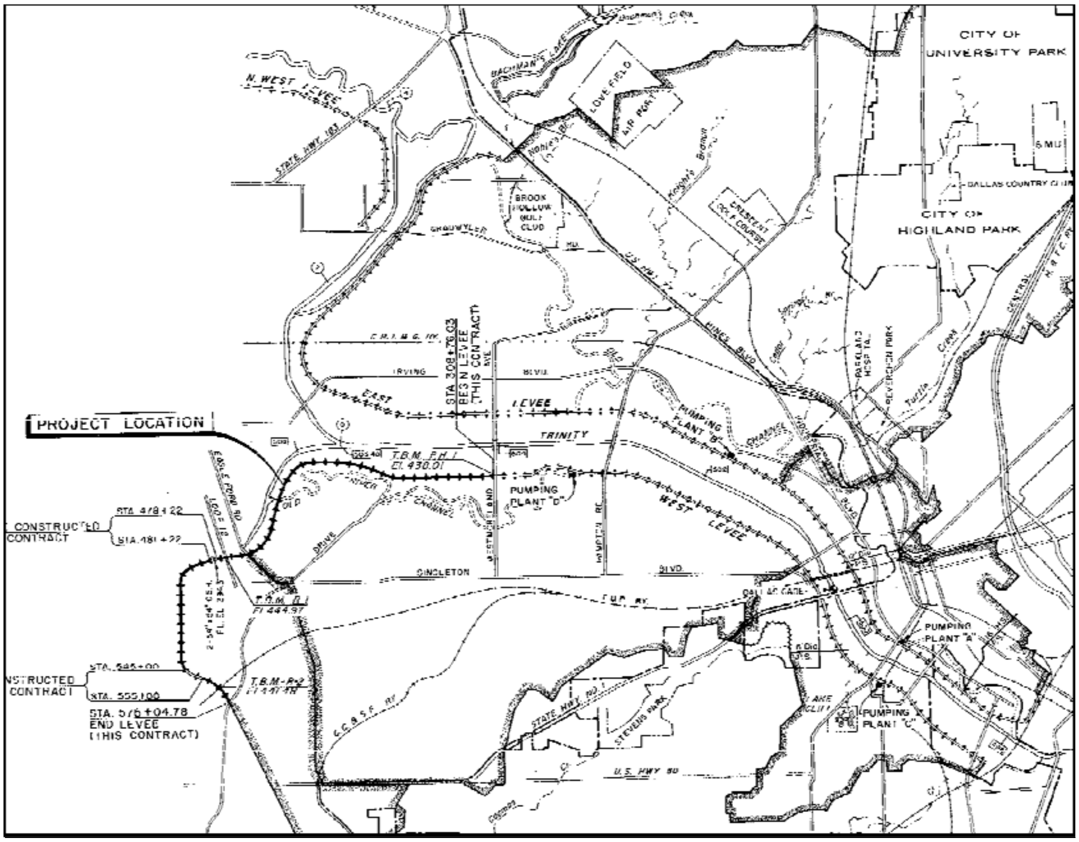


Figure 4-11. USACE Levee Strengthening, 1954

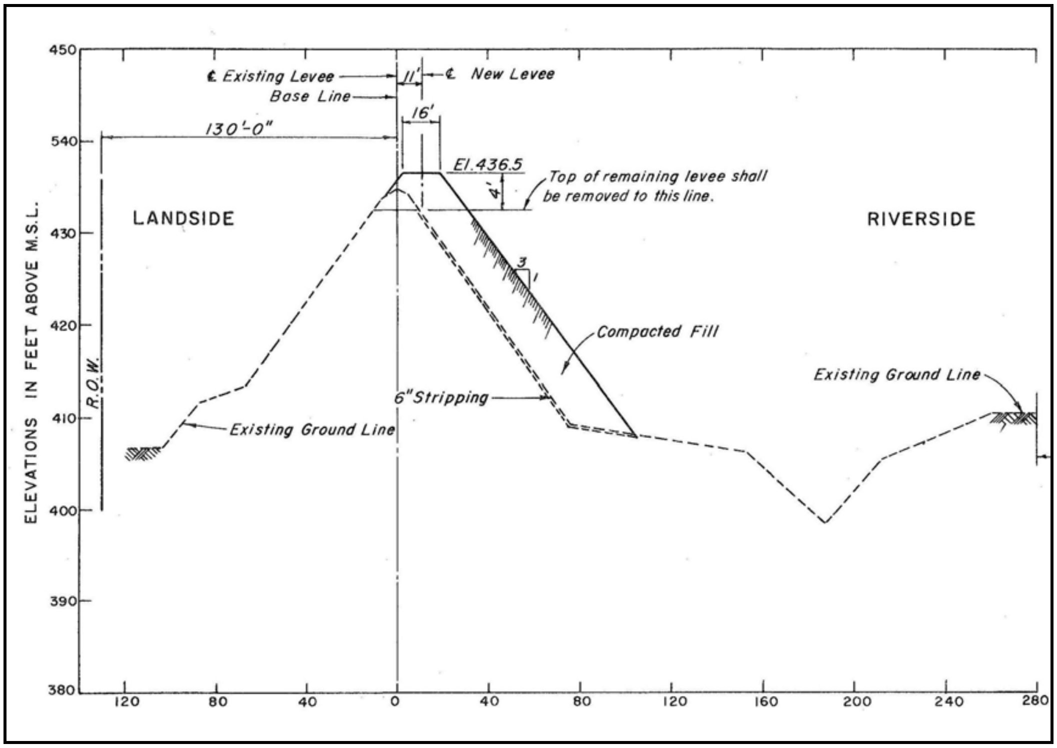


Figure 4-12. Typical Section, USACE Levee Strengthening, 1954

In addition to the levee strengthening, sumps were enlarged for storage of local drainage and interior drainage outfalls were cleaned out (USACE 1952, 1954a, 1955). Additionally, the 2,600-foot-long stretch of the diversion channel from the Belleview Pressure Sewer outlet to the Cadiz Street Viaduct (now eastbound IH-35) was moved to the west by 100 feet to address potential levee toe erosion due to the proximity of the river channel (USACE 1955, 11).

The USACE strengthening of the floodway system in the 1950s included additional pumping plants on both sides of the levees (Hampton, Pavaho, and a new Able) and the two pressure sewers not constructed from the original design. Of the new pumping plants, the new Able Pumping Plant includes three pumps at 46,667 gpm capacity each; the Hampton Pumping Plant contains four pumps at 50,000 gpm capacity each; and the Pavaho Pumping Plant has two pumps at 60,000 gpm capacity each (Furlong et al. 2003, 8). The new Able Pumping Plant was built adjacent to the old Able Pumping Plant. The Hampton Pumping Plant is at the East Levee upstream from the Hampton Road Bridge. The Pavaho Pumping Plant is at the West Levee just downstream from Sylvan Avenue. The two new pressure sewers, Lake Cliff and Turtle Creek, carry drainage through the levees. The Turtle Creek Pressure Sewer is located at the East Levee between Sylvan Avenue and Continental Street and has more than 1.7 million gpm capacity, and the Lake Cliff Pressure Sewer is located at the West Levee just upstream from the Houston Street Viaduct and has 396,317 gpm capacity (Furlong et al. 2003, 8). Gravity sluices were also constructed through the levee on each side of the Lake Cliff Pressure Sewer (USACE 1954a, 2).

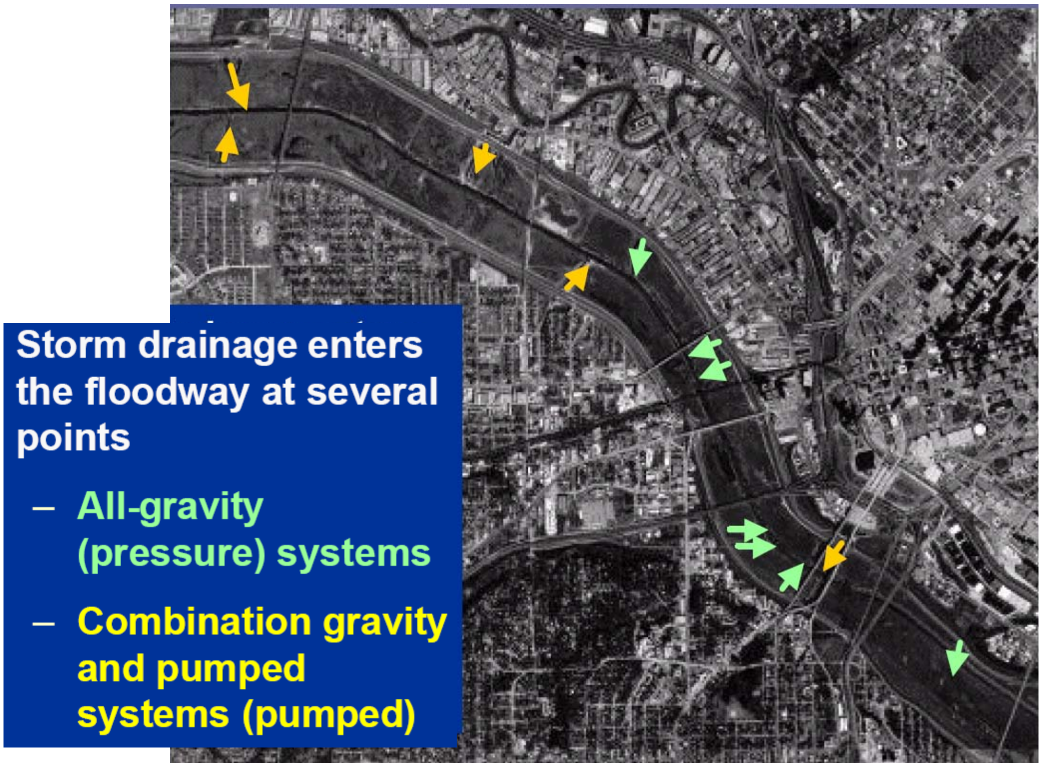
Other features of the USACE's Dallas Floodway project included construction of two gate-controlled culverts in the existing sump approximately 2,000 feet below Ledbetter Drive outside of the West Levee and an earth fill containing one gate-controlled culvert and one uncontrolled (non-gated) culvert in the existing sump upstream from Grauwyler Road outside of the East Levee (USACE 1952, 1953). Both of these structures are located on the old river channel.

4.6 FLOODWAY OPERATIONS

During flood events, interior drainage facilities collect stormwater runoff in ponds, or sumps, in low-lying areas outside of the floodway to the diversion channels within the overbank. Sumps are drainage ditches that collect local stormwater runoff and discharge it into a network of sluices and culverts throughout the floodway system. They are also located next to the land side of the levee walls where stormwater collects at pumping plants for diversion into the floodway.

Intake structures are the openings where water enters into the pressure sewers (Coombs Creek, Lake Cliff, and Turtle Creek) within the interior drainage system. Intakes are located at a distance from the floodway to aid in drainage farther into the watershed's interior. Trash racks at the opening to the intake structures and pumping plants are an important part of keeping large debris from entering the floodway system, as clogging can greatly diminish the floodway's ability to move and pump water (Carter and Burgess 2006).

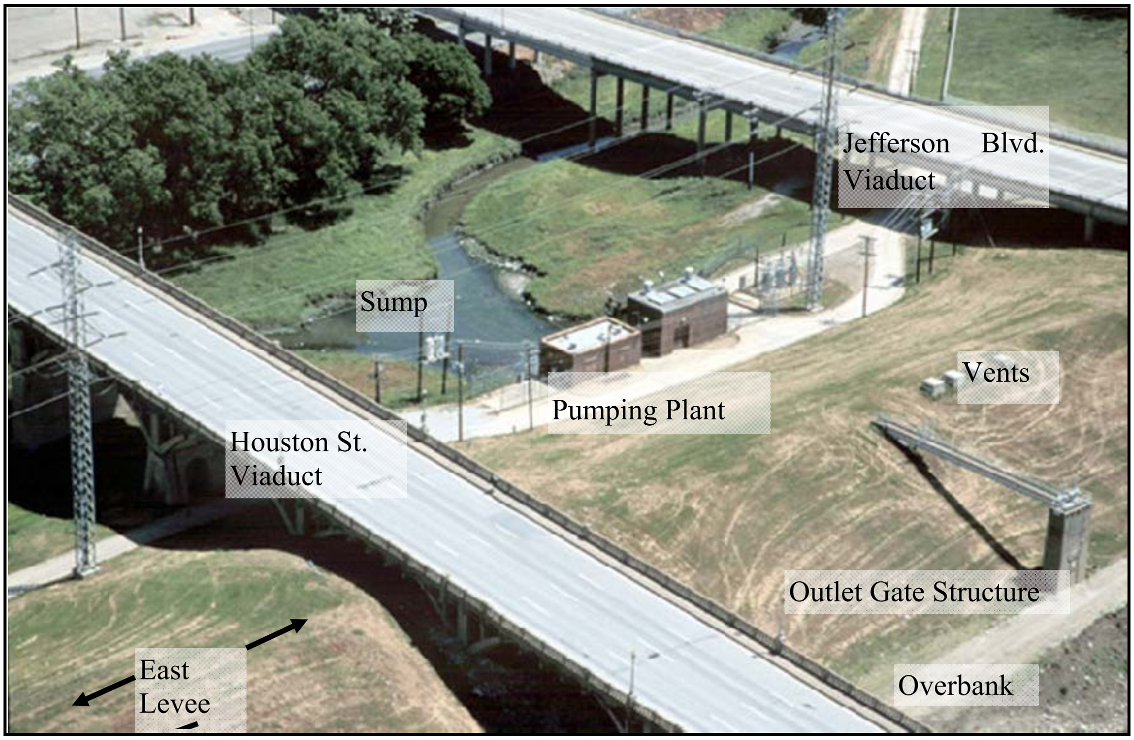
Stormwater from the sumps and intakes is redirected toward the floodway through a network of sluices or culverts. This is done by either pumping the stormwater through pumping stations or by allowing it to flow by gravity through pressure sewers. The pressure sewers are essentially large gravity trunk lines that discharge directly into the floodway. The inlets of these pressure sewers are located far enough upstream in the Trinity River watershed to develop sufficient head, or water force, to discharge against flood stages in the floodway (Carter and Burgess 2006). Figure 4-13 below illustrates the points where stormwater enters the Dallas Floodway via all-gravity pressure sewers and the combination of gravity and pumped systems.



Source: CDM 2003

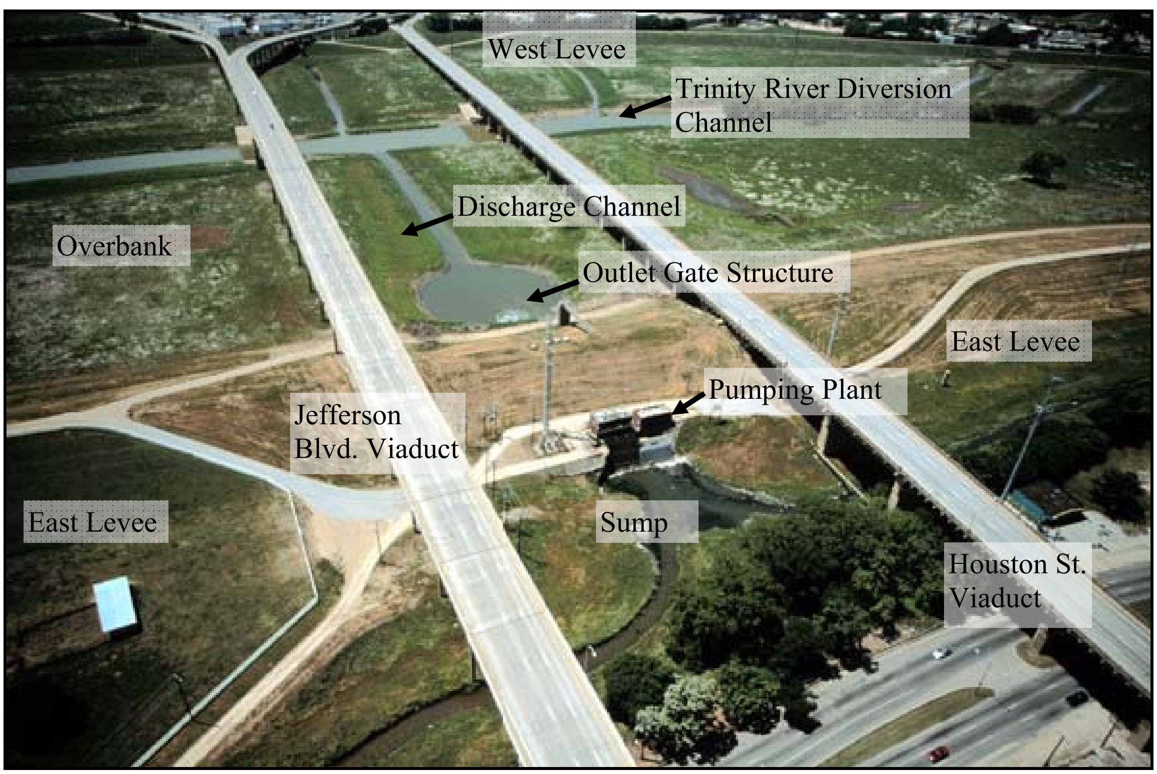
Figure 4-13. Primary drainage points along the Dallas Floodway corridor
Figure adapted from "Trinity River Corridor Project"

Stormwater that is directed to pumping plants gets pumped through the levee walls into the overbank. The floodway first consisted of four pumping plants (A, B, C, and D), with two on each bank of the floodway, plus three pressure sewers (Belleview, Coombs Creek, and Dallas Branch). The USACE improved this system during the 1950s by building two new pressure sewers (Lake Cliff and Turtle Creek), and by adding additional pumping stations at three of the existing pumping plants (A, C, and D). The USACE also built two new pumping plants (Pavaho and Hampton Road), one on each side of the floodway. Figures 4-14 and 4-15 below illustrate the floodway features at a pumping station, here Pumping Station A (Able).



Source: Carter and Burgess 2003

Figure 4-14. Floodway Operations at Pumping Plant A (Able)



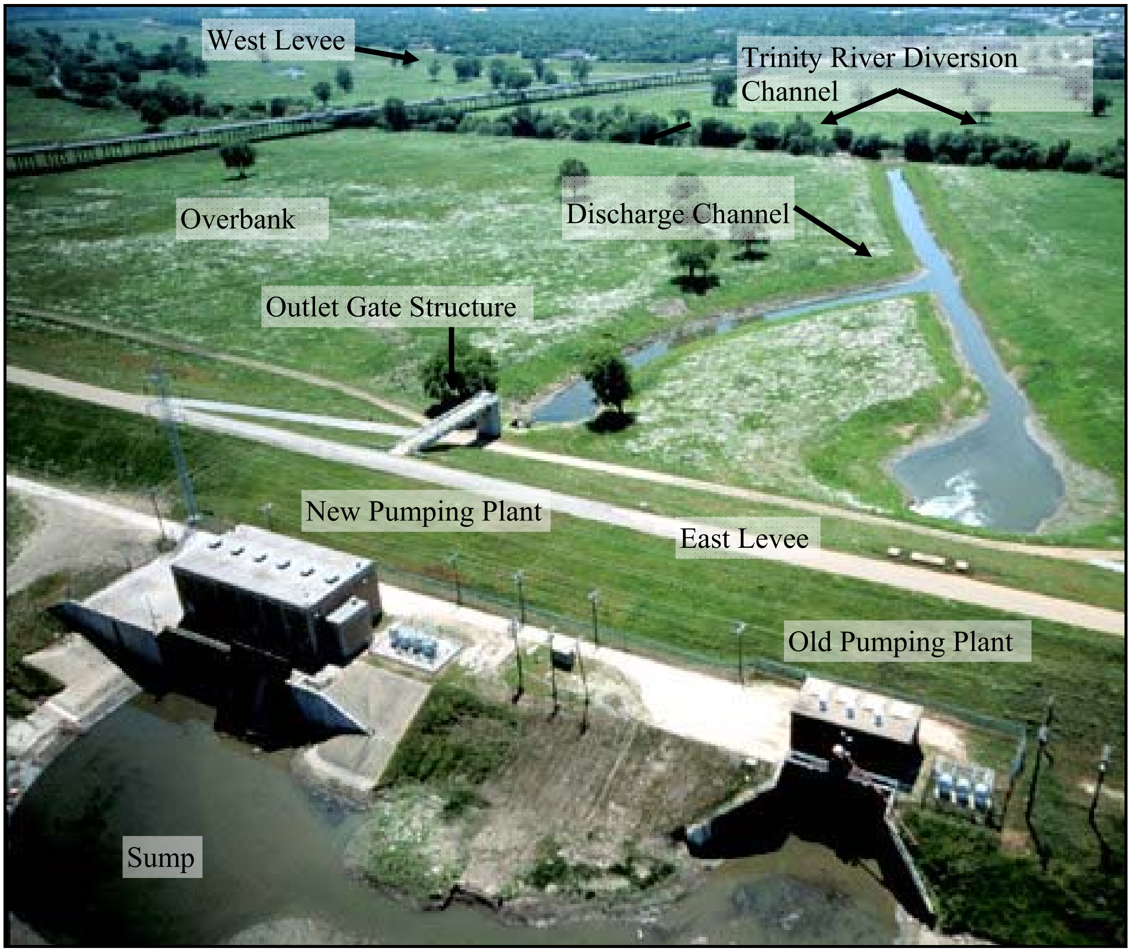
Source: Carter and Burgess 2003

Figure 4-15. Floodway Operations at Pumping Plant A (Able), Looking Toward the Overbank

Sluices connect the pressure sewers and pumping plants to the diversion channel. They carry stormwater through the levee walls and out to the overbank on the levee's river side though outlet gate structures. As the stormwater is pumped into the floodway from the pumping plants, discharge pipes ventilate up through the levee walls in air-relief vents situated on the levee crown. All sluices are controlled by an automatic flap gate as well as a hand-operated sluice gate.

Outlet gate structures are out spill structures that channel and control the stormwater's output into the overbank. Although they are connected to the pumping plants and pressure sewers, they are physically separated from these facilities by the levee walls and their location inside the overbank. The outlet gate structures divert discharged stormwater to the interior of the floodway via concrete box culverts under the levee. Components of the outlet gate structures include tall concrete towers that house gate hoists that operate to open or close the underground sluice gate below the tower.

After the stormwater exits the outlet gate structures, the water travels down discharge channels that lead directly to the main Trinity River diversion channel, the manmade dredged channel that extends down the center of the overbank (see Figure 4-16). As the stormwater runoff begins to fill the overbank and the water level rises, the East and West Levees hold in the water to protect the adjacent low-lying areas outside of the floodway from flooding. The East Levee protects Dallas' Industrial District and parts of the downtown Central Business District, while the West Levee protects the city's Oak Cliff and West Dallas neighborhood districts.



Source: Carter and Burgess 2003

Figure 4-16. View of the Hampton Pumping Plant, Looking Southeast Downstream

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Dallas Floodway

Survey Results and Evaluations

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CHAPTER 5. SURVEY RESULTS AND EVALUATIONS

5.1 INTRODUCTION

The intensive engineering survey was conducted December 16 through 19, 2009, by professional architectural historians. Historic and cultural resources were identified by physical feature based on an extensive literature review and recorded using a historic and cultural resource inventory form (see Appendix F).

5.2 INVENTORIED RESOURCES

The inventory of the resources of the Dallas Floodway is organized by hydraulic physical feature. The 55 components of the Dallas Floodway comprise 10 different types of hydraulic physical features. Each physical feature includes descriptions of common physical features, materials, its current condition as observed during the field survey, and a summary of the components present in the Dallas Floodway. Photographs of each resource recorded during fieldwork are included. The hydraulic physical feature categories are as follows:

Hydraulic Physical Feature 1	Levees
Hydraulic Physical Feature 2	Trinity River Diversion Channel
Hydraulic Physical Feature 3	Overbank
Hydraulic Physical Feature 4	Pumping Plants
Hydraulic Physical Feature 5	Pressure Sewers
Hydraulic Physical Feature 6	Outlet Gate Structures
Hydraulic Physical Feature 7	Intakes
Hydraulic Physical Feature 8	Sluices and Culverts
Hydraulic Physical Feature 9	Sumps
Hydraulic Physical Feature 10	Emergency Control Structures

The individual hydraulic components of these physical feature categories were inventoried and evaluated as part of the Dallas Floodway. Each of the individual components is listed in Table 5-1. A separate physical feature category includes several resources that are within the floodway, but are not components of the floodway and do not contribute to its function. These non-hydraulic physical features, which include bridges, power lines, and a park (see Subchapter 5.13), were considered in the assessment of ability to convey significance of the Dallas Floodway, but they were not individually inventoried or evaluated for significance. The non-hydraulic physical features are included with the hydraulic physical features in Figure 5-1.

Table 5-1 also indicates whether a hydraulic physical feature is essential or not essential to the function of the Dallas Floodway. A function essential hydraulic physical feature is required to make the floodway operational; i.e., it redirects floodwaters through the city and drains the land for development. A function non-essential hydraulic physical feature provides a means to collect the stormwater runoff, but it does not function to convey, move, or discharge the water into or through the floodway. Figures 5-2 through 5-11 show both the individual components of the hydraulic physical features of the Dallas Floodway and whether they are function essential and non-essential, and the non-hydraulic physical features that are in the floodway.

Table 5-1. Surveyed Resources Organized by Hydraulic Physical Feature

Physical Feature	*Date Built*	*Physical Feature Type*	*Function Essential/ Function Non-Essential*
East Levee	1929–1932; 1953	Hydraulic Physical Feature 1: Levee	Essential
West Levee	1929–1932; 1953	Hydraulic Physical Feature 1: Levee	Essential
Northwest Levee	1929; 1974	Hydraulic Physical Feature 1: Levee	Essential
Parallel Levee Channel	1929–1932; 1960s	Hydraulic Physical Feature 1: Levee	Essential
Trinity River Diversion Channel	1932	Hydraulic Physical Feature 2: Diversion Channel	Essential
West Fork Diversion Channel	1928	Hydraulic Physical Feature 2: Diversion Channel	Essential
Elm Fork Diversion Channel	1928	Hydraulic Physical Feature 2: Diversion Channel	Essential
Overbank	1932	Hydraulic Physical Feature 3: Overbank	Essential
Pumping Plant A (Able)	1929	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1953	Hydraulic Physical Feature 4: Pumping Plants	Essential
Pumping Plant A (Able) Outlet Gate Structure	1953	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Pumping Plant B (Baker)	1929	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1975	Hydraulic Physical Feature 4: Pumping Plants	Essential
Pumping Plant B (Baker) Outlet Gate Structure	1956	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Pumping Plant C (Charlie)	1929	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1956	Hydraulic Physical Feature 4: Pumping Plants	Essential
Pumping Plant C (Charlie) Outlet Gate Structure	1956	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Pumping Plant D (Delta)	1929	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1956	Hydraulic Physical Feature 4: Pumping Plants	Essential
Pumping Plant D (Delta) Outlet Gate Structure	1956	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Hampton Road Pumping Plant	1956,	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1975	Hydraulic Physical Feature 4: Pumping Plants	Essential
Hampton Road Pumping Plant Outlet Gate Structure	1956	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Pavaho Pumping Plant	1954	Hydraulic Physical Feature 4: Pumping Plants	Essential
	1975	Hydraulic Physical Feature 4: Pumping Plants	Essential
Pavaho Pumping Plant Outlet Gate Structure	1954	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
"New" Pump House (Northwest Levee)	ca. 1995	Hydraulic Physical Feature 4: Pumping Plants	Essential
"Old" Pump House (Northwest Levee)	1974	Hydraulic Physical Feature 4: Pumping Plants	Essential
Belleview Pressure Sewer	1928–1931	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Belleview Pressure Sewer Outlet Gate Structure	1950s	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Old Coombs Creek Pressure Sewer	1928–1931	Hydraulic Physical Feature 5: Pressure Sewers	Essential

Table 5-1. Surveyed Resources Organized by Hydraulic Physical Feature

Physical Feature	*Date Built*	*Physical Feature Type*	*Function Essential/ Function Non-Essential*
Old Coombs Creek Pressure Sewer Outlet Gate Structure	1989	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Dallas Branch Pressure Sewer	1932	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Dallas Branch Pressure Sewer Outlet Gate Structure	1950s	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Lake Cliff Pressure Sewer	1952–1955	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Lake Cliff Pressure Sewer Outlet Gate Structure	1955	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Turtle Creek Pressure Sewer	1953–1957	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Turtle Creek Pressure Sewer Outlet Gate Structure	1953–1957	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Woodall Rodgers Pressure Sewer	1979	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Woodall Rodgers Pressure Sewer Outlet Gate Structure	1979	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Coombs Creek Pressure Sewer	1957	Hydraulic Physical Feature 5: Pressure Sewers	Essential
Coombs Creek Pressure Sewer Outlet Gate Structure	1957	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Elm Fork Sluice Outlet Gate	1960s	Hydraulic Physical Feature 6: Outlet Gate Structures	Essential
Coombs Creek Intake	1957	Hydraulic Physical Feature 7: Intakes	Essential
Lake Cliff Intake	1950s	Hydraulic Physical Feature 7: Intakes	Essential
Turtle Creek Intake	1955–1956	Hydraulic Physical Feature 7: Intakes	Essential
Eagle Ford Sluice	1928–1931	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
Elm Fork Sluice	1928–1931	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
Ledbetter Dike Control Structure Gate (C.S.G.)	1950s	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
Grauwyler C.S.G.	1950s	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
Northwest Levee Sluices	1928	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
	1974	Hydraulic Physical Feature 8: Sluices and Culverts	Non-Essential
Old Trinity River Channel	1928; 1932	Hydraulic Physical Feature 9: Sumps	Non-Essential
60-inch Emergency Control Structure	1950s	Hydraulic Physical Feature 10: Emergency Control Structure	Non-Essential
East Bank Interceptor	1950s	Hydraulic Physical Feature 10: Emergency Control Structure	Non-Essential

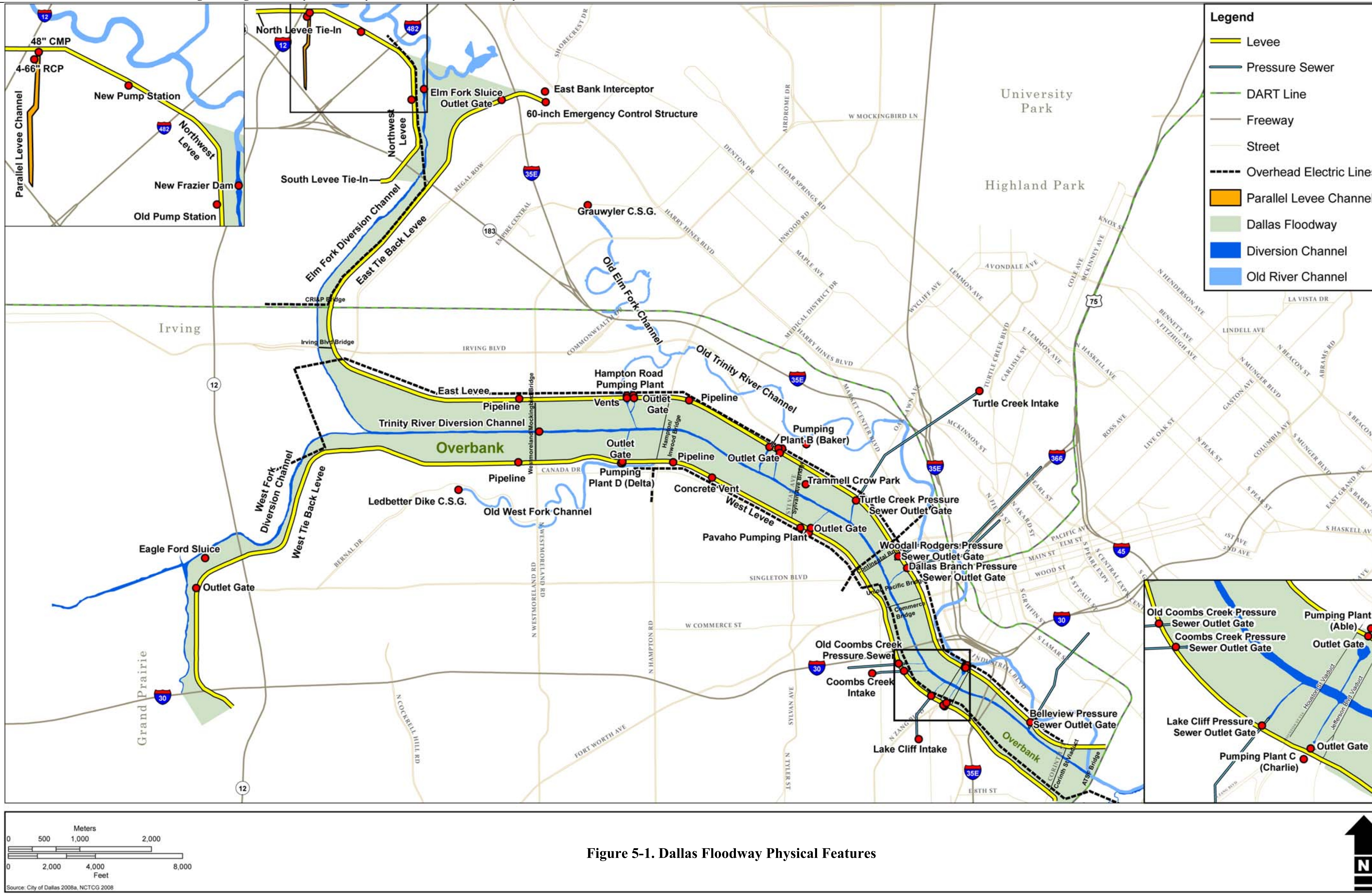


Figure 5-1. Dallas Floodway Physical Features

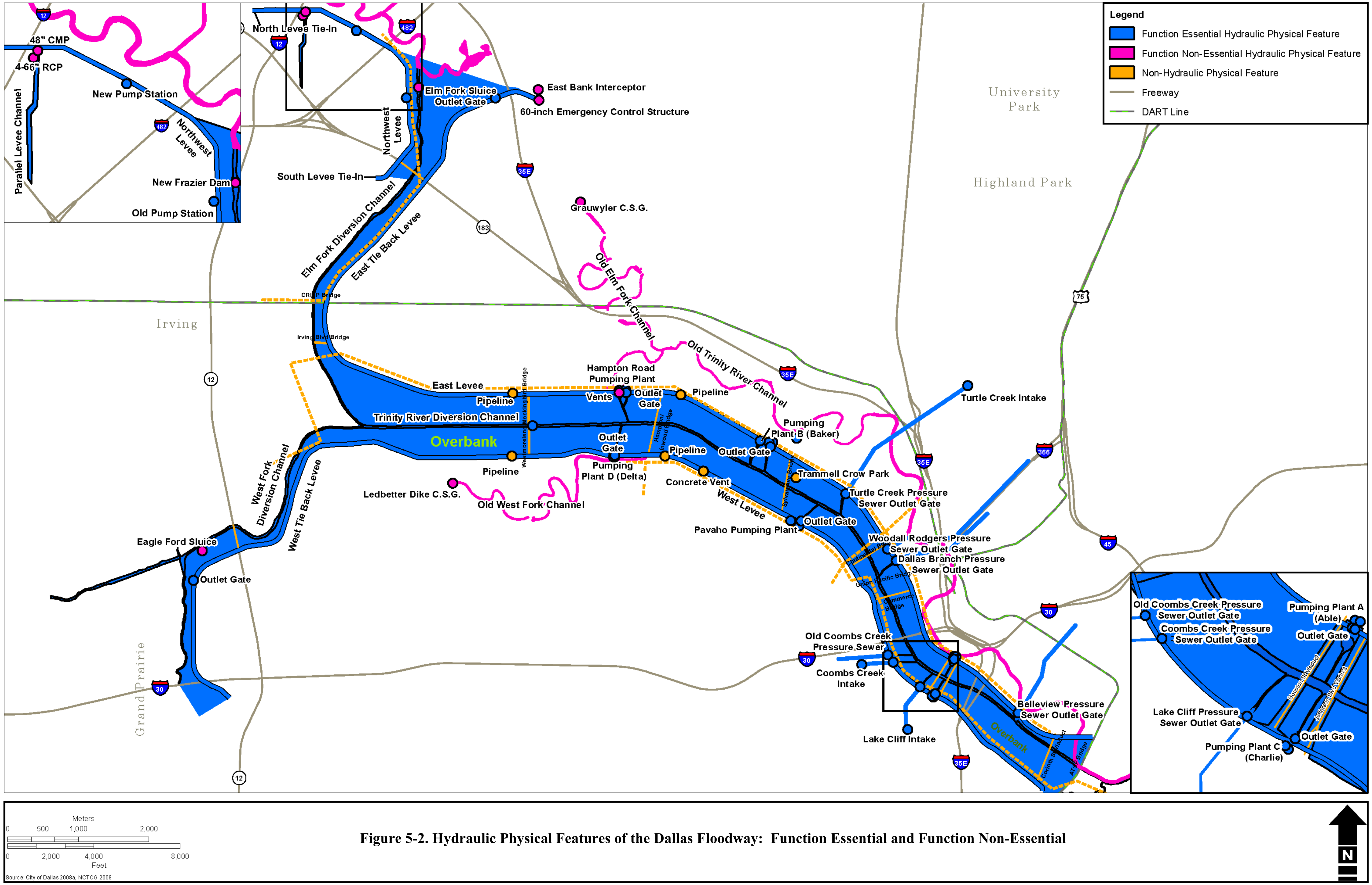


Figure 5-2. Hydraulic Physical Features of the Dallas Floodway: Function Essential and Function Non-Essential

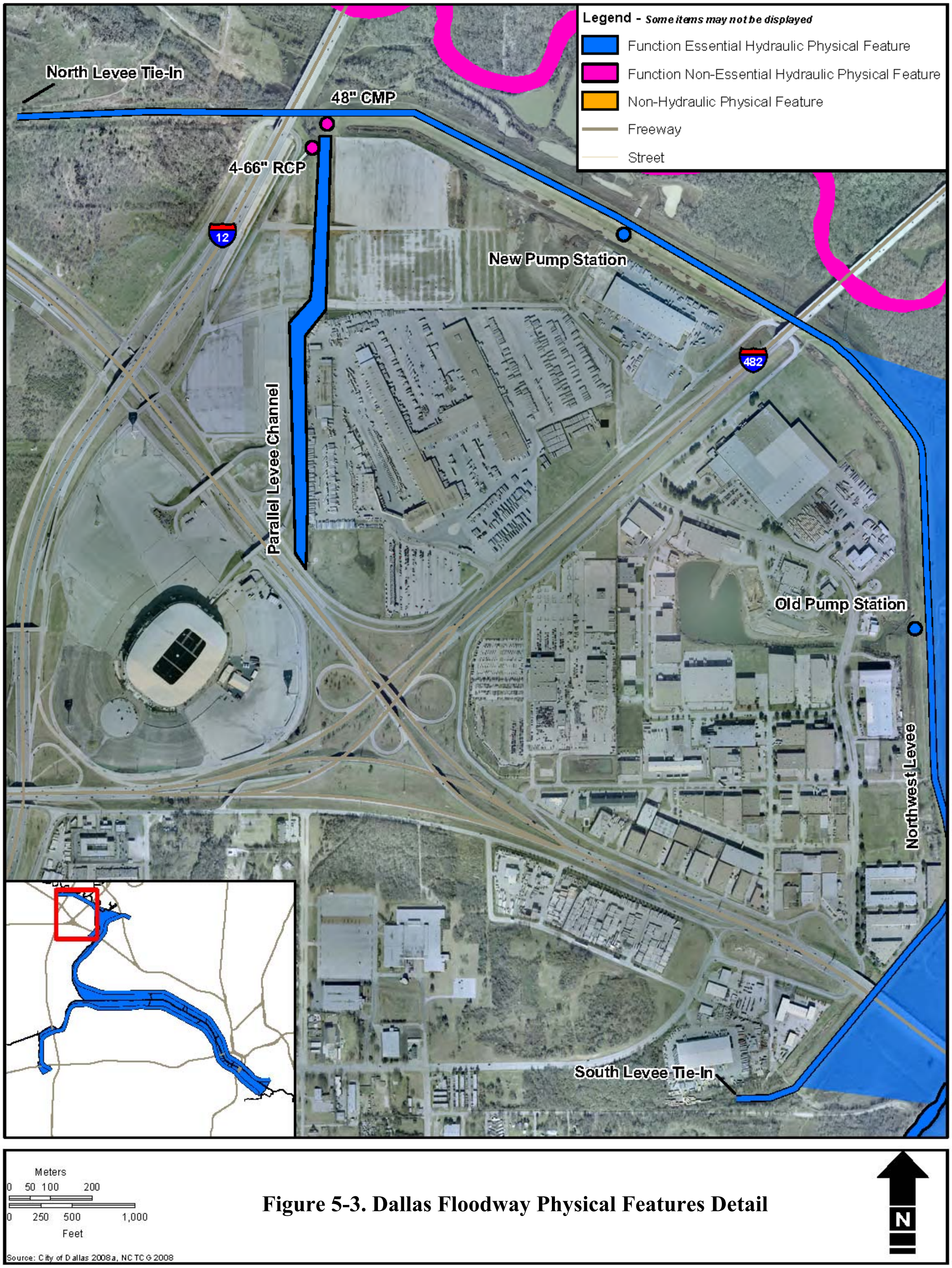


Figure 5-3. Dallas Floodway Physical Features Detail

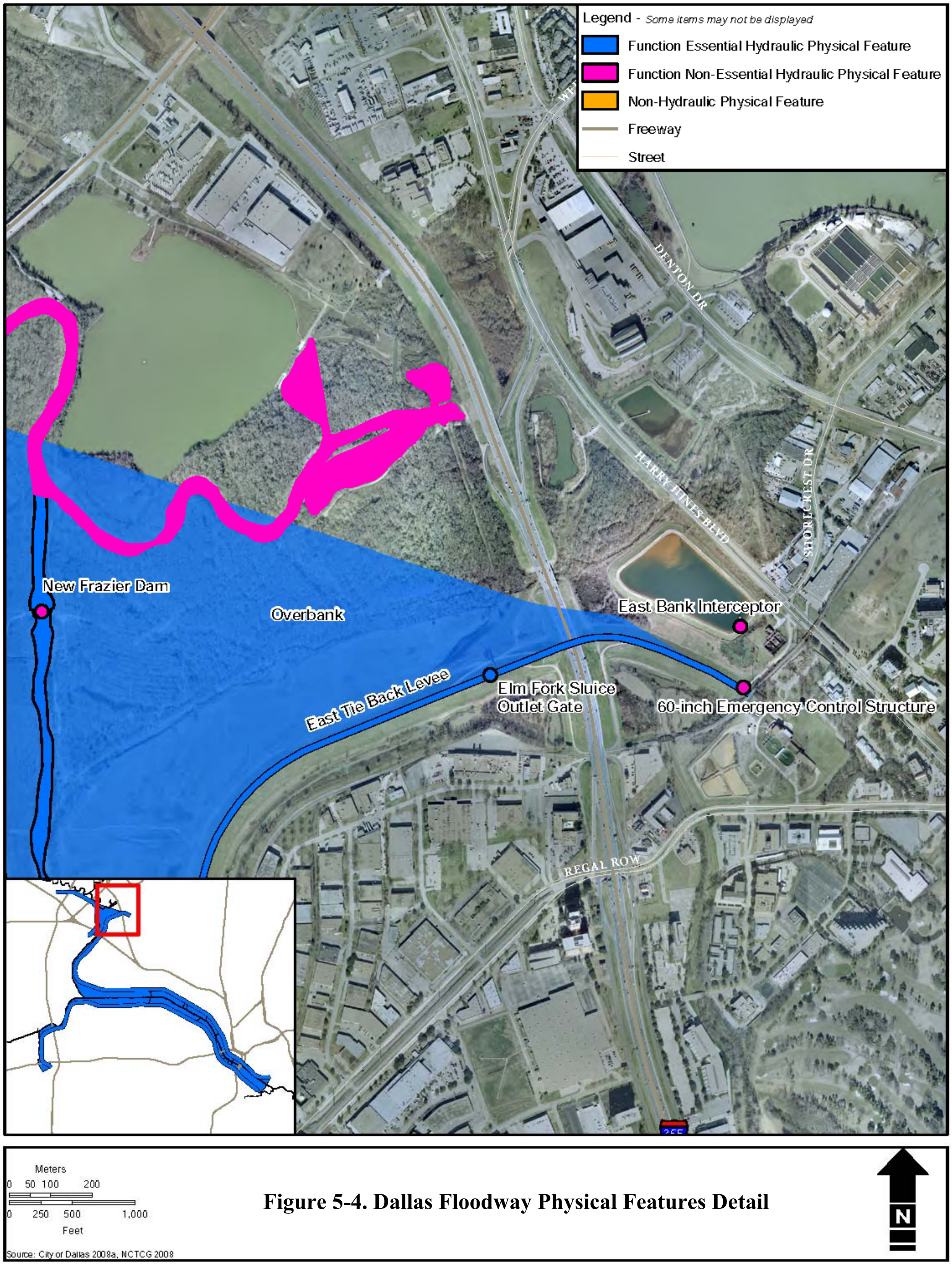


Figure 5-4. Dallas Floodway Physical Features Detail

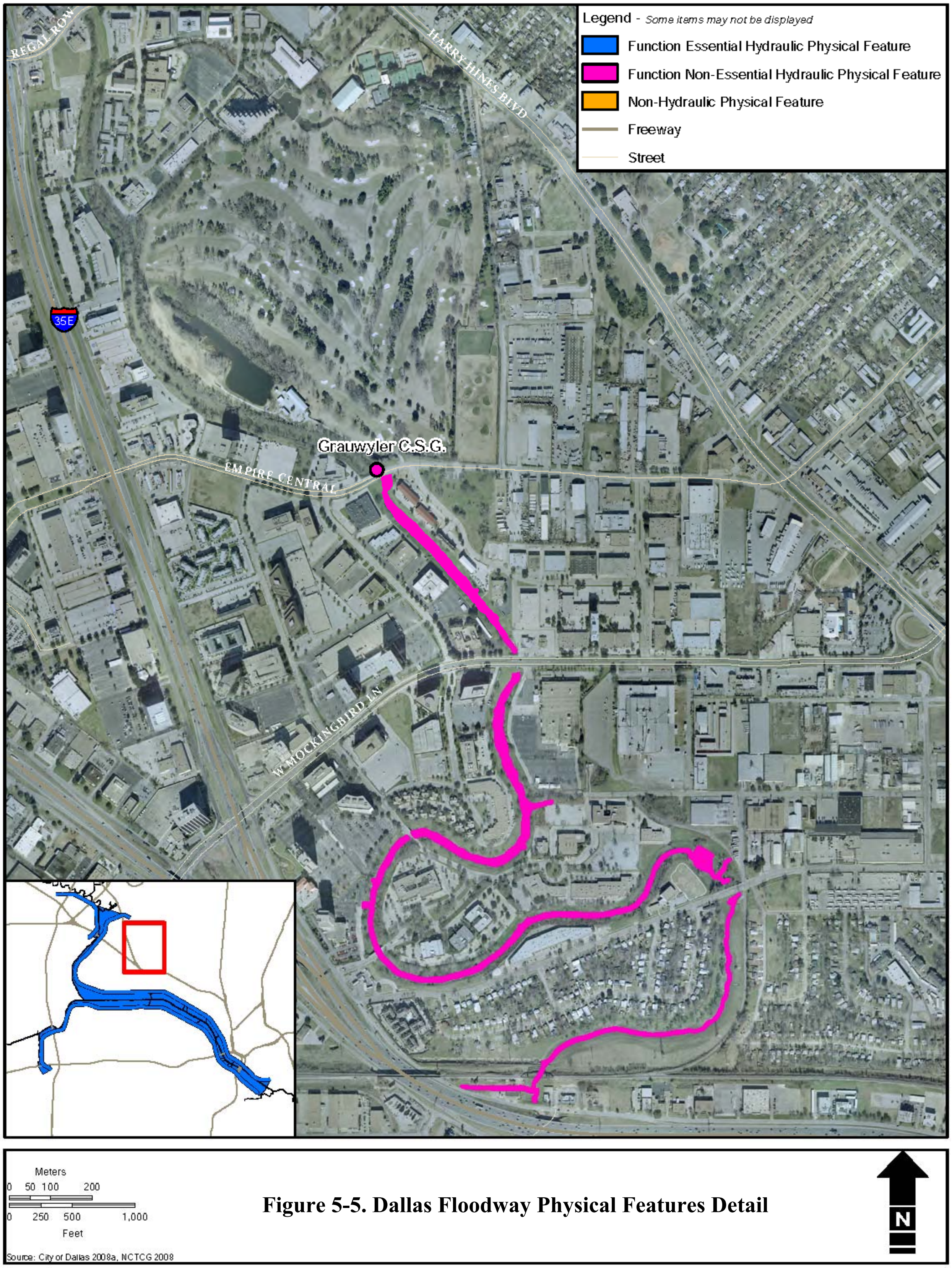


Figure 5-5. Dallas Floodway Physical Features Detail

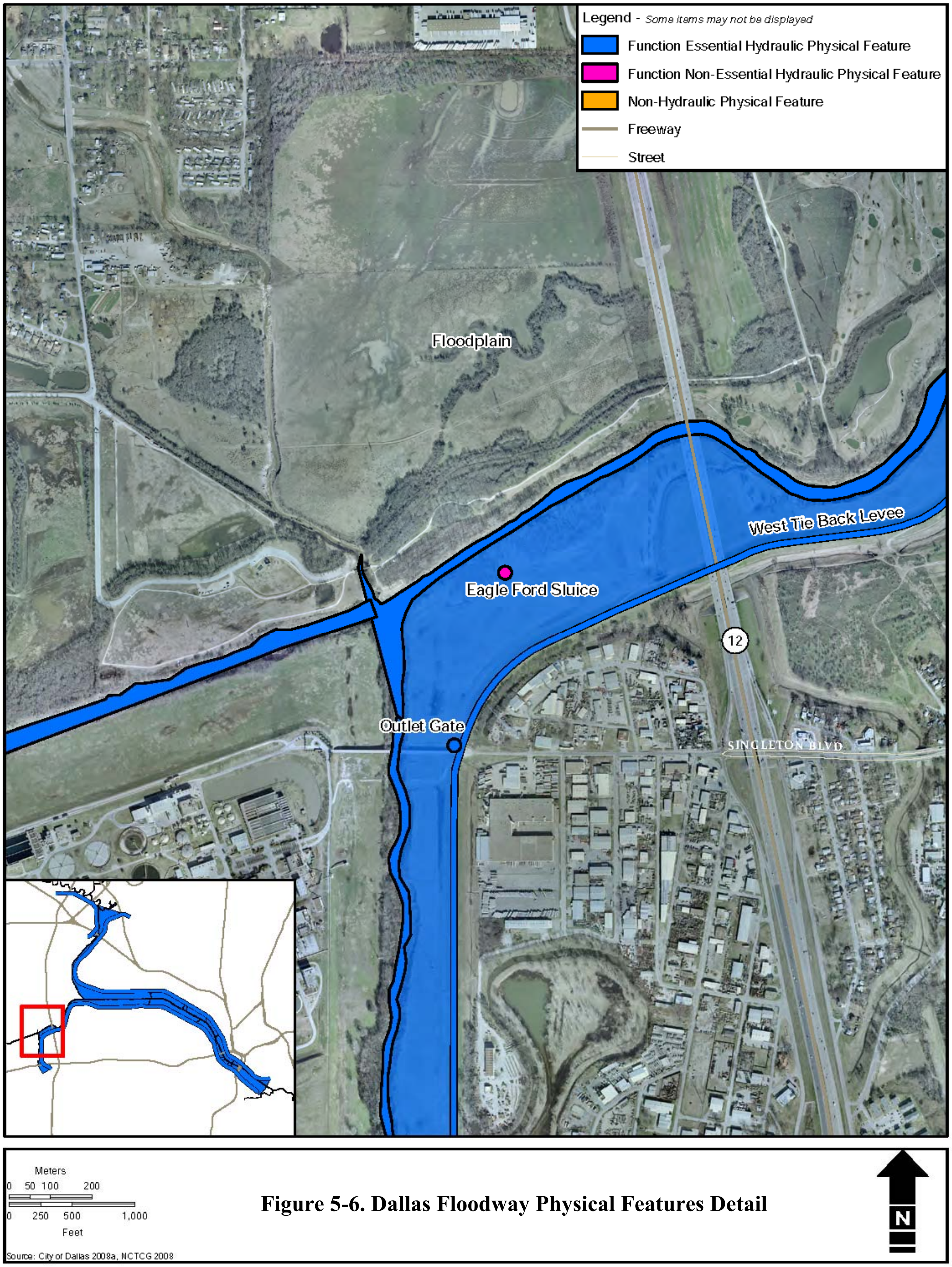


Figure 5-6. Dallas Floodway Physical Features Detail

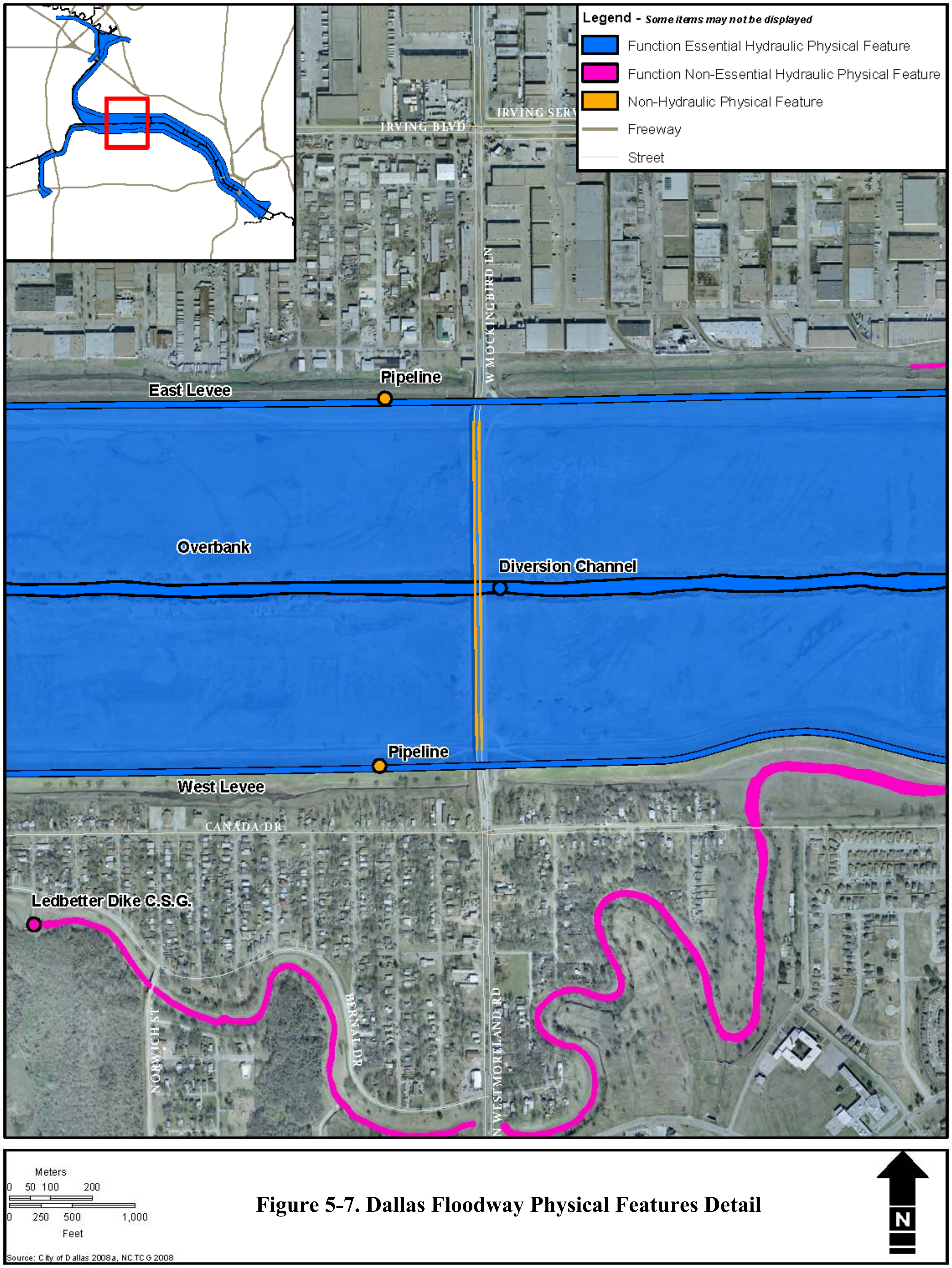


Figure 5-7. Dallas Floodway Physical Features Detail

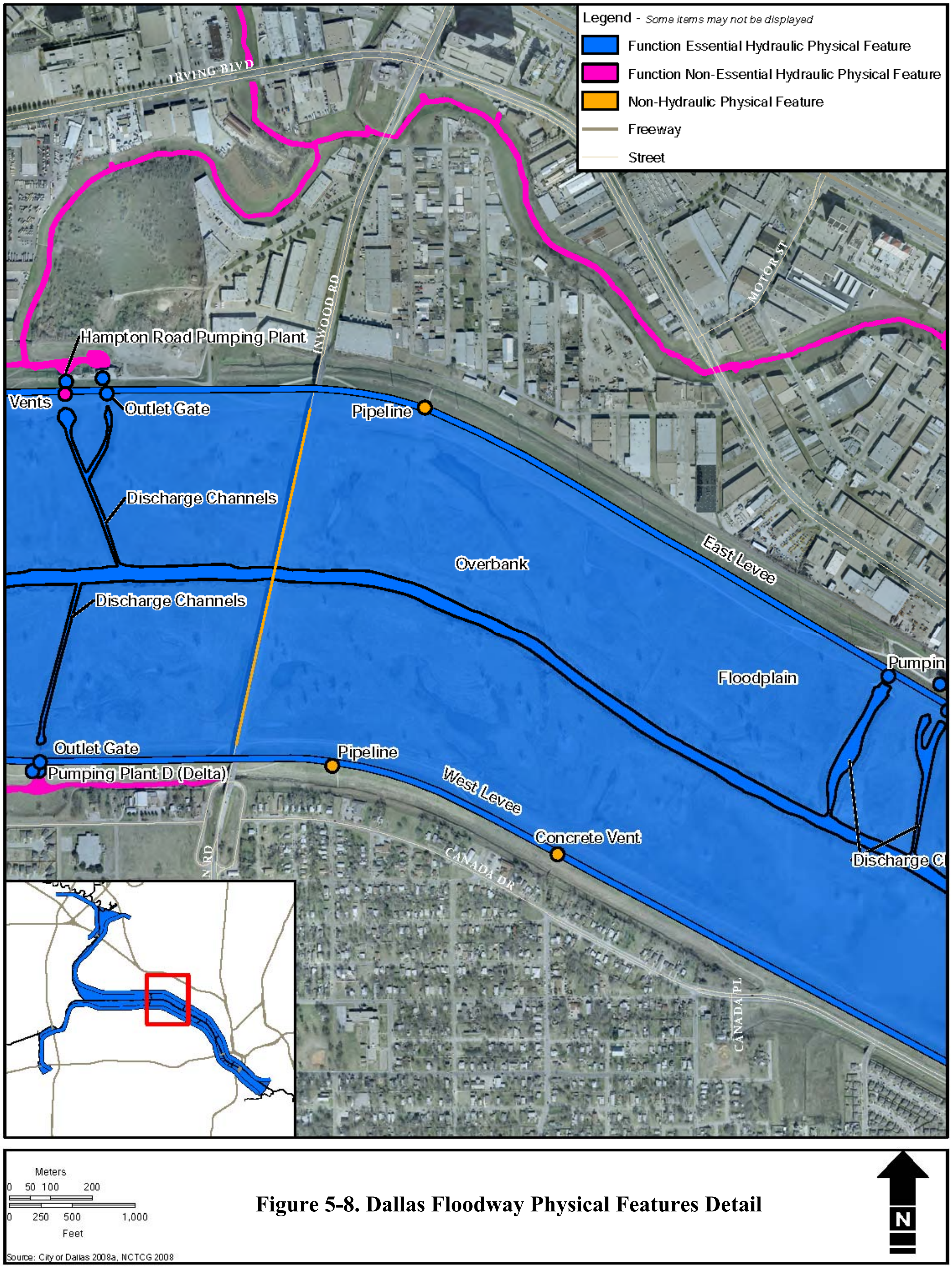


Figure 5-8. Dallas Floodway Physical Features Detail

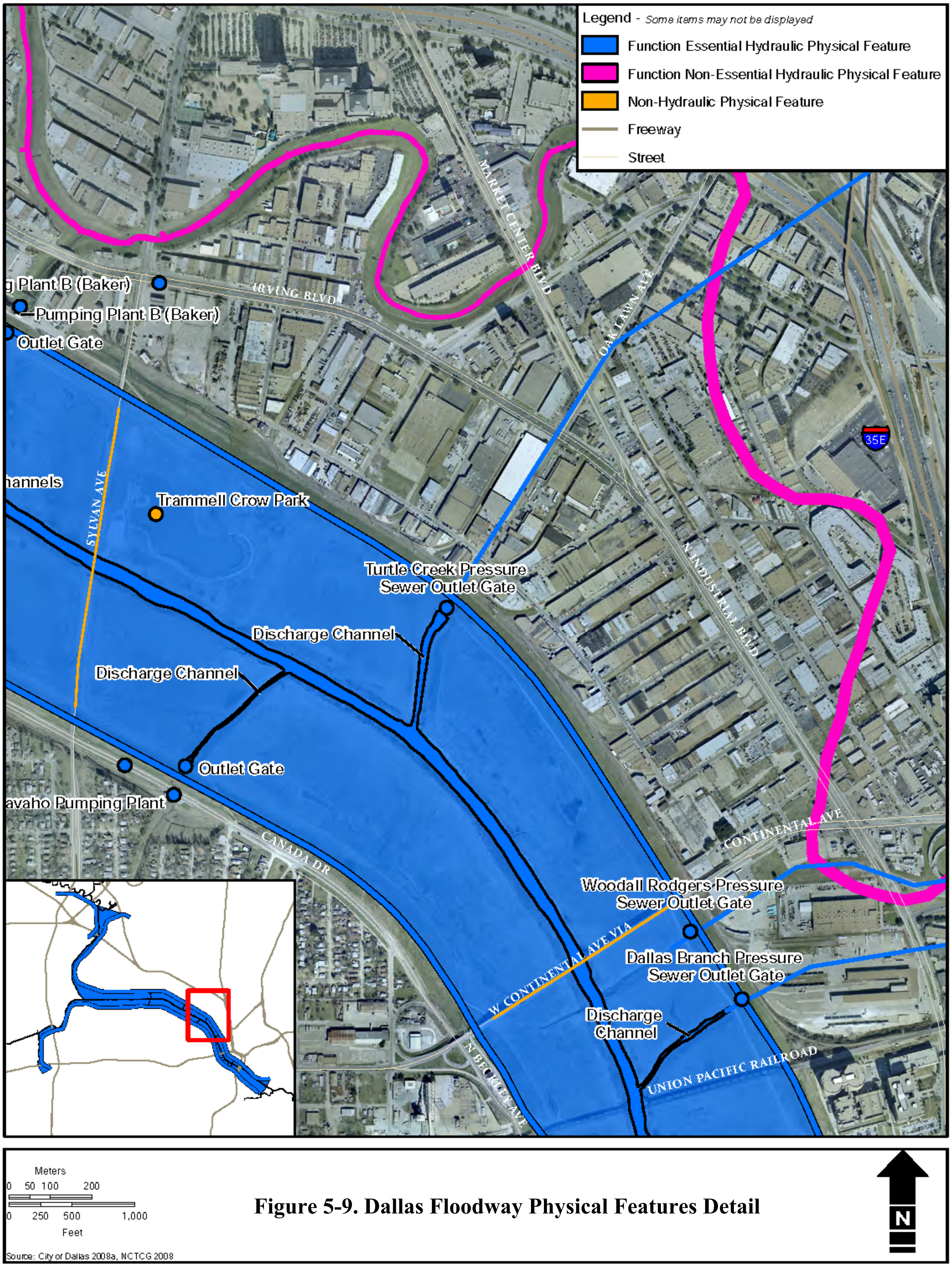


Figure 5-9. Dallas Floodway Physical Features Detail

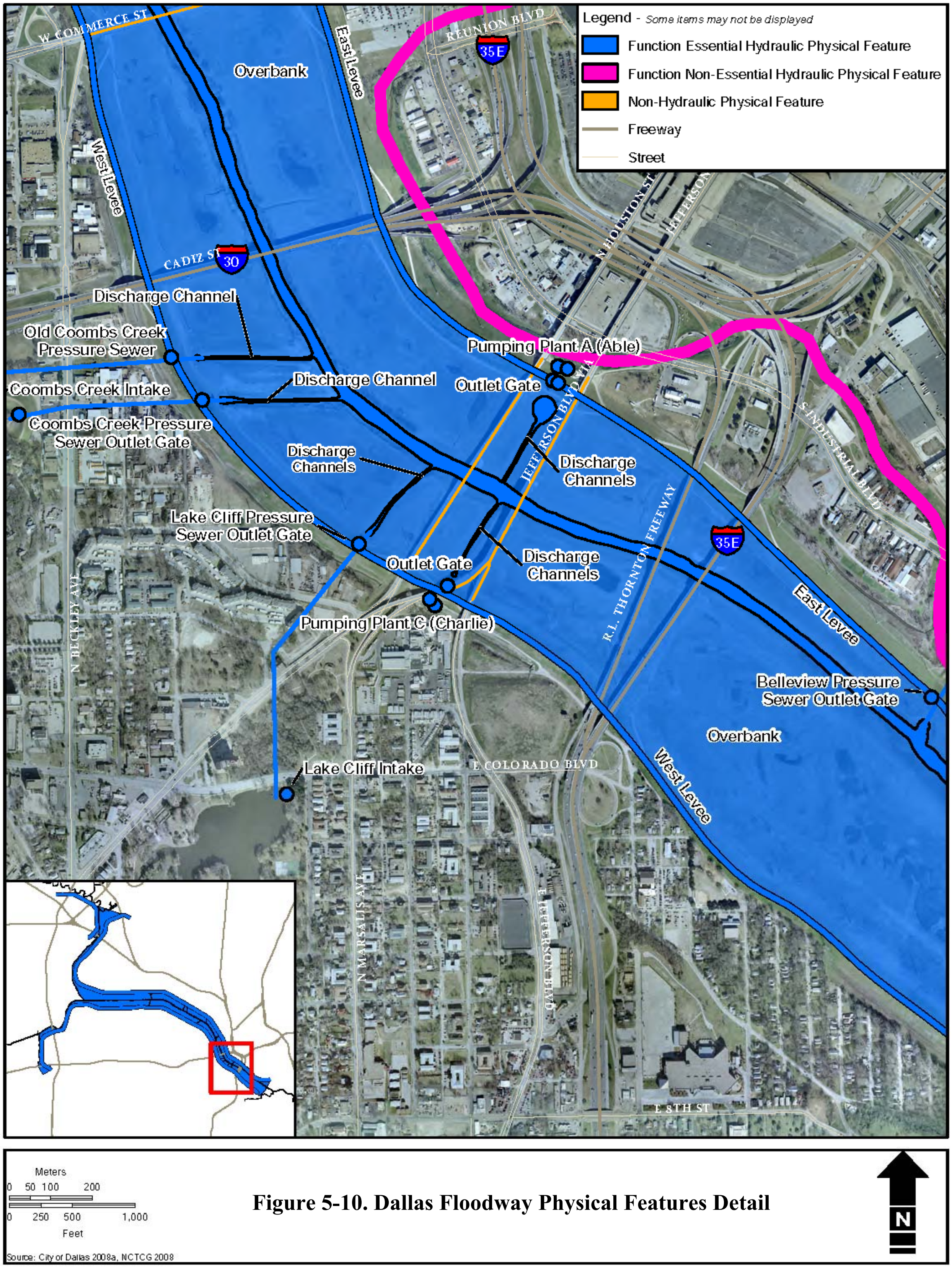


Figure 5-10. Dallas Floodway Physical Features Detail

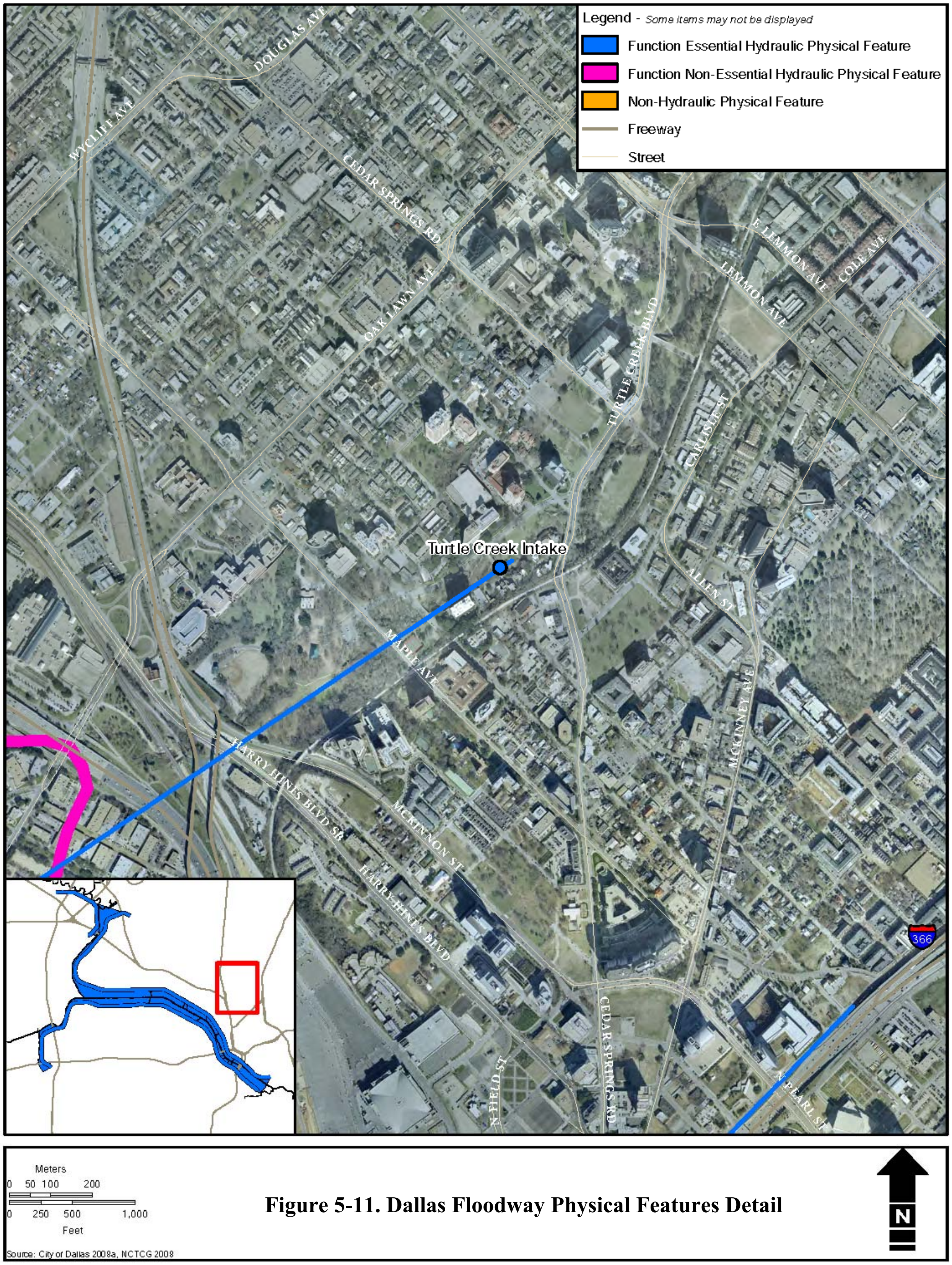


Figure 5-11. Dallas Floodway Physical Features Detail

5.3 HYDRAULIC PHYSICAL FEATURE 1: LEVEES

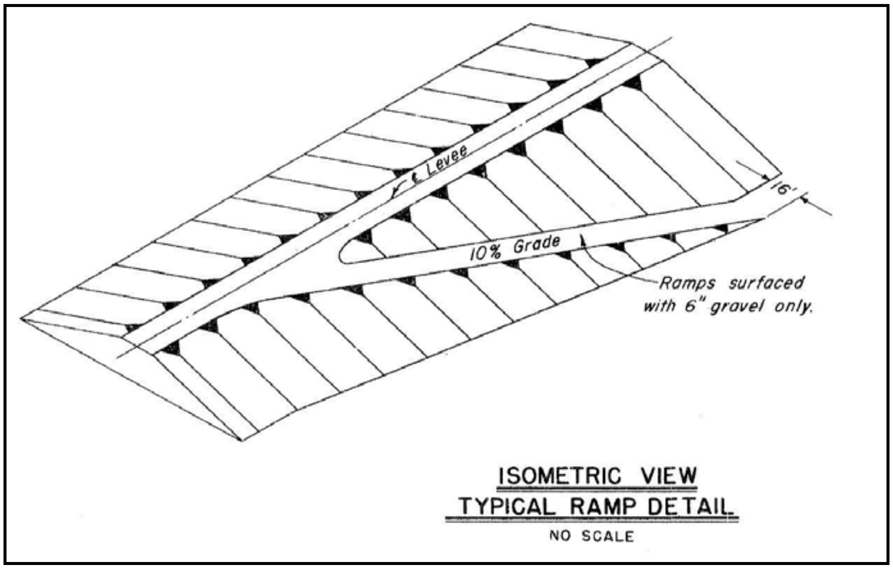
Figure 5-12. Levee, Viewed from the Crown

5.3.1 Physical Description

Levees are battered, manmade earthen embankments that form the outer walls of the Dallas Floodway system's diversion channel and overbank area to contain floodwater (Figure 5-12). The Dallas Floodway system consists of three loops: the Northwest Levee, East Levee, and West Levee. The 2.8-mile-long Northwest Levee is located at the extreme northwest area of the floodway system relative to the city of Dallas. While the city of Dallas controls and maintains the East and West Levees, the Northwest Levee is managed by the city of Irving. The Northwest Levee's direct relationship with the floodway at Elm Fork Diversion Channel makes it a component of the entire Dallas Floodway system.

The levee walls form the dominant physical feature and structural backbone of the Dallas Floodway system by holding floodwater within the floodway. The East and West Levees each extend nearly 12 miles along the floodway in a general west-to-northwest downstream direction parallel to the Trinity River diversion channel. The East and West Levees run parallel to each other for approximately seven miles upstream from the AT&SF rail crossing at the south end of the floodway, and then split into two separate floodways at the northwest end of the main channel. At this divide the East Levee turns northeast along the diversion channel's Elm Fork and the West Levee turns to the southwest along the channel's West Fork.

The levee walls are trapezoidal in section and rise approximately 28 feet above the adjacent overbank (see Figure 5-13) (HNTB 2009). The components of an earthen levee wall consists of the *crown* at its apex, or top; the *main body*, which comprises most of the levee's interior mass; the *foot* at the lower portion of the levee's base; and the *toe* at the extreme outer edges of the base. The top of the Dallas Floodway levees have a flat 16-foot-wide crown that accommodates an unpaved roadway running the length of the levee walls (USACE 2009a). The battered side walls generally have a 3:1 slope (horizontal to vertical) on both the river side and land side, but some portions of the land side have a flatter 3.5:1 slope. The levee walls are comprised of solid clay fill pierced only by the sluiceways that connect the interior drainage system to



Source: USACE 1954b

Figure 5-13. A Typical Isometric View of a Levee

the floodway's diversion channel (USACE 1968). The surface is covered in Bermuda grass, along with other invasive grass species, with the exception of the dirt wheel ruts of the levee roadway system (USACE 2007). The East and West Levees are separated by a 2,000-foot to 3,000-foot distance between the levee toes within the floodway for their seven-mile distance along the main diversion channel.

The levee walls incorporate angled earthen ramps that allow vehicular access to and from the roadways at the levee crown. These ramps have a 10 percent grade and are built into the outer levee walls, making the base of the levees wider in these areas. The ramps connect to the dirt roadway at the toe of the levees on the river side roads, and to city roads outside of the levee system. The levees most often continue underneath the numerous bridges that cross the floodway, but in some cases they about the base of the lowest bridges that predate the levee's strengthening, such as the Corinth, Continental, and Commerce Street Viaducts.

Pipelines laid atop the levee's sloping walls and crown, are uniformly covered with dirt fill. Two covered pipelines were observed during survey, and were located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge on the East and West Levees. These covered pipelines are typically 4 feet tall and 12 feet wide throughout, making them narrow features crossing over the East and West Levees.

5.3.2 Structural History

The East, West, and Northwest levees were originally constructed in 1928–30 by the Dallas County Levee Improvement District No. 5 and the City and County of Dallas Levee Improvement District. When the levees were originally completed in 1930, they measured a total of 25.4 miles in length and were designed to confine flood waters roughly two-and-one-half times the water level of the 1908 flood. Each levee measured 156 feet wide at the base tapering to 6 feet at the crown, and averaged approximately 26 feet high with a maximum height of 37 feet (HNTB 2009). Although the original design for the levees called for a 3:1 slope, the design was changed to a steeper 2.5:1 slope, and in some places as steep as 2:1, to reduce construction costs. Their construction also lacked moisture control measures. The levees began to deteriorate by the late 1940s as numerous cracks, landslides and seepage failures began to occur (Carter and Burgess 2006).

Between 1953 and 1959, the USACE Fort Worth District strengthened the East and West levees as part of an undertaking to improve the entire floodway system (see Figure 4-12). The USACE did not strengthen the Northwest Levee at this time. Documentary evidence that explains why the Northwest Levee, which was probably in the same condition as the East and West Levees, was not included in the USACE strengthening project was not found. The project involved stripping six inches of surface material on the river side of the levees plus four feet off the crown. The USACE then added an average of three feet of compacted fill on the levees' river side to widen the base by 25 feet and raise the levee to an average height of 28 feet, and a maximum height of about 35 feet (USACE 1969). The USACE designed the new height to have eight feet of levee freeboard in an 800-year flood event as estimated at that time. This 800-year Standard Project Flood (SPF) was uncommon at the time, as a 100-year SPF or 500-year SPF was more universal for flood control levee systems. The USACE used these exceptional design parameters in their improvements due to the Dallas Floodway's location at the confluence of multiple forks of the volatile Trinity River (*DMN* 1993). The USACE's additional fill also accounted for shrinkage that was expected to occur. The levee crowns were widened from 6 feet to 16 feet with a loose-aggregate roadway atop the crown to facilitate maintenance and monitoring. The USACE buttressed the levees' slopes to 3:1 by adding fill to make them wider and flatter. This project consisted of leveling off the levees' surface layer and adding new layers of dirt fill to the crown and river side only. As a result, the levee's base increased toward the river side, and the crown's center point shifted from between 2 to 45 feet toward the river side as well. The average shift in the position of the crown was 20 feet. The USACE then planted Bermuda sprigs for turfing (HNTB 2009).

Changes to the levees include the addition of pipelines placed atop the East and West Levees in accordance with the USACE's *Criteria for Additional Construction Within the Limits of Existing Floodways* (USACE 1977). A USACE project in the late 1990s to improve drainage resulted in slightly flattening small portions of the levees' river side walls to a slope of 4:1 (HNTB 2009).

The levee surface is maintained by mowing and replanting the grass as needed. Access roads are maintained to ensure vehicular access to all areas of the levee system. The levee walls are monitored and repaired for proper drainage to prevent deterioration and erosion. Gated barricades at the roadway entrances to the levee walls prevent access to unauthorized vehicles.

5.3.3 Existing Condition

The East, West, and Northwest levees are currently in fair-to-good physical condition overall. The nature of the levees' solid clay-fill construction and the region's hot, dry summers followed by heavy rainfall events and resulting moisture changes within the levees have caused 23 shallow landslides on the levee walls since the 1950s strengthening project (HNTB 2009). USACE reports on these slides state that they were superficial and did not detract from the ability of the levees to protect against flood events and were easily repaired (USACE 1968). Most recently in 2009, two embankment landslides occurred on the river side of the West Levee in the area north of the Westmoreland Road Bridge. The USACE repaired these areas in-kind using clay backfill and replaced the grass turf on the embankment walls (HNTB 2009). These actions are part of the regular repair and maintenance of the levee walls. Improvements in the late 1990s to improve drainage and prevent landslides flattened the East and West Levee to a 4:1 slope and raised the crown by an average of two feet downstream of the Continental Street Viaduct. The material fill used to buttress the levees was excavated from the diversion channel widening, and from several borrow pits in the floodway (HNTB 2009).

The Irving Flood Control District No. 1 constructed the Northwest Levee's stormwater pump station and related facilities in 1974. The District has since made some small-scale improvements to the Northwest Levee, including the addition of a small pump station in ca. 1995 (Fennell 2010; Skipwith et al. ca. 2007).

Since the USACE's floodway improvements in the 1950s, the height of the levees has been reduced in some areas due to settlement, soil creep, or lack of maintenance. However, the levee walls have retained their overall trapezoidal form, their alignment within the floodway system is unchanged, the 16-foot levee crowns are intact, and the levee walls generally maintain their 3:1 slope. The limited vehicular use on the levee roadways has helped minimize deterioration of the levee walls, while the grass covering the walls has helped curb erosion as well as can be expected. Although the levee slopes have flattened slightly since the 1950s and have received other small changes, such as the addition of two pipelines, these changes are negligible relative to the levees' total scale, footprint, and dimensions, and thus, the levees remain intact overall to their original construction period between 1928 and 1959. The 2008 Annual Inspection Report rated the Dallas Floodway system as "Very Good," with the levees retaining a freeboard height of less than three feet to over six feet (HNTB 2009). However, the 2009 Annual Inspection revealed the results of the USACE's new National Levee Safety Program that added a much more stringent rating system process for inspections of levee systems. Under these new criteria, the Dallas Floodway system rated 91 items as acceptable, 80 as minimally acceptable, and 43 as unacceptable. An unacceptable rating on any item that would prohibit the floodway system from functioning as intended results in an unacceptable rating for the whole system. Thus, the system is considered unacceptable. Since the inspection, the city of Dallas has corrected 22 items rated unacceptable, and continues to correct or repair others.

5.3.4 Levees of the Dallas Floodway

East Levee

Figure 5-14. East Levee, Looking Northeast

The East Levee is an original resource to the 1929 floodway system (Figure 5-14). The levee runs a total of 11.9 miles to form the levee at the east and northeast side of the floodway system (HNTB 2009). It runs parallel with the West Levee for a distance of seven miles starting from the AT&SF Railroad crossing, Cockrell Avenue, and the DART line, running upstream in a northwest direction, turning toward the west before it curves sharply in the northeast direction in the vicinity of Irving Boulevard to follow the Elm Fork of the Trinity River's diversion channel. The East Levee along this latter northeast-southwest direction is also called the East Tie Back Levee, and terminates at the 60-inch E. B. I. Emergency Control Structure near Harry Hines Boulevard, due north of Regal Row. Two covered pipelines were observed during the field survey on the East Levee, and are located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge. Improvements in the late 1990s to improve drainage flattened the East Levee to a 4:1 slope and raised the crown by an average of two feet on the river side downstream of the Continental Street Viaduct. The fill used to buttress the levees was excavated materials from the diversion channel widening and from several borrow pits in the floodway (HNTB 2009).

West Levee

Figure 5-15. West Levee, Looking South

The West Levee, like the East Levee, is an original resource to the 1929 floodway system (Figure 5-15). The levee generally mirrors the East Levee and extends a total of about 10.9 miles to enclose the levee at the west and southwest sides of the floodway (USACE 1968). The West Levee runs parallel with the East Levee for a distance of seven miles starting from the AT&SF Railroad crossing at the south end, running upstream in a northwest direction, turning toward the west before it curves sharply to the south to follow the West Fork of the Trinity River to the Trinity Authority Waste Treatment Plant (USACE 1989). The West Levee terminates just beyond its intersection with IH-30. The West Levee runs adjacent to Oak Cliff at its southern end and borders West Dallas as it moves upstream and to the west. Two covered pipelines were observed during the field survey on the West Levee, and are located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge. Like the East Levee, improvements in the late 1990s to improve drainage flattened the West Levees to a 4:1 slope on the river side and added two feet to the crown in the vicinity south of the Continental Street Viaduct (HNTB 2009).

Northwest Levee

Figure 5-16. Northwest Levee, Looking North

The 2.8-mile-long Northwest Levee is located in the city of Irving at the northwest part of the Dallas Floodway system. Originally built in 1929 when the East and West Levees were built, the Northwest Levee was not significantly improved by the USACE in the 1950s (Figure 5-16). In 1974, the Irving Flood Control District No.1 raised and widened the levee from its original 2:1 slope to its current 3:1 slope. The Northwest Levee forms a continuous, angular semi-circle that extends approximately 2.8 miles around the city of Irving at the northwest portion of the Dallas Floodway. Although the Northwest Levee is continuous, the northwestern-most end of the levee, west of Loop 12, is called the North Levee Tie-In. The opposite southernmost portion is called the South Levee Tie-In. Both Tie-In segments are original to the Northwest Levee's design and construction in 1929–1932.The Northwest Levee currently has a 3:1 slope, but is slightly steeper in some places. The levee rises from 16 and 22 feet high from toe to crown, approximately 428 to 443 feet in elevation. The city of Irving's maintenance ends at the west bank of the Elm Fork diversion channel; Dallas controls the channel itself (Fennell, personal communication 2010). Although the USACE's 2008 Inspection Report found the levee's pumps and components in good working condition, the Northwest Levee's overall rating was "unacceptable" under FEMA's increased levee certification standards due to repair work that had not yet been completed (Sissom 2008). The Irving Flood Control District removed woody vegetation consisting mainly of mesquite trees from the North Levee Tie-In in 2006. In 2008, the Irving Flood Control District removed tree growth and woody vegetation from the South Levee Tie-In. After the vegetation was cleared, the levee was regraded and resurfaced with grass cover to its original design and construction. The levee was re-covered in grass and was reported in good condition in 2008 (Sissom 2008).

Parallel Levee Channel

A unique sub-feature of the Northwest Levee is the Parallel Levee Channel. The Parallel Levee Channel is a concrete-lined open ditch that runs from State Highway 114 northward to the Northwest Levee's intersection with Loop 12. The channel is an original 1929 feature that drains the 300-acre area encircled by the Northwest Levee. The Parallel Levee Channel is approximately 8 feet wide and 8 feet tall, with concrete walls embedded into the ground and parallel levee berms running along either side of the channel. The channel extends northward, downstream to the north end of the levee, where it conveys rainwater to a long sump area at the Northwest Levee toe. The channel drains its water through a 48-inch corrugated metal pipe (CMP) to the interior sump area. This pipe was built sometime in the 1960s. By 2007, the Parallel Levee Channel walls began to buckle and fail from holding back the earth on either side. The Irving Flood Control District installed steel tie-rods to brace and reinforce its side walls, as well as metal sheet pile along the side walls (Fennell 2010).

5.4 HYDRAULIC PHYSICAL FEATURE 2: DIVERSION CHANNEL

Figure 5-17. Main Diversion Channel

5.4.1 Physical Description

The Trinity River diversion channel is the relocated channel of the Trinity River (Figure 5-17). It is a manmade dredged channel that is partially lined with rock rip rap on its banks. The channel extends down the center of the floodway in a northwest-to-southeast direction, and is designed to carry redirected water from the original river bed and from stormwater outfalls of the Dallas Floodway interior drainage system for purposes of flood control and water supply. The Trinity River diversion channel also receives water aided by the pressure sewers and sluiceways that carry stormwater to the channel. Within the Dallas Floodway system, 15 miles of diversion channels and two miles of auxiliary channels divert waters draining to the Trinity River. This system includes the seven-mile main diversion channel that runs in between the East and West Levees from the approximate location of the AT&SF Railroad Bridge upstream to the northwest where the channel divides into the West Fork and the Elm Fork.

5.4.2 Structural History

The diversion channel was created in 1932 when the Dallas County Levee Improvement District relocated the confluence of the West and Elm Forks three-and-one-half miles to the west of the original Trinity River bed. The West and Elm Forks combined to form one main diversion channel running in a straight line down the center of the floodway. The new river channel was excavated on the low-lying floodplain, which was primarily used for agricultural purposes at that time. The downstream portion of the diversion channel in the vicinity of the Corinth Street Viaduct was located closer to the East Levee in order to avoid costly rock excavation. When the Trinity River bed was drained to this new diversion channel, part of the old Trinity River bed was replaced with hydraulic fill taken from the floodplain, while portions of the river bed were left in place to serve as sump storage in the interior. The West Fork diversion channel occurred on November 15, 1928, while the main Trinity River diversion channel was completed in 1932 (HNTB 2009).

The USACE made improvements to the diversion channel in the 1950s by widening and straightening the channel. The USACE moved the river channel 100 feet to the west of its original path between the Belleview Pressure Sewer and the Cadiz Street Viaduct (Furlong et al. 2003).

In the late 1990s, the diversion channel was widened and the excavated material fill was used to strengthen the levees (HNTB 2009).

5.4.3 Existing Condition

The Trinity River diversion channel remains mostly unchanged since the USACE's improvements in the 1950s. Ongoing maintenance concerns include silt deposits, the collection of debris, and areas of erosion at its banks (USACE 2007). The channel's current condition relative to its conception in the 1950s remains unchanged overall.

5.4.4 Diversion Channels of the Dallas Floodway

Main Diversion Channel

Figure 5-18. Main Diversion Channel

The main diversion channel extends approximately seven miles down the center of the Trinity River floodway from the channel's fork downstream to the approximate location of the AT&SF Railroad Bridge (Figure 5-18). This channel runs down the floodway's center, parallel with and in between the East and West Levees at the overbank edges.

West Fork Diversion Channel

The diversion channels' West Fork turns to the southwest and south in the vicinity of the West Dallas neighborhood within the city of Dallas.

Elm Fork Diversion Channel

The Elm Fork begins at the original Trinity River bed near the river's intersection with State Highway 482 and runs downstream to the southwest turning to the southeast near Irving Boulevard, where it meets the West Fork to form the confluence of the Trinity River.

The New Frazier Dam is located at the Elm Fork diversion channel due east of the "old" pump station at the Northwest Levee. The city of Dallas constructed the dam in 1965 for flood control purposes and it is currently owned by the Dallas Water Utilities Department. The New Frasier Dam is a gravity dam measuring 16 feet high and 180 feet long. Its capacity is 651 acre feet and its normal storage is 651 acre feet (Ajemian 2010).

5.5 HYDRAULIC PHYSICAL FEATURE 3: OVERBANK

Figure 5-19. View of Overbank near the Hampton Road Bridge, Looking Southwest

5.5.1 Physical Description

The overbank is the area of land between the diversion channel and the levees throughout the floodway system (Figure 5-19). The overbank contains the Trinity River channel at its center and measures approximately 2,000 to 3,000 feet between the levee toes. The overbank encompasses the area between the West Fork Diversion Channel and the West Tie Back Levee, and the land between the East Tie Back Levee and the Northwest Levee at either side of the Elm Fork Diversion Channel. Beginning at the confluence of these two channels, the main Trinity River Diversion Channel extends the 7-mile distance between the East and West Levees. The outer edges of the overbank adjacent to the levees house the outlet gates and outspill structures associated with the floodway's pumping plants and pressure sewers. These components empty stormwater into narrow discharge channels that redirect the runoff to the main diversion channel.

The overbank primarily consists of a wide, undeveloped stretch of land that is relatively flat. Riparian areas and wetland depressions lie adjacent to wide expanses of open areas with native grasses. Tree growth is dispersed throughout the overbank, and is primarily found in the wetland areas along the banks of the Trinity River diversion channel.

The overbank also includes the pier footings for the bridges that cross over the floodway, with the exception of the 1958 Sylvan Avenue Bridge's on-grade roadway atop the overbank. Other manmade features within the overbank include the Trammell Crow Lake Park, which includes a lake, sports fields, and a boat ramp to the diversion channel, and steel-frame electrical towers in the lower portion of the floodway.

5.5.2 Structural History

The overbank began as a naturally occurring landscape feature that harbored the original winding Trinity River west of Dallas. In July 1926, the land became part of the City and County of Dallas Levee Improvement District, whose footprint extended from the confluence of the West and Elm Forks downstream of the Trinity River to the AT&SF Railroad Bridge.

In 1928, the city of Dallas enclosed the land area with levee walls and it became part of the floodway system. The 1928 Joint Plan of Reclamation called for the overbank to be maintained in an unobstructed condition, but also "assume ultimately, a park like aspect. They may even become so attractive, that the city will make them public recreation grounds, thereby strengthening the likelihood of perpetual maintenance in a smooth condition" (Morgan Engineering 1928). Although the 1928 plans included clearing the trees and shrubs downstream of the AT&SF Railroad Bridge, the work was not undertaken and the tree growth remains in place as the Trinity Forest. Construction was completed in 1932, with the newly realigned Trinity River flowing through an excavated diversion channel down the center the overbank. The floodway included drainage ditches flanking the east and west levees on the river side at the overbank (as well as the land side) as late as the 1950s (HNTB 2009).

New structures added to the overbank since 1959 include an overhead electric line in the lower, downstream portion between Continental Street and the AT&SF Railroad Bridge near the foot of the West Levee and an overhead electric line in the upstream portion near the foot of the East Tie Back Levee between the Chicago, Rhode Island and Pacific Railroad Bridge and SH 183 and near the foot of the Northwest Levee north of SH 183. The city of Dallas created Trammell Crow Lake Park in 1985 as a public park adjacent to the Sylvan Avenue Bridge roadway, which was constructed in 1958 (Ajemian 2010).

5.5.3 Existing Condition

Although portions of the overbank have obstructive tree growth, the majority of the overbank area is maintained as open, grassy flat land for receiving floodwaters. Although the additions of the electrical towers and Trammell Crow Lake Park were not originally planned in the 1928–1932 construction period they do not hinder the overbank's function because of these features' low profile or reduced footprint within the overbank.

5.5.4 Overbank Features of the Dallas Floodway

Open Space

Figure 5-20. View of Open Space near the C.R.I. & P. Railroad/DART Bridge, Looking Southwest

The vast majority of the overbank is open, undeveloped space (Figure 5-20).

Roadways

Figure 5-21. Roadway at the East Levee toe

Roadways within the overbank consist of the unpaved dirt or aggregate roadways at the levee toes (Figure 5-21). These roadways extend virtually the entire length of the overbank along the East and West Levees, and maneuver around the bridge footings as necessary. The only connection between these two levee roadways is via an unpaved east-west road that runs underneath the Hampton Road Bridge and crosses over the Trinity River diversion channel on a low bridge. All of these roadways are restricted access by the city of Dallas maintenance and monitoring, and are not open for public use.

The Sylvan Avenue Bridge consists of flyover bridges over the East and West Levees that descend down to the overbank grade between the levees. This at-grade roadbed is the only roadway of this type within the Dallas Floodway System, and allows for public access to the overbank via the Trammell Crow Lake Park at its east side.

5.6 HYDRAULIC PHYSICAL FEATURE 4: PUMPING PLANTS

Figure 5-22. Aerial View of the Pumping Plant B (Baker) Facility

5.6.1 Physical Description

Pumping plants are facilities that contain the pumps necessary for moving water from one location to another. Six plants are located adjacent to the land sides of the East and West Levees (Figure 5-22). The East and West Levee pumping plants hold anywhere from two to five pumps and serve to handle any water the sluiceways cannot store. Two pump stations are located at the Northwest Levee, and include one pump each. Pumping plants contain pumps in a room over a discharge chamber, which diverts the water from the plant into the overbank area through an underground sluiceway that leads to the outlet gate structures. Open sump areas are adjacent to the pumping plants to collect drained stormwater.

Structures for the discharge vents are associated with the air-relief valves. They are typically housed in small concrete box structures that house outlet pipes ventilation. These concrete boxes can be atop the levee crowns next to the levee roadway. The boxes include manhole access on the top, and include slots in the concrete side-walls for ventilation (USACE 1969).

5.6.2 Structural History

The four pumping plants that comprise the first generation of plants built in 1929 are A (Able), B (Baker), C (Charlie), and D (Delta). These original ca. 1929 pumping plants are typically composed of red-brick masonry walls, a rectangular footprint, concrete foundation, and either a flat roof enclosed by a low brick parapet, or, as seen in Pumping Plant B (Baker), a gable-front roof that is covered by concrete tiles. The windows are rectangular with concrete headers, with the exception being Pumping Plant B (Baker), which has arched openings. All of the windows have been filled-in with brick. This likely occurred when new pumping plants were built during the USACE's floodway improvement project in the 1950s.

Three pumping plants, New Pumping Plants A (Able), C (Charlie), and D (Delta) were added in 1954-56 adjacent to each respective ca. 1929 pumping plant. The new buildings are built simply of brick-veneer walls with a square or rectangular footprint, flat roof, metal trim, and solid walls lacking windows. These buildings match the brick of their older counterparts, but are more utilitarian in design.

Two additional pumping plants constructed in 1956, Hampton Road and Pavaho, were built either of poured concrete or concrete block with brick veneer, and have rectangular footprints with concrete foundations, and solid, windowless walls.

The city of Dallas upgraded pumps at three pumping plants during the 1960s. In 1963, Pumping Plant D (Delta) received new upgraded pumps and switchgear in the pump station. Pumping Plant C (Charlie) also received replacement pumps and switchgear in the original 1932 station. In 1967, the city of Dallas replaced the two 20,000 gpm pumps in the original pump station within Pumping Plant A (Able) with upgraded 40,000 gpm pumps. One 2,500 gpm sump pump was added to the Hampton Road Pumping Plant in 1975 (City of Dallas Flood Control District 2010).

Two new pumping plants were built in 1975, one each at the existing Pumping Plant B (Baker) and Hampton Road Pumping Plant. Comprising the most recent generation of plants to date, they were designed larger than their predecessors, and were built either of poured concrete, or in a mixture of poured concrete and brick veneer, as in the case of Pumping Plant B (Baker). Two small pump houses were added to the pumping plants at A (Able), C (Charlie), D (Delta) and Pavaho.

Improvements to the pumping plants in 1989 and in the 1990s included upgraded self-cleaning trash racks at the intakes at A (Able), New B (Baker), New Hampton, and C (Charlie). In the 2000s, additional self-cleaning trash racks with debris conveyors were installed at all of the pumping plants except for Pumping Plant B (Baker) and the Pavaho Pumping Plant. In 1990, six 10- x 10-foot gravity sluices were constructed through the East Levee adjacent to the New Baker Pumping Plant. In 2001, the Pavaho Pumping Plant upgraded its existing 30,000 gpm vertical pump to a 45,000 gpm submersible pump (City of Dallas Flood Control District 2010).

The city of Dallas' improvements primarily took place underground, within, or underneath the existing pumping plant complexes and their pumping houses with the exception of added trash racks, and conveyor systems for debris removal. In some cases, the roofs of the pump houses were modified with openings to accommodate the larger upgraded pumps (City of Dallas Flood Control District 2010). Modifications to the exterior of the pump houses are noted in the physical descriptions of each.

The Northwest Levee has two pump stations, located at the northeast and east portions of the levee. The Irving Flood Control District built the "old" pump station in 1974 and the "new" pump station in ca. 1995, in response to the damage caused by the 1990 flood.

5.6.3 Existing Condition

All of the pumping plants are in good condition as observed in the field, and have been well-maintained since their original construction. The only major alterations observed are the bricked-in windows of the ca. 1929 Pumping Plant A (Able), Pumping Plant B (Baker), Pumping Plant C (Charlie), and Pumping Plant D (Delta).

5.6.4 Pumping Plants of the Dallas Floodway

Pumping Plant A (Able)

Figure 5-23. Pumping Plant A (Able)

The Pumping Plant A (Able) complex consists of two pump houses, one constructed in 1929 and one in 1953. The 1929 pump house, commonly referred to as Small Able, is a one-story, rectangular building clad in variegated red-brick masonry, with a flat, parapet roof, and a concrete foundation (Figure 5-23). The roof is covered in rolled asphalt with a course of tile covering the parapet cap. The tile includes the inscription *W.S. Dickey Texarkana*, possibly indicating where the tile was manufactured. The parapet is distinguished by a course of vertical stretcher-bond brick framed by a single band of protruding horizontal brick course around all four sides of the building. The building retains its original multi-light windows with concrete sills and lintels. The building's south façade contains two windows with concrete lintels that are filled in with brick. The west façade contains one four-light window on the northern bay of the façade, and a metal, overhead, rolling garage door on the southern bay; both have metal lintels. This pump house contains two axial flow pumps manufactured by Fairbanks Morse and Company, a 36-inch gate valve and a 36-inch check valve, two 4- x 4-foot sluice gates, and two 3- x 3-foot sluice gates. Pumping Plant A (Able)'s intake structure was built in 1932 (City of Dallas Flood Control District 2010).

Figure 5-24. Pumping Plant A 1929 Pump House at Left, 1953 Pump House at Right

The 1953 pump house associated with Pumping Plant A is commonly referred to as Large Able. This building is a one-and-one-half story, rectangular structure clad in variegated, rough red brick with a flat roof (Figure 5-24). The south façade contains a one-bay overhead garage door with a metal lintel. The east façade contains a set of metal double-doors in its northern bay with a plaque stating "Addition to Pumping Plant 'A' Dallas Floodway Project, Constructed by Corps of Engineers, U.S. Army in Cooperation with Dallas County Flood Control District, 1953." This pump house contains three axial flow pumps manufactured by the Peerless Pump Division, Food Machinery & Chemical Corporation out of Los Angeles, California. Additionally, the pump households three lubricating oil reservoirs and oil lines, an 8-ton trolley-type, spur-geared hoist with bridge manufactured by Robbins & Myers, Inc. from Springfield, Ohio; two water level recorders manufactured by Leupold & Stevens Instruments, Inc. from Portland, Oregon; a water level control manufactured by Healy Ruff Company; and an air compressor manufactured by Binks Manufacturing Company from Chicago, Illinois.

Figure 5-25. Pumping Plant A Trash Rack and Sump Area, at Right

The sump area for the Able Pumping Plant is located on the north side of the structure. This sump is served by an intake structure that adjoins the two pump houses on the north (Figure 5-25). This intake structure consists of approach wing walls and apron, a raking platform, and trash racks. The trash racks are located along the north façade of the pump houses, with the shorter of the two racks associated with Small Able and the larger of the two associated with Large Able.

Pumping Plant B (Baker)

Figure 5-26. Pumping Plant B (Baker)

Figure 5-27. 1929 Pump House at Pumping Plant B (Baker)

Pumping Plant B consists of two pump houses (Figures 5-26 and 5-27), an intake structure, four gravity sluices, and an outlet structure. The original pump house, constructed in 1929, is a one-and-one-half story building clad in rough, variegated red brick with a concrete foundation. The building has a medium-pitch, front-gabled roof covered in concrete tiles. The primary entrance to the building is located on the east façade. This metal, double door is located under a brick-in-filled segmental arch and includes multi-light windows above it. Above this entrance is a sheet metal sign which reads “City of Dallas Old Baker Pump Station Flood Control Div.” Four in-filled windows with segmental arches are located on the south façade, while three in-filled windows with segmental arches are located on the west façade. The north façade contains four multi-light windows under segmental arches. These windows appear to be original, but the building's 1928 construction drawings indicate that fan lights were originally within the arched portion of the window openings that are now covered. Three circular brick design elements are interspaced between the window bays roughly two feet below the roofline. According to the original drawings, these portal window elements have always been blind, i.e. filled-in by a brick panel. The pump house contains four screw-type pumps manufactured by Fairbanks, Morse and Company; four gate valves one trolley type chain hoist with a chain operated bridge and two vacuum pumps.

Figure 5-28. 1975 Pump House at Pumping Plant B (Baker)

The second pump house associated with the Baker Pumping Plant was constructed in 1975 (Figure 5-28). This building is a rectangular, poured-concrete structure with brick panels to match the exterior of the adjacent 1929 pump house. The south façade contains five bays of brick interspersed with concrete. A small, rectangular extension is located on the east façade that measures roughly 10 x 18 feet. The west façade contains an oversized garage bay with a metal door. Within the oversized bay is a personnel door. The north façade contains five vents located within the brick bays. Located along the north façade is the trash rack for the pumping plant.

Pumping Plant C (Charlie)

Figure 5-29. Pumping Plant C (Charlie)

Pumping Plant C consists of two pump houses, intake structures, two gravity sluices, and an outlet structure (Figure 5-29). The pump house, constructed in 1929, is a one-story, rectangular building clad in horizontal, variegated rough red brick with a flat, parapet roof and a concrete foundation. The flat, parapet roof is covered in rolled asphalt with a course of tile covering the apex of the parapet. Roughly one foot below the apex of the roof, a course of vertical brick flanked by a band of protruding horizontal brick wraps the building. The building contains in-filled window bays with concrete lintels. The north façade contains two in-filled window bays while the west façade contains one in-filled window bay. The east façade contains a metal overhead garage door in the northern bay. The pump house contains two open suction centrifugal pumps, two vertical pumps manufactured by Fairbanks, Morse and Company; two hand-operated gate valves; two sluice gates with two motor driven hoists; and two sluice gates with two hand-operated gates hoists.

Figure 5-30. Pumping Plant C (Charlie), 1929 Pump House at Left, 1956 Pump House at Right

A second pump house, built in 1956, is located directly east of the 1929 pump house at Pumping Plant C (Figure 5-30). It is a utilitarian one-story, rectangular, brick-clad building with a flat roof and a metal overhead garage door on its east façade.

The remaining structures associated with Pumping Plant C include an intake structure that is adjacent to the pump house. The intake structure consists of concrete approach, wing walls, apron, a raking platform, and metal trash racks. Two gravity sluices measuring 4 x 4 feet pass through the levee at Plant C with a gated control structure and a flap gate on the outlet gate structure of each sluice. Additionally, the gated control structure on the riverside of the levee contains two 4- x 4-foot sluice gates run by two hand-operated gate hoists. Access to Pumping Plant C is restricted by a six-foot chain-link fence.

Pumping Plant D (Delta)

Figure 5-31. Pumping Plant D (Delta)

Pumping Plant D (Delta) consists of two pump houses, an intake structure, two gravity sluices, and an outlet structure. The pump house, constructed in 1929, is a one-story, rectangular building clad in horizontal, variegated red brick with a flat, brick-parapet roof (Figure 5-31). The roof parapet is ornamented by a course of vertical brick flanked by a band of protruding horizontal brick above and below it, and wraps around all sides of the building. The building contains two bricked-in window bays on the north façade, and a metal entrance door on the east façade. The pump house contains two vertical pumps manufactured by Fairbanks, Morse, and Company; two hand-operated gate valves; two sluice gates operated by two motor-operated gate hoists; and two sluice gates operated by two hand-operated gate hoists.

A second pump house, constructed in 1956, is located directly east of the 1929 pump house at Pumping Plant D. This building is a utilitarian one-story, rectangular, brick-veneer structure with a flat roof and a metal entrance door on its west façade.

The remaining structures associated with Pumping Plant D include an intake structure, gravity sluices, and an outlet structure. The intake structure adjoins the pump house and consists of concrete approach wing walls and apron, a raking platform, and metal trash racks. The two gravity sluices associated with Plant D were built in 1932 and are 4 x 4 feet in size. They have a gated control structure on the riverside of the levee and a flap gate on the outlet of each sluice. The gated control structure on the riverside of the levee consists of two 4- x 4-foot sluice gates which are run by two hand-operated gate hoists. The associated outlet structure consists of a concrete headwall, wing walls, and an apron. Access to Pumping Plant D is restricted by a six-foot chain-link fence.

Pavaho Pumping Plant

Figure 5-32. Pavaho Pumping Plant

The Pavaho Pumping Plant consists of a pump house and its adjoining building, a discharge chamber, an inlet structure, and an outlet structure (Figure 5-32). The pump house, built in 1954, is a two-story, concrete structure with a flat roof and a concrete foundation (Figure 5-33). The building contains no windows and has a double door entrance on the east façade. The pump households two vertical mixed flow pumps manufactured by Economy Pumps, Inc. from Philadelphia, Pennsylvania; two grease lubricating systems manufactured by the Farval Corporation of Cleveland, Ohio; a water level recorder manufactured by Leupold & Stevens Instruments, Inc. of Portland, Oregon; an 8-ton trolley type spur geared hoist with bridge; a water level control manufactured by Healy Ruff Co.; two motor-operated sluice gate hoists' and two 6- x 8-foot sluice gates. The associated building is a small rectangular building directly west of the pump house with a metal overhead door on the west façade.

Figure 5-33. 1954 Pump House

The associated structures include an inlet structure, discharge chamber, sluice, and an outlet structure. The inlet structure consists of approach walls, guide walls, an approach apron, trash racks, and a raking platform. The outlet structure consists of a headwall, wing walls, and apron with flap gates on the outlets. The discharge chamber consists of two 6- x 8-foot sluice gates for control of gravity flow with motor-operated floorstands to operate the gates located in the pump house. Access to the Pavaho Pumping Plant is restricted by a six-foot chain-link fence.

Hampton Road Pumping Plant

Figure 5-34. Hampton Road Pumping Plant

The Hampton Road Pumping Plant consists of two pump houses, an adjoining intake structure, four discharge pipes, and an outlet structure (Figure 5-34). The original pump house, known as Old Hampton, was constructed in 1956. It is a one-story, rectangular building clad in horizontal, variegated red-brick veneer with a flat roof and metal trim (Figure 5-35). The east and west façade each contain one metal door for entrance to the building. This building contains four vertical mixed flow pumps manufactured by

Economy Pumps, Inc. of Philadelphia, Pennsylvania, with three phase motors manufactured by Ideal Electric Company of Mansfield, Ohio; four grease lubricating systems manufactured by the Farval Corporation of Cleveland, Ohio; an 8-ton trolley type spur geared hoist; a top running hand-geared crane; a four-element float switch; six metal clad switchgear cabinets housing five oil circuit breakers, control switches and other control equipment; a 10 KVA single-phase dry type transformer; and a 24-volt battery and NEMCO battery charger.

Figure 5-35. 1956 Pump House

The intake structure adjoins this building and consists of approach wing walls and apron, a raking platform, and twelve trash racks. Also located at this site are four discharge pipes which run over the levee. Each pipe is provided with a 4-inch air-relief valve and 7-inch vacuum breaker at the top of the levee. The pipes are housed in two square and one rectangular concrete box structures. These structures are located on the crown of the East Levee (Figure 5-36).

Figure 5-36. Concrete Vents Structures Housing the Air Relief Valves on the East Levee

Figure 5-37. 1975 Pump House

A secondary building, known as New Hampton, was constructed due east of Old Hampton in 1975 (Figure 5-37). This structure is a utilitarian two-story, rectangular building constructed of poured concrete with a flat roof. This building contains one entrance on the east façade of the building and a small rectangular extension on the west façade. Old Hampton and New Hampton are enclosed by a 6-foot chain-link fence.

"Old" Pump Station (Northwest Levee)

The Northwest Levee's easternmost "old" pump station was built in 1974 and is located adjacent to the New Frazier Dam. The station consists of a small concrete-block building, which houses the pump and sluice gate (Fennell 2010).

"New" Pump Station (Northwest Levee)

The Northwest Levee's "new" pump station located at the northeast portion of the levee was built in ca. 1995. A small concrete-block building houses the station's 40,000 gpm pump and sluice gate (Chovan and Erskine 2008).

5.7 Hydraulic Physical Feature 5: Pressure Sewers

5.7.1 Physical Description

Pressure sewers are systems of pipes that carry stormwater runoff to higher elevations, or in the case of the Trinity River, to the diversion channel. Pressure sewers for the Trinity River are located on both the river and land sides of the levees. The pressure sewer systems along the Dallas Floodway, also known as pressure conduits, consist of concrete structures that carry stormwater from specific outfall regions of the Trinity River watershed through the levees through water-tight pipes to access the overbank's network of diversion channels. The pressure sewers are constructed out of concrete with reinforced metal pipes to handle the water flow between the riverside and landside of the levees. They include a trash rack grate at outspill openings to catch debris.

5.7.2 Structural History

Although the 1928 Plan of Reclamation called for five pressure sewers, only three were constructed. These were the Mill Creek Pressure Sewer (later known as the Belleview Pressure Sewer), Dallas Branch Pressure Sewer, and the (Old) Coombs Creek Pressure Sewer (Furlong et al. 2003, 6).

The USACE strengthening of the floodway system in the 1950s included constructing the two pressure sewers left out from the original 1928 design. These two pressure sewers were the Turtle Creek Pressure Sewer and the Lake Cliff Pressure Sewer. The city of Dallas built the Woodall Rodgers Pressure Sewer in 1979 as part of TxDOT's construction of the Woodall Rodgers Freeway.

5.7.3 Existing Condition

The pressure sewers appear to be highly intact and in good condition overall. The 2009 Inspection Report indicates that repairs are required in areas where wingwalls have been displaced slightly (HNTB 2009).

5.7.4 Pressure Sewers of the Dallas Floodway

Old Coombs Creek Pressure Sewer

Figure 5-38. Enclosed Concrete Culvert Associated with the Coombs Creek Pressure Sewer

The "Old" Coombs Creek Pressure Sewer (also known as Little Coombs) is located at the West Levee, upstream from the Houston Street Viaduct (Figure 5-38). It consists of an emergency spillway, storm sewer, and conduit. The pressure sewer itself measures 18.5 feet with a 40-foot trash rack at the intake area. Near the riverside of the levee, an 18.5-foot semi-elliptical conduit transitions to four 8- x 10-foot passages into a gate well. Another four 9- x 11-foot passages lead from the gate well into the outlet, with four gate passages controlled by slide gates. The four associated slide gates are run by hand-operated floorstands or portable hoists provided at the Turtle Creek Pressure Sewer. The storm sewer measures 6 feet and has a gated control and a hand-operated hoist (USACE 1969). Two vertical intakes measuring 7 x 8 feet are protected by trash racks. Its capacity is a little more than 3.1 million gpm (Furlong et al. 2003, 5).

Coombs Creek Pressure Sewer

The USACE built the "New" Coombs Creek Pressure Sewer (also known as Big Coombs) in 1957 during its 1950s strengthening project (USACE 1989). This additional pressure sewer was constructed due south of and parallel to the original 1928–32 Coombs Creek Pressure Sewer to provide additional discharge capabilities. The only physical evidence of this addition that was observed above ground during survey was the additional outlet gate structure for the Coombs Pressure Sewer, described under Hydraulic Physical Feature 6.

Belleview Pressure Sewer (formerly Mill Creek)

Figure 5-39. Berm Covering the Underground Belleview Pressure Sewer

The Belleview Pressure Sewer is located at the East Levee upstream from the Corinth Street Viaduct (Figure 5-39). Originally known as the Mill Creek Pressure Sewer, the Belleview Pressure Sewer differs from the other pressure sewers in the Dallas Floodway in design. This pressure sewer has a width of 16 feet and a height of 12.8 feet and is a modified horseshoe shape. The associated storm sewer is controlled by a gated control feature similar to the Dallas Branch Pressure Sewer in its operation; however, the gate on the Belleview Pressure Sewer measures 12 x 17 feet. The Belleview Pressure Sewer has more than 2.6 million gpm in capacity.

Lake Cliff Pressure Sewer

The Lake Cliff Pressure Sewer is located at the West Levee just upstream from the Houston Street Viaduct and has 396,317 gpm capacity. The structure is located within the levees and contains a gated outlet structure, sluices, and intake structure. The associated conduit measures 7 feet in diameter with a 6- x 8-foot box section. A circular intake structure with a diameter of 22 feet is also located at this site along with two circular sluice gates, an 18-inch diameter structure and a 24-inch diameter structure. Each of the sluices associated with the Lake Cliff Pressure Sewer is run by a hand-operated floorstand and portable hoist. Along the levee is a gated outlet structure consisting of a triple 6- x 8-foot sluice gate on the pressure sewer and two 6- x 8-foot sluice gates on the gravity sluices alongside the pressure sewer. Two 8-foot-diameter flap gates are associated with the two gravity sluices on the outlet structure.

Turtle Creek Pressure Sewer

The Turtle Creek Pressure Sewer is located at the East Levee between Sylvan Avenue and Continental Street and has more than 1.7 million gpm capacity. The structure consists of four separate structures including a diversion dam with spillway, an intake structure, a conduit, and a gated outlet structure. The emergency spillway is a 175-foot-high concrete structure with a crest elevation of 419.5 feet adjacent to the pressure sewer intake. Also located at the pressure sewer intake is a trash rack, which has a net area of 460 square feet. The pressure sewer itself is controlled by a gate at the downstream end of the structure and has four 8- x 10-foot sluice gates at the outlet end of the pressure sewer along the river side. The concrete control tower for the pressure sewer is run by four hand-operated gate hoists to control flood levels and is located within the levees.

Woodall Rodgers Pressure Sewer

The Woodall Rodgers Pressure Sewer is located at the East Levee downstream from the Continental Street Viaduct and upstream from the Dallas Branch Pressure Sewer. The line was added to the floodway in 1979 when the Woodall Rodgers Bridge was constructed across the floodway.

Dallas Branch Pressure Sewer

The 1932 Dallas Branch Pressure Sewer is located at the East Levee just downstream from the Woodall Rodgers Pressure Sewer, and has a capacity of 256,731 gpm. A gated control structure manages the 12-foot Dallas Branch Pressure Sewer and consists of one gate 12 feet, 6 inches by 13 feet. This gate is operated by two floorstands that are interconnected and can be operated manually or with a portable power hoist.

5.8 HYDRAULIC PHYSICAL FEATURE 6: OUTLET GATE STRUCTURES

Figure 5-40. Turtle Creek Outlet Gate Structure

5.8.1 Physical Description

Outlet gate structures are outspill structures that carry stormwater from the pressure sewers and pumping plant facilities out to the river channel to avoid flooding. Although they are connected to the pumping plants and pressure sewers, they are physically separated from these facilities by the levee walls, and their location of the inside of the overbank. The outlet gate structures carry discharged stormwater to the interior of the floodway via concrete box culverts (Figure 5-40).

Components of the outlet gate structures include tall concrete towers that house gate hoists. These hoists operate to open or close the sluice gate below the tower. The tops of the hoists are accessible at an operation deck atop the tower. Outlet gate structures include concrete towers typically around 30 feet tall and 8 feet deep, while their width parallel to the levee walls can vary from 13 up to 50 feet. The operation deck is connected to the top of the levee wall by a narrow service bridge composed of a steel-plate girder deck and walkway enclosed by a metal-pipe handrail. The bridges vary in length according to the distance spanned, ranging between approximately 45 to 90 feet in length. It connects the top of the intake tower to the river side of the levees just below the crown, where the bridge is anchored into the levee side with concrete footings (USACE 1953, 1956c, 1969).

Below the base of the tower is an outlet opening of the sluiceway that carries stormwater from the pressure sewer or pumping plant to release it into a discharge channel within the overbank. The opening is below the grade of the overbank, has a concrete header at the opening, and flanking concrete wing walls. An automatic flap gate keeps the water from back-flowing into the landside of the levee. Open channels connect the outlet structure to the diversion channel.

The outlet gate structures are associated with all six pumping plant facilities A (Able), B (Baker), C (Charlie), D (Delta), Hampton Road, and Pavaho; seven pressure sewers, Belleview, Old Coombs Creek, Coombs Creek, Dallas Branch, Lake Cliff, Turtle Creek, and Woodall Rodgers ; the Elm Fork Sluice; and the 60-inch E.B.I. Emergency Control Structure (see Section 5.12).

5.8.2 Structural History

The earliest outlet gate structures were constructed by the USACE during the 1950s strengthening project.

5.8.3 Existing Condition

All of the outlet gates observed within the floodway appear to be in good condition and no deterioration was observed. Several of the outlet gate structures had spray-painted graffiti, which is a superficial alteration that does not substantially alter the structures' condition.

5.8.4 Outlet Gate Structures of the Dallas Floodway

Pumping Plant A (Able) Outlet Gate Structure

Figure 5-41. Pumping Plant A (Able) Outlet Gate Structure, with Concrete Valve Vents in the East Levee

The outlet gate structure at Pumping Plant A consists of a base 4- x 4-foot double box culvert that is 20 feet long (Figure 5-41). The tower housing the gates, stems and floorstands is 4 x 11 feet in footprint and 44 feet high. The pump outlet pipes over the top of the levee are 39-inch diameter and 48-inch diameter pipes that are placed on a concrete pad at the knee of the pipe and covered by compacted backfill. Access manholes to the pipe valves are provided at the levee crown with ventilation slots near the top, housed in concrete boxes. The outspill opening consists of concrete cantilever-type retaining walls and a 6-inch concrete paved apron with a cut-off wall at the downstream edge to the discharge channel (USACE 1969).

Pumping Plant B (Baker) Outlet Gate Structure

Figure 5-42. Pumping Plant B (Baker) Outlet Gate Structure

The outlet gate structure for Pumping Plant B consists of the outlet opening of four 6-foot-diameter gravity sluices that run through the levee to the outlet gate (Figure 5-42). All four sluices have corresponding gate control valves housed within the concrete tower. The outlet structure consists of a concrete headwall, wingwalls, and apron (USACE 1969).

Pumping Plant C (Charlie) Outlet Gate Structure

Figure 5-43. Pumping Plant C (Charlie) Outlet Gate Structure

Pumping Plant C has a gate control structure consisting of two 4- x 4-foot sluice gates with two 4- x 4-foot flap gates and corresponding control valves (USACE 1969) (Figure 5-43).

Pumping Plant D (Delta) Outlet Gate Structure

Figure 5-44. Pumping Plant D (Delta) Outlet Gate Structure

Like Pumping Plant C, Pumping Plant D has a gate control structure consisting of two 4- x 4-foot sluice gates with two 4-foot flap gates and corresponding control valves (USACE 1969) (Figure 5-44).

Hampton Road Pumping Plant Outlet Gate Structure

Figure 5-45. Hampton Road Pumping Plant Outlet Gate Structure

The Hampton Road Pumping Plant has a gate control structure consisting of one hoist and stem. The flap gates on the outlet are recessed at the back of retaining wingwalls. Large rip rap lines the top and sides of the end of the discharge channel.

Pavaho Pumping Plant Outlet Gate Structure

Figure 5-46. Pavaho Pumping Plant Outlet Structure

The Pavaho Pumping Plant's Outlet Gate Structure lacks a hoist tower, but consists of a headwall, wing walls, and apron with flap gates on the outlets (Figure 5-46). The discharge chamber consists of two 6- x 8-foot sluice gates for control of gravity flow with motor-operated floorstands to operate the gates located in the pump house.

Belleview Pressure Sewer Outlet Gate Structure

Figure 5-47. Belleview Pressure Sewer Outlet Gate Structures

The USACE added the Belleview Pressure Sewer Outlet Gate to the 1928–31 pressure sewer in the 1950s. The sluice gates are housed in the 27-foot tall reinforced concrete tower with a 68-foot access bridge. The tower includes two interconnected floorstand-type hoists.

Old Coombs Creek Pressure Sewer Outlet Gate Structure

Figure 5-48. Old Coombs Creek Pressure Sewer Outlet Gate Structures

The USACE added the Old Coombs Creek Pressure Sewer Outlet Gate to the 1928–31 pressure sewer in 1989. It consists of four 96- x 120-inch sluice gates housed within a 47-foot concrete tower structure with an 8-foot-wide access bridge (Figure 5-48). The outspill opening consists of cantilevered retaining wingwalls, a paved apron with baffle blocks, and end sill. Also included are a structure consisting of a 6-foot-diameter storm sewer by adding a concrete box conduit 7 feet, 6 inches by 7 feet, 6 inches and an outlet structure with cantilever type walls and apron with 8-foot diameter flap gate. The city of Dallas replaced the foundation of the outlet gate's walkway in the 1990s (City of Dallas Flood Control District 2010).

Coombs Creek Pressure Sewer Outlet Gate Structure

Figure 5-49. Coombs Creek Pressure Sewer Outlet Gate Structures

The Coombs Creek Pressure Sewer's Outlet Gate structure was built in the 1957 when the USACE constructed an additional pressure sewer line adjacent to the original 1928–32 line, to the north.

Dallas Branch Pressure Sewer Outlet Gate Structure

Figure 5-50. Dallas Branch Pressure Sewer Outlet Gate Structures

The USACE added the Dallas Branch Pressure Sewer Outlet Gate to the 1932 pressure sewer in the 1950s. Sluice gates 13 feet by 12 feet are contained within the 38-foot tall reinforced concrete tower. The bridge is approximately 45 feet long. The gate structure exits into a two-cell box conduit with flared concrete wingwalls and apron. The outspill openings have eight 6- x 6-foot flap gates.

Lake Cliff Pressure Sewer Outlet Gate Structure

Figure 5-51. Lake Cliff Pressure Sewer Outlet Gate Structures

The Lake Cliff Pressure Sewer Outlet Gate is attached to the pressure sewer's 325-foot conduit, which is flanked on each side by a 6- x 8-foot box culvert that terminates at the gate structure (Figure 5-51). The gate structure houses three 6- x 8-foot sluice gates and is 20 feet long by 27 feet, 6 inches wide at the base. The tower portion is 6 feet by 27 feet, 6 inches, and houses three stems and hoists. The gate structure includes a three-cell, 8- x 8-foot box conduit 28 feet long, which ends at the outlet opening onto the spillway and discharge channel. This opening consists of flared concrete cantilever wingwalls and a 6-inch concrete-paved apron with a cut-off wall at the downstream edge (USACE 1969).

Turtle Creek Pressure Sewer

Figure 5-52. Turtle Creek Outlet Gate Structures

The Turtle Creek Outlet Gate structure consists of four 10- x 10-foot-diameter outspill openings to the discharge channel (Figure 5-52). Each sluice includes slide gates at the entrance to the gate-control tower, and four circular flap gates are installed at the portal head wall. The control tower is supplied with electrically-operated gate hoists located on the operation decks. A foot bridge is provided from the tower's operation deck to the top of the East Levee (USACE 1969).

Woodall Rodgers Pressure Sewer Outlet Gate Structure

Figure 5-53. Woodall Rodgers Pressure Sewer Outlet Gate Structures

The Woodall Rodgers Pressure Sewer Outlet Gate Structure was added to the floodway in 1979 (Figure 5-53). It is located upstream (to the northwest) from the Dallas Branch Pressure Sewer, and terminates at the East Levee.

Elm Fork Sluice Outlet Gate

Figure 5-54. Elm Fork Sluice Outlet Gate Structure

The Elm Fork Sluice terminates at a gate control structure with one 36-inch diameter circular sluice gate and an outlet structure with trash bars (USACE 1969) (Figure 5-54).

5.9 HYDRAULIC PHYSICAL FEATURE 7: INTAKES

5.9.1 Physical Description

Intake structures are large openings where water enters into the floodway's system of sluiceways and culverts. Intakes within the Dallas Floodway system are associated with the larger pumping plants and pressure sewers in the interior drainage system. Generally, when intake structures within the floodway are associated with the pumping plants, they adjoin the pump houses and consist of concrete approach wing walls and apron, a raking platform, and a trash rack. The aprons associated with the approach wing walls serve to prevent erosion by flowing water. The raking platform and trash rack serve to remove debris from the water held in sump areas before it is moved to the riverside of the levees.

The intakes in the Dallas Floodway are all constructed of poured concrete with metal piping on the interior. The associated wing walls and aprons are also concrete with metal raking platforms and trash racks.

5.9.2 Structural History

The intakes associated with the three 1928 pressure sewers, Coombs Creek, Dallas Branch, Belleview, were located far enough upstream in the watershed to develop sufficient head to discharge against flood stages in the floodway. Construction on the interior drainage began with the construction of these three earliest pressure sewers, and was completed by the USACE in the 1950s. Although the Turtle Creek and Lake Cliff intake structures were part of the original 1928 design of the floodway, they were constructed by the USACE in 1955. The Coombs Creek Intake structure was also constructed by the USACE in the 1950s.

5.9.3 Existing Condition

Only the intake openings could be observed in the field. All intake resources appeared to be in good condition.

5.9.4 Intakes of the Dallas Floodway

Coombs Creek Intake

Figure 5-55. Coombs Creek Intake

The 1957 Coombs Creek intake structure consists of an 18-foot, 6-inch semi-elliptical concrete conduit opening with a large, angled trash grate attached (Figure 5-55). The structure is embedded into the side of the West Levee walls, and includes concrete wingwalls. A metal-pipe handrail sits atop these concrete header and wingwalls.

Turtle Creek Intake

Figure 5-56. Turtle Creek Intake

Figure 5-57. View toward Turtle Creek Intake and Adjacent Concrete Wall of its Diversion Dam

The Turtle Creek Intake structure is located near Fairmount Street. It consists of a diversion dam across Turtle Creek, with a 175-foot concrete spillway overflow as well as two earthen overflows that are 100-feet in length (Figures 5-56 and 5-57). Downstream of the spillway overflow is a concrete stilling basin with two rows of baffle blocks. The entrance to the intake is covered by an angled trash rack, which leads to an underground poured concrete approach channel to the East Levee that is 7,800 feet long (USACE 1969).

Lake Cliff Intake

Figure 5-58. Lake Cliff Intake

The Lake Cliff intake structure is a circular spillway located within Lake Cliff in the Oak Park neighborhood of Dallas (Figure 5-58). A concrete, cylindrical stem structure rises from the lake bed and opens vertically and is flush with the surface water. The top of this opening is enclosed by a metal-pipe handrail. The base of the structure is then connected to a pressure sewer that runs under the lake and the adjacent Colorado Boulevard (USACE 1969).

5.10 HYDRAULIC PHYSICAL FEATURE 8: SLUICES AND CULVERTS

5.10.1 Physical Description

Sluices and culverts are water channels controlled by a gate utilized to direct water levels. The gravity sluices in the floodway are typically associated with a pumping plant and are located along the outer edges of the east and west levees. In the case of the Trinity River, the sluiceways are reinforced concrete, gravity structures that are located in areas prone to flooding. The sluiceways along the floodway all utilize automatic and manual gates.

A total of six sluices in the Dallas Floodway were inventoried and evaluated: the Elm Fork Sluice, Eagle Ford Sluice, Ledbetter Dike and Sluice, and three other sluices located in the Northwest Levee. These sluices were part of the original 1928–1932 construction or were included in the USACE's construction drawings for the 1950s enhancement project. All the sluices are controlled by an automatic flap gate as well as a hand operated sluice gate. There are two named culverts with associated Control Structure Gates (C.S.G.); the Grauwyler Road C.S.G. and the Ledbetter C.S.G. Both C.S.G.s help control flood water leading to pumping plants via the former Trinity River channel.

5.10.2 Structural History

In 1928, interior drainage was accommodated by a system of gravity sluices functioning alongside the culverts. The Elm Fork Sluice appears to have been original to the 1928–32 construction of the floodway. Construction plans in 1952 indicate that existing sumps in the locations of Eagle Ford Road and Ledbetter

Drive were converted into culverts during the USACE's strengthening project in the 1950s (USACE 1952).

The USACE's 1950s improvements added the Eagle Ford Sluice, the Sluice and Dike near Ledbetter Drive, and the Grauwyler Road Culvert. Plans describe numerous culverts added throughout the floodway's interior drainage system, including three concrete box culverts under Vilbig Road, three under Hampton Road, and two under Westmoreland Road (USACE 1952).

The Northwest Levee originally included three ca. 1929 gravity sluices at the north, east, and southeast sections of the levee (USACE 1989). The sluices at the north and southeast locations were abandoned after the 1990 flood and were replaced by the addition of a second "new" pump station.

5.10.3 Existing Condition

Only the openings of the sluices and culverts could be observed in the field. These visible portions of the sluices appeared to be in good condition in terms of design, materials, and form.

5.10.4 Sluices and Culverts of the Dallas Floodway

Elm Fork Sluice

The Elm Fork Sluice is used to provide drainage water from the Elm Fork. This sluice consists of a 36-inch diameter gate-controlled channel, which passes through the East Levee near Bachman Lake. In the 1960s, the sluice was extended 36 feet on the inlet side and a new 15-foot-wide head wall structure was added. This included a control gate structure with one 36-inch diameter circular sluice gate and trash bars (USACE 1969; City of Dallas Flood Control District 2010).

Eagle Ford Sluice

Figure 5-59. Eagle Ford Sluice (USACE 2007)

The Eagle Ford Sluice is located in the 2,000-acre Eagle Ford and West Fork area adjacent to the West Levee. The sluice is a two-cell 4-foot, 6-inch by 4-foot, 6-inch box conduit with an automatic flap gate and a hand-operated sluice gate (Figure 5-59). It includes an outlet structure (USACE 1969).

Ledbetter Dike C.S.G.

Figure 5-60. Ledbetter Dike C.S.G.

Figure 5-61. View West of Ledbetter Dike C.S.G. Drainage Ditch

Located in the old channel of the West Fork of the Trinity River adjacent to the intersection of Kilgore Street and Ledbetter Drive, the Ledbetter Dike C.S.G. (also known as Canada Drive Sluice and Dike) contains two drainage ditches with an earthen causeway between them and two pumps within the berm. As designed, the Ledbetter Sluice and Dike is an earth dike with a maximum height of 30 feet with a 10-foot crown, seal coating, and a 3:1 side slope (Figures 5-60 and 5-61). Additionally, the Ledbetter Dike was designed to contain two 48- x 72-inch concrete sluices with hand-operated hoists to control the gates (USACE 1960). A later modification in the 1960s added a gate-control structure, a two-cell 4- x 6-foot conduit, and an intake and outlet structure for that conduit (USACE 1969). In the 1990s, automated gate operators were added to allow for remote operation and pressure transducers were installed for reading water levels on both the upstream and downstream sides (City of Dallas Flood Control District 2010). The Ledbetter Dike C.S.G. is connected to Pumping Plant D (Delta) via the old river channel of the West Fork of the Trinity River, where the stormwater collects at the pumping plant's sump for drainage into the floodway.

Grauwyler C.S.G.

Figure 5-62. Grauwyler C.S.G.

The Grauwyler C.S.G., or culvert, located at Grauwyler Road, consists of an intake structure with a 60-inch diameter sluice gate at the opening of a 60-inch diameter concrete pipe culvert (USACE 1969) (Figure 5-62). The original culvert was modified with a Control Gate Structure in 1960. As with the Ledbetter Dike C.S.G., automated gate operators to allow for remote operation and pressure transducers for reading water levels on both the upstream and downstream sides were installed in the 1990s (City of Dallas Flood Control District 2010). The Grauwyler C.S.G. is connected to the Hampton Pumping Plant via the old river channel of the Elm Fork of the Trinity River, where the stormwater collects at the pumping plant's sump for drainage into the floodway.

Northwest Levee Sluices

Both the "old" and "new" pump stations at the Northwest Levee in Irving include a sluice with a sluice gate through which water is diverted through the sump areas on the interior side of the levee wall and discharged to the Elm Fork Diversion Channel. A newer gravity sluice consisting of four 66-inch reinforced concrete pipes (RCP) was added to the area of the Loop 12 highway crossing the levee in 1974. This sluice drains water to the sump area along the toe of the Northwest Levee.

5.11 Hydraulic Physical Feature 9: Sumps

Figure 5-63. Sump Ponds near Harry Hines Boulevard

5.11.1 Physical Description

The sumps are drainage ditches that collect local stormwater runoff and discharge it into culverts throughout the floodway system (Figure 5-63). They are most often located next to the land side of the levee walls where stormwater collects, with a 15- to 40-foot distance between the levee toe and the sump. The sump's angled sidewalls range from 1:1 to 1.5:1 or 1:3 in slope, and are an average of 20 feet deep. Their shape can vary widely to accommodate the topography or structures in their location. Sumps are typically located adjacent to pumping plants where large sumps exist outside of the levees. Low-lying sumps, or wetland sumps, often contain permanent water and thus also contain vegetation.

5.11.2 Structural History

The original sumps constructed in 1928 consisted of the old channels of the Elm Fork, West Fork, and Main Stem of the Trinity River, as well as the borrow ditches created during levee construction. The overbank originally included sumps on both the river side of the floodway as well as the land side, but the river side sumps were removed during the USACE's strengthening project between 1953 and 1959 (USACE 1969). During that time, the USACE upgraded the sumps located at Eagle Ford Drive and Ledbetter Drive with gated culverts and dikes (USACE 1952). The city of Dallas also built six additional 6- x 6-foot concrete box culverts through the East Levee at Pumping Plant B (Baker) (Furlong et al. 2003).

5.11.3 Existing Condition

The sump areas appear to be in good condition overall.

5.11.4 Sumps of the Dallas Floodway

In 1969, 373 sumps of all sizes were noted to exist throughout the entire Dallas Floodway system (USACE 1969). They primarily flank the land sides of the levee walls where stormwater collects for drainage into the diversion channel, and thus are primarily associated with the floodway's six pumping plant complexes (refer to Subchapter 5.6 for discussions of these sumps).

The old Trinity River channel is still located in its original meandering path north of the East Levee wall to serve as part of the interior drainage system in the industrial district north of the floodway (Figure 2-1). It serves as a basin, or sump, in which to collect and divert stormwater to the pumping stations along the East Levee; Pumping Plant A (Able), Pumping Plants B (Baker), and the Hampton Pumping Plant.

Additionally, the Northwest Levee sump serves as the catch basin for the Northwest Levee's two pump stations. The sump area extends along the interior of the levee wall. It typically carries about 6 to 12 inches of water and is covered in mowed grass.

5.12 HYDRAULIC PHYSICAL FEATURE 10: EMERGENCY CONTROL STRUCTURES

5.12.1 Physical Description

Emergency control structures within the Dallas Floodway allow for the closure of two sanitary sewer lines that cross the East Levee, if necessary, due to excessive leakage or failure during periods of high water. The 60-inch emergency control structure associated with the Dallas Floodway was constructed at a 60-inch sanitary sewer crossing that flows under the East Levee. This structure contains a concrete bulkhead, which can be lowered into a closed position when necessary. The associated building is a one-story poured-concrete structure with a rectangular plan. The building is enclosed by a six-foot chain-link fence.

5.12.2 Structural History

The USACE added the 60-inch Emergency Control Structure at the end of the East Tie Back Levee in the late 1950s during the strengthening project of the Dallas Floodway.

5.12.3 Existing Condition

The emergency control structures appear to be in good condition overall. No changes were observed.

5.12.4 Emergency Control Structures of the Dallas Floodway

60-inch E.B.I. Emergency Control Structure

Figure 5-64 60-inch E. B. I. Emergency Control Structure

The 60-inch E. B. I. Emergency Control Structure is located at the end of the East Tie Back Levee near Harry Hines Boulevard, due north of Regal Row (Figure 5-64). The structure is adjacent to a sump pond and the Park Cities Water Treatment Plant. This facility is a bulkhead gate structure surrounding a 5-foot-high horseshoe conduit, and measures 5 feet, 8 inches by 6 feet in 9-inch-thick concrete (USACE 1969). The structure includes a small outlet gate structure including a concrete tower housing gate hoists for the sanitary sewer culvert below it (USCAE 1956).

East Bank Interceptor

Figure 5-65. East Bank Interceptor

The East Bank Interceptor is located at the East Tie Back levee along with the Emergency Control Building (Figure 5-65). It is a valve structure housing a 36-inch diameter concrete pipe. It appears to be housed within a concrete platform at the sump ponds in this area. Access is restricted and the area is enclosed by a chain-link fence.

5.13 NON-HYDRAULIC PHYSICAL FEATURES WITHIN THE DALLAS FLOODWAY

The non-hydraulic physical features within the Dallas Floodway engineering system are those that do not contribute to the function of the floodway drainage system, but that physically contact the floodway's overbank. These include bridges and viaducts, electrical towers and power lines, and a recreation area; these are illustrated in Figure 5-66. The bridges, viaducts, and electrical power lines cross over the floodway but include piers that set into the floodway's overbanks.

5.13.1 Bridges

Twenty-two bridges, including the ruins of a former bridge, cross over the floodway (see Table 3-3 Bridges over the Dallas Floodway). The bridges' supporting piers' footprint within the overbank varies by bridge, but generally consists of concrete footings underneath the bridge spans (Figure 5-67). These footings do not impact the function of the floodway's overbank area during flood events.

Many of these bridges existed before the Dallas Floodway was created or were built between its initial construction and the USACE's strengthening improvements completed in 1959. Although the bridges are physical features within the floodway, they serve as transportation connections of the greater city of Dallas and do not enhance or detract from the floodway's flood control engineering operation.

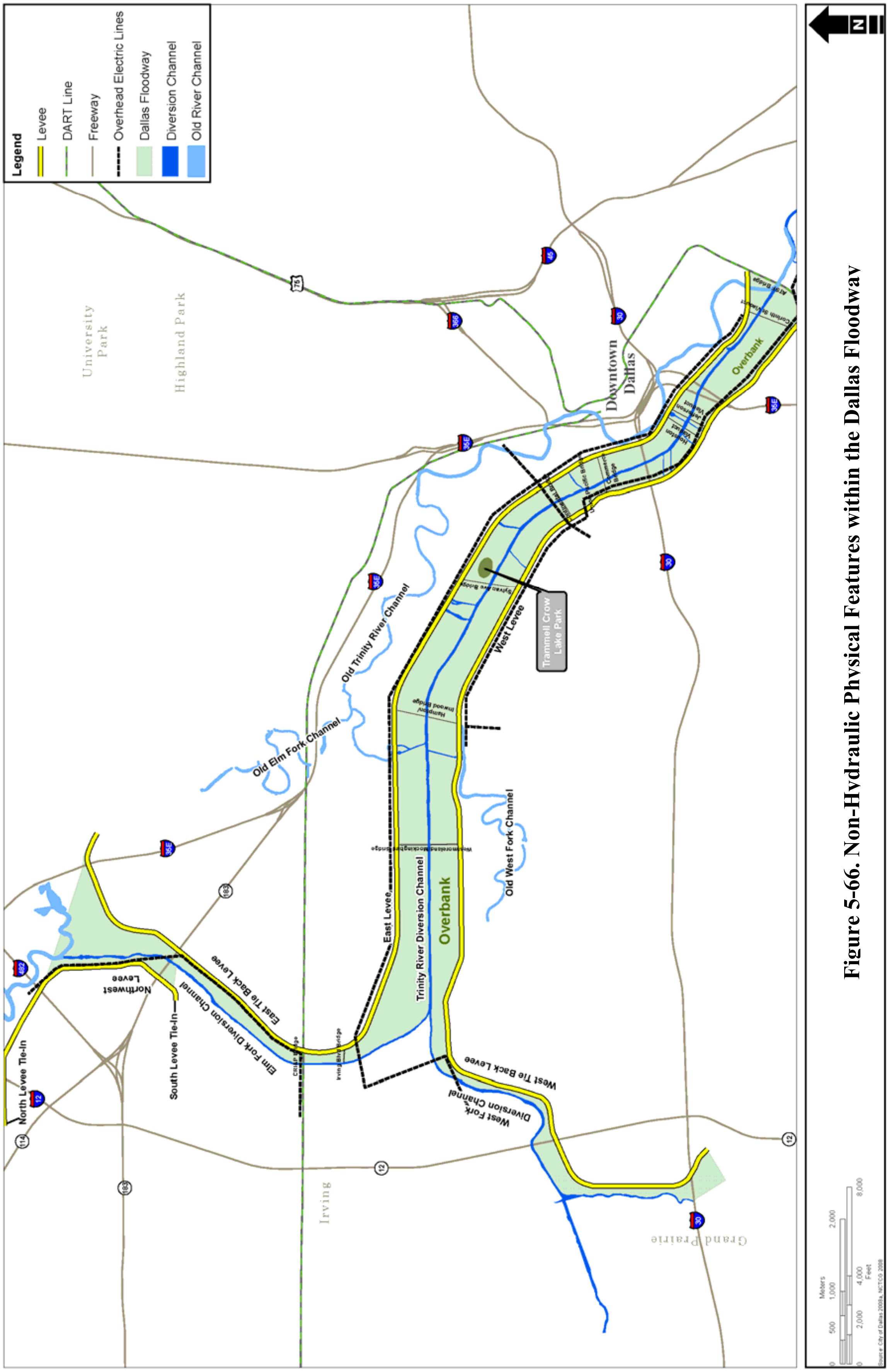


Figure 5-66. Non-Hydraulic Physical Features within the Dallas Floodway

Figure 5-67. Union Pacific Railroad Bridge, Looking Southwest

5.13.2 Power Lines

Power lines and electrical towers were included in the original plans set forth in 1928 and again were accommodated in the USACE's plans in 1955. They currently still exist within the floodway overbank. Many of these towers and lines have since been replaced with upgraded structures since the USACE's improvements in the 1950s, as necessary. The towers' footprint within the overbank consists of single piers set into concrete footings (Figures 5-68 and 5-69; see historical and current locations of overhead electrical lines in Figure 5-70). Like the bridges, the power lines are non-hydraulic physical features within the Dallas Floodway that neither enhance nor detract from the floodway's function as an engineering system for flood control.

Figure 5-68. Power Line on the Overbank next to the West Levee due South of the Commerce Street Viaduct, Looking Southeast

Figure 5-69. Power Line on the Outside of the East Levee, Looking Southeast

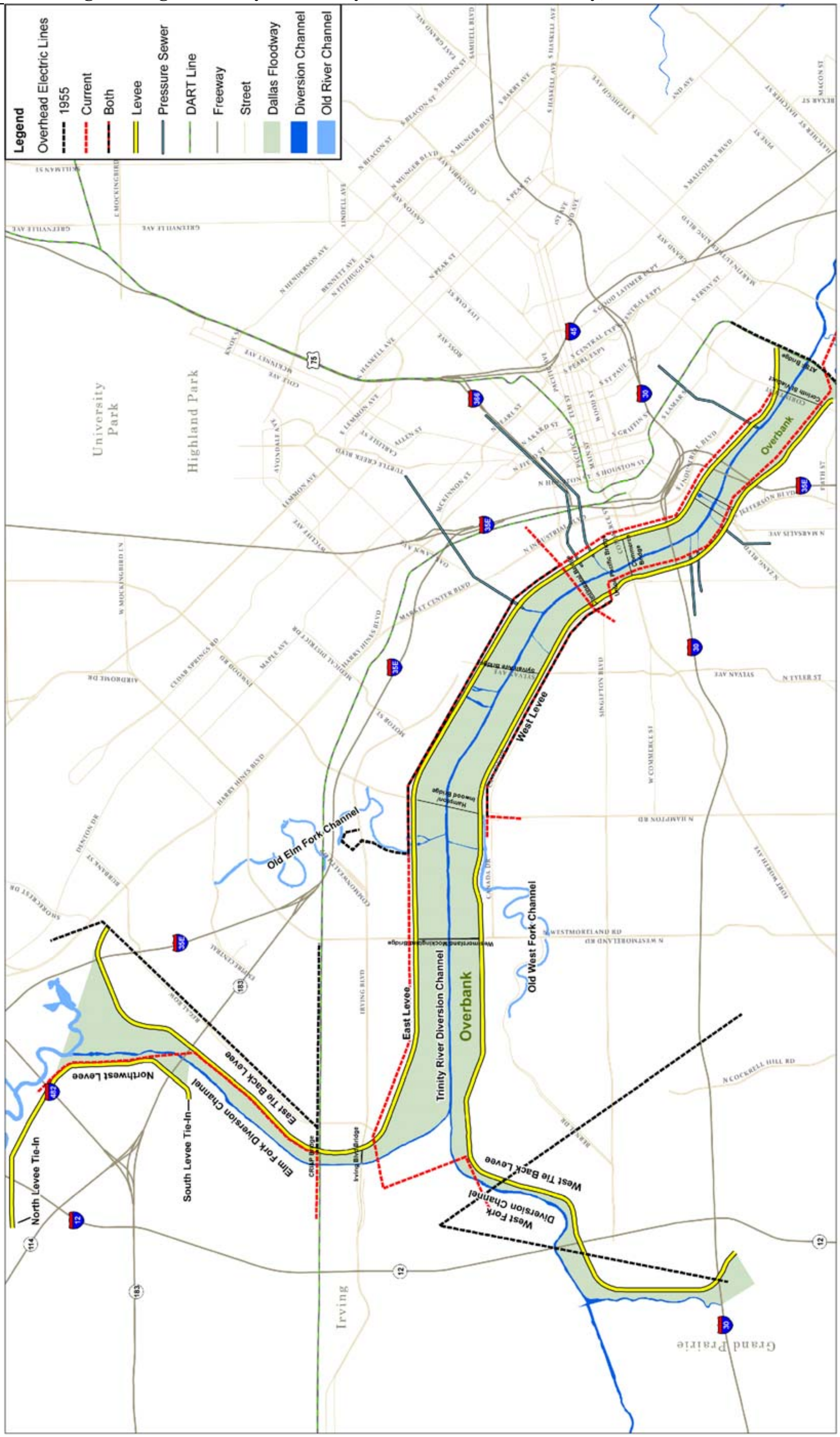


Figure 5-70. 1955 and Current Electric Line Routes

5.13.3 Parks

Although parks were part of the original floodway plans for the overbank in 1928–32 and again in the 1950s, they were planned as non-hydraulic physical features that do not contribute directly to the Dallas Floodway's engineering operations. Rather, the existing park and designated open spaces within the overbank are neutral features that neither improve nor hinder the floodway's operations. These areas are Dallas County Open Space and Trammell Crow Lake Park.

Dallas County Open Space has a designated 65-acre area adjacent to the West Fork, near Hunter-Ferrell Road and Singleton Boulevard. This area is undeveloped, but provides public access to fishing, canoeing, and boating on the West Fork of the Trinity River (USACE 1989).

Trammell Crow Lake Park, located at 3700 Sylvan Avenue, was constructed in 1985 by the city of Dallas (Figure 5-71). The park is approximately 20 acres, and includes a 2.5-acre pond, walkways and benches, a picnic area, landscaping, an open field with sculptures, and a hard-surface parking area adjacent to Sylvan Avenue, due west. The park also has boat ramp access to the Trinity River diversion channel, which runs on the south side of the park. The grassy field adjacent to Trammell Crow Lake has concrete sculptures of life-sized cows. Development of the Trammell Crow Lake Park involved in-filling the land and planting trees for landscaping (USACE 1989).

Figure 5-71. Aerial view of Trammell Crow Lake Park (Google Maps)

5.14 SURVEY SUMMARY AND FINDINGS

The following sections include an evaluation of the Dallas Floodway. This evaluation explains the relationship of the resource to the four types of significance established to qualify as a historic and cultural resource under NEPA, proposes a period of significance, and assesses its ability to convey significance to an observer. For the latter, the assessment identifies the essential physical features of the Dallas Floodway and is based on a comparative analysis of historic features and existing conditions. The ability to convey significance is assessed for the overall resource as well as for individual structural components.

This evaluation categorizes the Dallas Floodway as a structure. A structure is distinguished from buildings those functional constructions made usually for purposes other than creating human shelter. The floodway comprises an array of engineered components (10 different types of hydraulic physical features, as described in Chapter 5) that were designed and configured as one system to prevent floods. The components of the floodway function collectively to drain, collect, and contain water. Thus, this report evaluates the floodway as one large structure made up of numerous interconnected structural components related by function and physical development.

As described in Chapter 3.0 Research Design, although an evaluation of a potential historic district could apply to the collective physical features of the Dallas Floodway, this evaluation categorizes it as a single unified engineering entity that constitutes a flood control machine. The floodway's hydraulic physical features are the engineering components that make it operate as a unified unity to control floodwater and bypass urban Dallas. The Dallas Floodway would operate regardless of the presence of the non-hydraulic physical features, such as the bridges and power lines, which are not engineering components of the floodway's operation. Therefore, this survey evaluates the Dallas Floodway as one contiguous entity that includes all of its underground and aboveground components as one engineering system working in concert.

5.14.1 Significance

The Dallas Floodway is locally significant for association with events that have made a significant contribution to the broad patterns of American history in the area of community planning and development. The Dallas Floodway has significant historical associations with flood control and the history of city planning and community development in Dallas. It comprises a major flood control and reclamation project that facilitated the physical expansion and growth of Dallas through the middle of the twentieth century.

The floodway possesses local significance in the area of community planning and development for providing regional flood control and stormwater management that was instrumental to the development of Dallas and surrounding communities. The most devastating flood in the city's history occurred in May 1908 and catalyzed city planning in Dallas. At the time of the flood, the city had grown haphazardly on the east side of the Trinity River and was a tangle of streets and railroads. The river isolated the communities to the west and represented a barrier to the growth and development of Dallas. *Dallas Morning News* publisher and civic activist George Dealey persuaded the city of Dallas to hire landscape architect and city planner George Kessler to develop a city plan for Dallas. Flood control and reclamation of the Trinity River, accomplished through a massive engineering program, was at the heart of Kessler's 1911 *A City Plan for Dallas*, the first formal city plan for Dallas. A large-scale public works program remained essential to Kessler's update of the city plan in 1920 and to the 1926 Ulrickson Committee's bond proposal plan for financing a myriad of citywide improvement projects.

By the late 1920s, Dallas ultimately settled on a course of action for harnessing the Trinity: to contain a relocated and channelized river within earth levees with the "necessary appurtenant structures" in order to reclaim more than 10,000 acres in the Trinity River floodplain (Myers, Noyes and Forrest Engineers 1926). As outlined in the Ulrickson Committee's plan, the floodway system was the primary part of a comprehensive plan for public works and civic improvements throughout Dallas that would be financed by property owners within the area to be reclaimed (i.e., bonds issued by the flood control districts): the city of Dallas, the county of Dallas, the railroads, and the utilities. Construction of the Dallas Floodway began in 1928, but the Great Depression thwarted the completion of the entire system as planned, resulting in a two-phase development of the floodway. During the second phase of development between 1953 and 1959, the USACE Fort Worth strengthened the levee system, which had degraded under a lack of funding to maintain the structures, and enhanced the flood control drainage systems by adding three pumping plants and building the pressure sewers that had been left out during the cash-strapped first phase of development. Since its completion in 1959, the Dallas Floodway has effectively controlled flooding, enhancing the safety and welfare of Dallas' citizens and protecting structures (including bridges and viaducts of state and Federal highways) and property.

While the Dallas Floodway was integral to regional flood control and Dallas city planning efforts, just as importantly, it was instrumental (and continues to be) to the actual physical growth and development of Dallas. The floodway facilitated the growth of Dallas by providing thousands of acres of reclaimed land for development. Some development occurred in the vicinity of the floodway during the 1940s and 1950s, including initial commercial development in the Trinity Industrial District, and commercial and residential development in West Dallas. Substantial development occurred after the USACE Fort Worth District built the missing flood control drainage systems to complete the system in the late 1950s. Consequently, development in the Trinity Industrial District exploded in the 1960s and was nearly fully developed by the early 1970s. Stemmons Freeway, an important north-south connector in Dallas, is entirely within the reclaimed area. Stemmons Freeway enhanced the value of the reclaimed land adjacent to it and was a contributing factor to its commercial and industrial development. Trammell Crow and John and Storey Stemmons realized the enormous development potential of the reclaimed areas along the freeway, and along with the Industrial Properties Association, partnered to build several buildings in the 1950s and 1960s that to this day, contribute to the economic vitality of Dallas. They include the Decorative Center, Furniture Mart, Trade Mart, Market Hall, and Apparel Mart. Other important developments in this area include the Anatole Hotel and the University of Texas Southwestern Medical Center and School. The Dallas Floodway changed the face of the city by providing large tracts of dry land that otherwise would not have been capable of meaningful development.

The Dallas Floodway is not significant for a direct association with the lives of persons significant in our past. Several individuals who made important contributions to the history of Dallas were involved in the Dallas Floodway project. They include George Dealey, Leslie Stemmons, and John Stemmons. Nonetheless, the Dallas Floodway is not the property that best illustrates the respective important achievements and productive lives of these individuals.

George Dealey had an instrumental role in the development of the floodway. Historical records indicate he was the first to champion the idea of reclamation of the Trinity River for development. He used his newspaper, the *Dallas Morning News*, to raise support for the project and organized a few different planning organizations to spearhead local efforts. Nonetheless, Dealey's contributions to the city of Dallas are many, and the Dallas Floodway is likely not the best example of his historical contributions. The structure itself does not directly illustrate the important achievements of Dealey.

Leslie Stemmons is associated with the development of the floodway system for his role in the establishment of the Dallas Floodway as the creator and supervisor of the City and County of Dallas Levee Improvement District, which developed the Joint Plan of Reclamation and oversaw management of floodway construction between 1928 and 1932. Within the history of Dallas, Leslie Stemmons is also noted as an important business leader and real estate developer. He was the developer of several subdivisions in Oak Cliff, owner and director of the Atlas Metal Works in West Dallas, and director of two other companies (Maxwell 2009b). Thus, although Leslie Stemmons' association with the Dallas Floodway is historically significant, his association with the floodway falls just short of the level of significance required for association with persons who made significant contributions to our history because his most significant achievements in community development are better illustrated by his other projects in Dallas.

John Stemmons, son of Leslie Stemmons, helped to create the Dallas County Flood Control District, which operated and maintained the Dallas Floodway between 1945 and 1968 and contributed to the cost of strengthening the levees and constructing the missing interior drainage structures in the late 1950s. John Stemmons made important contributions to the history of Dallas through real estate development. John was president and part owner (along with his brother, Storey) of the Industrial Properties Corporation, which developed the Trinity Industrial District into an important business and industrial center in Dallas. The Industrial Properties Corporation, under the helm of John and Storey Stemmons, partnered with commercial real estate developer Trammell Crow in a number of successful commercial real estate ventures on reclaimed land in the Trinity River valley. Their multiple mart developments established Dallas as a leader in wholesale trade (TxDOT 2004, 27). As such, one or more properties associated with their complex of wholesale showrooms, such as Furniture Mart and Trade Mart, or the Trinity Industrial District are the best representatives of the important local historical contributions of John Stemmons, and not the Dallas Floodway. John Stemmons' most significant achievements in community development are not illustrated by the floodway.

In consideration of association with design, the Dallas Floodway is a significant example at the state level of an engineering system designed for flood control in Texas and development enhancement in Dallas. Although the Dallas Floodway is not exceptionally innovative in terms of engineering, it does embody distinctive characteristics of a type, period, and method of construction. The Dallas Floodway moves massive amounts of floodwater rapidly through a highly developed urban area using basic floodway design concepts that have remained largely unchanged in principle but radically changed in execution due to the advances in the application of the science of hydrology.

The entire Dallas Floodway as a hydraulic engineering machine clearly illustrates a pattern of features common to floodway resources through its presence of levees, pumping plant complexes, overbanks, pressure sewers, sluices, and all other hydraulic physical features that contribute to its function as a flood control machine.

The Dallas Floodway expresses the visual, associative, and spatial qualities common to large-scale resources that are designed for flood control. As no two floodways are alike, the Dallas Floodway is individually tailored to meet the specific needs of moving Trinity River floodwaters from Dallas' downtown and adjacent areas. Like all levees, the Dallas Floodway's levees are continuous earthen berms that extend along the corridor of a body of water. A unique feature of the Dallas Floodway is the nearly one-half-mile-wide overbank between the two levee walls. The availability of the former floodplain during the 1920s made this distance possible, and it is a character-defining feature as a result.

The Dallas Floodway was designed to be an engineering machine equipped to handle one of the nation's highest-risk areas prone to flooding. To this end, the entire Dallas Floodway system illustrates levee design and floodway engineering between 1928 and the 1950s. The floodway's first phase of construction consisted of steep 2:1-slope levee walls and four relatively small pumping plants. The USACE's strengthening project illustrates the completion and enhancement of the 1920s engineering and design standards through its addition of two more pumping plants and additional pressure sewers, intakes, sluices, and outlet gate structures for all six pumping plants. Additionally, the USACE's 1950s strengthening project exceeded the common 100-year SPF or 500-year SPF by improving the levees to an exceptional 800-year SPF to ensure protection from the floodwaters of the volatile Trinity River, thus enhancing the original design. Although the 1929–1932 levee design is not entirely visible underneath the USACE's 1950s improvements, this historical evolution of engineering is visible through the four 1929 Pumping Plants (Able, Baker, Charlie, and Delta), all of which are still present within the floodway.

Thus, although the Dallas Floodway's engineering may have employed well-established industry standards and designs of the 1928–1959 period, the floodway's historic context demonstrates that the system was a singular and distinguished engineering achievement on the local level in Dallas, and at the state level in Texas. For these reasons the Dallas Floodway has been recognized by the Texas Section of the American Society of Civil Engineers (ASCE) for its reflection of "the practical application of civil engineering practice with respect to providing a solution for a regional flooding problem that aided future economic development of the Southwest region" of the United States (Texas Section ASCE 1989).

The floodway is not significant for association with information potential because it is not a resource that has yielded or is likely to yield information important in history or our understanding of it. There is a plethora of historical documentation about the planning and construction of the floodway and reclamation that provide a comprehensive understanding of the individuals and historical, political, and economical issues behind the project's development. Likewise, historical records and the floodway itself document the design, construction, operations, and technologies of flood control engineering.

Period of Significance

Period of significance refers to the length of time when a property was associated with important events, activities, or persons, or attained the characteristics which make it significant. The period of significance of the Dallas Floodway is from 1928, the year construction began on the floodway, to 1959, the year construction was completed on the USACE's strengthening of the system.

The floodway is associated with the historic trend of flood control and reclamation of land for commercial and industrial development in Dallas; therefore, the period of significance is the span of time in which the floodway actively contributed to this trend. In this case, it is necessary to consider the span of time in which the floodway achieved the character on which this significance is based. The significance of the floodway began in 1928, when construction started on the levees and other components of the floodway. The period of significance extends to 1959, when construction of the entire floodway system as originally designed was completed. It does not end in 1932, when the construction of some of the original floodway components was completed because the Great Depression prevented completion of all the structural components necessary for the entire engineering system to work, i.e., prevent floods and drain the land for reclamation. While the levees held in the floods of 1935 and 1942, these floods demonstrated the poor condition of the system and the likelihood it would fail in the near future. Likewise, development was not practicable within the entire 10,000-plus-acre reclamation area after 1932 because of the incomplete nature of the system. Full implementation of a flood control system and reclamation for Dallas was not achieved until the USACE constructed the remaining components of the floodway and added structures to increase the capacity of the floodway. Upon completion of the floodway in 1959, Dallas finally secured long-term flood protection and thousands of acres of reclaimed land for commercial and industrial development; thus, 1959 terminates the period of significance.

5.14.2 Ability to Convey Significance

A property that conveys historic significance possesses several, and usually most, of these seven aspects: location, design, setting, materials, workmanship, feeling, and association (refer to Chapter 3 for their definitions).

To convey its historic identity, it is not necessary for a resource to retain all its character-defining physical features or characteristics, but it must retain its *essential physical features*. (Please see Chapter 3.3.4 for a more detailed explanation of these terms.)

> A ***character-defining feature*** is a prominent or distinctive aspect, quality, or characteristic of a historic and cultural resource that contributes significantly to its physical character.
>
> An ***essential physical feature*** is a feature that defines both *why* a historic and cultural resource is significant and *when* it was significant. Essential physical features are the features without which a historic and cultural resource can no longer be identified.

As an engineered flood-control system, the Dallas Floodway's primary significance is its impact on community planning and development by enabling reclamation of the natural Trinity River floodplain. Its character-defining features are those that contribute to the Dallas Floodway's historic significance for associations with historic events and design. They include the following:

- Water features: diversion channel, discharge channels, and sump areas
- Spatial organization: the floodway's footprint in the city of Dallas, the width of the floodway between the levees, and its relationship with the adjacent urban areas outside of the levees
- Vegetation: planted or natural growth that allows the levees and the overbank areas to be unencumbered to aid the floodway system operations
- Topography: the approximate height of the levee walls that bracket the low, flat areas of the overbank area
- Circulation: the maintenance roadways at the levee crowns and toes
- Structures: the six pumping plants, pressure sewers, associated outlet gate structures, sluices, intakes, dikes, and emergency control structure

The essential physical features *required* to identify the Dallas Floodway are as follows:

- The levees (East and West), comprised of trapezoidal cross sections of earthen material designed to contain stormwater inside a floodway;
- The diversion channels, to divert and redirect the natural flow of the Trinity River and its Elm and West Forks; and
- The overbanks, to contain stormwater in concert with the levees (Figure 5-72).

These physical features are essential because they define why the Dallas Floodway is significant as a flood control structure built to protect Dallas from floodwaters and allow community development. These physical features are also essential to defining when the floodway was significant. The historical appearance of the floodway was defined by the East and West Levees, the diversion channels, and the overbanks. This is illustrated when one compares aerial photographs of Dallas before the construction of the levees and diversion channels and clearance of the overbank (Figure 4-8), during their construction in 1929 (Figure 4-9), and the present character and appearance of the floodway (Figure 4-10). Without these essential physical features, the Dallas Floodway cannot effectively convey its significance. Without either the East or West Levee, it is not a floodway. Without the diversion channel, there would be no rechanneled Trinity River. Without the overbanks, there is not a way to contain the volume of floodwaters between the levees.

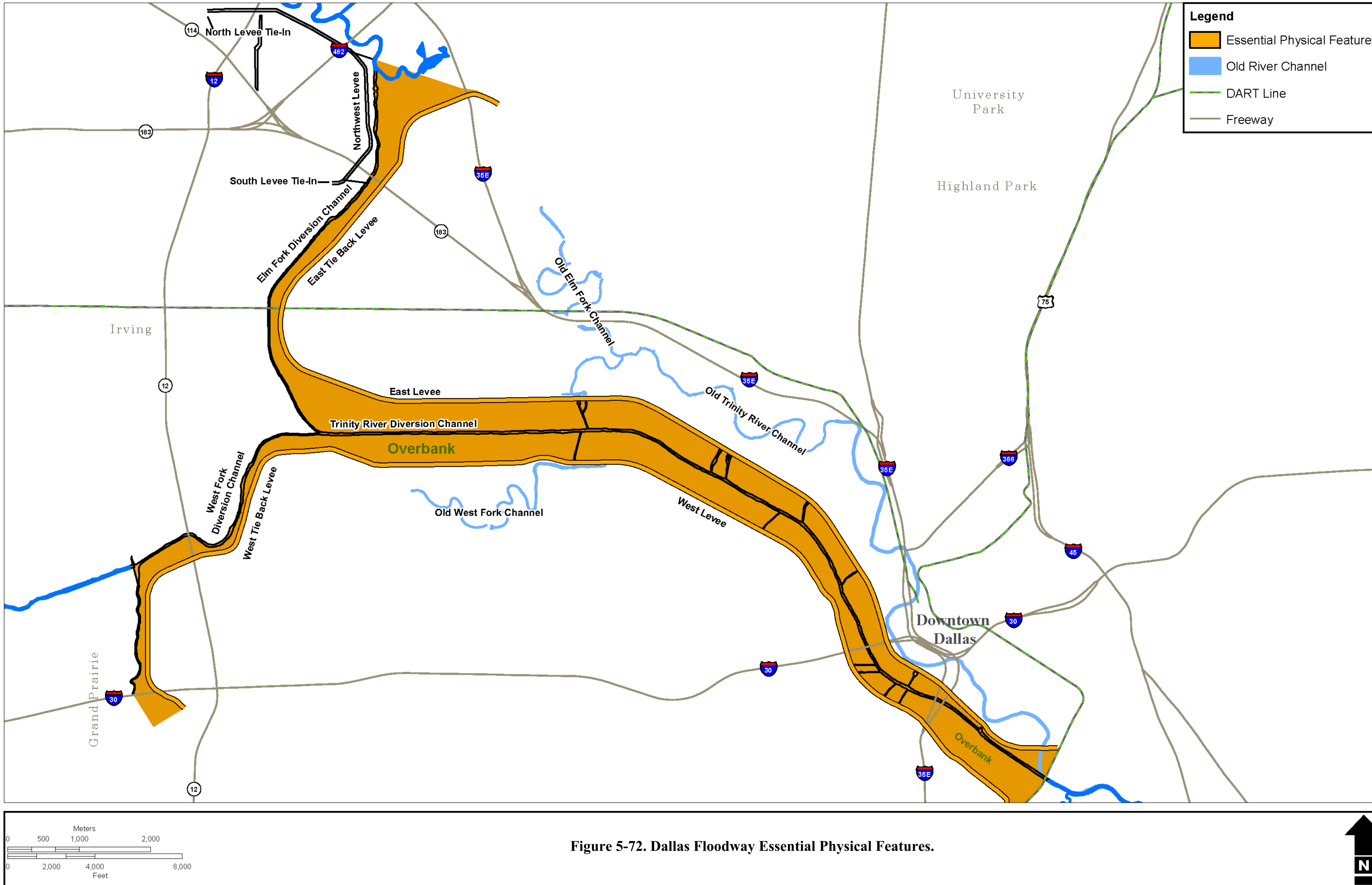


Figure 5-72. Dallas Floodway Essential Physical Features.

Other physical features of the floodway comprise the aboveground interior drainage structures (i.e., the pumping plants, sluices, outlet gate structures, intakes), floodwater retention features (the old Trinity River channel), and the transportation nodes (bridges). These features are not essential physical features because they are not necessary to the identification of the floodway as a hydraulically engineered system for flood control. The interior drainage structures function to convey water from the outside of the floodway to its interior. The old Trinity River channel functions as part of the interior drainage. The interior drainage structures support the eligibility of the Dallas Floodway through their function and design, but the Dallas Floodway can be identified easily regardless of the presence or absence of any particular interior drainage structure, which is dwarfed by the immense size and scale of the essential physical features that define and dominate the identity of the resource (Figure 5-73). The bridges are also physical characteristics of the floodway even though they are not a component of the floodway itself and do not contribute to its function. The presence or absence of any particular bridge is not essential to convey the significance of the floodway. Although the bridges are visible across the floodway, they are relatively small in scale compared to that of the essential physical features of the floodway, which encompass 5.7 square miles.

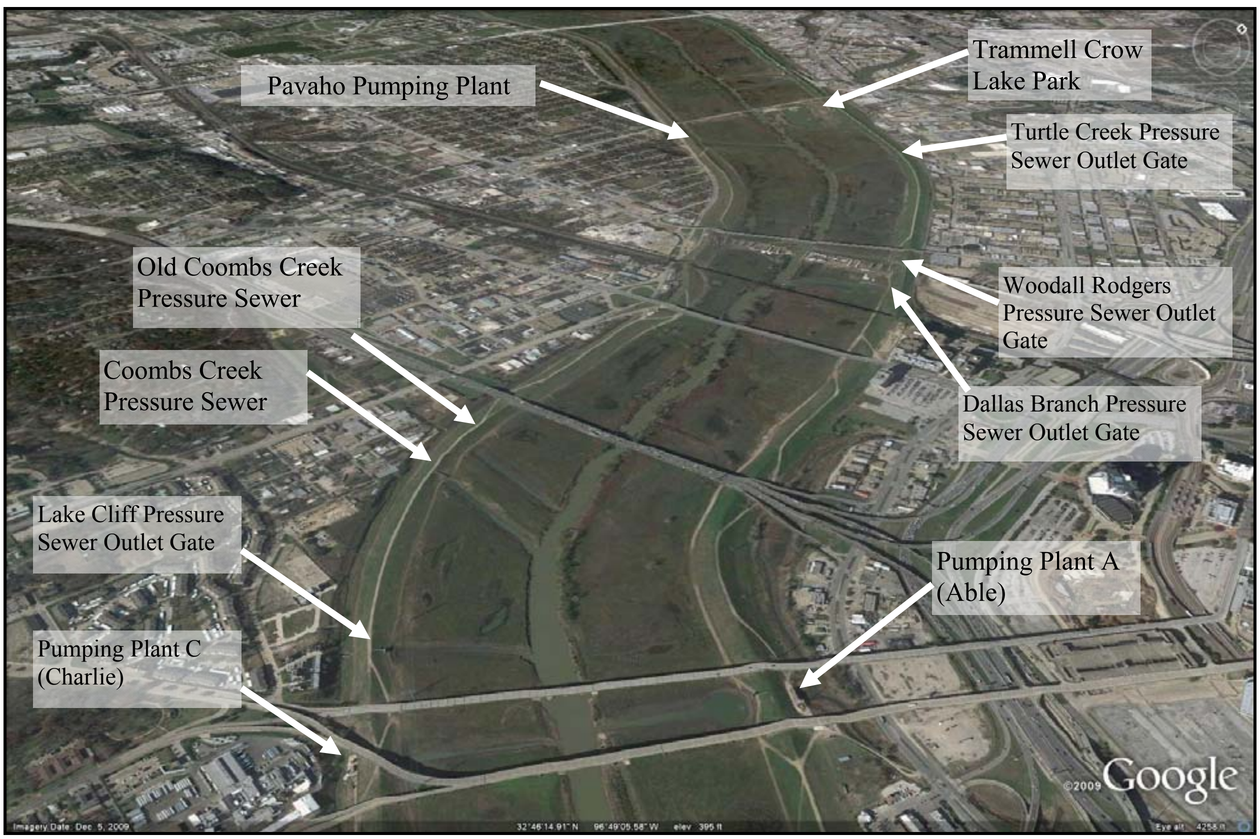


Figure 5-73. Aerial View of Dallas Floodway Looking Northwest above Jefferson Viaduct

The Northwest Levee is not an essential physical feature because it does not help to identify when and why the Dallas Floodway is significant. If the Northwest Levee was removed, the Dallas Floodway could still be identified as the same engineered flood control system that was under construction in 1929 (Figure

4-9). The same could not be said if either the East Levee or West Levee was removed. Furthermore, even though the Northwest Levee was initially related to the original floodway, it physically and operationally became divorced from the Dallas Floodway by its exclusion from the USACE enhancement project. The Northwest Levee was "officially" separated from the Dallas Floodway in 1968, when its operation and maintenance was transferred to the city of Irving as a hydraulic feature related to that city's flood control system (Skipwith et al. ca. 2007).

A resource's significance and essential physical features are the basis for determining which aspects of its ability to convey its significance are most important. The aspects that are more important for the Dallas Floodway to convey its historical significance for association with events are *Location*, *Setting*, *Feeling*, and *Association*. In order for the Dallas Floodway to convey its significance in engineering, retention of *Design*, *Materials*, and *Workmanship* are more important than the other aspects. The Dallas Floodway is a dynamic and continuously functioning engineering system. As such, it requires routine maintenance and periodic repairs and upgrades. The assessment of the ability of the resource to convey its significance, especially its design and workmanship, takes this into consideration.

Ability to Convey Significance for Association with Events

Location

The floodway retains the ability to convey significance through the aspect of *location*. The diversion channels and overbanks are in their original locations and although some channel erosion has occurred due to the dynamic nature of these hydraulic physical features, they generally follow their original alignment. No segments of the East or West Levees have been moved or re-aligned to take a different course. During the strengthening project between 1953 and 1959, which is within the period of significance, the USACE reestablished the 3:1 slopes from the original design by adding new layers of dirt fill to the crown and to the river side of the East and West Levees. As demonstrated in the cross sections of the working drawings (see Figure 4-12), this shifted the levee crown's center alignment by an average of 20 feet toward the river channel. However, the levees occupy the same base as to when they were constructed in 1929–1932; the strengthening of the East and West Levees added to the existing base by adding fill on the river side. The geographical linear footprint of the levees has not changed since completion of the USACE's strengthening project in 1959.

All the other hydraulic physical features of the floodway, such as the sluices, pressure sewers, and pumping plants, remain on the original sites in which they were built. Because the essential physical features as well as the other hydraulic physical features of the floodway are in the same place as where they were constructed, the floodway retains its ability to convey its local significance in community planning and development from 1928 to 1959 through *location*.

Design

For its historical significance for association with events, design considers the larger-scale qualities of the Dallas Floodway design, such as the scale, configuration, and original intent and functionality, for its purposes in flood control and urban development. The important design elements of the Dallas Floodway are the levees, diversion channels, and overbanks, which collectively work to prevent flooding. In its earlier period of development, the floodway was designed with earthen levees constructed on each side of a relocated Trinity River and the river's confluence with the West and Elm Forks. The diverted route of the river was designed as a straight channel excavated one-half mile west of its original snaking course, in the middle of the floodplain (the overbanks), which was cleared of obstructions save for a few telephone and power lines and the piers of existing and future vehicular or railroad bridges and viaducts. The new confluence of the West and Elm Forks with the Trinity River was also placed in the middle of the floodplain. The spatial arrangement of all the hydraulic physical features comprised a long and broad corridor of open land contained within embankments (the levees) that cut through the dense urban environment of Dallas: its central business district on the east and the communities of Oak Cliff and West Dallas on the west.

During the 1950s period of enhancement of the Dallas Floodway by the USACE, the intent and functionality of the design of the floodway remained the same as in the earlier period of its development. As such, the design of the essential physical features for the 1950s enhancement shares the same overall design attributes from the early period of floodway development: trapezoidal earthen levees containing a broad corridor of flat, nearly open land (the floodplain) through the city, and diverted river channels on straight alignments in the middle of the floodplain.

The Dallas Floodway retains all the hydraulic physical features from its original *design*. Most importantly, the essential physical features of the floodway—the East and West Levees, the diversion channels, and the overbanks—are intact. However, the configuration of two segments of the levees has been altered by the addition of two new pipelines within the past ten years (Figure 5-74). Earth and gravel cover the pipes as they extend over the levees. The pipes are approximately four feet tall and 12 feet wide. The pipes are then buried beneath the floodway proper (the overbanks). Given their relatively small size and scale in comparison to the levees (28 feet high and 10.9 and 11.7 miles long [West and East Levee, respectively]), the pipelines have an inconsequential impact on the design of the floodway (Figure 5-75).

Figure 5-74. View South-Southwest of the Overbank Showing one of the New Pipelines on the Riverside Wall of the East Levee

Figure 5-75. Aerial View Looking West Showing Scale of Pipelines Relative to Dallas Floodway

The addition of the New Frazier Dam in 1965 comprises a relatively minor modification to the Elm Fork Diversion Channel. The city of Dallas built the dam for enhanced control of runoff. As a straight, dredged channel to carry redirected floodwaters, the Elm Fork Diversion Channel still physically and functionally performs as originally designed. No design changes to the Trinity River or West Fork diversion channels were observed.

The original design for the floodway took into account crossings by five major viaducts and four minor roads, as one of the goals of preventing floods was to allow more reliable connections between Dallas and West Dallas and Oak Cliff. The levees were originally designed around the existing Houston Street Viaduct (Figure 5-76), and the foundation of the viaduct was protected during construction of the main diversion channel (Myers, Noyes and Forrest Engineers 1926). During the 1950s strengthening project, the USACE designed the crown of the levees to be at or below the superstructure of existing bridges and viaducts and the side slopes to envelope existing bridge piers (USACE 1954b) (Figure 5-77). The design also took into account the structures of bridges and roads that were under construction in the mid 1950s: U.S. 67 (the current westbound IH-35E/U.S. 67/U.S. 77), the Dallas Fort Worth Turnpike (the current IH-30), and the Sylvan Avenue at-grade crossing.

Several more bridges (e.g., Jefferson Viaduct, Westmoreland Road, Irving Boulevard, SR 356, westbound SH 482, Loop 12, and DART) presently cross over the floodway, but the heights of the new bridges are nearly the same as that of the older bridges, so the spatial relationship of the new bridges to the floodway is quite similar. The decks of the post-1959 bridges are several feet above the crown of the levees (Figure 5-78). Nonetheless, construction of these bridges did not alter the form, structure, or plan of the levees or other floodway component structures. Furthermore, the City and County of Dallas Levee Improvement District and the Dallas County Levee Improvement District No. 5 accounted for future bridges to cross over the floodway, and as such, specified in the Joint Plan of Reclamation certain design guidelines for bridges to protect the function of the levees, diversion channels, and overbank. The plan states: "Existing and future structures such as bridges, viaducts, trestles, etc., crossing the floodway shall be without embankment between the levees with a channel span of approximately 150 feet, the balance of the structure to be trestle or pier and girder construction. The bottom of the superstructure of all bridges or other structures crossing the floodway shall be at or above levee grade and the structures shall be free from longitudinal bracing below levee grade" (Myers, Noyes and Forrest Engineers 1926). The foresight of the districts to plan for and provide specific design attributes for the inevitable addition of more bridges over the floodway has ensured the historic design and overall historic character of the floodway remain intact.

Figure 5-76. View Northwest of Arch of Houston Street Viaduct Spanning the East Levee

Figure 5-77. View Northwest of Continental Street Viaduct (behind Woodall Rodgers Pressure Sewer Outlet Gate) Spanning the East Levee

Figure 5-78. View East-Southeast of the Houston Street Viaduct, Jefferson Boulevard Viaduct, and IH-35 Bridge (*from front to back*) on and over the West Levee

The intent and functionality of the design of the floodway has remained the same as in its period of development between 1928 and 1959. Although a number of new physical features have been added to the floodway, they are largely consistent with the original design qualities and attributes of the floodway system. The Dallas Floodway still retains a sufficient amount of its historic *design* elements to convey significance for its historical associations with community planning and development in Dallas from 1928 to 1959.

Setting

Because much of its historical significance derives from the impact of the flood control system on the urban development of the city, *setting* must consider the intent of the Dallas Floodway to reclaim land for the expansion of the metropolitan area. During its early period of development, areas adjacent to the downstream end of the floodway consisted of urban commercial and residential development. The mid-rise buildings of downtown Dallas rose to the east beyond the vacant hydraulic fill area. Bordering the west side were the residential neighborhoods of Oak Cliff and West Dallas. Largely undeveloped areas bordered the upstream sides of the floodway. By the later part of the period of significance, the development of the existing areas had intensified. A few high rises punctuated the Dallas skyline. Commercial and industrial development had expanded farther west, adjacent to the upstream half of the floodway. Only a small amount of industrial development had occurred in the hydraulic fill area.

At the present time, the setting surrounding the floodway exhibits both continuity and change. The floodway system still defines the western edge of the business district and also delineates the east boundary of the communities of Oak Cliff and West Dallas. The floodway itself comprises open space between the two urban areas, linked by road and rail bridges. This same type of urban environment exists today, only the density of development in the communities on either side of the floodway has changed. Since 1959, the hydraulic fill area was completely developed into the Trinity Industrial District, and commercial, industrial, and institutional properties fill in the areas all along the north side of the floodway in great density. West Dallas completely encompasses the area south of the floodway, with low-rise residential, commercial, and industrial properties.

Setting often reflects the basic physical conditions under which a property was built and the functions it was intended to serve. The intent of the Dallas Floodway was not only to provide an open swath of land next to the city to contain discharged stormwater, but also to reclaim an otherwise undevelopable floodplain to enlarge the surface area of buildable land near Dallas' central business district so the city could continue to grow. Thus, it is only natural that the setting of the area surrounding the floodway has changed since the USACE completed construction in 1959. No urban landscape is frozen in time. The urban environment surrounding the floodway evolved between the first and second phases of construction of the floodway, and it continued to evolve after the system was completed in 1959. Land reclaimed as a result of the floodway system was intended to be developed, and indeed, has been.

Considering the dynamic urban environment within which the floodway was built and continues to exist, the Dallas Floodway retains the *setting* to convey its significance with community planning and development in Dallas between 1928 and 1959.

Materials

Because the historical significance of the Dallas Floodway is largely derived from its function, the assessment of *materials* evaluates whether changes to the use of materials have affected the function or historic character of the floodway and its essential physical features. The original materials of the levees consisted of compacted clay soil covered with grass. The source of the fill used in the original construction of the levees is not known, but for the USACE strengthening project, the fill came from the material that was removed from the river side crown of the existing levees and from excavation of existing and new sumps in the floodway. After the levees were strengthened in the 1950s, their crowns were widened and graded for a roadway. Riprap, instead of grass, covered the river side slopes of the levees under bridges over the floodway. For the Trinity River diversion channel, riprap was used to line portions of its dirt banks. Because preparation of the overbanks meant clearing the floodplain of timber, brush, and other obstructions, the historical materials of the overbanks comprise dirt and grass.

The materials of the levees has been somewhat diminished, as some fill has been removed and replaced with new fill in selected segments of the levees where erosion, cracking, or subsidence has occurred. New fill material has been used to stabilize the affected areas; however, the majority of fill used to construct the levees during the period of significance still makes up the majority of the existing levee system. In some cases, fill for repairs is obtained from borrow pits in the overbank. In the case of the late 1990s project that flattened the river side levee slopes to 4:1 on the East and West Levees downstream of the Union Pacific Railroad Bridge and Continental Street Viaduct, respectively, excavated material came from overbank borrow pits and the widening of the Trinity River diversion channel downstream of the Continental Street Viaduct (HNTB 2009). Grass covers the areas of new fill, so the non-historic material is not visible.

Pylons of some of the post-1959 bridges pierce the levee walls. In addition, the sides of the levees where the bridges cross them have been covered in concrete or riprap. As a result, original fill material has been removed, altered, or obscured in these areas. The use of concrete on levee slopes under selected overhead bridge crossings is inconsistent with the historic character of the levees. Although this has affected the materials of the levees, the affected areas encompass a relatively small area of the levees compared to its overall surface area, and does not affect the ability of the levees to perform their intended purpose.

Within the overbank, the only material change noted was the addition of two asphalt-paved parking areas at Trammell Crow Lake Park. The function and character of the overbank is not affected by the parking lots because it is still a flat stretch of open land. Additionally, these paved surface areas cover a considerably small area of the overbank, so they do not compromise the material of the overbank. No significant material changes to the diversion channels were observed.

The essential physical features of the floodway—the levees, overbank, and diversion channels—retain most of their historic materials. In comparison to the larger surface area and volume of the floodway's essential physical features, the amount of new materials that has been added is small. Because the use of the small amount of new materials does not inhibit the function or compromise the historic character of the essential physical features, the Dallas Floodway still retains the *materials* to convey significance for its historical associations with community planning and development in Dallas from 1928 to 1959.

Workmanship

Workmanship is an aspect that is of less relevance to the ability of the Dallas Floodway to convey significance for its historical associations with mid-twentieth century community planning and development in Dallas than location, setting, materials, feeling, and association. The floodway is a type of engineering structure that exhibits minimal amounts of craftsmanship. Workmanship is not readily applicable to the essential physical features of the Dallas Floodway. For instance, excavation of the diversion channels and sumps in the overbanks, and placement of embankment materials and soil compaction of the levees was completed mechanically with construction equipment. Likewise, the continued maintenance of these hydraulic physical features is by mechanical equipment.

The floodway's essential physical features historically have lacked evidence of any notable workmanship. As the floodway's essential physical features are still characterized by minimal amounts of craftsmanship, the Dallas Floodway meets the threshold of *workmanship* to convey its local significance in community planning and development between 1928 and 1959.

Feeling

Assessing the impact of changes in design, setting, and materials (location is unchanged) is helpful in determining whether the floodway sufficiently conveys the historic sense of a flood control system during the period of significance. The form and arrangement of the essential physical features remain largely unchanged since 1959. Collectively the grass-covered earthen berms (levees) and flat, grass-covered floodplain bisected by a straight water channel clearly identify the function of this resource, despite a bit of vegetative intrusion and a few more bridges crossing over it. The addition of new fill to repair segments of the levees or accommodate a flatter slope at the downstream ends is not discernible to the average Dallas resident and does not impact the visual or functional qualities of the levees. The physical and visual relationship of the Dallas Floodway with the adjacent urban environment has continued from the period of significance, even though land use and the density of surrounding development have changed.

The feeling of this system is most apparent in the middle of the floodway, whether at grade or on a bridge overlooking the overbank. Here, the feeling of this massive public works project, with its long levees, linear river channels, drainage structures, and wide, open basin, is apparent (Figures 5-79 and 80). It is clearly evident when the floodway is full and the levees contain stormwater (Figure 5-81).

Because the Dallas Floodway remains identifiable as a flood control system and retains the physical, functional, and visual qualities that evoke a sense of time and place within the period of significance, the floodway possesses the aspect of *feeling* to convey its significance for historical associations with community planning and development in Dallas from 1928 to 1959.

Figure 5-79. Panoramic View Southeast from the Commerce Street Bridge

Figure 5-80. Panoramic View Southeast from the East Levee near the Confluence

Figure 5-81. View East-Southeast of the Dallas Floodway During 1990 Flood
(photo provided by the City of Dallas)

Association

The floodway retains its *association* with flood control and development enhancement in Dallas. The hydraulic physical features of the floodway system are in place and intact. The historical association between the floodway and urban corridor has been maintained and substantial development has occurred around the floodway as intended. There are no intrusions in the floodway that have blocked or changed its view sheds or site lines from within the floodplain. All the character-defining features that existed when the floodway attained significance are still present today and largely unchanged since the period of significance. Thus, the Dallas Floodway conveys its historical *association* in community planning and development because it is still serving its original function in flood control and drainage of developed land as in its historic period of significance.

Ability to Convey Significance for Association with Design

Location

The floodway retains the ability to convey significance through the aspect of *location*. The diversion channels and overbank are in their original locations and although some channel erosion has occurred due to the dynamic nature of these hydraulic physical features, they generally follow their original alignment. No segments of the East or West Levees have been moved or re-aligned to take a different course. As discussed under the assessment of location for association with events, the base of each levee is in the same location as when they were originally constructed. The bases of the East and West Levees were broadened on the river side during the USACE strengthening project in the 1950s. No segment of the levees has been moved since the completion of the USACE's strengthening project in 1959. All the other hydraulic physical features of the floodway remain on the original sites in which they were built. Therefore, since the geographical linear footprints of the essential physical features have not been moved and the other hydraulic physical features of the floodway remain in the same place where they were constructed, the floodway retains its ability to convey its significance as an important statewide example of an engineering system designed for flood control and development enhancement from 1928 to 1959 through *location*.

Design

As an important example of an engineering system for flood control and development enhancement, the aspect of *design* focuses on the structure itself in terms of the form and combination of the system's hydraulic physical features. In its earlier period of development, the form of the levees was trapezoidal, with steep 2.5:1 slopes (as built), a narrow crown, and an average height of 26 feet. The form of the levees, however, was changed by the USACE in its design to strengthen them. The East and West Levees retained a trapezoidal profile, but the size of the levees was augmented by additional fill, resulting in a flatter slope (to 3:1) and a broader base and crown. The average height of the levees also increased to 28 feet.

Repairs to segments of the levees have modified their form. In the late 1990s, a drainage improvement project involving the East and West Levees included flattening the river side levee slope to 4:1 downstream from approximately 300 feet south of the Union Pacific Railroad Bridge on the East Levee, and downstream from approximately 900 feet north of the Continental Street Viaduct on the West Levee (HNTB 2009). This was undertaken to strengthen the levees and prevent slides of the walls. The change in the design slope occurred on only the river side portions of the levees and is not visually apparent when observing the levees, nor the floodway as a whole. These segments of the East and West Levees still retain the trapezoidal cross section that characterizes their form and structure. Otherwise, repaired areas of the levees are built to preserve the existing 3:1 slope of the levees.

Flood control at the north end of the Elm Fork Diversion Channel was enhanced in 1965 when the city of Dallas built the New Frazier Dam across the channel. From a design aspect, a very small segment of the diversion channel was affected by the addition of the 180-foot-long gravity dam. The channel itself retains its original design attributes of a straight, dredged channel for carrying redirected floodwaters.

The interior drainage structures, i.e., the pumping plants, pressure sewers, sumps, sluices, etc., are the "necessary appurtenant structures" for land reclamation. To drain the "overflowed lands," the design of the floodway from its earlier period of development provided five separate areas on each side of the levees, two on the east and three on the west, with sluice gates and conduits (pressure sewers) and/or pumping plants to allow stormwater to pass through to the interior of the floodway. With three more pumping plants and two more pressure sewers added during the 1950s improvements, the arrangement of these interior drainage structures next to and through the levees remained. The design for the system was augmented by the addition of interior drainage features (sluices and culverts) in the old channels of the West and Elm Forks. The old West and Elm Fork channels are natural conduits for run-off into the floodway interior. The culverts and other structures associated with these features were of standard concrete construction.

Since 1959, the design of the floodway's drainage system has been augmented a few times with additional interior drainage structures to enhance the floodway capacity. Three pumping plants (New Baker, New Hampton, and New Pavaho) were added in 1975. Each was built next to the existing 1929 and/or mid-1950s pumping plants. Two pressure sewers and outlet gate structures, Woodall Rodgers and Coombs Creek, have also been added (1979 and 1989, respectively). Like the new pumping plants, the pressure sewers were built next to existing ones. Thus, the distribution and configuration of the floodway's later interior drainage structures and the spatial relationships between them is consistent with the floodway design from the period of significance.

The continuing urban development made possible by the floodway has resulted in increased runoff, and combined with changing design standards, has resulted in numerous comparatively small changes to the system and its design since 1959. However, the overall design of the system has not changed since 1959. The Dallas Floodway still conveys the identity for which it is significant by possessing the essential physical features of the original 1928 and 1950s design: the levees, the diversion channel, and the overbanks. Moreover, all the original 1929 pump stations are intact with few alterations, as is the 1950s additions by the USACE. Therefore, the Dallas Floodway retains the aspects of its *design* to convey its significance as an important example at the state level of an engineering system for flood control and urban development.

Setting

The *setting* of the Dallas Floodway as an important example of an engineered water control system relies heavily on the qualities and character of the land contained within the floodway (between each levee and diversion channel) during the period in which it attained significance. During the period of significance, the setting within the floodway was characterized by flat, open land with wide vistas of the floodplain and the city beyond. Breaks in the grass-covered overbanks were provided by the linear edges of the diversion channel or periodic sumps. A few trees here and there dotted views up and down the floodway. The grass-covered embankments of the levees not only physically contained the floodplain, but because of their height, also visually defined its edges. Visual elements along portions of the levees included power lines. Extending across and above the broad plain of the downstream end of the floodway were a few bridges during the early period of the floodway's development; by the 1950s enhancement several more of these linear structures characterized both the downstream and upstream portions of the floodway.

The setting inside the floodway is still largely characterized as a broad swath of flat, open grassy land with extensive views within and beyond the floodplain landscape (Figures 5-79, 5-80, 5-82, and 5-83).

Figure 5-82. Panoramic View Northwest from Commerce Street Bridge

Figure 5-83. Panoramic View East from East Levee at Hampton Pumping Plant

The tall, grass-covered levees visually define the sides of the overbanks, which contain many more trees, primarily along the banks of the diversion channel. The floodway setting inside the floodway has experienced some change since the USACE completed construction in 1959.

Several non-hydraulic physical features have been added within the floodway: additional bridges, power transmission lines, and Trammell Crow Lake Park. Although additional bridge crossings over the floodway have been constructed after the period of significance, they are still consistent with historic patterns of development; as described above, the design and development of the floodway system included provisions for multiple transportation crossings. Figures 5-77, 5-78, 5-82 and 5-83 show the overhead power lines that are within the overbank or are next to the land side of the East Levee. These utility lines consist of skeletal steel towers that comprise a very small footprint in the land area of the overbank. They do not create a physical or visual barrier in the floodway system. More importantly, the presence of utility lines in the floodway is not inconsistent with its setting from the period of significance. The USACE as-built drawings of the Dallas Floodway in 1955 depict several power lines (USACE 1955) (refer to Figure 5-70). Segments of two of the current power lines follow the same routes as power lines that were present in 1955. Furthermore, the 1926 Joint Plan of Reclamation and 1928 plan update included provisions for utility lines in the floodway: "All gas, oil, water and other pipe lines, telephone, telegraph and power and light lines and other structures within the [levee districts] will necessarily be required to conform to the plans of the [Levee] Districts" (Myers, Noyes and Forrest Engineers 1926). The 1985 Trammell Crow Lake Park, which includes a lake, boat launch, and parking lots, lies within the overbank (Figure 5-84). However, the features of this park retain a low profile and the park has no buildings and structures to obstruct the overbank. The construction of the park, which encompasses approximately 20 acres or 0.03 square miles, is a relatively minor change in the floodway when considered within the larger scale of the Dallas Floodway engineering system, which covers roughly 5.7 square miles (Figure 5-85). Moreover, the presence of the park in the floodway is not contrary to the original conception of the physical character of the overbank. In the 1928 Joint Plan of Reclamation, the designers of the Dallas Floodway acknowledged that because of the necessity to perpetually maintain the overbank in an unobstructed condition, it would "assume ultimately, a park like aspect" and create the potential that "the City will make [the overbank] public recreational grounds" (Morgan Engineering Company 1928).

Figure 5-84. View East of Trammell Crow Lake Park

Figure 5-85. Aerial View of Dallas Floodway Looking Northwest

The post-1959 non-hydraulic physical features in the floodway are dwarfed by the scale of the floodway and do not significantly impact the setting. The Dallas Floodway remains a large, linear, open green space between the urban environs of Dallas on the east and West Dallas and Oak Cliff on the west with non-hydraulic physical features that are still consistent with patterns of development in the floodway that date back to the period of significance. The Dallas Floodway, therefore, retains the *setting* to convey its significance as an important example of an engineering system designed for flood control and development enhancement from 1928 to 1959.

Materials

For its significance in the area of engineering, the assessment of *materials* considers the effects of material alterations on the ability of the engineering system to convey a sense of place and time. The earlier section on the materials for association with events describes the materials that were historically used to construct the floodway's essential physical features, and what non-historic materials have been added since 1959. As indicated previously, portions of the levees have been repaired with new fill, poured concrete has been added to the levee walls under selected bridges to prevent erosion and subsidence, and two asphalt-paved parking lots for Trammell Crow Lake Park have been built in the overbank. The Dallas Floodway is an ongoing, dynamic system. It was designed to change as engineering needs increased to meet continuing development. Therefore, it is not surprising then that some of the essential physical features of the floodway structure have been repaired or modified since their construction as needs have changed.

The original materials of the other hydraulic physical features of the Dallas Floodway, although not essential physical features, vary by the type of structure. All the pumping plants built in 1929 and all but one of the pumping plants built in the 1950s by the USACE are brick; one of the 1950s pumping plants (Pavaho) was constructed of reinforced concrete. Structures associated with the pumping plants, such as intake structures and outlet structures, are poured concrete and the intake opening is covered by metal grates (i.e., the trash racks). Intakes for the pressure sewers were built the same way as the intake structures at the pumping plants: reinforced concrete walls and metal trash racks over the opening. Valve vents, culverts, emergency control structures, and pressure sewer outlet gate structures, whether from the floodway's earlier period of development or the 1950s enhancement, were also constructed of reinforced concrete. For the latter, steel I-beams support the concrete walkway and steel tube guard rails.

These hydraulic physical features of the floodway retain sufficient original *materials*. Records were not found concerning repairs or improvements to the gates of the outlet structures. However, it can be assumed that some of the gates have been repaired or replaced over the years with ones of the same or similar materials and design. Changes of this nature are expected and do not impair the ability of the structures to convey their function and significance to the system. Due to natural material degradation, riprap has been removed or replaced around intakes and outlet structures and new riprap had been added at the outlet gate structure of the Hampton Road Pumping Plant's discharge channel to prevent erosion. This is to be expected given the dynamic nature of these hydraulic features, and does not compromise the overall quality of materials of the structures. The materials of the four 1929 pumping plants ("Old" Able, Baker, Charlie, and Delta) is somewhat diminished by the removal of some original windows and infilling the openings with brick, but the rest of these structures appear to be intact (Figure 5-86). No alterations or modifications to the 1950s pumping plants were observed.

Figure 5-86. View East of 1929 Able Pumping Plant (1953 Able Pumping Plant in Background)

The essential physical features of the Dallas Floodway retain most of their historic materials. Non-historic materials have been introduced, but represent a small amount when considered within the large scale of the surface areas of the floodway's physical features. Some non-historic materials also have been incorporated in minor elements of the other hydraulic physical features. These do not represent substantial alterations that compromised the overall historic character of the physical features. Therefore, the floodway still retains a sufficient amount of its *materials* to convey significance as an engineering system for flood control and development enhancement.

Workmanship

For consideration of *workmanship*, the floodway is a type of engineering structure that exhibits minimal amounts of craftsmanship. This aspect is not readily applicable to the essential physical features of the Dallas Floodway. For instance, excavation of the diversion channels and sumps in the overbanks, and placement of embankment materials and soil compaction of the levees was completed mechanically with construction equipment. Likewise, the continued maintenance of these hydraulic physical features is by mechanical equipment. Qualities of workmanship are more apparent on the other physical features of the floodway. The only example of craftsmanship in the floodway system is on display on the exterior of the 1929 pumping plants, which feature modest decorative brickwork and clay tile coping (Figure 5-86). The brick pumping plants from the 1950s exhibit plain brick laid in a traditional common bond pattern. The 1954 Pavaho Pumping Plant, built of reinforced concrete, exhibits a bit of ornamental embellishment with three recessed bands below the parapet (Figure 5-33).

The floodway's hydraulic physical features historically have lacked evidence of any notable workmanship. As the floodway's hydraulic physical features are still characterized by minimal amounts of craftsmanship and no changes have occurred to the few modest displays of architectural details on the pre-1960 pumping plants, the Dallas Floodway meets the threshold of *workmanship* to convey its significance at the state level as an example of an engineering system for flood control and development enhancement between 1928 and 1959.

Feeling

The floodway retains the design, location, materials, and setting to convey the *feeling* of an engineered flood control structure from the mid-twentieth century. The combined effect of these aspects illustrates how the structure possesses significance (refer to the section on the feeling of the floodway for association with events). Comparative “then and now” photos of historical conditions during the 1950s strengthening project and existing conditions, which follow this section in Table 5-2, illustrate the extent that the *feeling* of the resource remains. These photos demonstrate that the floodway system retains those features and qualities that evoke a sense of time and place from the period of significance. Therefore, the Dallas Floodway possesses the *feeling* to convey its significance as an example of an engineering system for flood control and development enhancement from 1928 to 1959.

Association

The Dallas Floodway retains its *association* as an example of a mid-twentieth century engineered flood control system through the retention of the natural and built physical features within the floodway system. The engineering system is still in place and the floodway remains effective in controlling flooding. The hydraulic physical features of the floodway and the relationship among them are largely unchanged since the period of significance. The Dallas Floodway remains identifiable as a flood control system, and thus, retains its *association* to convey its significance in engineering as a flood control and drainage system during the period of significance.

Table 5.2. "Then" and "Now" photographs illustrating historical and existing conditions of selected Dallas Floodway structures

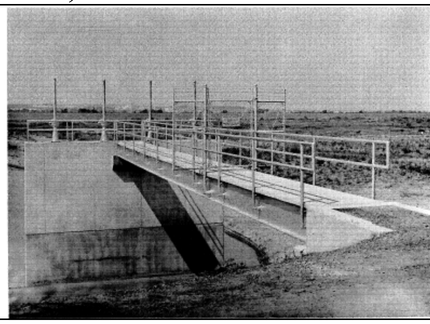
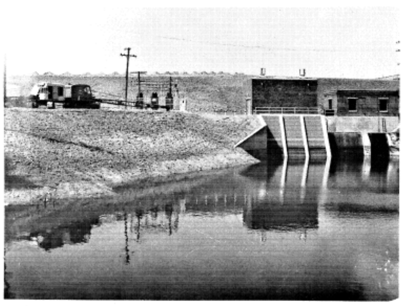
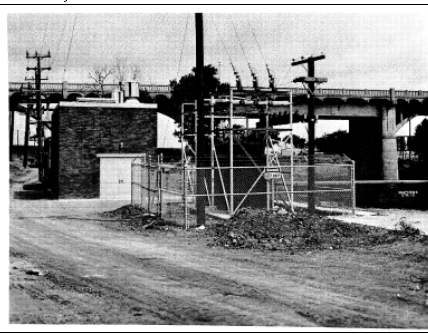
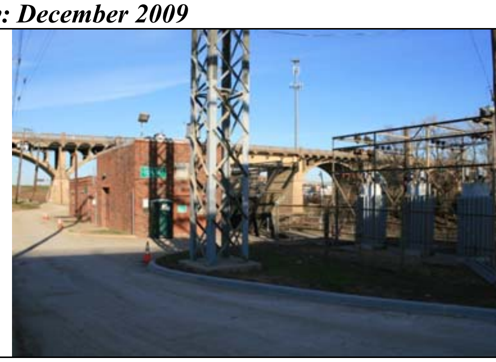
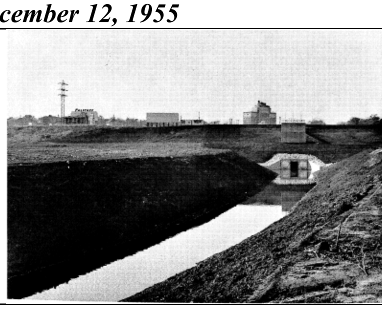
Pumping Plant B (Baker) Outlet Gate Structure	
Then: June 6, 1958	***Now: December 2009***
	
Pumping Plant A (Able), Old and New	
Then: June 8, 1954	***Now: December 2009***
	
Pumping Plant A (Able)	
Then: June 8, 1954	***Now: December 2009***
	
Lake Cliff Pressure Sewer	
Then: December 12, 1955	***Now: December 2009***
	
Old Coombs Creek, Outlet	
Then: December 10, 1956	***Now: December 2009***

Table 5.2. "Then" and "Now" photographs illustrating historical and existing conditions of selected Dallas Floodway structures

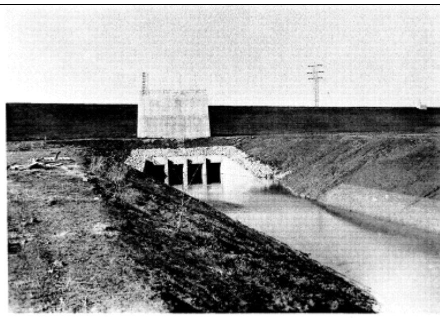
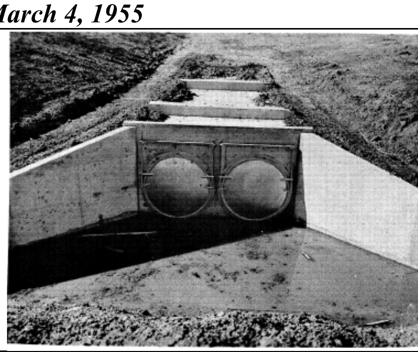
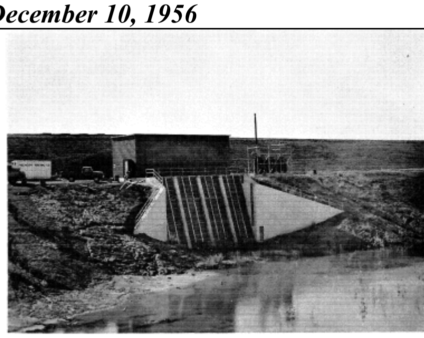
	
Coombs Creek, Intake and Levee	
Then: December 10, 1956	***Now: December 2009***
	
Pavaho, Outlet, 8-Foot Flap Gates	
Then: March 4, 1955	***Now: December 2009***
	
Pavaho, Inlet and Completed Structure	
Then: December 10, 1956	***Now: December 2009***
	
Turtle Creek, Intake Structure	
Then: March 13, 1957	***Now: December 2009***

Table 5.2. "Then" and "Now" photographs illustrating historical and existing conditions of selected Dallas Floodway structures

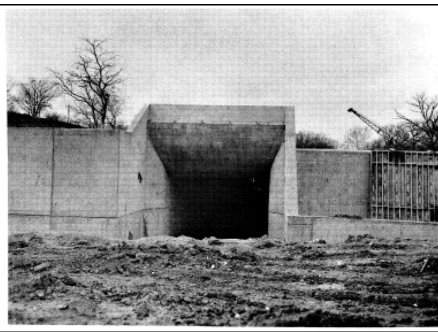
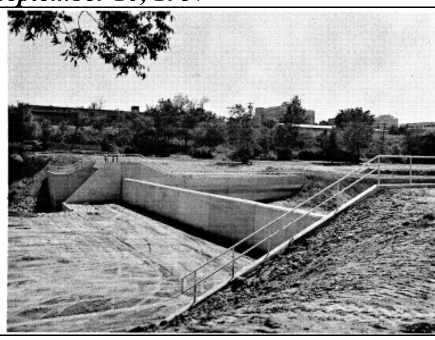
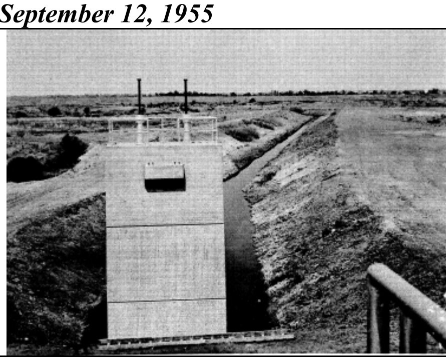
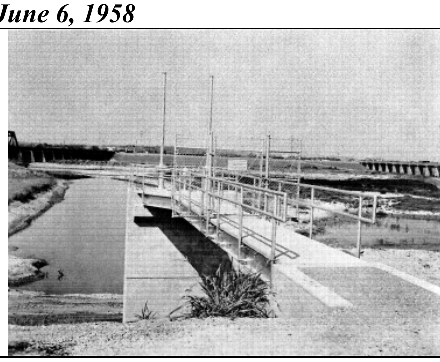
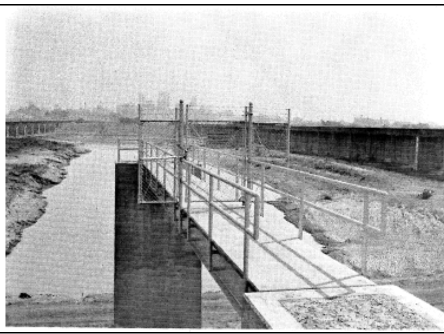
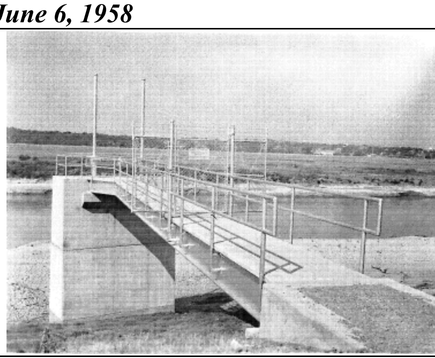
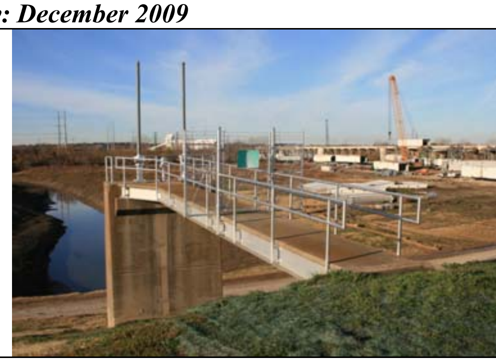
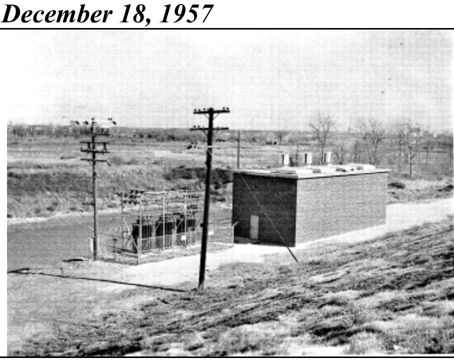
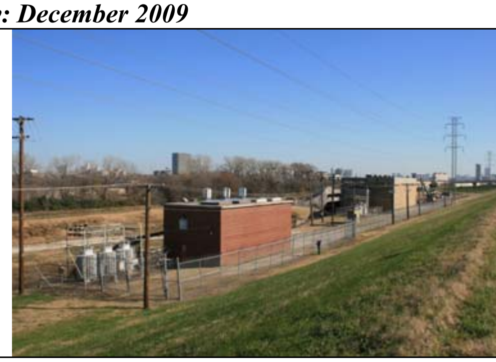
	
Turtle Creek, Overflow Section	
Then: September 10, 1957	***Now: December 2009***
	
Pumping Plant D (Delta), Outlet Gate and Discharge Channel	
Then: September 12, 1955	***Now: December 2009***
	
Belleview, Outlet Gate Structure	
Then: June 6, 1958	***Now: December 2009***
	
Pumping Plant C (Charlie), Outlet Gate Structure	
Then: June 6, 1958	***Now: December 2009***

Table 5.2. "Then" and "Now" photographs illustrating historical and existing conditions of selected Dallas Floodway structures

	
Elm Fork Sluice, Outlet Gate Structure	
Then: June 6, 1958	***Now: December 2009***
	
Dallas Branch, Outlet Gate Structure	
Then: June 6, 1958	***Now: December 2009***
	
Hampton Pumping Plant	
Then: December 18, 1957	***Now: December 2009***
	

Source of historical photographs: USACE 1960

In summary, the Dallas Floodway is significant as a structure for its historical association with events of local significance in the area of community planning and development and for its state significance in the area of engineering. As a flood control system, the floodway had, and still has, an important role in protecting Dallas and furthering its growth and development. Because of the Dallas Floodway, thousands of acres of land in the Trinity River floodplain were reclaimed, spurring substantial urban growth and development in the city. As an engineering system, the floodway itself is an important example of how standard engineering design was employed to meet the extreme design parameters of the site. The resultant phased design and execution demonstrates a singular and distinguished engineering achievement in the Dallas context and beyond.

The period of significance extends from 1928 to 1959, which covers its phased construction. The floodway retains the essential physical features to illustrate its function and purpose for flood control and reclamation. The floodway retains the aspects of location, setting, materials, feeling, and association, and to a lesser degree, design. Due to the inevitable design changes that have occurred (i.e., additional pumping plants, pressure sewers, and sluices), design and workmanship are not as relevant to the local significance of the floodway in community planning and development. For association with design, however, the floodway still retains a sufficient amount of design and workmanship to convey significance as an engineering system for flood control and development enhancement.

The Dallas Floodway retains its historic ability to convey significance to the 1928–1959 period of significance. The floodway possesses the ability to convey significance because it retains the identity for which it is significant. A basic test for a property with significance for important historical associations is whether a historical contemporary would recognize the property as it exists today. A historical contemporary, such as a Dallas citizen, floodway project engineer, or city planner from the floodway's period of significance, would readily recognize the Dallas Floodway as it exists today due to its retention of all its essential physical features and some of all seven aspects of location, setting, design, materials, workmanship, feeling, and association. Refer to Table 5-3 for an overall summary of these aspects for the Dallas Floodway. Changes in setting outside the floodway are the direct result of the presence of the floodway and enhance its significance in community planning and development. Changes in setting inside the floodway consist of additional bridges, additional power transmission lines, and a park. However, these changes are dwarfed by the scale of the floodway and do not significantly impact the interior setting. The floodway's essential physical features are on their original location. Materials, primarily earth, are essentially intact as the 1928–1932 levee material is still in situ. The floodway conveys its historical feeling since, as demonstrated by comparing historical and current photographs, its physical features collectively still convey the property's historic character and remain identifiable as an operational floodway of 1928–1959 that protects the city and allows development of reclaimed lands. The Dallas Floodway retains association from its period of significance because it is still in place and its physical features continue to convey their historic character and function of preventing flooding.

Table 5-3. Aspects of the Ability to Convey Significance for Each Recommended Type of Significance of the Dallas Floodway.

	Location	Design	Setting	Materials	Workmanship	Feeling	Association
Asssociation with Events	●	◐	●	◐	◐	●	●
Association with Design	●	◐	●	◐	◐	●	●

● = High degree of ability to convey significance

◐ = Moderate degree of ability to convey significance

○ = Low degree of ability to convey significance

5.14.3 Supporting and Non-Supporting Physical Features

The Dallas Floodway includes 42 hydraulic physical features that support the significance of the Dallas Floodway and 13 hydraulic physical features that do not support its significance, as summarized below in Table 5-4 and Figure 5-87. Table 5-4 also indicates whether a hydraulic physical feature is essential or not essential to the function of the Dallas Floodway, as described in Subchapter 5.2. Supporting features of the Dallas Floodway are those physical features that survive from the period of significance (1928–1959), are associated with the areas of significance for the floodway, and retain sufficient ability to convey significance to represent their historic appearance and function and convey the character of the floodway at that time. Conversely, non-supporting physical features are those that have become part of the floodway since the period of significance and do not support the areas of significance of the floodway, or are features surviving from the period of significance that no longer possess the ability to convey significance.

Overhead power lines located within the overbank have existed in the floodway since its period of significance between 1928 and 1959. The Joint Plan of Reclamation accounted for the inclusion of power

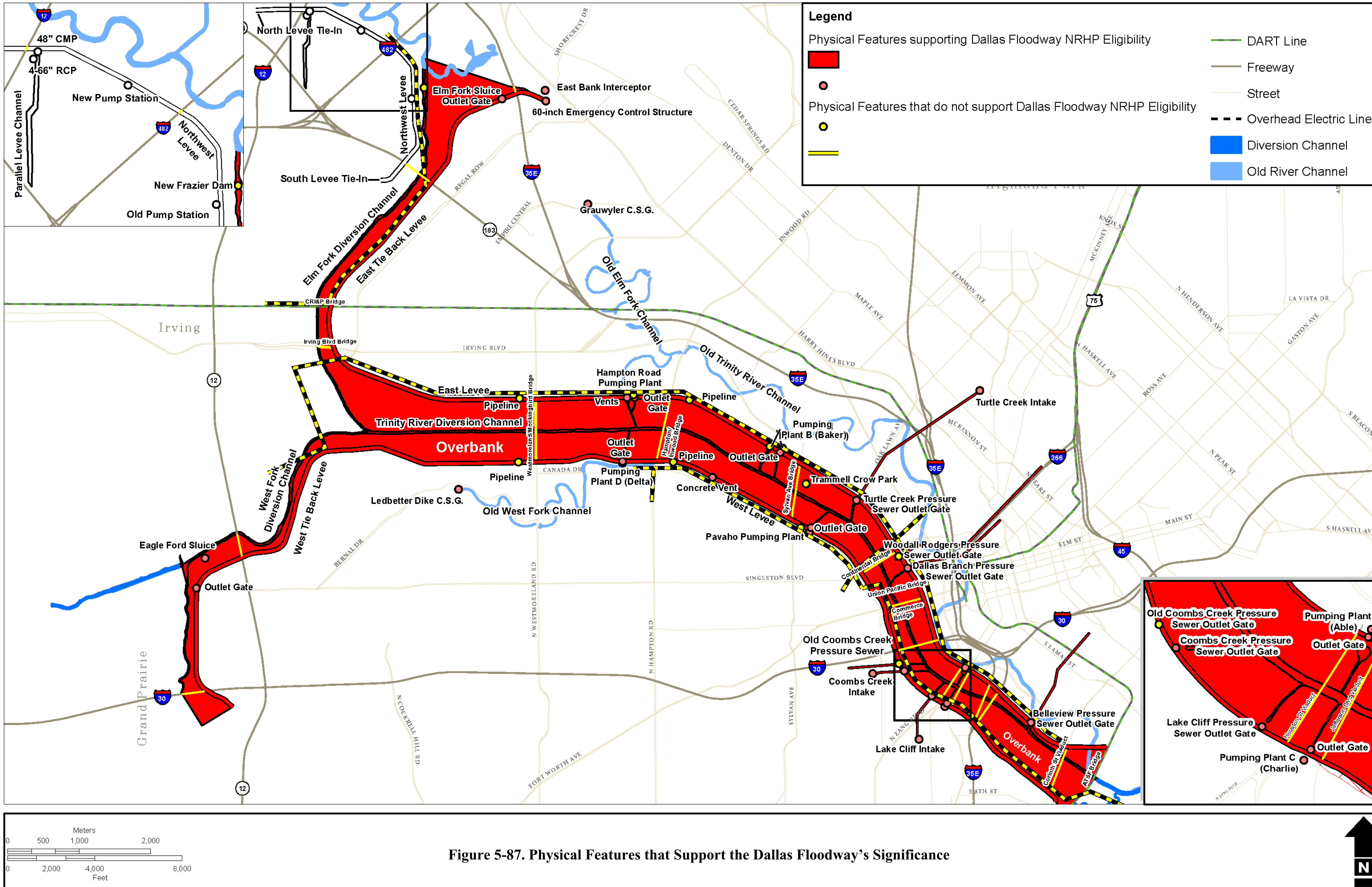


Figure 5-87. Physical Features that Support the Dallas Floodway's Significance

lines in the floodway, and in 1955, the USACE's plans accommodated existing power lines as well. Two power lines have remained in the same location since the end of the period of significance in 1959, and a few new lines have been added since then. Similarly, the majority of the bridges that cross over the floodway were built between 1911 and 1959 and continue to cross over the floodway today. Neither the power lines nor the bridges create a physical or visual barrier in the floodway system, and as a result, these features have not diminished the historic character of the floodway or its ability to convey its historic significance. Nonetheless, the power lines and bridges, as well as Trammell Crow Lake Park, are not engineered hydraulic physical features of the Dallas Floodway and do not support its significance.

Table 5-4. Significant Hydraulic Physical Features of Dallas Floodway

Hydraulic Physical Feature and Type	***Construction Date(s)***	***Function Essential/ Function Non-Essential***	***Supporting/ Non-Supporting***
East Levee Hydraulic Physical Feature 1: Levee	1929–1932 (B)* 1953 (M)*	Essential	Supporting
West Levee Hydraulic Physical Feature 1: Levee	1929–1932 (B) 1953 (M)	Essential	Supporting
Northwest Levee Hydraulic Physical Feature 1: Levee	1929–1932 (B) 1974 (M)	Essential	Non-Supporting –outside boundary of floodway and insufficient ability to convey significance
Parallel Levee Channel Hydraulic Physical Feature 1: Levee	1929 (B) 1960s (M) 2007 (M)	Essential	Non-Supporting –outside boundary of floodway and insufficient ability to convey significance
Trinity River Diversion Channel Hydraulic Physical Feature 2: Diversion Channel	1932 (B)	Essential	Supporting
Elm Fork Diversion Channel Hydraulic Physical Feature 2: Diversion Channel	1928 (B)	Essential	Supporting
West Fork Diversion Channel Hydraulic Physical Feature 2: Diversion Channel	1928 (B)	Essential	Supporting
Overbank Hydraulic Physical Feature 3: Overbank	1932 (B)	Essential	Supporting
Pumping Plant A (Able) Hydraulic Physical Feature 4: Pumping Plants	1929 (B)	Essential	Supporting
Pumping Plant A (Able) Hydraulic Physical Feature 4: Pumping Plants	1953 (B)	Essential	Supporting
Pumping Plant A (Able) Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1953 (B)	Essential	Supporting
Pumping Plant B (Baker) Hydraulic Physical Feature 4: Pumping Plants	1929 (B)	Essential	Supporting

Table 5-4. Significant Hydraulic Physical Features of Dallas Floodway

Hydraulic Physical Feature and Type	*Construction Date(s)*	*Function Essential/ Function Non-Essential*	*Supporting/ Non-Supporting*
Pumping Plant B (Baker) Hydraulic Physical Feature 4: Pumping Plants	1975 (B)	Essential	Non-Supporting – built after period of significance
Pumping Plant B (Baker) Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1956 (B)	Essential	Supporting
Pumping Plant C (Charlie) Hydraulic Physical Feature 4: Pumping Plants	1929 (B)	Essential	Supporting
Pumping Plant C (Charlie) Hydraulic Physical Feature 4: Pumping Plants	1956 (B)	Essential	Supporting
Pumping Plant C (Charlie) Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1956 (B)	Essential	Supporting
Pumping Plant D (Delta) Hydraulic Physical Feature 4: Pumping Plants	1929 (B)	Essential	Supporting
Pumping Plant D (Delta) Hydraulic Physical Feature 4: Pumping Plants	1956 (B)	Essential	Supporting
Pumping Plant D (Delta) Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1956 (B)	Essential	Supporting
Hampton Road Pumping Plant Hydraulic Physical Feature 4: Pumping Plants	1956 (B)	Essential	Supporting
Hampton Road Pumping Plant Hydraulic Physical Feature 4: Pumping Plants	1975 (B)	Essential	Non-Supporting – built after period of significance
Hampton Road Pumping Plant Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1956 (B)	Essential	Supporting
Pavaho Pumping Plant Hydraulic Physical Feature 4: Pumping Plants	1954 (B)	Essential	Supporting
Pavaho Pumping Plant Hydraulic Physical Feature 4: Pumping Plants	1975 (B)	Essential	Non-Supporting – built after period of significance
Pavaho Pumping Plant Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1954 (B)	Essential	Supporting
"New" Pump House (Northwest Levee) Hydraulic Physical Feature 4: Pumping Plants	ca. 1995 (B)	Essential	Non-Supporting – outside boundary of Dallas Floodway and built after period of significance

Table 5-4. Significant Hydraulic Physical Features of Dallas Floodway

Hydraulic Physical Feature and Type	*Construction Date(s)*	*Function Essential/ Function Non-Essential*	*Supporting/ Non-Supporting*
"Old" Pump House (Northwest Levee) Hydraulic Physical Feature 4: Pumping Plants	1974 (B)	Essential	Non-Supporting – outside boundary of Dallas Floodway built after period of significance
Belleview Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1928–1931 (B)	Essential	Supporting
Belleview Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1950s (B)	Essential	Supporting
Old Coombs Creek Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1928–1931 (B)	Essential	Supporting
Old Coombs Creek Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1989 (B)	Essential	Non-Supporting - built after period of significance
Coombs Creek Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1957 (B)	Essential	Supporting
Coombs Creek Pressure Sewer Outlet Gate Hydraulic Physical Feature 6: Outlet Gate Structures	1957 (B)	Essential	Supporting
Dallas Branch Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1932 (B)	Essential	Supporting
Dallas Branch Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1950s (B)	Essential	Supporting
Lake Cliff Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1952–1955 (B)	Essential	Supporting
Lake Cliff Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1955 (B)	Essential	Supporting
Turtle Creek Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1953–1957 (B)	Essential	Supporting
Turtle Creek Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1953–1957 (B)	Essential	Supporting
Woodall Rodgers Pressure Sewer Hydraulic Physical Feature 5: Pressure Sewers	1979 (B)	Essential	Non-Supporting – built after period of significance

Table 5-4. Significant Hydraulic Physical Features of Dallas Floodway

Hydraulic Physical Feature and Type	*Construction Date(s)*	*Function Essential/ Function Non-Essential*	*Supporting/ Non-Supporting*
Woodall Rodgers Pressure Sewer Outlet Gate Structure Hydraulic Physical Feature 6: Outlet Gate Structures	1979 (B)	Essential	Non-Supporting – built after period of significance
Elm Fork Sluice Outlet Gate Hydraulic Physical Feature 6: Outlet Gate Structures	1960s (B)	Essential	Non-Supporting – built after period of significance
Coombs Creek Intake Hydraulic Physical Feature 7: Intakes	1957 (B)	Essential	Supporting
Lake Cliff Intake Hydraulic Physical Feature 7: Intakes	1950s (B)	Essential	Supporting
Turtle Creek Intake Hydraulic Physical Feature 7: Intakes	1955–1956 (B)	Essential	Supporting
Eagle Ford Sluice Hydraulic Physical Feature 8: Sluices and Culverts	1928–1931 (B)	Non-Essential	Supporting
Elm Fork Sluice Hydraulic Physical Feature 8: Sluices and Culverts	1928–1931 (B)	Non-Essential	Supporting
Ledbetter Dike C.S.G. Hydraulic Physical Feature 8: Sluices and Culverts	1950s (B)	Non-Essential	Supporting
Grauwyler C.S.G. Hydraulic Physical Feature 8: Sluices and Culverts	1950s (B)	Non-Essential	Supporting
Northwest Levee Sluices Hydraulic Physical Feature 8: Sluices and Culverts	1928 (B)	Non-Essential	Non-Supporting – outside boundary of Dallas Floodway
Northwest Levee Sluices Hydraulic Physical Feature 8: Sluices and Culverts	1974 (B)	Non-Essential	Non-Supporting – outside boundary of Dallas Floodway and built after period of significance
Old Trinity River Channel Hydraulic Physical Feature 9: Sumps	1928; 1932 (B)	Non-Essential	Supporting
60-inch Emergency Control Structure Hydraulic Physical Feature 10: Emergency Control Structures	1950s (B)	Non-Essential	Supporting
East Bank Interceptor Hydraulic Physical Feature 10: Emergency Control Structures	1950s (B)	Non-Essential	Supporting

* (B) = Year(s) built; (M) = Year(s) of major modification

5.14.4 Boundary Description and Justification

Figure 5-87 illustrates the boundaries of those portions of the Dallas Floodway that possess significance and retain the ability to convey significance (the outer limits of the features shown in red). These boundaries encompass approximately 3,065 acres. The boundaries generally extend from the AT&SF Railroad trestle on the southeast to the confluence of the Elm Fork and West Fork diversion channels on the northwest, between the toe of the land side of the East Levee to the toe of the land side of the West Levee. These boundaries encompass the levees, overbanks, Trinity River Diversion Channel, pumping plants, and outlet gates. The boundaries extend out from the land sides of the levees to encompass the pre-1960 intakes (Turtle Creek, Old Coombs Creek, and Lake Cliff) via the underground pressure sewers that connect the intakes to the overbank. Likewise, the boundaries encompass the Grauwyler CSG and the old Elm Fork river channel, which is its drainage channel, and the Ledbetter Dike CSG and its drainage channel, the old West Fork river channel.

At the confluence, the boundaries of the significant property continue north to the respective northern termini of the East Tie Back Levee. Within this part of the floodway, the boundaries correspond to the toe of the land side of the East Tie Back Levee to the west side of the Elm Fork Diversion Channel from the confluence north to the point where the Elm Fork Diversion Channel ends and the old Elm Fork river channel begins. These boundaries encompass the East Tie Back Levee, Elm Fork Diversion Channel, overbank, Elm Fork Sluice Outlet Gate, East Bank Interceptor, and 60-inch Emergency Control Structure. The boundaries also extend south from the confluence to the terminus of the West Tie Back Levee. In this section of the structure, the boundaries parallel the west side of the West Fork Diversion Channel and the toe of the land side of the West Tie Back Levee. This portion of the boundaries encompasses the West Tie Back Levee, West Fork Diversion Channel, overbank, Eagle Ford Sluice, and an outlet gate.

The boundaries previously described are based on historical and current physical limits of floodway construction, operations, and maintenance. Historical maps and the 1928 Joint Plan of Reclamation by the Levee Districts define the Dallas Floodway by the limits of the physical features that contain flood water. The plan explains: "Flood water from Elm Fork and West Fork will be confined to separate floodways formed partly by levees and partly by bordering highlands, until they reach a confluence near the upper end of the Levee Districts. The combined flood waters will then flow downstream, confined in a floodway between levees…" (Morgan Engineering Company 1928). Later, it indicates that at the new confluence, "a new main channel will be located in a more or less direct line down the center of the valley to an outlet in the present channel of Trinity River at the Santa Fe Railroad crossing below Dallas" (Morgan Engineering Company 1928). Work for the Dallas Floodway project by the USACE in the 1950s also extended to the AT&SF Railroad, as both the East Levee and the Trinity River Diversion Channel terminate at the railroad trestle. The West Levee terminates approximately 600 feet upstream of the AT&SF Railroad Trestle, but the overbank continues to the railroad. Today, the city of Dallas manages and maintains the overbanks, levees, and sumps from the AT&SF Railroad Trestle to the confluence. Upstream of the confluence, the city manages and maintains the levees (East and West Tie Backs) and overbanks to the opposite side of the diversion channel (Elm Fork and West Fork, respectively), even though flooded waters extend beyond the channel. The city also maintains all drainage channels (Ajemian 2010; Lawrence 2010).

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Dallas Skyline

Conclusions and Recommendations

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CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

The need for this intensive-level survey arose from the USACE's decision to examine all its actions within the Dallas Floodway under the Dallas Floodway Project EIS. Heretofore, individual undertakings have prompted a more limited survey of resources, such as an individual levee or bridge, and resulted in Federal agencies not considering various components of the floodway within the larger context of flood control and reclamation. The historic context developed for this survey provided a local context within which to evaluate the Dallas Floodway components under the themes of Engineering and Community Planning and Development.

Section 405 (a) of the 2010 Supplemental Disaster Relief and Summer Jobs Act (Public Law 111-212) states that the Army is not required to make determinations under the National Historic Preservation Act for the Dallas Floodway project. USACE Implementation Guidance dated 19 October 2010 directs the Fort Worth District not to make determinations under the National Historic Preservation Act (NHPA) and to examine the Dallas Floodway Project as a engineering system with a discussion of the cultural resource's significance without making explicit references NHPA eligibility criteria. This study fulfills the USACE requirement to identify historic and cultural resources within the context of the scope of impacts that must be analyzed under NEPA (Appendix G).

This report is a cultural inventory and evaluation of the engineering components associated with the Dallas Floodway Project. It includes a historic context of the floodway as a flood control system and as the outgrowth of community planning. The historic context investigates the Dallas Floodway as a part of the larger Dallas Trinity Reclamation Project (1908–1959). This context is then used to identify the appropriate structural components of the floodway, record the current condition of each component, and evaluate the collective historical significance of these components and the floodway system as a whole. This study fulfills the USACE requirement to identify historic and cultural resources under the NEPA in order to assess environmental impacts.

This intensive-level survey inventoried and evaluated all the structures in the Dallas Floodway. A total of 55 engineering components were identified and categorized under one of 10 different types of hydraulic physical features: levees, diversion channels, overbanks, pumping plants, pressure sewers, intakes, outlet gate structures, sluices, sumps and culverts, and emergency control structures.

The Dallas Floodway resources were evaluated under the local historic context "Flood Control Development along the Trinity River in Dallas, 1908–Present." This historic context explores the development of the Dallas Floodway within the themes of Engineering, i.e., designing and constructing machinery and equipment to create a flood control system for the Trinity River, and Community Planning and Development. Flood prevention has been a crucial issue in the desire to develop Dallas into a leading city center in Texas and the Southwest. Community leaders (city and county officials, businessmen, and private citizens) took action to harness the Trinity River. The process to plan and finance a major public works project on the Trinity River was long, complicated, and wracked with political rancor and public cynicism, but nonetheless, ultimately succeeded. The floodway system of levees, pumping plants, pressure sewers, and sluices that, because of the Great Depression and World War II, was constructed in two phases, 1928–1932 and 1953–1959, has successfully controlled the stormwaters of the Trinity River, preventing major floods in Dallas, and reclaimed thousands of acres of land for commercial and industrial development.

Based on an analysis of the field and research data, the Dallas Floodway, as a single engineering system for flood control and reclamation, is a historic and cultural resource with locally significant historical associations with flood control and the history of city planning and community development in Dallas, and is a significant statewide example of an engineering system designed for flood control and development enhancement. The period of significance of the Dallas Floodway spans from 1928, when floodway construction started, to 1959, when the project was completed. The essential physical features of the Dallas Floodway are the levees, diversion channels, and overbank. The Dallas Floodway retains all its essential physical features and its ability to convey its significance to the observer.

The Dallas Floodway meets the NEPA definition of a significant historic and cultural resource that must be considered in assessment of environmental impacts as required under CEQ regulations Part 1502.16.

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Charlie Pump Station (1928-1931)

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Delta Pumping Plant Outlet Gate

Appendix A

Panoramic Photographs of the Dallas Floodway
March 2010

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1. Trinity Overlook with Continental Street Viaduct at left, View to the East

2. View from the Commerce Street Viaduct, Looking Northwest

3. View from the Commerce Street Viaduct, Looking Southwest

4. East Levee, Hampton Pumping Plant, at left. View to the Southeast

5. View from the Irving Street Bridge, Looking Southeast

6. East Levee near Confluence of the Trinity River Diversion Channel, Looking Southeast

7. Northwest Levee

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Dallas Skyline

Appendix B

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Pavaho Pumping Plant

Appendix C

USACE District Fort Worth, Operation and Maintenance Manual: Dallas Floodway
May 1960

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DEPARTMENT OF THE ARMY
Fort Worth District, Corps of Engineers
Fort Worth, Texas 76102

FWDP 1150-2-1

SWFED-HG

Permits

Pamphlet
No. 1150-2-1

13 May 1977

Local Cooperation

CRITERIA FOR ADDITIONAL CONSTRUCTION WITHIN THE LIMITS OF EXISTING FLOODWAYS

1. **Purpose.** This pamphlet has been compiled to provide guidance to local governmental agencies and individuals who desire to construct facilities within the limits of a floodway which has been constructed by the Corps of Engineers and for which local governmental agencies have the responsibility for operation and maintenance. The Corps of Engineers retains the right to approval on all improvements which are passed over, under or through the walls, levees, improved channels, or floodways of such projects.

2. **Applicability.** This pamphlet applies to all flood protection works which have been constructed by the Fort Worth District of the Corps of Engineers and for which a letter of assurances agreeing to the operation and maintenance of the floodway has been furnished the Corps of Engineers by the local sponsor.

3. **General Criteria.**

a. Furnish plans and specifications for the proposed work to the Operations Division (ATTN: Reservoir Br.) Fort Worth District sufficiently in advance of construction to allow adequate time for review and comments. Proposals should be discussed with the District Office at the concept level prior to preparation of plans to avoid major revisions. Concept proposals may be submitted to the Engineering Division for review. The proposed construction starting date and the construction schedule should be submitted prior to initiation of work.

b. Approved construction methods will be practiced to minimize erosion at the construction site.

c. When construction work is in progress in a floodway, a request from the contractor for changes in regulated releases will be considered on individual bases only. Normally, regulated releases from upstream lakes for evacuation of floodwaters, water supply, recreation, or other purposes considered to be in the best interest of the public will have first consideration.

d. In addition to other requirements set forth in this pamphlet, permits may be required under Sections 10 and 404 for work within the floodway. These permits require a minimum of 90 days to process. Operations Division, Permit Section should be asked to make determinations on the need for these permits in the early planning stages to prevent delays.

4. **Criteria for Pressure Pipeline Crossing Existing Levees.**

a. No excavation will be performed on the levee. Place the pipeline on the levee slopes and provide a minimum of 2 feet of cover. Place the fill uniformly on the slopes and top of the levee to slope away from the pipe and parallel to the longitudinal axis of the levee. The slope of the fill shall be between 1 and 10 and 1 and 15. Remove all existing vegetation before fill is placed.

b. Where the pipeline crosses a discharge channel place the pipeline on piers (the piers must not obstruct flow in the channel) or place it under the discharge channel and encase it with concrete. Extend the encasement a minimum of 5 feet into the channel side slopes.

c. Any maintenance and operation roads disturbed during construction will be repaired or replaced to a condition equal to or better than their condition before construction.

d. All valves located within 15 feet either side of the toe of the levee shall be provided in a concrete box enclosure with a manhole type cover. If the valve is placed in the top of the levee, the bottom of the excavation shall be not lower than one foot above the design water surface elevation. Place fill to uniformly slope away from the top of the valve box.

e. Provide all manholes within the floodway having tops below design water surface elevation with water-tight sealed manhole covers fastened to the manholes.

f. Where a pipeline parallels the levee on the channel side of the levee, the excavation will be a minimum distance of 15 feet from the toe of the levee. Where the pipeline parallels the channel, the excavation will be a minimum distance of 15 feet from the top of the channel bank.

g. Where the pipeline is on the landside of and running parallel to the levee, the pipeline shall be a minimum distance of 15 feet from the toe of the levee. Retain existing sumps, ditches, and swales. Finish grading and returfing are required.

h. Pipelines shall have a minimum cover of 2 feet.

i. Compact all fill and backfill in 6-inch lifts as specified in job specifications approved by the Corps of Engineers.

j. Fill, compact and grade all disturbed area. Re-establish vegetation to its original condition.

k. Fill any pipelines to be abandoned under existing levees with concrete.

l. See General Criteria.

5. **Criteria for Gravity Pipeline Crossing Existing Levees.**

a. Provide a temporary ring levee (cofferdam) on the river side of the existing levee at the location of the subject crossing to the same top elevation as the existing levee. Construct the levee of impervious materials in accordance with the provisions specified in paragraph 6.

b. When the temporary ring levee is complete, excavate the existing levee using 1 vertical on 3 horizontal cut slopes. The toe of the levee cut shall be a minimum of 20 feet (measured horizontally) from the top edge of the excavation.

c. Locate sources for borrow materials a minimum of 500 feet from the land side toe of the existing levee.

d. All levee backfill shall consist of impervious materials.

e. When construction has been completed, the entire foundation area to be occupied by the levee fill shall be scarified, plowed and/or harrowed to a depth of 6 inches and then compacted by at least 16 complete passes of the tamping roller.

f. Accomplish levee replacements by placing fill in 6-inch lifts and compacting by not less than eight complete passes of a tamping roller. The fill shall also be equal to 95 percent Standard AASHO density. After compaction the moisture content shall be within the limits of 3 percentage points above optimum to 2 percentage points below optimum moisture content.

g. Determine the in-place moisture content and density of the levee fill on a frequency of about one sample for each 2500 cubic yards of backfill placed.

h. When the breached levee has been reconstructed to its original grade, remove the temporary ring levee and dress and turf the surface areas of the plugged section.

i. Provide water-tight sealed manhole covers for all manholes within the floodway having tops below design water surface elevation. Fasten manhole covers to the manhole structures.

j. Fill any pipelines to be abandoned under the existing levees with concrete.

k. Locate a positive cut-off structure on the riverside of the levee crown to prevent water from the riverside to flow through the pipeline to the landside. Extend the cut-off structure to the levee crown elevation. This structure must be accessible no matter what flood condition may exist. The closure device must be operational by manpower, if necessary.

l. Provide seep rings when required by ETL 1110-2-192, 26 August 1974.

m. No pervious bedding shall be provided except as specified in ETL 1110-2-192.

n. Provide gravity storm drains discharging into the floodway with automatic flap gates at the discharge end of the line and energy dissipators, as required.

o. Use Monolitic conduits or conduits with watertight joints under the levee.

p. See General Criteria.

6. **Headwalls, Chutes, Gate Valves, Flap (Automatic) Gates & etc.**

a. Install headwalls, chutes, gate valve structures, flap (automatic) gates, and other types of outfall structures in such a manner to prevent obstruction of flow or creation of scouring conditions in the floodway. Approved methods will be used for fill, backfill and required compaction. The fill shall be subject to testing and the compaction shall equal that of the adjacent levee or the current approved standard, whichever requires greater compaction.

b. Construction equipment, supplies, forms, etc. shall not be stored in the floodway during the construction.

c. Restore all disturbed areas to original grade and turf.

d. See haul road requirements and restrictions under Roadway Crossings of Floodways.

e. Submit plans and specifications for all proposed construction for review and comment.

7. **Criteria for Pump Discharge Pipelines Over Levees**

a. The invert of the discharge lines shall be at the top of the protective works (levee) and shall be free-vented at the highest point.

b. No flap (automatic) gates are required at the outfall of the discharge lines.

c. Provide scour protection at the outfall consisting of riprap or a stilling basin depending upon the issuing jet velocity.

8. **Electrical & Telephone Criteria for Overhead Wire Crossings.**

a. No structure (poles or otherwise) shall be located closer than 10 feet from the toe of any levee.

b. No structure (poles or otherwise) shall be located closer than 15 feet from the top of any channel backslope.

c. Provide a minimum vertical clearance of 20 feet between the crown of the levee and the low wire at the low point of the wire at the levee crossing computed under the most adverse conditions (temperature, wind, load, etc.).

d. Provide a minimum vertical clearance of 20 feet between the natural ground and the low wire at the low point of the sag in the area of the floodway channel, or three feet above the floodway design water surface level, whichever is higher. (Check Electrical Code for minimum clearances for high voltage lines.)

e. Locate guy wires and anchors in such a manner that they do not interfere with the operation and/or maintenance of the channel, levees, or related structures.

f. Also see crossing under and over Rivers and Channel Criteria.

9. **River and Channel Crossing Criteria.**

a. **Pipeline Crossings Under Rivers and Channels.** Bury the pipeline so that:

(1) A minimum of 3 feet of cover is provided between the river or channel bottom and top of pipeline.

(2) The pipeline shall be sufficiently anchored or encased to prevent floatation.

b. **Pipeline Crossings Over Rivers and Channels.**

(1) Provide a minimum freeboard between the low point of the crossing and the design water surface elevation of three feet or to the top of any levee, whichever is higher.

(2) The obstruction caused by the bridge and its piers should not exceed 10 percent of the floodway waterway area. No longitudinal cross-bracing will be used.

10. **Roadway Crossing of Floodways.**

a. **Permanent Roadways.**

(1) Carefully analyze new roadways or roadways being rebuilt or modified as to their effect on the hydraulic capacity of the floodway and to their adverse effects on the existing or approved levees. The low steel of the bridge shall have an elevation not lower than the crown of the levee or 3 feet above the design water surface, whichever is higher.

(2) Any roadway over a navigable stream will require a permit from the U. S. Coast Guard.

b. **Temporary (Haul) Roadways.**

(1) Provide drainage structures to convey low flow discharges. Hold roadway fill to a minimum to prevent increasing the water surface elevation should a flood occur during the period the roadway is in place. Construct all ramps from levees going in a downstream direction. This will prevent flows from being directed into the face of the levees.

(2) Remove all materials (fill, drainage structures, etc.) upon completion of construction. Restore all disturbed areas to original grade and restore turf.

(3) Submit plans for review and comment.

11. **Low Dams or Diversion of Flows.**

a. Low Dams or Other Obstructions. Submit plans and specifications for review and comments prior to the construction of any type dam structure in a floodway area. These plans will be reviewed to determine if adverse hydraulic or structural effects would occur within the floodway as a result of the proposed construction. Prior to an extensive engineering study for any type of water barrier in a floodway, the concept plan, proposed location, and purpose should be reviewed by the Corps of Engineers.

b. Diversion of flows into or out of a floodway area shall be reviewed as to possible adverse hydraulic or structural effects.

12. **Construction of Recreation Facilities.** Submit plans to Corps of Engineers for review and comments on any proposed recreation type facilities to be constructed in an existing or approved floodway area. Each plan will be reviewed for individual and cumulative effects to determine if the proposed construction would produce adverse effects on an existing or approved floodway area.

13. **Planting of Trees.**

a. No shallow-rooted trees shall be planted anywhere within a floodway. Trees with deep-type root systems, may be planted in selected areas of existing or approved floodways. The planting shall be a minimum of 50 feet from the toe of the levee or the top of channel bank. Plant trees at an average spacing of 50 feet, center to center. Prune trees to permit mowing with tractor type mowers. No bush or vine type plants shall be permitted.

b. Submit a coordinated planting plan for review and comment.

FOR THE DISTRICT ENGINEER:

L. M. HAWKINS, JR.
Executive Assistant

DISTRIBUTION:
B-2; F; G; H; I
X - 25-Hydraulics Br, Eng Div
1-Design Br, Eng Div
1-F&M Br, Eng Div
1-Prog Dev Br, Eng Div
1-Flood Plain Mgt Br, Eng Div
5-Planning Br, Eng Div
25-Ops Div

Pumping Plant A

Station 99+45 East Levee

Pumphouse (2)

1. Old-Pumphouse

A. 2 - 10,000 gpm pumps/with 85hp motors, each has a 36" gate & check valve

B. 2 - 4' x 4' sluices with manual operated sluice gates and flap gates (outlet elevation 374.35)

2. New-Pumphouse

A. 3 - 46,667 gpm pumps/with 500hp motors

B. 3 - 39" discharge lines with gate and check valves

C. Invert Elevation ~~374.35~~ 374.5 (outfall)

Pumping Plant B

Station 235+04 East Levee

1. Pumphouse

A. 4 - 52,000 gpm pumps/with 4 - motor gate values

B. 4 - 6' Ø gravity sluices with 4 - 72" Ø hand operated sluice gates and 4 - 72" flap gates

C. Invert Elevation 379.40 Sluice Flap (outfall) 378.65

Pumping Plant C

Station 68+33 West Levee RM 499.40

1. Pumphouse

A. 2 - 30,000 gpm pumps, with 125hp motors (each), with 2 - 24" hand operated gate values

B. 2 - 4' x 4' gravity sluices, with 2 - 4' x 4' manual operated sluice gates (intake) and 2 - 4' x 4' flap gates (outfall).

C. Invert Elevation 377.63 (outfall)

Pumping Plant D

Station 267+95 West Levee

1. Pumphouse

A. 2 - 30,000 gpm pumps/with 125hp motors (each)
with 2-24" hand operated gate valves

B. 2 - 4' x 4' gravity sluices/with 2 - 4' x 4' hand operated ~~sluices~~ sluice gates ~~(outlet)~~ intake and 2 -
4'x4' motor operated sluice gates (outlet) & 2 -
4' x 4' flap gates.

C. Invert Elevation 387.11 (outfall)

Pumping Plant Pavaho Street

Station 174+60 West Levee

1. Pumphouse

A. 2 - 30,000 gpm pumps/with 250hp motors

B. 2 - 6' x 8' x 284' gravity sluices (dual-purpose structure) with 2 - 6' x 8' motor operated sluices gates (intake) and 2 - 96" Ø flap gates.

C. Invert Elevation 381.0 (outfall)

Pumping Plant Hampton Road

Station 312+05 East Levee

1. Pumphouse

A. 4 - 50,000 gpm pumps/with 600hp motor/ with

4 - 42" O.D. discharge lines with sluice & flap gates.

B. Invert Elevation ~~384.0~~ 386.0 (outfall) pressure Line.

? C. gravity sluice

Ledbetter Dike and Sluice

Ledbetter Dike and Sluice 2 -6' x 4', sluice (4+55 W. Levee) and manual operated (2 - 6' x 4') sluice gates.

Invert Elevation 389.6 (outfall)

Elm Fork Sluice

<u>Elm Fork Sluice</u> 36" CSH - (601+32 E. Levee) and manual operated 36" ϕ sluice gate.

Invert Elevation 390.42 (outfall)

N. West Levee - Station 17+60 - 24" sluice and manual operated sluice gate and flap gate.
Invert elev. 399± (outfall)

N. West Levee - Station 53+40 - 36" sluice and manual operated sluice gate and flap gate.
Invert elev. 400± (outfall)

N. West Levee - Station 117+65 - 36" sluice and manual operated sluice gate and flap gate.
Invert elev. 400± (outfall)

Dallas Branch Pressure Sewer

<u>Dallas Branch Pressure Sewer</u> 12' storm sewer (154+33 E. Levee) and manual operated/ 13' x 12' - 6" sluice gates.

Invert Elevation 377.84 (outfall)

Woodall - Rodger Pressure Sewer

Coombs Creek Pressure Sewer

Coombs Creek Pressure Sewer 18' - 6" semi elliptical/

4 - 9' x 11" conduit and 4 - 96" x 120" sluice gates

(sta. 93+57 W. Levee)

Invert Elevation 373.94 (outfall)

392.5 (intake)

Adjacent Structure 90" x 90" CBC conduit (97+29) manual

operated 2 - 72" ϕ sluice gates and 2 - 8' ϕ flap gates.

Invert Elevation 377.75 (outfall)

100' Broad-Crested Emerg. Spillway

Lake Cliff Pressure Sewer

Lake Cliff Pressure Sewer 2 - 6' x 8' sluice, 1 - 6' x 8' pressure sewer (75+92 W. Levee) and manual operated 3 - 6' x 8' sluice gates and 2 - 96" flap gates.

Invert Elevation 377.0 (outfall)

Eagle Ford Sluice

Eagle Ford Sluice 2 - 54" x 54" sluices (479+72 W. Levee) and manual operated 2 - 54" x 54" sluice gates and 2 - 54" x 54" flap gates.

Invert Elevation 393.65 (outfall)

Turtle Creek Pressure Sewer

<u>Turtle Creek Pressure Sewer</u> 4 - 9' x 10' CBC (194+13 E. Levee) and power operated 4 - 96" x 120" sluice gates

Invert Elevation 376.17 (outfall)

Belleview Pressure Sewer

Belleview Pressure Sewer 16' horseshoe storm sewer (59+93 East Levee) and manual operated 17' x 13' sluice gate.

Invert Elevation 373.44 (outfall)

U. S. ARMY ENGINEER DISTRICT, FORT WORTH

CORPS OF ENGINEERS

OPERATION AND MAINTENANCE MANUAL

DALLAS FLOODWAY

WEST FORK - ELM FORK - TRINITY RIVER TEXAS

MAY 1960

FOREWORD

THE SUCCESSFUL FUNCTIONING OF A FLOOD PROTECTION SYSTEM IS NOT ASSURED BY MERE CONSTRUCTION OF ANY ADEQUATE SYSTEM OF LEVEES AND RELATED APPURTENANCES. IF THE SYSYEM IS TO FUNCTION IT MUST BE CAREFULLY MAINTAINED THROUGHOUT PERIODS OF NORMAL RIVER STAGES AND PROPERLY OPERATED DURING FLOOD PERIODS. FAILURE TO DO SO CAN RESULT IN SEVERE LOSSES IN PROPERTY AND LIFE AND MAY UNDERMINE THE CONFIDENCE OF THE CITIZENS IN THEIR RELIANCE ON THE SYSTEM. THE NECESSITY FOR PROPER CONTINUOUS MAINTENANCE CAN NOT BE TOO HIGHLY STRESSED IN VIEW OF THE FACT THAT CONSIDERABLE DAMAGE MAY BE INCURRED THROUGH FAILURE OF A MINOR ELEMENT OF THE SYSTEM AT FLOOD TIMES CAUSED BY NEGLECT, DETERIORATION OR DAMAGE THAT COULD HAVE BEEN PREVENTED BY PROPER MAINTENANCE. PROPER MAINTENANCE AND OPERATION REQUIRE THAT RESPONSIBLE LOCAL PERSONS HAVE A THOROUGH UNDERSTANDING OF THE FUNCTIONS OF THE VARIOUS UNITS OF THE SYSTEM AND THE KNOWLEDGE OF BEST METHODS OF MAINTAINING THE SYSTEM AND OPERATING IT DURING FLOOD EMERGENCIES. IT IS WITH THIS PURPOSE IN MIND THAT THIS MANUAL HAS BEEN PREPARED FOR THE GUIDANCE OF THOSE RESPONSIBLE FOR THE MAINTENANCE AND OPERATION OF THE FLOOD PROTECTION SYSTEM. IN CONFORMANCE WITH AGREEMENTS ENTERED INTO WITH THE LOCAL INTERESTS FOR THE CONSTRUCTION OF THE PROJECT, IT IS ESSENTIAL THAT MAINTENANCE AND OPERATION BE PROVIDED IN STRICT ACCORDANCE WITH THIS MANUAL.

OPERATION AND MAINTENANCE MANUAL
Dallas Floodway
TRINITY RIVER, TEXAS

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SECTION I

GENERAL INFORMATION

Chapter 1

1.01. Authorization.- The completed flood control project was authorized by Section 2, Public Law 14, 79th Congress, 1st Session, approved 2 March 1945 and Section 101, Public Law 516, 81st Congress, Second Session, approved 17 May 1950.

1.02. Location.- The completed flood control works are located in Dallas County, Texas, along the Trinity River upstream from river mile 497.37 to the confluence of West Fork and Elm Fork at river mile 505.5, thence upstream along the West Fork about 2.2 miles and upstream along the Elm Fork about 4.0 miles. See ANNEX 1 .

1.03. Description of the Project.- The completed project consists of channel improvement, clearing of the floodway, strengthening of 22.6 miles of levees, installation and modification of drainage structures, construction of pressure sewers, alteration of railroad bridges, construction and installation of pump stations, construction and modification of sump areas, sodding and seeding of embankment slopes adjacent to and along the above described portion of the Trinity River and tributaries.

1.04. Protection Provided.- The completed flood control project in conjunction with the Grapevine and Garza-Little Elm reservoir projects provides a high degree of protection to a large area of highly developed industrial and residential property located in portions of the flood plain within the City and County of Dallas, Texas.

1.05. Dates of Construction.- Work was initiated on the Dallas Floodway on 26 July 1950 and was completed on 30 April 1959. The completed work was performed under the following contractors:

Contract No.	Contractor & Address	Const. Item	Date
DA-41-443-ENG-90	Wm. Stanley Dozier Hebron, Texas	Clearing and Grubbing	26 Jul 50 5 Jan 51
DA-41-443-ENG-2095	E.E. Contracting Co., South Houston, Texas	Const. of pump, Plant A	2 Feb 53 2 Jun 54
DA-41-443-ENG-2106	John A. Petty Longview, Texas	Sump excavation & Strengthening Ptn. of E. Levee	4 Feb 53 2 Aug 54
DA-41-443-ENG-3203	Whittle Contr. Co. Dallas, Texas	Part I-Turtle Creek Pres. Sewer	8 Feb 54 19 May 55

Contract No.	Contractor & Address	Const. Item	Date
DA-41-443-ENG-2692	T&P Railway Co., Dallas, Texas	Alteration of Rwy facilities	29 Mar 54 14 Feb 55
DA-41-443-ENG-3500	Dean Skinner Dallas, Texas	Turf Levee Slopes	6 May 54 23 Jul 54
DA-41-443-ENG-3740	McKenzie Const. Co. Dallas, Texas, and Whittle Contr. Co., Dallas, Texas	Part II-Turtle Creek Pres. Sewer	25 Jun 54 19 May 55
DA-41-443-ENG-3886	List & Clark Const. Co. Kansas City, Missouri	Payahoe St. Pump Sta.	30 Jul 54 29 Sep 55
DA-41-443-ENG-3934	Cleal T. Watts, Dallas, Texas	Portion of W. Levee	27 Sep 54 5 Nov 55
DA-41-443-Eng-4251	McKenzie Const. Co., Dallas, Texas, and Whittle Contr. Co., Dallas, Texas	Part III-Turtle Creek Pres. Sewer	28 Feb 55 8 Nov 55
DA-41-443-ENG-4430	W. T. Crouch Arlington, Texas	Turf Levee Slopes	7 April 55 9 Aug 55
DA-41-443-ENG-4474	McKenzie Const. Co., Dallas, Texas, and Whittle Contr. Co., Dallas, Texas	Lake Cliff Pres. Sewer	11 Apr 55 12 Dec 55
DA-41-443-ENG-4467	McKenzie Const. Co. Dallas, Texas, and Whittle Contr. Co., Dallas, Texas	Part IV-Turtle Creek Pres. Sewer	12 Apr 55 18 Sep 56
DA-41-443-ENG-3589	MK&T RR Co. of Texas, Dallas, Texas	Alteration of Rwy Facilities	25 Apr 55 31 Dec 56
DA-41-443-ENG-4528	Cleal T. Watts Dallas, Texas	Part I - East Levee	20 May 55 13 Mar 56
DA-41-443-CIVENG-56-106	Whittle Contr. Co., Box 5602 Dallas, Texas	Hampton Rd Pump Plant	14 Nov 55 22 Oct 58
DA-41-443-CIVENG-56-162	E.H. Reeder Const. Co., Inc., Dallas, Texas	Part V-Turtle Creek Pres. Sewer	22 Dec 55 1 Oct 57

Contract No.	Contractor & Address	Const. Item	Date
DA-41-443-CIVENG-56-188	Whittle Contr. Co., P. O. Box 5602 Dallas, Texas	Coombs Creek Diver. Facil.	3 Jan 56 21 Jan 57
DA-41-443-CIVENG-56-206	Cleal T. Watts Dallas, Texas	Part II - East Levee	13 Feb 56 2 3 Dec 57
DA-41-443-ENG-4589	City of Dallas Dallas, Texas	Turtle Creek Pres. Sewer	1 Mar 56 17 May 56
DA-41-443-ENG-3885	Chicago, Rock Island and Pacific Rwy Ft. Worth	Alteration of Rwy Facilities	7 Jul 55 28 Mar 56
DA-41-443-CIVENG-56-599	W.T. Crouch Arlington, Texas	Part I - Turf East Levee	30 Mar 56 10 May 56
DA-41-443-ENG-4105	Chicago Rock Island and Pacific Rwy	Alteration of Rwy Facilities	18 Jul 55 12 Jul 56
DA-41-443-CIVENG-56-815	Cleal T. Watts Dallas, Texas	Part I - West Levee	1 Aug 56 3 20 Oct 57
DA-41-443-CIVENG-57-495	W.T. Crouch Arlington, Texas	Erosion Control	16 Mar 57 11 Jan 58
DA-41-443-CIVENG-57-651	Griffin & Dickson Kilgore, Texas	West Levee, Part II, Strengthening and Channel Excavation	8 Apr 57 4 30 Apr 59
DA-41-443-CIVENG-57-581	Whittle Contr. Co., Box 5602 Dallas, Texas	Miscellaneous Structures	19 Mar 57 3 Jul 58
DA-41-443-CIVENG-58-289	LeRoy Hart Const. and Lumber Co., Dallas, Texas	Heating, Ventilating & Air Cond.	16 Dec 57 21 Jul 58
DA-41-443-CIVENG-58-374	W.T. Crouch Arlington, Texas	Erosion Control	3 Feb 58 8 Apr 58

1.06. Definitions.

a. Local Interests.- For the purpose of this manual, the term "Local Interests" shall be construed as being Dallas County Flood Control District, as represented by the Chairman and Board of Directors.

b. <u>District Engineer</u>.- For the purpose of this manual the term "District Engineer" refers to the District Engineer, U. S. Army Engineer District, Fort Worth, Texas.

1.07. <u>Maps and Drawings</u>.- The location of the Dallas Floodway and pertinent details are shown on the Operation and Maintenance plans, profiles, and sections which are included as ANNEXES to this manual. (See ANNEX 1)

SECTION II

LOCAL COOPERATION
Chapter 1

2.01. Authority.- Dallas County Flood Control District furnished assurances to the United States of America on 18 December 1952 as follows:

"WHEREAS, the United States of America has undertaken or is about to undertake the improvement of the levees and floodways at Dallas, Texas, for flood protection and water conservation in the Trinity River Basin in Texas, as authorized by Act of Congress approved March 2, 1945, Public Law No. 14, Chapter 19, 79th Congress, first session, 59 Stat. 18, substantially in accordance with plans set out in H. D. 403, 77th Congress, first session, as modified by Act of Congress approved May 17, 1950, (Public Law 516 - 81st Congress, first session), in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in H. D. No. 242, 81st Congress, first session, and

WHEREAS, said laws and plans require the local interests to:

a. Furnish without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the works;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Construct necessary improvements to the interior drainage facilities for the delivery of run-off to the pumps and sluices; and

e. Contribute $300,000.00 in cash toward the construction cost of the Turtle Creek pressure sewer when and as required; and

WHEREAS, the City of Dallas has agreed to pay the sum of Three Hundred Thousand ($300,000.00) Dollars in cash towards the construction of the Dallas Floodway Project and to provide all rights-of-way for those improvements, and

WHEREAS, Dallas County Flood Control District is empowered to comply with the local cooperation required by the Acts of Congress and by said document and plans, as evidenced by Chapter 355, Page 619, Acts of 1945, 49th Legislature of the State of Texas and by contract dated May 7, 1946 by and between Dallas County Flood Control District, City and County of Dallas Levee Improvement District and Dallas County Levee Improvement District No. 5, and

WHEREAS, Dallas County Flood Control District desires to comply with the requirements of the local cooperation by the District;

NOW THEREFORE BE IT RESOLVED by the Board of Directors of the Dallas County Flood Control District that Dallas County Flood Control District does hereby agree with respect to the foregoing matters as follows:

1. To authorize and permit the modification of the levees, floodways and pumping plants and drainage ditches at Dallas, Texas;

2. To maintain and operate these improvements after completion in accordance with regulations prescribed by the Secretary of the Army;

3. To provide without cost to the United States all lands, rights-of-way and easements necessary for the construction of the said Dallas Floodways;

4. Hereby gives assurance to hold and save the United States free from damages due to said construction works;

5. Remove or adjust obstructing bridges;

6. Remove or adjust all obstructing utilities and dams;

7. To construct necessary improvements to the interior drainage facilities for the delivery of runoff to the pumps and sluices; and

8. To contribute or cause to be contributed, $300,000.00 in cash toward the construction cost of the Turtle Creek pressure sewer when and as required."

2.02. Acceptance of Assurances.- The above assurances were accepted by the Office of the Chief of Engineers on 14 January 1953.

2.03. Acceptance of Project.- In accordance with the above assurances in a letter to the District Engineer dated 30 April 1959, Dallas County Flood Control District formally accepted the maintenance and operation of the entire Dallas Floodway. It was stipulated that the floodway would be operated and maintained in accordance with Flood Control Regulations, Maintenance and Operation of Flood Control Works, approved by the Secretary of the Army. The effective date for transfer of the entire Dallas Floodway was established as 30 April 1959.

SECTION III

GENERAL PROCEDURES

Chapter 1

3.01. General.- Under the authority of the Flood Control Act approved on 22 June 1936 as amended and supplemented (49 Statute 1571; 50 Statute 877; and 55 Statute 638; 33 U. S. C. 701C; and 701C-1), the Secretary of the Army approved regulations on 9 August 1944 to govern the maintenance and operation of flood control works constructed by the Federal Government. These Regulations, which were published in the Federal Register of 17 August 1944, are attached as ANNEX 2 . Where they apply, these regulations shall govern the maintenance and operation of this project.

3.02. Purpose of the Manual.- The purpose of the manual is to furnish detailed information regarding the Dallas Floodway and its essential features, and to aid local interests in carrying out their obligations under the regulations.

3.03. Flood Control District Organization.

a. Board of Directors.- The overall responsibility for the direction and control of the operation, maintenance and inspection of the Dallas County Flood Control District facilities and structures is vested in a Board of Directors whose chairman functions as the Chief Executive for the Flood Control District. Detailed administration and supervision of office and field functions will be directed by a General Manager and a Superintendent. Other employees will be employed as, if, and when, needed upon approval of the Board of Directors.

b. General Manager.- The General Manager is responsible to the Board of Directors for the general administration, supervision and management of all the functions and responsibilities of the Flood Control District. He is selected by the Board of Directors.

c. Superintendent.- The Superintendent is responsible to the General Manager for the actual supervision and direction of all field and plant operations, maintenance and inspection functions of the Flood Control District.

d. Other Personnel.- The number of subordinate personnel needed for administrative, operation, maintenance and inspection functions of the Flood Control District will be determined by the General Manager subject to the approval of the Board of Directors.

3.04. Periodic Inspection.- In order to insure uninterrupted service during flood conditions, it is to the best interest of all concerned that periodic inspections be made of all levees, floodways, plants, sumps, structures, equipment and other facilities. Responsibility for such inspections are as follows:

a. Local Interest Inspections.- Regularly scheduled inspections by Local Interests will be carried out as shown in paragraphs 4.03c, 4.041c, 4.042c, 4.043c, 4.044c, 4.045c, 4.046c, 4.051c, 4.052c, 4.053c, 4.054c, 4.055c, 4.056c, 4.06c, 4.07c and 4.08c. In addition, non-scheduled inspections will be made of all levees, floodways, sumps, structures, equipment and facilities immediately following the recession of each flood in the Flood Control District.

b. Corps of Engineers Inspections.- Representatives of the Fort Worth District Engineer will make inspections of levees, floodways and structures at least once each year and more often when indicated. A copy of the report of such inspections will be forwarded to the General Manager, Dallas County Flood Control District, Dallas, Texas.

3.05. Compliance with District Engineers Requests.- Local interests shall promptly make such repairs or take such maintenance measures which the District Engineer deems necessary for the proper functioning of the floodway. Appropriate measures shall be taken by local interests to insure that the activities of all local organizations operating public or private facilities connected with protective works are coordinated with those of the General Manager's forces during flood periods.

3.06. Improvements in the Floodway.- No improvement shall be passed over, under or through the levees, improved channels, or floodways; nor shall any excavation or construction be permitted within the limits of the project right-of-way; nor shall any change be made in any feature of the works without prior determination by the District Engineer, or his authorized representative of such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations which are found to be desirable and permissible by the District Engineer shall be constructed in accordance with sound engineering methods. Advice regarding effect of the proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable by sound engineering methods shall be obtained from the District Engineer and shall be submitted for his approval, if otherwise obtained. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

3.07. Tools, Equipment, and Supplies.

a. Tools and Equipment on Hand.- Dallas County Flood Control District has the equipment listed below stored at their headquarters, 2245 Irving Blvd, Dallas, Texas.

7 - Farm tractors with mowers

1 - Caterpillar tractor, D-6

3 - 18" power saws

1 - 200-gallon pressure sprayer

3 - Pickup trucks ½-ton

Miscellaneous hand tools

b. Tools, Equipment, and Supplies on Call.- The Flood Control District has arrangements for securing the following types of equipment and supplies from the firms named as needed in emergencies:

(1) Draglines and Winch Trucks.

Harper Sand & Gravel Co., 2509 Inwood, FL 7-2761.

Whittle Construction Co., 4007 Irving Blvd, FL 1-5363.

Wamix, 2221 Irving Blvd., RI 8-4093.

(2) Lighting Generators and Pumps.

Homelight, 167 Leslie, RI 1-4679.

(3) Redi-Mix Trucks and Sand.

Wamix, 2221 Irving Blvd., RI 8-4093.

Dallas Concrete Co., 123 Commerce St., RI 7-8621.

(4) Sandbags (500,000 to 1,000,000 on hand)

Dallas Bag & Burlap Co., 2301 Griften, RI 1-6094.

A & B Bag Co., 2300 Good-Latimir, HA 8-1558.

Imperial Bag Co., 1208 Marila St., RI 8-2439.

(5) Radio Trucks.

Whittle Construction Co., 4007 Irving Blvd., FL 1-5383.

3.08. Trespassing.- No encroachment or trespassing, which will adversely affect the efficient operation or maintenance of the project works, shall be permitted upon the rights-of-way.

3.09. Access for Inspection.- The District Engineer, or his authorized representative, shall have access at all times to all portions of the protective works.

3.10. Reports.- "Local Interests" will furnish the following reports to the District Engineer:

a. Semi-Annual Report.- A semi-annual report will be made to the District Engineer, which shows in detail the expenditures, during the period of the report, for maintenance work done on the floodway and appurtenant facilities. This report will also show inspections made and the general condition of the floodway. (See Annex 3).

b. Special Reports.- Special narrative reports of incidents involving major breakdowns of facilities, extensive vandalism, sabotage, and any other incidents that will seriously affect the capability of the floodway to function as designed.

c. River Stage and/or Rainfall Reports.- Reports will be made to the Fort Worth District Office whenever the Trinity River is above a 30-foot stage on the Commerce Street gage at Dallas or whenever a 3-inch rain is reported in the Dallas area.

3.11. Photographs.- Photographs of the Dallas Floodway are attached as ANNEX 4.

SECTION IV

PROJECT FACILITIES

CHAPTER 1

GENERAL INFORMATION

4.01. General.- The Congressional authorization for the improvement of the Dallas Floodway provided in general for the strengthening of the levees, clearing of floodway, installation of interior drainage facilities, increasing existing pump and sump capacities, and construction of pressure sewers, diversions, and gravity outlets. Improvements and/or additions were made to the following facilities:

a. Clearing of the Floodway on the Trinity River from river mile 504.0 to river mile 498.0.

b. Channel improvement from mile 503.0 to mile 497.5.

c. Strengthening East Levee and West Levee.

d. New pumping plants at A, Pavaho, and Hampton Road and improvements and/or alterations to pumping plants A, B, C, and D.

e. Construction of Turtle Creek and Lake Cliff pressure conduits, diversion of Coombs Creek, improvements and/or additions to Dallas Branch and Belleview pressure sewers.

f. East bank interceptor, Elm Fork sluice, Grauwyler Road sluice, Ledbetter drive sluice and dike, and Eagle Ford sluice.

g. Alterations of RR facilities at the intersection of Turtle Creek pressure sewer and the MKT RR and CRI&P Ry at the East Levee and CRI&P Ry and T&P RR.

h. Constructed emergency control structure at sta 622+18 East Levee.

SECTION IV

PROJECT FACILITIES

CHAPTER 2

CHANNEL IMPROVEMENTS

4.02. Channel Improvements.

a. Description.

(1) West Fork Channel.- The West Fork Channel was improved under previous development programs.

(2) Elm Fork Channel.- The Elm Fork Channel was improved under previous development programs.

(3) Trinity River Channel.- Under the Dallas Floodway improvement program the Trinity River Channel was cleared of brush and timber, from river mile 504.0 to river mile 498.0, widened, realligned, and otherwise improved from River Mile 503.0, which is located 580 feet downstream from Hampton-Inwood Bridge to River Mile 497.5, which is located at the centerline of Forrest Ave. Bridge.

b. Operation.- Both banks of each channel shall be patrolled during periods of high water, and appropriate measures shall be taken to protect those reaches from being damaged by the current. Particular attention will be taken to prevent the formation of log jams and other obstructions. (Also see Section V, Special Requirements During High Water Periods).

c. Inspection.- Each channel shall be thoroughly inspected as soon as practicable after each major high water period. In addition periodic inspections, not to exceed 90 days between inspections, will be made during low water periods. The exact location of trees, logs, debris, restrictions of channel, shoals, bank drainage or sloughing, and/or obstructions to approach and egress channels will be noted and reported to the Superintendent in order that maintenance work can be carried out without delay.

d. Maintenance.- In order that channels will properly carry the flood waters for which they are designed, preventative maintenance shall be given high priority. Such maintenance shall include but not be limited to the following:

(1) Keep channel or floodway clear of all trees, logs, and other debris that will in any way interfere or divert the flow of water.

(2) Remove all waste materials, unauthorized structures or other encroachments from channels.

(3) Remove or correct shoals or sand, gravel or mud bars.

(4) Correct or repair any areas damaged by runoff or wave wash, and sloughing of banks.

(5) Clear all obstructions and debris from approach or egress channels adjacent to the floodway which will in any way interfere with the proper functioning of the flood control works.

(6) Trees, tall weeds, and other vegetation detrimental to proper operation of the floodway shall be controlled by cutting or spraying with appropriate herbicides. (Also see Section V, Special Requirements During High Water Periods.)

SECTION IV

PROJECT FACILITIES

CHAPTER 3

LEVEES

4.03. Levees.

a. General.- The levee system which constitutes the Dallas Floodway is composed of three loops: the Northwest Levee, the East Levee, and the West Levee. (See ANNEX 1). The levees were constructed in 1928-1932 under joint agreement between Dallas County Levee Improvement District No. 5 and City and County of Dallas Levee Improvement District. Strengthening of the East and West Levee was accomplished by the Federal Government under the recently completed Floodway Project.

b. Operation.- Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet emergencies. Patrolling of the levees in the Dallas Floodway will be initiated and continued when the Trinity River Commerce Street gage height is at 30 feet or more. During flood periods the levees shall be patrolled continuously to locate possible sand boils and to be certain that:

(1) No slides or sloughs are developing.

(2) Wave wash or scour action is not occurring.

(3) There are no existing low reaches of the levee which may be overtopped.

c. Inspections.- All levees will be inspected as soon as practicable following each period of high water. Periodic inspections not to exceed 90-day intervals shall also be made by the Superintendent to insure that the maintenance measures shown in sub-paragraph d., below are being carried out and to be certain that:

(1) No unusual settlement, sliding, or material loss of grade has occurred.

(2) No riprap has been displaced, washed out, or removed.

(3) No burning of grass or weeds is allowed except just prior to the growing season.

(4) Access roads to the levee are properly maintained.

(5) Crown of levee is sloped so as to drain readily.

(6) There is no unauthorized grazing or vehicular traffic on the levee.

d. Maintenance.- The Superintendent shall provide at all times such maintenance as may be required to secure full protection to the levees from floods. Therefore, preventative maintenance is of the utmost importance in preventing needless damage. Proper measures shall be taken to promote and maintain a dense growth of Bermuda grass on each levee. This shall be accomplished by refertilizing, controlling of trees and weeds by mowing, cutting or spraying with appropriate herbicides, extermination of burrowing animals, removal of debris, and other sound turf maintenance practices. Replanting of sparsely grassed or eroded areas shall be accomplished by the sprigging of Bermuda grass and the application of 100 to 150 pounds of Ammonia Nitrate per acre. Slopes damaged by high water shall be repaired prior to replanting. The burrowing of animals will be eliminated and/or prevented. Displaced and/or removed riprap will be replaced and brought back to normal grade. Access roads to the levee shall be repaired and maintained in such condition that ready access is assured at all times. The crown of the levee will be maintained so that it drains properly at all times and low places where water may collect during rains will be filled. Proper barricades which are necessary to prevent unauthorized vehicular traffic on the levee will be maintained at all times.

SECTION IV

PROJECT FACILITIES

CHAPTER 4

PUMPING PLANTS

4.04. Pumping Plants, General Information.

a. Description.- There are six pumping plants located within the Dallas County Flood Control District. They serve to pump interior waters from the land side of levees into the river channels in order to remove interior runoff and minimize interior water damage in the adjacent industrial and residential areas. Each pumping plant has a sump or other type of water collecting basin adjacent to it. The pumping plants are designated and located as follows:

Plant Designation	Location
Pumping Plant A	Station 99+45, East Levee
Pumping Plant B	Station 235+04, East Levee
Pumping Plant Hampton Road	Station 312+05, East Levee
Pumping Plant C	Station 68+32, West Levee
Pumping Plant Pavaho	Station 174+60, West Levee
Pumping Plant D	Station 267+95, West Levee

b. General Instructions.

(1) Operation Log.- A log will be maintained at each pumping plant which will serve as a permanent record of each and all significant operations at the plant. This record shall be kept by the Chief Operator on duty for each shift worked. The log will include but not be limited to the following information:

(a) Date and hour of reporting for duty.

(b) River stage readings each hour.

(c) Starting time and stopping time of each pump.

(d) Names of employees on duty.

(e) Resume of operational and maintenance duties performed.

(f) Detailed record of any interruption of operations. Negative reports will be recorded as "No interruptions".

(g) Date and hour of leaving duty.

(h) Signature of the Operator at bottom of the record for his shift.

(2) Reports of Unusual Incidents.- A written report shall be made to the District Engineer of each instance of major breakdown of plant or equipment and/or other incidents such as flood damage, extensive vandalism or sabotage which in any way will interfere with normal operations of the plant. Incidents which disable the plant will be reported to the District Engineer by telephone. Telephoned reports will be confirmed by written reports.

c. Operation, Inspection and Maintenance.- Pumping Plants and related facilities and equipment will be operated, inspected, and maintained as required in the succeeding sub-paragraphs on pumping plants.

SECTION IV

PROJECT FACILITIES

CHAPTER 4

PUMPING PLANTS

4.041. PUMPING PLANT A.

a. Description.

(1) General.- Pumping Plant A consists of two pumphouses, an adjoining intake structure, 3 pump discharge pipes over the levee, two gravity sluices through the levee, and an outlet structure.

(a) The intake structure, adjoining the pumphouses, consists of approach wingwalls and apron, a raking platform, and trash racks. An enameled metal staff gage is located on downstream wall near the trash rack.

(b) There are three discharge pipes over the levee with a 4" air relief valve and a 7" vacuum breaker at the high point of each line.

(c) There are two 4 x 4-foot gravity sluices through the levee, with a gated structure on the riverside of the levee, to discharge interior runoff when the river is below sump elevation. The gated structure consists of two 4 x 4-foot sluice gates operated by two hand-operated floor stands. An enameled metal staff gage is located near the downstream end of the land side of this structure.

(d) The outlet structure consists of a concrete headwall, wingwalls, and apron. A flapgate is on each gravity sluice outlet.

(2) New Pumphouse.- The new pumphouse consists of a reinforced concrete substructure, used as a sump pit, and a brick superstructure that houses three 46,667 gpm vertical, axial flow pumps. The following equipment is in the pumphouse:

(a) Three 46,667 gpm, 500 h.p., vertical, axial flow pumps manufactured by the Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles, California.

(b) Three lubricating oil reservoirs and oil lines.

(c) An 8-ton trolley-type spur-geared hoist with bridge manufactured by Robbins & Myers, Inc., Springfield, Ohio.

(d) Two water level recorders manufactured by Leupold & Stevens Instruments, Inc., Portland, Oregon. (For details see Annex 6 .)

(e) A water level control manufactured by Healy Ruff Company.

(f) An air compressor manufactured by Binks Manufacturing Company, Chicago, Illinois.

In the new pumphouse, five metal-clad cabinets house the electrical switchgear for the incoming line and the three 2300V, 500 h.p. vertical pump motors. The incoming electrical service is 2300V, 3 Ø, 3 wire. Lighting and low voltage power is supplied through a 5 KVA, 1 Ø, 2300-115 volts, dry type transformer mounted on the wall behind the switchgear. Protection for the dry type transformer consists of two 5A, 5000V power fuses in a cabinet above the transformers.

The switchgear and pump motors are supplied with 115V heaters to maintain their temperature approximately 10° F. above ambient temperature to prevent condensation on the equipment. The heaters are controlled by circuit breakers in the lighting distribution panel.

The incoming line and pump motors are protected by four oil circuit breakers rated 2400V, 3-phase, 600 amp., with 50 MVA interrupting capacity. The oil circuit breaker 230V, AC closing coils are supplied from a control panel transformer mounted in Cubicle #5. 24V D.C. power for the trip circuit is supplied from a 24V storage battery and charger mounted at the end of the switchgear.

Auxiliary units contained in the switchgear consist of under voltage time delay relays, instantaneous over-current relays and thermal overload relays on each pump motor circuit and time delay relays which insert delays of approximately 30 and 60 seconds in the starting of pumps #2 and #3. During automatic operation, the time delay relays insure that two pumps are not started at the same time.

A three element float switch set to start the pump motors at elevations 380, 382, and 384, and to stop motors at elevations 379, 380, and 381, respectively, is employed when the pumps are to be operated automatically.

3. Old Pumphouse.- The older pumphouse consists of a concrete substructure used as a sump pit and a brick superstructure that houses two 10,000 gpm, vertical, axial flow pumps. The following equipment is in the pumphouse:

(a) Two 10,000 gpm vertical, 85 h.p., axial flow pumps manufactured by Fairbanks Morse and Co.

(b) A 36" gate valve and a 36" check valve on each pump discharge line. The gate valves are operated by motor-operated hoists.

(c) Two 4 x 4-foot sluice gates in the outlet wall of the sump, operated by two hand-operated hoists.

(d) Two 3 x 3-foot sluice gates in the sump inlet wall, operated by two hand-operated hoists.

b. <u>Operation of facilities</u>.

(1) <u>New Pumphouse</u>.- See paragraph 4.046 for instructions on Operation Log.

(a) Start air compressor.

(b) Open stop valve on the air compressor tank.

(c) Open air valve on top of oil reservoir and set to 5 psi.

(d) Open valve to vent the air from the pump bearings. As soon as oil drips from the valve, close valve. Repeat after running a few minutes.

(e) Use a hand grease gun to grease bowl seal and suction bearing through the two small fittings at the base of each pump.

(f) Check oil level of upper and lower pump motor bearings.

(g) Start pumps by manual or automatic operation.

(h) Lubricate every hour with a hand lubricator.

(2) <u>New Pumphouse - Manual Operation</u>

(a) Turn off pump motor heaters.

(b) Set selector switches on Panels 1, 2, & 3 to "Hand" position.

(c) Turn control switch for incoming line to "Close" and release.

(d) Turn control switch for motors to be operated to "Close" and release.

(e) With the pumps running, read the current in the three phases to the motors. These motors are designed for a maximum full load current of 124 amperes. If this value is exceeded by 15% or more after the pumps have established siphoning, shut down pump by means of the control switch.

(3) <u>New Pumphouse - Automatic Operation</u>

(a) Check tape to floatswitch to see that is is free with no binds.

(b) With the selector switches on Panels 1, 2, & 3 on "Hand", turn control switch for the incoming line (Cubicle 4) to "Close", and release.

(c) Check batteries for full charge (24 volts on volt-meter on battery panel).

(d) Set selector switches on Panels 1, 2, & 3 to "Automatic."

(e) The float switches will then start one pump when the water reaches elevation 380. If the water continues to rise the float switch will start the next pump at elevation 382 and the third pump at elevation 384.

(f) As the water level is reduced the pumps will be stopped in turn, one at elevation 381, one at 380, and the last pump at elevation 379.

(4) New Pumphouse - Special Notes.

(a) With the pumps set for automatic operation, time delays are incorporated in the starting circuits of Pumps 2 & 3 to insure that two pumps do not start simultaneously. Approximately 30 seconds will elapse between the time the operating contact on the float switch is closed and the time Pump #2 starts. The time delay on Pump #3 is approximately 60 seconds.

(b) It is imperative that the batteries at the end of the switchboard be fully charged during operation of the pumps. These batteries supply the operating power for the circuit breaker trip coils and energize the motor circuit breakers upon closure of the float switch contacts.

(c) Heaters are provided in both the switchgear and the motor bases. These heaters maintain the temperatures of the equipment high enough to prevent condensation and resultant lowering of insulation resistance.

(d) The switchgear heaters are supplied from the control power transformer in Cubicle 5. Circuit breakers protecting these circuits are labelled 08 in Cubicle 5.

(e) Heaters at the motor bases are supplied from the circuit breaker distribution panel mounted in the wall.

(f) The switchgear heaters should be on at all times. The motor heaters should be on except when the motors are running.

(g) The float switch contains three receptacles to which control circuits to the three motor control cabinets are connected. The motor starting sequence during automatic operating can be varied by interchanging these control cable connections. This sequence should be changed periodically during times of automatic operation so that the total operating times of the pumps are made equal. The control circuit of the pump with the lowest total operating time should be connected to the float switch so that it will be started at elevation 380 and the control circuit to the pump with the most total operating time should be connected to the float switch so that it will not start until elevation 384 is reached.

(h) One or more of the pumps may be shut down by operation of the protective equipment. A fault on the 2300V feeder or on the power company's lines could result in operation of the undervoltage relays. When these relays are operated, the trip coils on the motor protection circuit breakers are energized removing the pumps from service. If the power interruption was only momentary, the pumps may be restarted after resetting the undervoltage relays. Operated relays will show a white flag operation indicator. Reset the white flag by means of the push rod in the cover. Check voltmeter if flag cannot be reset.

(i) Three induction and three thermal overcurrent relays are provided for each motor. They are operated from current transformers located in the motor protection cubicles and are mounted on the cubicle doors. If the motor should draw excessive current in one or more phases due to a locked rotor, insufficient lubrication or grounding through substandard insulation, the overcurrent relays would be operated tripping the motor protection circuit breakers. A white flag operation indicator will then show on the relays so operated.

(5) <u>New Pumphouse - Power Failure</u>.

(a) If possible reduce water level until the pump can be inspected.

(b) Turn the pump over by hand to insure that the rotor is free of binds.

(c) Check oil level.

(d) If rotor is free and it is apparent that the rotor had not been blocked, megger the leads to pump.

(e) If all tests are satisfactory, reset white flag by means of the push rod in the relay case and start and run the pump for a short time.

(6) <u>New Pumphouse - Stopping Pumps</u>.- The procedure to stop pumps is as follows:

(a) Turn hand-off-auto switch to "off" and trip breaker control.

(b) Stop air compressor, close the oil valves and vent the oil reservoirs.

(c) Turn on the motor heaters.

(d) If the siphon breakers on top of the levee do not break, there is danger of the system siphoning the water from the river back into the sump. To break the vacuum by hand, there are 1" globe valves located inside the block house on top of the levee. Remove the pipe cap from the end of the 1-inch pipe and open the valve to let air into the pump discharge lines.

(7) Old Pumphouse - General Instructions. See paragraph 4.046 for instructions on Operation Log. The procedure for placing the pumphouse in operation is as follows:

(a) Check pumps and exciters by hand to see that they are free to run.

(b) Check all contact points on all switches, and also check and clean the collector rings on the pump motors.

(c) Close the sluice gates and check to see that the intake gate and the pump discharge gates are open.

(d) Close the two 3-pole knife switches at the top of the control panel.

(8) Old Pumphouse - Starting Pumps.- The procedure for starting the pumps is as follows:

(a) Start one exciter and adjust until board lights are glowing brightly.

(b) Start one pump and adjust the D.C. current to 7 amps. (Full load is 85 amps at 440 volts.)

(c) Start the second pump if it is to be used.

(9) Old Pumphouse - Stopping Pumps.- The procedure for stopping the pumps is as follows:

(a) Stop pump.

(b) If the pump reverses rotation, close the pump discharge gate.

(c) After both pumps have stopped turning, pull the exciter switch.

(d) Pull the two 3-pole switches at the top of the control panel.

(10) Old Pumphouse - Power Failure.- The procedure for stopping the pumps is as follows:

(a) ~~Close the~~ pump discharge gate if pump reverses rotation.

(b) Check the circuit breaker in the main feeder box.

(c) Check the 3 disconnect links (outside on the transformer bank).

c. Inspections and Tests.

(1) Megger Tests.- Megger tests on the motors should be performed annually. A curve of minimum insulation resistance versus temperature should be obtained from the motor manufacturer and kept with the records of the insulation resistances taken each year. To measure insulation resistance, the following procedure should be used:

(a) With the motor cold and the magnetic contactor in the open position, read the insulation resistance between any one of the load contacts and the frame ground. If the megger reading falls below the minimum insulation resistance curve supplied by the manufacturer for the corresponding temperature, the motor should be disconnected from the line and the megger test repeated at the terminal box of the motor. If this megger reading is still below that of the curve, a report to the Corps of Engineers' District Office should be submitted immediately. No attempt should be made to start the motor. Enter the megger reading and the temperature on the permanent record maintained for the equipment.

(b) Obtain D.C. resistance of the stator windings by impressing a D.C. voltage across the windings and reading the voltage and current. Record the circuit designations of the winding used.

(c) Run the motor under normal load for a minimum of 15 minutes, shut down and repeat megger and D.C. resistance readings. Use the coil recorded under step 2 for the resistance measurements.

(d) By means of one of the formulae given at the end of this section, compute the temperature of the stator using the "hot" resistance obtained in step 3. Record this temperature and the megger reading on the permanent test record. If the megger reading for this temperature falls below the minimum insulation resistance curve at the same temperature, the procedure outlined in step 1 should be followed.

(e) On the curve of megger reading vs temperature furnished by the manufacturer locate the point found in Step 1. Through this point lay a straightedge parallel to the minimum insulation resistance curve. Record the insulation resistance in megohms found at the intersection of the straightedge and the base temperature of 75° C., on the permanent test record under "Adjusted Insulations Resistance."

(f) Perform Step 5 for readings taken in Step 3. The adjusted insulation resistance for both the motor "cold" and the motor "hot" should be approximately the same.

(g) If both the "cold" and "hot" test values fall above the minimum curve, the winding is satisfactory. If they fall below, the winding insulation is deteriorating or damp. The recommended method for drying out motors is by blowing heated air across the windings. Another method in which extreme care must be exercised is by circulating a low voltage current through the windings. This method should be used only by qualified personnel. An exceptionally low insulation resistance reading indicates probable contact between stator winding and frame. This condition should be corrected before any other remedial measures are initiated.

(2) Periodic Trial Runs and Tests.- All equipment including switchgear, transformers, motors, pumps, and gates shall be trial operated and checked at least once every 90 days.

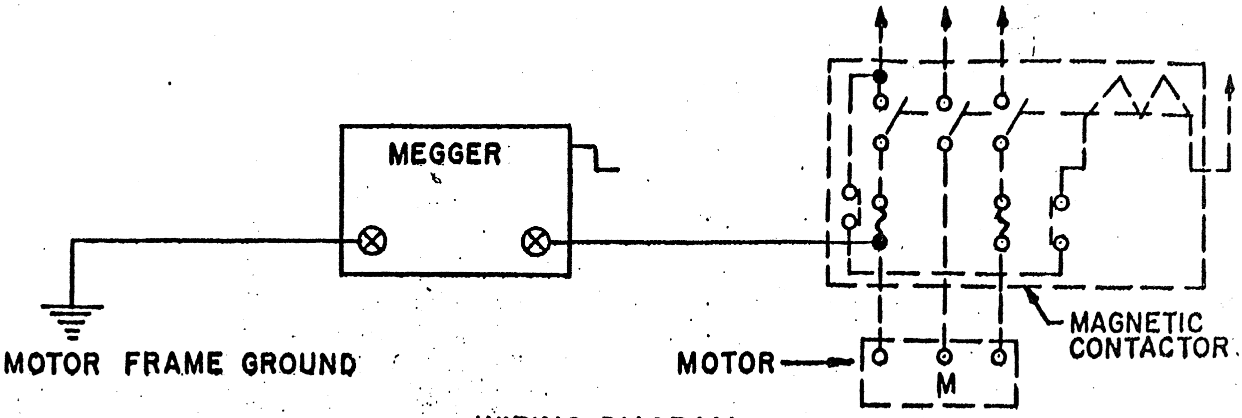
(3) Inspection of Equipment and Machinery.- Pumping plants shall be inspected at intervals not to exceed 30 days during the flood season and 90 days during the off season to insure that all equipment is in order for instant use.

d. Maintenance.- To insure maximum operation during flood conditions it is important that all equipment and machinery be inspected and maintained on a regularly scheduled basis. Undue wear at any point should be reported to supervisors without delay. The inspection intervals shown for each item are considered maximum periods between inspections. Preventative maintenance should be given major consideration at all times. A complete inspection of all machinery, equipment, and facilities should be made immediately after the recession of each flood which required the use of such facilities. The legend below explains the inspection interval symbols used in the succeeding maintenance instructions.

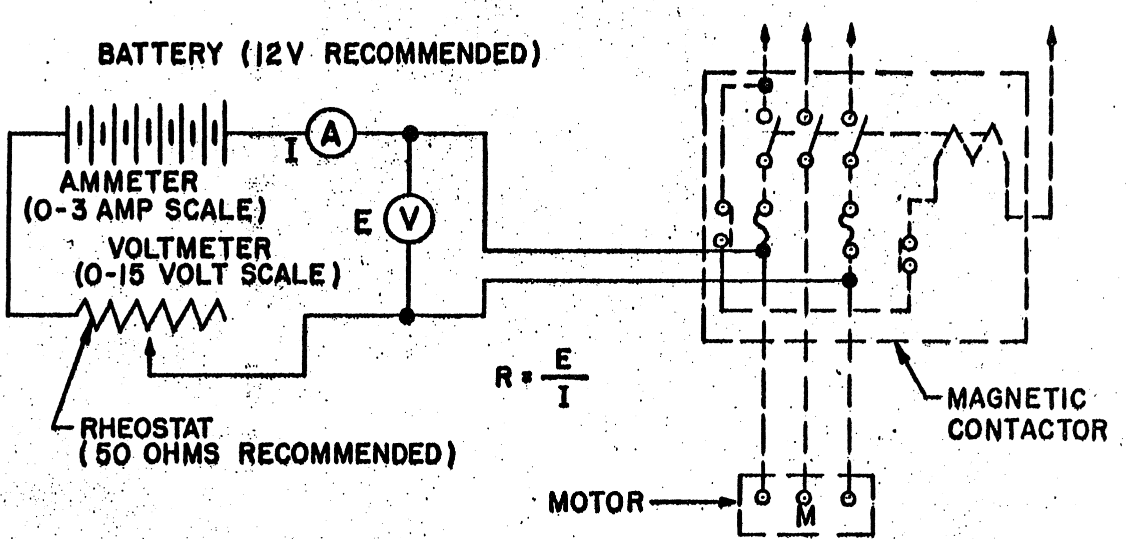
Legend to Inspection Interval

D - Daily Inspection
SW - Semi-weekly
W - Weekly
Bi-W - BiWeekly
M - Monthly
Bi-M - Bi-Monthly

Q - Quarterly
SA - Semi-annually
A - Annually
B-E - Bienially
N.S. - Not Scheduled



WIRING DIAGRAM
INSULATION RESISTANCE



WIRING DIAGRAM
STATOR WINDING RESISTANCE (D-C)

CENTIGRADE: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}}(234.5 + T_{COLD}) - 234.5$

FAHRENHEIT: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}}(390.0 + T_{COLD}) - 390.0$

R = STATOR WINDING RESISTANCE (D-C)
T_{COLD} = AIR TEMPERATURE (COLD MOTOR)
T_{HOT} = TEMPERATURE TO BE DETERMINED AT END OF RUN

FORMULA FOR COMPUTING TEMPERATURES

INSULATION RESISTANCE
CONNECTION DIAGRAMS

CORPS OF ENGINEERS FORT WORTH DISTRICT

(1) Buildings and Grounds.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Building	W-A	(a)
Yard and grounds	W-N.S.	(b)

(a) Buildings.

Weekly.- Check interior for cleanliness. Remove trash and fire hazards. Keep oil drips cleaned up. Keep door locks in good condition.

Annually.- Check roof, walls and floors for damage to concrete and/or masonry. Repair as needed. Check ventilators to insure proper functioning. Check for settlement of floors or foundations and/or cracks in walls.

(b) Yard and Grounds.

Weekly.- Check for fire hazards. Remove trash and debris. See that gates, buildings, etc., are locked where necessary to prevent unauthorized persons from entering or tampering with tools and equipment.

Not-Scheduled.- Clear grounds of all drift and other debris after each high water period.

(2) Access Roads, Walks and Parking Areas.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Access Roads, Walks and Parking Areas	A-N.S.	(a)

(a) Access Roads, Walks, Parking Areas.

Annually.- Check road, walks and parking area surfaces for holes, bumps, ruts, etc. Fill, shape and/or repair as needed.

Not Scheduled.- While making routine trips over roads and in parking areas, damaged areas should be noted and repaired before extensive damage results.

(3) Pumps and Motors.

(a) Pumps.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Foundation	M	1
Impeller	A	2
Bearing	D-A-N.S.	3
Packing Gland	D-M-N.S.	4
Coupling	A-N.S.	5
Lubrication	D-SA	6

1. Foundation.

Monthly.- Inspect foundation for cracks, settling, etc.

2. Impeller.

Annually.- Make annual check when condition or performance of pump indicates overhaul is necessary, then perform general overhaul maintenance. Inspect impellers and seals.

3. Bearings.

Daily.- Check lubrication of bearings.

Annually.- Change oil and/or grease in bearings and couplings.

Not Scheduled.- At general overhaul inspect bearings; make repairs if needed.

4. Packing Gland.

Daily.- Observe leakage at the gland. Take up gland as needed.

Monthly.- Inspect gland repack if needed. Inspect sleeve for wear.

Not Scheduled.- At general overhaul inspect packing gland and sleeve. Renew sleeve if needed, and make other repairs as needed.

6. Lubrication.

Daily.- Check lubricating system. See that oil reservoirs are full.

Semiannually.- Drain and flush all oil reservoirs. Refill with oil. Remove old grease from lines and bearings and refill.

(b) Motors.

Inspection and Check List

Item to be Inspected	Inspection Interval	Paragraph
Foundation, base, or support	M	1
Frame	NS	2
Laminations and pole pieces	NS	3
Armature or rotor	Q	4
Air gap	A	5
Windings	Q-B.E.	6
Slot wedges	B.E.-N.S.	7
Couplings and gears	M-A	8
(Thrust bearings	D-Q	9
(	A-Four years	
(Guide bearings	D-Q	10
(	A-Four years	
Thrust bearing oil strainer	Q	11
Painting	B.E.	12

1. Foundation Base or Support.

Monthly.- Note any unusual condition of foundations or supports.

2. Frame.

Not Scheduled.- Tighten bolts in stator splits and other parts.

3. Laminations and Pole Pieces.

Not Scheduled.- Tighten lamination bolts when a check indicates this should be done.

4. Armature or Rotor.

Quarterly.- Check squirrel-cage rotor bars for loose or broken bars or connections, by unusual sounds, by refusal to carry full load, or failure to build up full synchronous speed.

5. Air Gap.

Annually.- Check air gap at four quadrature positions and recenter rotor if necessary. Replace bearings or recenter as required.

6. Windings.

Quarterly.- Visual inspection for damaged insulation, dirt, oil, or mo sture on winding. If required, blow out with clean dry air at low pressure, and clean winding thoroughly with a noninflammable cleaner using suitable brushes and air cleaning spray gun. Check insulation resistance.

Biennially.- Inspect the condition of the winding insulation, connections, clamps and related items. Clean thoroughly and revarnish windings if required to place in good condition. Renew any other items that have deteriorated to the point that they should be replaced. Check insulation resistance.

7. Slot Wedges.

Biennially.- Check slot wedges and replace loose ones. Tighten coils in slots by rewedging if necessary.

Non-Scheduled.- If wedges become loose, rewedge, clean and paint stator.

8. Couplings and Gears.

Monthly.- Check oil level in gear cases.

Annually.- Check to see that set screws and coupling bolts are tight. Change oil in gear cases. Lubricate couplings.

9. Thrust Bearing.

Daily.- Check oil level in bearing, add oil as needed.

Quarterly.- Inspect for oil leaks.

Annually.- Change oil if analysis or condition of oil shows this to be desirable.

Four Years.- Dismantle thrust bearing. Inspect plates, smooth off sharp edges, cracks if found, lightly scrape high spots. Remove and inspect runner plate, hone if necessary. Clean springs, housing, baffles and all internal parts and area. Remove, clean, and inspect vapor ring.

10. Guide Bearings.

Daily.- Check oil level in bearings.

Quarterly.- Inspect bearing housing and piping for oil leaks.

Annually.- Change oil if analysis or condition of oil show this to be desirable.

Four Years.- Dismantle and lower bearings for inspection and cleaning. Lightly scrape bearing. Polish and hone journal. Check bearing alignment and clearance, altering same if needed.

11. **Thrust Bearing Oil Strainer.**

Quarterly.- Remove and clean thrust bearing oil strainer.

12. **Painting.**

Biennially.- Clean, inspect, touch up paint as needed.

(4) **Cranes and Hoists.**

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Crane, rails, supports, stops	A	(a)
Crane bridge	A	(b)
Trucks	A	(c)
Bumpers	A	(d)
Hoist conductors, supports & pickup cable	A	(e)
Trolley wheels	M	(f)
Chain sheaves	W-A	(g)
Chains	W-A	(h)
Blocks and hooks	W-M	(i)
Driving gears, shafts, bearings & wheels	W-M-A	(j)

(a) **Crane Rails, Supports and Stops.**

Annually.- Check rails for alignment and obstructions. Check supports for cracks and spalling if concrete, and for corrosion and loose rivets and bolts if steel. Repair concrete as necessary. Tighten or calk loose rivets and bolts. Check stops for security to building or rails.

(b) **Crane Bridge and Carriage.**

Annually.- Check frame work for looseness and cracks. Check rivets and bolts for tightness. Check girders for alignment. Examine girders for corrosion. Clean and paint as necessary.

(c) Trucks.

Annually.- Check trucks for skew and condition of wheels.

(d) Bumpers.

Annually.- Check for looseness. Examine bumpers to see that they are properly positioned. Tighten or adjust as necessary.

(e) Trolley Conductors Supports and Pickup Cable.

Annually.- Check hoist system for damaged or worn conductors, broken insulators, worn supply cable and plugs or loose connections. Repair or replace as neccessary.

(f) Trolley Wheels.

Monthly.- Make visual inspection of collector system. Repair as needed.

(g) Sheaves.

Weekly.- Check sheaves for broken or chipped wheels.

Annually.- With chain removed, check for wear, chipping and corrosion. Check bearings for clearance and refit if needed.

(h) Cables or Chains.

Weekly.- Visual inspection for broken or frayed strands or broken or elongated chain links.

Annually.- Run cable or chain out and inspect carefully for frayed or broken strands, stretched or weakened links. Examine for wear and corrosion, especially down between the cable strands. Lubricate.

(i) Blocks and Hooks.

Weekly.- Inspect hook for bending and stretching.

Monthly.- Lubricate sheaves.

(j) Driving Gears, Shafts, Bearings and Wheels.

Weekly.- Check lubrication. Examine for excessive wear.

Monthly.- Lubricate sleeve and box bearings.

Annually.- Lubricate ball and roller bearings and change oil in gear cases.

(5) Electrical Equipment.

(a) Oil Circuit Breakers.

Maintenance Schedule Guide

Item to be Inspected	Inspection Interval	Paragraph
Frame and tanks	B.M.-A	1
Oil valves and plugs	B.E.	2
Oil levels and gauges	D	3
Breathers and vents	A	4
Panels and cabinets	M	5
Bushings or insulators	M-A	6
Bushing CT's and potential devices	A	7
Main terminals & ground connections	M	8
Main contacts	A-B.E.	9
Contact pressure springs	B.E.	10
Arc interrupter	B.E.	11
Crosshead	B.E.	12
Lift rods and guides	B.E.	13
Operating solenoids, latch & trip mechanism	Q	14
Auxiliary switches	Q	15
Dashpots or snubbers	B.E.	16
Mechanism cabinets	A	17
Cabinet heaters	Q	18
Power supply and wiring	Q	19
Oil dielectric tests	SA	20
Oil purification	NS	21
Breaker operation	D	22
Control and protective relays	(See par 4.041(5)(b) 5 and 10)	

1. Frame and Tanks.

Bimonthly.- Check for oil leaks and note tank temperature by touch.

Annually.- Lubricate mounting mechanism according to manufacturer's instructions.

2. Oil Valves and Plugs.

Biennially.- Check condition of paint and refinish as necessary. Inspect oil valves and plugs; stop oil leaks. See that oil drain valves are locked where plugs are not provided. Tighten bolts.

3. Oil Levels and Gauges.

Daily.- Check oil levels in gauges of tanks and oil filled bushings.

4. Breathers and Vents.

Annually.- Check for external obstructions to breathers and vents.

5. Panels and Cabinets.

Monthly.- Check panels for cracks and cleanliness. Check condition of enclosing cabinets, including hinges, locks, door gaskets, and paint.

6. Bushings or Insulators.

Monthly.- Check for chipped or broken porcelain, excessive dirt film, oil level, and oil or compound leaks.

Annually.- Clean porcelain as required. Repair chipped spots by painting with red glyptal. Inspect gasket for leaks. Tighten bolts, check insulation resistance. Inspect for foreign material and make dielectric test.

7. Bushing CT's and Potential Devices.

Annually.- Inspect terminal board. Clean and tighten all connections.

8. Main Terminals and Ground Connections.

Monthly.- Visual inspection for loose connections in connecting bus-work, loose or broken frame, ground connections.

9. Main Contacts.

Annually.- Check main contact resistance from terminal to terminal with a low resistance ohmmeter and record.

Biennially.- Overhaul as required by service and tests. Inspect main and arcing contacts. Smooth contacts as required. Adjust and align if necessary.

10. Contact Pressure Springs.

Biennially.- Check springs for loss of temper, breaks, or defects.

11. Arc Interrupter.

Biennially.- Check arc interrupting device for faulty or broken parts.

12. Crosshead.

Biennially.- Check contact crosshead for misalignment, breaks, bends, or looseness on lift rod.

13. Lift Rods and Guides.

Biennially.- Check contact lift rod for breaks, warping, pulling out at ends, and other wekanesses. Check lift rod guides for alignment.

14. Operating Solenoids, Latch and Tripping Mechanism.

Quarterly.- Inspect electrically operated solenoid mechanism. Megger manually operated tripping mechanism, observing that tripping mechanism is free. Run breaker through three operating cycles and carefully observe action.

15. Auxiliary Switches.

Quarterly.- Visual inspection. Maintain contacts as indicated.

16. Dashpots or Snubbers.

Biennially.- At overhaul check for proper setting and adjust as necessary. Clean out and replenish liquid in liquid dashpots.

17. Mechanism Cabinet.

Annually.- Check condition of metal and hardware. Repaint as necessary. See that door gaskets are tight and properly exclude dust and dirt.

18. Cabinet Heaters.

Quarterly.- Inspect heaters, make repairs as needed to keep heaters in service.

19. Power Supplies and Wiring.

Quarterly.- Check fuses or circuit breakers in all power and supply circuits. Maintain in their operating position.

20. Oil Dielectric Tests.

Semiannually.- Check dielectric strength of the insulating oil in the main tanks of oil circuit breakers and oil-filled bushings.

21. Oil Purification.

Not Scheduled.- Oil that tests under 22 kilovolts should be scheduled for purifying. Oil that tests under 20 kilovolts should not remain in use without purifying. Purified oil should test 26 kilovolts or more.

22. Breaker Operation.

Daily.- Some breakers, particularly those carrying high values of current, have a tendency to develop contact heating if left closed for long periods. Daily test for abnormal temperatures by placing a bare hand on each switch tank. Opening and closing breakers several times at intervals as system operation will permit may alleviate the heating by wiping the oxide from the contact surfaces, as well as demonstrate that the breaker is in operating condition. Then test with "Ductor" bridge through main contacts to indicate if fault condition exists in main contact circuit.

(b) Switchboards and Control Equipment.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Panels, supports, cabinets, and cubicles	W-A	1
Panel wiring and terminal blocks	A	2
Auxiliary and control relays	D-A	3
Control switches and push buttons	W-M-Q-A	4
Indicating lamps	D	5
Meters and instruments	D-A	6
Position indicators	D-B.E.	7
Protective relays	D-A	8
Resistors	B.E	9
Test switches and jacks	A	10

1. Panels, Supports, Cabinets, and Cubicles.

Weekly.- Check for general cleanliness and condition of finish. Clean off dust, dirt, and grease. Use a solution of mild soap and water on Okite Renovator diluted as per directions, to remove dirt and grease from panels. Many cleaning compounds are harmful to the finish and should not be used. Since switchboard panels having considerable equipment on them are difficult to refinish, care must be taken in cleaning them. Wax may be used where the gloss is not objectionable.

Annually.- Repair finish and hardware and clean as necessary. Tighten bolts and screws. Check boxes and cabinets in damp locations for corrosion and rust. Clean and refinish as necessary.

2. Panel Wiring and Terminal Blocks.

Annually.- Check for general housekeeping. Vacuum out terminal cabinets and wiring and control cubicles using due care and caution around live relays and controls. Check condition of wiring, particularly observing evidence of damaged insulation. Remark tags for terminal blocks when needed. Tighten connection at terminal points.

3. Auxiliary and Control Relays.

Daily.- Note and report any unusual heating, vibration, or other unusual condition of relays.

Annually.- Inspect relays. Dress contacts or replace if needed. Check contact spring and wiping action. Check contact shunts, etc. Make other adjustments, alignments, etc., as required. Test relay circuits.

4. Control Switches.

Weekly.- Operate control switches for test when feasible. Make repairs as needed.

Monthly.- Test control switches and push buttons on motors of all auxiliary equipment. Make repairs as needed.

Annually.- Overhaul all control switches at least once a year, oftener if needed. Check spring action and replace all switch units having unsatisfactory action.

5. Indicating Lamps.

Daily.- Replace any burned-out pilot lights. Make repairs as found necessary.

6. Meters and Instruments.

Daily.- Observe performance of instruments, adjust and repair as needed.

Annually.- Check calibration of meters and instruments; clean, adjust and repair as necessary. Tighten connections, check wiring connections if any changes have been made in associated circuits or equipment.

7. Position Indicators.

Daily.- Observe operation of position indicators. Make adjustments, repairs, etc., as needed.

8. Protective Relays.

Daily.- Visual inspection for anything unusual about contacts, coils, or moving element. Keep targets reset.

Annually.- Test relays as per instructions.

9. Resistors.

Biennially.- Vacuum. Make repairs as needed.

10. Test Switches or Jacks.

Annually.- Examine test switch contacts and refinish with file or abrasive if burned or corroded. Tighten connections.

(c) Low Voltage Switchgear - Busses and Cables.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Bus bars, joints, and connections	B.E.	1
Bus insulators and supports	B.E.	2
Bus enclosures and barriers	B.E.	3
Switchgear panels and enclosures	M-A	4
Locks and interlocks	M	5
Warning and safety signs	M	6
Current and potential transformers	A	7

1. Bus Bars, Joints, and Connections.

Biennially.- Check bus bars, joints, and connections for overheating. Tighten joint and connection bolts. Refinish joint contact surfaces. Silver plate if required on high current connections to prevent heating.

2. Bus Insulators and Supports.

Biennially.- Inspect and clean insulators or insulating block supports. Paint chip spots on porcelain with red glyptal. Tighten bolts. Check supports for rigidity. Inspect tape insulation on bus bars, if any, and revarnish as required.

3. Bus Enclosures and Barriers.

Biennially.- Check bus enclosures and interphase barriers for tightness and adequate ventilation. Clean as required.

4. Switchgear Panels and Enclosures.

Monthly.- Inspect and clean as required with industrial type hand vacuum cleaner.

Annually.- Inspect, clean and check for loose bolts, repaint or refinish as required.

5. Locks and Interlocks.

Monthly.- Check all key locks and mechanical interlocks. Lubricate cylinder locks with powdered graphite only. Leave in proper operating position.

6. Warning and Safety Signs.

Monthly.- Check to see that adequate warning and safety signs are in place around live parts or other safety hazards.

7. Current and Potential Transformers.

Annually.- Check oil level and oil leaks in oil-filled transformers. Check for leaking compound from dry type transformers. Clean insulators. Check and tighten primary and secondary connections. See that short circuiting device on current transformer secondary is secured in the open position and that protector tubes are not bypassing current at normal loads. Check potential transformer fuses.

(d) Storage Batteries and Chargers.

Item to be Inspected	Inspection Interval	Paragraph
Base or rack	A	1
Base pad	A	2
Separators	M	3
Electrolyte	D-M	4
Intercell connectors and terminals	M	5
Hydrometers and thermometers	D-M	6
Sink, funnels, and fillers	M	7
Electronic and metallic	WA	8

1. Base or Rack.

Annually.- Inspect concrete base or wooden racks for deterioration. Repair or repaint with acid-resisting paint as necessary.

2. Base Pad.

Annually.- Check base pad of sheet rubber, sand, or other material, for deterioration from acid or other causes.

3. Separators.

Monthly.- Visual inspection for condition.

4. Electrolyte.

Daily.- Check electrolyte gravity of pilot cells.

Monthly.- Check electrolyte gravity of entire battery and enter on proper form. Add water of suitable purity, as instructed, and record on proper form. Check individual cell voltages and record on proper form.

5. Intercell Connectors and Terminals.

Monthly.- Neutralize acid with ammonia and clean from battery connectors and cell tops.

6. Hydrometer and Thermometer.

Monthly.- Report condition of hydrometer and thermometer if necessary.

7. Sink, Funnels, and Fillers.

Monthly.- Maintain sink, funnels, and fillers in clean and safe condition.

8. Electronic and Metallic Rectifiers.

Weekly.- Visual inspection of transformers, tubes, control switches or resistors. Replace or repair any defective items. Check operations.

Annually.- Make thorough inspection of all items on the rectifier, replacing any defective equipment and tighten connections.

(e) Disconnecting Switches and Fuses.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and mounting	BE	1
Insulators	A-BE	2
Line and ground connections	Q-BE	3
Blades and contacts	Q-A-BE	4
Locks and interlocks	Q	5
Fuse tubes and fuse links	Q	6

1. <u>Base and Mounting</u>.

<u>Biennially</u>.- Inspect for loose bolts or structure.

2. <u>Insulators</u>.

<u>Annually</u>.- Check for chipped and broken insulators. Clean as required.

<u>Biennially</u>.- Tighten loose assembly bolts.

3. <u>Line and Ground Connections</u>.

<u>Quarterly</u>.- Make visual inspection of line connections and where evidence of loose connections exist, tighten as required. Check condition of ground connection to assure that it is not broken and ground connection is tight.

<u>Biennially</u>.- Inspect and tighten connections as required.

4. <u>Blades and Contacts</u>.

<u>Quarterly</u>.- See that blades are properly seated in the contacts. Where necessary, adjust blades.

<u>Annually</u>.- Operate switch several times and see that blades are properly alined to engage contacts.

<u>Biennially</u>.- Check alignment and condition of blades and contacts. Tighten bolts and screws, adjust contact pressure and maintain silver or other contact surface in good condition.

5. <u>Locks and Interlocks</u>.

<u>Quarterly</u>.- See that switches are properly locked in the open or closed position as required, by padlocks or other key-type locks or interlocks. Lubricate with powdered graphite only, from a graphite gun. No other lubricant shall be used on padlocks or cylinder locks. See that locks and keys operate as intended. Check mechanical interlocks such as between main disconnecting switch and ground switch for operation.

6. <u>Fuse Tubes and Fuse Links</u>.

<u>Quarterly</u>.- Inspect and check fuses and their holders for evidence of failure or improper conditions. When fuse trouble occurs due to high resistance contact between ferrule and holder, refinish ferrule and fuse dips. On fuses of high current rating or exposed to unfavorable atmospheric conditions it may be found desirable to silverplate the contact surfaces.

(6) Sluice Gates.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Sluice gates	A	(a)
Seals and guides	A	(b)

(a) Sluice Gates.

Annually.- Inspect condition of bolts, studs, latching devices, paint, or other surface treatment. Repair or replace as necessary. Check operation of gate and leakage of

(b) Seals and Guides.

Annually.- Check seals and guides for wear and deterioration. Renew seals and build up guides where scored, as necessary. Remove accumulated mineral deposit.

(7) Flap Gates.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Flap gates	Q	(a)

(a) Flap Gates.

Quarterly.- Flap gates should be trial operated, serviced, and lubricated to be certain they swing freely and do not bind. Caution: In order to prevent possible damage, do not allow the flaps to slam against the seats.

(8) Trash Racks.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Trash racks	W-A	(a)

(a) Trash Racks.

Weekly.- Check trash racks for debris. See that trash and debris is removed.

Annually.- Inspect trash racks, including underwater portion so far as feasible; remove lodged debris not removed on routine cleaning. Check condition of metal work, repair as needed. Paint every 5 years unless inspection shows more frequent painting to be necessary.

(9) Gages and Gage Wells.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Gages and gage wells	S.A-A-N.S.	(a)

(a) Gages and Gage Wells.

Semiannually.- Flush both 3-inch pipe intakes to the sump gage and the intake to the river gage.

To flush the intakes to the sump gage proceed as follows:

1. Raise the float clear of the water and make it fast by inserting nail or small rod through the hole in tape allowing the nail or small rod to rest on table top.

2. Remove the weighted self-centering cone from the bottom of the well by lifting the chain which extends from the gage well and allow well to drain.

3. Turn 3-way cock on lower intake 1/4 turn counter clockwise and open valve from flush tank and allow water to run from flush tank to gage well thus flushing that portion of the intake and also cleaning out gage well.

4. Turn 3-way cock on lower intake 1/4 turn clockwise and allow flush tank to refill. Turn 3-way dock 1/4 turn clockwise thus flushing the portion of the intake from the flush tank to the lower end of the intake.

5. Turn 3-way cock on lower intake 1/4 turn counter clockwise and leave in this position.

6. Repeat above procedure from (c) through (e) using 3-way cock on upper intake.

7. Replace weighted self-centering cone in bottom of gage well.

8. Unfasten the float and place the recording gage back in operation. Check the gage operation.

To flush the intake to the river gage proceed as follows:

1. Raise the float to the top of the well and make it fast by inserting nail or small rod through the hole in the tape allowing the nail or small rod to rest on table top.

2. Remove the weighted self-centering cone from the bottom of the well by lifting the chain which extends from the gage well and allow well to drain. If river is above intake, water will come into well from river and flush intake. When water from the bottom of the well runs clear, replace the weighted self-centering cone and allow well to refill. If river is below the intake, close the cock at entrance to well by turning 1/4 turn clockwise after removing cone. Then wash out float well with hose. Replace weighted self-centering cone and fill float well with water from hose. Open cock on intake by turning 1/4 turn counterclockwise and allow water in well to drain to river, thus flushing 3-inch intake line.

3. Unfasten the float and place the recording gage back in operation. Check the gage operation.

Annually.- Give all bearings and rubbing parts of the two water stage recorders a drop of oil once a year. On bearings where there is no oil holes, put a drop of oil on the side of the bearing with a fine toothpick. Use only the instrument oil provided.

Not Scheduled.- Clean the staff gages at intervals required to facilitate reading.

(10) Air Compressor.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Foundation	M	(a)
Frame Casting	M	(b)
Belt	M	(c)
Crankshaft, Connecting rod, Crosshead, Piston and piston rod, Cylinder, Bearings	One to three Years	(d)
Packing gland	D	(e)
Lubrication	D-A	(f)
Receiver tank	A - 6 Years	(g)
Air intake and cleaner	M	(h)
Gages and pressure switches	A	(i)
Unloader and valves	D-M	(j)
Safety valve	A	(k)

(a) Foundation.

Monthly.- Visually inspect foundation for cracking, spalling, or settling.

(b) Frame Casting.

Monthly.- Inspect frame casting for cracks, etc.

(c) Belt.

Monthly.- Inspect for slipping, tighten belt, or apply dressing as needed.

(d) Crankshaft, Connecting Road, Crosshead, Piston and Rod, Cylinder and Bearings.

One to three years.- When performance or trouble reports indicate a general overhaul is needed, follow overhaul instructions.

(e) Packing Glands.

Daily.- Check glands for leakage, take up packing gland or repack as needed.

(11) Painting.- Periodic painting is required of the parts of pumping plant, closure materials, and other structures that require this type of protection in order to protect metal parts from corrosive action of water and other elements. Frequency of painting varies, depending on type of paint used, methods of application, and conditions of wear. Always paint metal surfaces before corrosion becomes so severe that equipment is damaged. Prepare metal surfaces by sandblasting, if practical, or by cleaning them thoroughly with sandpaper and wire brush. Only specially prepared paints should be used on damp surfaces that will be encountered. Corrosion-Preventive compounds may be used in moist or wet places where paint would not last.

e. Shut Down Procedure.- Immediately upon final recession of flood waters, switches and sluice gates shall be restored to their normal settings. The pumping plant shall then be thoroughly cleaned and equipment thoroughly inspected, oiled, and greased. After each flood period, all parts of the pumps should be checked thoroughly. The pump bowls should be checked for damage, pitting, or other damage. The impellers should be checked for damage, pitting, looseness on the shaft, etc. The bearings, the oil feed piping, and other parts should be inspected for possible damage from floating debris, vibration, or excessive strain. A log of pumping plant operation shall be furnished the District Engineer following each flood.

4.042. **PUMPING PLANT B.**

a. Description.

(1) General.- Pumping Plant B consists of a pumphouse, an adjoining intake structure, four gravity sluices through the Levee, and an outlet structure.

(a) The intake structure, adjoining the pumphouse, consists of approach wingwalls and apron, a raking platform, and trash racks.

(b) There are four 6-foot diameter gravity sluices through the levee, with a gated control structure and a flap gate on the outlet of each sluice. The gated structure consists of four 72" round sluice gates operated by four hand-operated gate hoists.

(c) The outlet structure consists of a concrete headwall, wingwalls, and apron.

(d) The pumphouse consists of a concrete substructure used as a sump pit and a brick superstructure that house four 52,000 gpm pumps. The following equipment is in the pumphouse:

1. Four 52,000 gpm, screw type pumps manufactured by Fairbanks, Morse and Company.

2. Four gate valves equipped for motorized operation.

3. A trolley type chain hoist with chain-operated bridge.

4. Two vacuum pumps.

b. Operation of Facilities.- See paragraph 4.04b for instructions on operation log. The procedure for operating the pumping plant is as follows:

(1) Starting Procedure.

(a) Check to see that the city water is on and that the water tank is at least half full.

(b) Check to see that the brakes on the pumps are free.

(c) Start the flood control pumps as follows:

1. Open the water valve to lubricate the rubber bearings.

2. Grease packing gland and check oil level in motor bearings.

3. Start one exciter and adjust until the board lights are glowing brightly.

4. Close sluice gates.

5. Open the water valve to the vacuum prime pump, and then throttle valve to allow a small flow during operation.

6. See that the vacuum pump discharge and suction line is open.

7. Grease the packing gland.

8. Start the vacuum pump.

9. Start No. 1 flood control pump and immediately open the discharge valve.

10. After the vacuum pump has a vacuum, open the 4" valve on No. 1 pump. (Pumps cannot be primed until sump is above elevation 387.5).

11. Watch the vacuum gage for prime which can be heard or seen. When the pump is primed, close the 4" valve. Leave the vacuum pump running. Full load is 368 amps at 440 volts.

12. Adjust the D. C. Ammeter to 37.5 amps.

13. Repeat the above procedure to start additional pumps, as needed.

14. When the required pumps have been started, stop the vacuum pump.

15. During operation keep the trash racks free of trash and brush.

(2) Stopping Procedure.- Stop the flood control pumps as follows:

(a) Open the 4" vacuum valve at the pump.

(b) Close the pump discharge valve.

(c) Stop the pump.

(d) When the pump stops, close the water valve to the rubber bearing.

(e) Stop the exciter when all pumps are stopped.

(3) Power Failure Procedure.- The procedure to be used in case of power failure is as follows:

(a) Apply brakes as pump reverses rotation.

(b) See that overload circuit breaker is closed.

(c) Close pump discharge gates.

(d) See that the three disconnect links located outside on the transformer banks are closed.

c. Inspections and Tests.- (These instructions also apply to Pumping Plants C and D.)

(1) Megger Tests.- Megger tests on the motors should be performed annually. A curve of minimum insulation resistance versus temperature should be obtained from the motor manufacturer and kept with the records of the insulation resistances taken each year. To measure insulation resistance, the following procedure should be used:

(a) With the motor cold and the magnetic contactor in the open position, read the insulation resistance between any one of the load contacts and the frame ground. If the megger reading falls below the minimum insulation resistance curve supplied by the manufacturer for the corresponding temperature, the motor should be disconnected from the line and the megger test repeated at the terminal box of the motor. If this megger reading is still below that of the curve, a report to the Corps of Engineers District Office should be submitted immediately. No attempt should be made to start the motor. Enter the megger reading and the temperature on the permanent record maintained for the equipment.

(b) Obtain D. C. resistance of the stator windings by impressing a D. C. voltage across the windings and reading the voltage and current. Record the circuit designations of the winding used.

(c) Run the motor under normal load for a minimum of 15 minutes, shut down and repeat megger and D. C. resistance readings. Use the coil recorded under step 2 for the resistance measurements.

(d) By means of one of the formulae given at the end of this section, compute the temperature of the stator using the "hot" resistance obtained in step 3. Record this temperature and the megger reading on the permanent test record. If the megger reading for this temperature falls below the minimum insulation resistance curve at the same temperature, the procedure outlined in step 1 should be followed.

(e) On the curve of megger reading vs temperature furnished by the manufacturer locate the point found in Step 1. Through this point lay a straightedge parallel to the minimum insulation resistance curve. Record the insulation resistance in megohms found at the intersection of the straightedge and the base temperature of 75° C., on the permanent test record under "Adjusted Insulations Resistance."

(f) Perform Step 5 for readings taken in Step 3. The adjusted insulation resistance for both the motor "cold" and the motor "hot" should be approximately the same.

(g) If both the "cold" and "hot" test values fall above the minimum curve, the winding is satisfactory. If they fall below, the winding insulation is deteriorating or damp. The recommended method for drying out motors is by blowing heated air across the windings. Another method in which extreme care must be exercised is by circulating a low voltage current through the windings. This method should be used only by qualified personnel. An exceptionally low insulation resistance reading indicates probable contact between stator winding and frame. This condition should be corrected before any other remedial measures are initiated.

(2) <u>Periodic Trial Runs and Tests</u>.- All equipment including switchgear, transformers, motors, pumps and gates shall be trail operated and checked at least once every 90 days.

(3) <u>Inspection of Equipment and Machinery</u>.- Pumping plants shall be inspected at intervals not to exceed 30 days during the flood season and 90 days during the off season to insure that all equipment is in order for instant use.

d. <u>Maintenance</u>.- (These instructions also apply to Pumping Plants C and D.) To insure maximum operation during flood conditions it is important that all equipment and machinery be inspected and maintained on a regularly scheduled basis. Undue wear at any point should be reported to supervisors without delay. The inspection intervals shown for each item are considered maximum periods between inspections. Preventative maintenance should be given major consideration at all times. A complete inspection of all machinery, equipment, and facilities should be made immediately after the recession of each flood which required the use of such facilities. The legend below explains the inspection interval symbols used in the succeeding maintenance instructions.

<u>Legend to Inspection Interval</u>

D - Daily Inspection
SW - Semi-weekly
W - Weekly
Bi-W - Bi-weekly
M - Monthly
Bi-M - BiMonthly

Q - Quarterly
SA - Semi-annually
A - Annually
B-E - Bienially
N.S. - Not Scheduled

(1) Buildings and Grounds.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Building	W-A	(a)
Yard and grounds	W-N.S.	(b)

(a) Buildings.

Weekly.- Check interior for cleanliness. Remove trash and fire hazards. Keep oil drips cleaned up. Keep door locks in good condition.

Annually.- Check roof, walls and floors for damage to concrete and/or masonry. Repair as needed. Check ventilators to insure proper functioning. Check for settlement of floors or foundations and/or cracks in walls.

(b) Yard and Grounds.

Weekly.- Check for fire hazards. Remove trash and debris. See that gates, buildings, etc., are locked where necessary to prevent unauthorized persons from entering or tampering with tools and equipment.

Not-Scheduled.- Clear grounds of all drift and other debris after each high water period.

(2) Access Roads, Walks and Parking Areas.

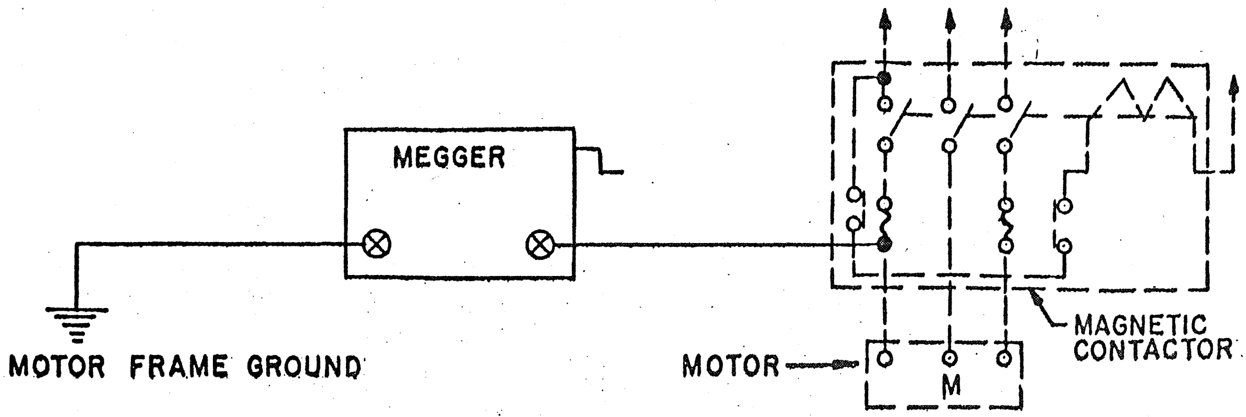
Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Access Roads, Walks and Parking Areas	A-N.S.	(a)

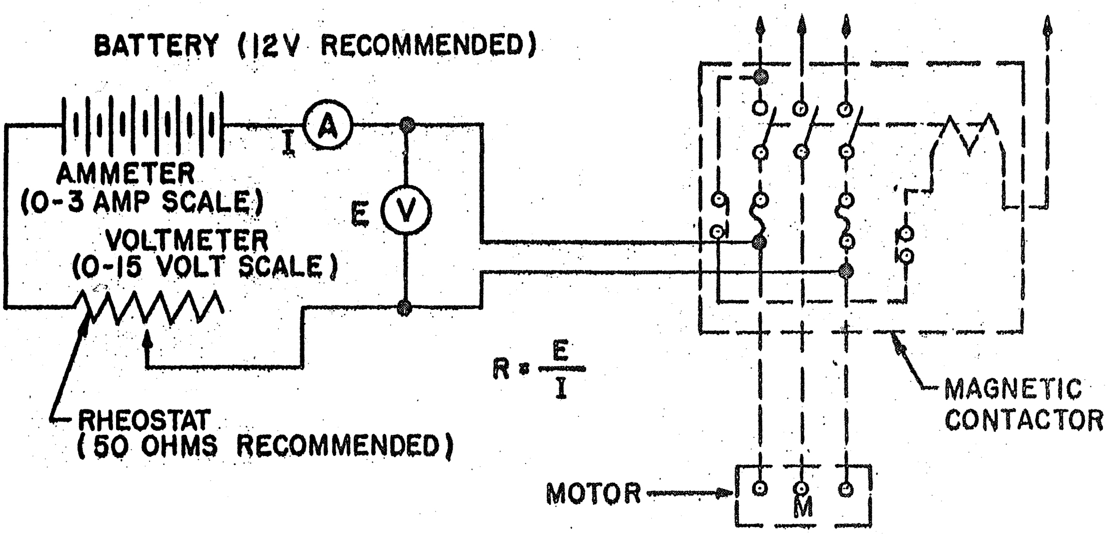
(a) Access Roads, Walks, Parking Areas.

Annually.- Check road, walks and parking area surfaces for holes, bumps, ruts, etc. Fill, shape and/or repair as needed.

Not Scheduled.- While making routine trips over roads and in parking areas, damaged areas should be noted and repaired before extensive damage results.



WIRING DIAGRAM
INSULATION RESISTANCE



WIRING DIAGRAM
STATOR WINDING RESISTANCE (D-C)

CENTIGRADE: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (234.5 + T_{COLD}) - 234.5$

FAHRENHEIT: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (390.0 + T_{COLD}) - 390.0$

R = STATOR WINDING RESISTANCE (D-C)
T_{COLD} = AIR TEMPERATURE (COLD MOTOR)
T_{HOT} = TEMPERATURE TO BE DETERMINED AT END OF RUN

FORMULA FOR COMPUTING TEMPERATURES

INSULATION RESISTANCE
CONNECTION DIAGRAMS
CORPS OF ENGINEERS FORT WORTH DISTRICT

(3) Pumps and Motors.

(a) Pumps.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Foundation	M	1
Impeller	A	2
Bearing	D-A-N.S.	3
Packing gland	D-M-N.S.	4
Coupling	A-N.S.	5
Lubrication	D-SA	6

1. Foundation.

Monthly.- Inspect foundation for cracks, settling, etc.

2. Impeller.

Annually.- Make annual check when condition or performance of pump indicates overhaul is necessary, then perform general overhaul maintenance. Inspect impellers and seals.

3. Bearings.

Daily.- Check lubrication of bearings.

Annually.- Change oil and/or grease in bearings and couplings.

Not Scheduled.- At general overhaul inspect bearings; make repairs if needed.

4. Packing Gland.

Daily.- Observe leakage at the gland. Take up gland as needed.

Monthly.- Inspect gland repack if needed. Inspect sleeve for wear.

Not Scheduled.- At general overhaul inspect packing gland and sleeve. Renew sleeve if needed, and make other repairs as needed.

5. Coupling.

Annually.- Lubricate coupling.

Not Scheduled.- At general overhaul, disassemble coupling and replace worn parts.

6. Lubrication.

Daily.- Check lubricating system. See that oil reservoirs are full.

Semiannually.- Drain and flush all oil reservoirs. Refill with oil. Remove old grease from lines and bearings and refill.

(b) Motors.

Inspection and Check List

Item to be Inspected	Inspection Interval	Paragraph
Foundation, base, or support	M	1
Frame	NS	2
Laminations and pole pieces	NS	3
Armature or rotor	Q	4
Air gap	A	5
Windings	Q-B.E.	6
Slot wedges	B.E.-N.S.	7
Couplings and gears	M-A	8
(Thrust bearings	D-Q	9
(	A - Four years	
(Guide bearings	D-Q	10
(	A - Four years	
Thrust bearing oil strainer	Q	11
Painting	B.E.	12

1. Foundation Base or Support.

Monthly.- Note any unusual condition of foundations or supports.

2. Frame.

Not Scheduled.- Tighten bolts in stator splits and other parts.

3. Laminations and Pole Pieces.

Not Scheduled.- Tighten lamination bolts when a check indicates this should be done.

4. Armature or Rotor.

Quarterly.- Check squirrel-cage rotor bars for loose or broken bars or connections, by unusual sounds, by refusal to carry full load, or failure to build up full synchronous speed.

5. Air Gap.

Annually.- Check air gap at four quadrature positions and recenter rotor if necessary. Replace bearings or recenter as required.

6. Windings.

Quarterly.- Visual inspection for damaged insulation, dirt, oil, or mo sture on winding. If required, blow out with clean dry air at low pressure, and clean winding thoroughly with a noninflammable cleaner using suitable brushes and air cleaning spray gun. Check insulation resistance.

Biennially.- Inspect the condition of the winding insulation, connections, clamps and related items. Clean thoroughly and revarnish windings if required to place in good condition. Renew any other items that have deteriorated to the point that they should be replaced. Check insulation resistance.

7. Slot Wedges.

Biennially.- Check slot wedges and replace loose ones. Tighten coils in slots by rewedging if necessary.

Non-Scheduled.- If wedges become loose, rewedge, clean and paint stator.

8. Couplings and Gears.

Monthly.- Check oil level in gear cases.

Annually.- Check to see that set screws and coupling bolts are tight. Change oil in gear cases. Lubricate couplings.

9. Thrust Bearing.

Daily.- Check oil level in bearing, add oil as needed.

Quarterly.- Inspect for oil leaks.

Annually.- Change oil if analysis or condition of oil shows this to be desirable.

Four Years.- Dismantle thrust bearing. Inspect plates, smooth off sharp edges, cracks if found, lightly scrape high spots. Remove and inspect runner plate, hone if necessary. Clean springs, housing, baffles and all internal parts and area. Remove, clean, and inspect vapor ring.

10. Guide Bearings.

Daily.- Check oil level in bearings.

Quarterly.- Inspect bearing housing and piping for oil leaks.

Annually.- Change oil if analysis or condition of oil show this to be desirable.

Four Years.- Dismantle and lower bearings for inspection and cleaning. Lightly scrape bearing. Polish and hone journal. Check bearing alignment and clearance, altering same if needed.

11. Thrust Bearing Oil Strainer.

Quarterly.- Remove and clean thrust bearing oil strainer.

12. Painting.

Biennially.- Clean, inspect, touch up paint as needed.

(4) Cranes and Hoists.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Crane, rails, supports, stops	A	(a)
Crane bridge	A	(b)
Trucks	A	(c)
Bumpers	A	(d)
Hoist conductors, supports & pickup cable	A	(e)
Trolley wheels	M	(f)
Chain sheaves	W-A	(g)
Chains	W-A	(h)
Blocks and hooks	W-M	(i)
Driving gears, shafts, bearings & wheels	W-M-A	(j)

(a) Crane Rails, Supports and Stops.

Annually.- Check rails for alignment and obstructions. Check supports for cracks and spalling if concrete, and for corrosion and loose rivets and bolts if steel. Repair concrete as necessary. Tighten or calk loose rivets and bolts. Check stops for security to building or rails.

(b) Crane Bridge and Carriage.

Annually.- Check frame work for looseness and cracks. Check rivets and bolts for tightness. Check girders for alignment. Examine girders for corrosion. Clean and paint as necessary.

(c) Trucks.

Annually.- Check trucks for skew and condition of wheels.

(d) Bumpers.

Annually.- Check for looseness. Examine bumpers to see that they are properly positioned. Tighten or adjust as necessary.

(e) Trolley Conductors Supports and Pickup Cable.

Annually.- Check hoist system for damaged or worn conductors, broken insulators, worn supply cable and plugs or loose connections. Repair or replace as neccessary.

(f) Trolley Wheels.

Monthly.- Make visual inspection of collector system. Repair as needed.

(g) Sheaves.

Weekly.- Check sheaves for broken or chipped wheels.

Annually.- With chain removed, check for wear, chipping and corrosion. Check bearings for clearance and refit if needed.

(h) Cables or Chains.

Weekly.- Visual inspection for broken or frayed strands or broken or elongated chain links.

Annually.- Run cable or chain out and inspect carefully for frayed or broken strands, stretched or weakened links. Examine for wear and corrosion, especially down between the cable strands. Lubricate.

(i) Blocks and Hooks.

Weekly.- Inspect hook for bending and stretching.

Monthly.- Lubricate sheaves.

(j) Driving Gears, Shafts, Bearings and Wheels.

Weekly.- Check lubrication. Examine for excessive wear.

Monthly.- Lubricate sleeve and box bearings.

Annually.- Lubricate ball and roller bearings and change oil in gear cases.

(5) Electrical Equipment.

(a) Switchboards and Control Equipment.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Panels, supports, cabinets and cubicles	W-A	1
Panel wiring and terminal blocks	A	2
Auxiliary and control relays	D-A	3
Control switches and push buttons	W-M-A	4
Indicating lamps	D	5
Meters and Instruments	D-A	6
Position indicators	D	7
Protective relays	D-A	8
Resistors	B. E.	9
Test switches and jacks	A	10

1. Panels, Supports, Cabinets and Cubicles.

Weekly.- Check for general cleanliness and condition of finish. Clean off dust, dirt, and grease. Use a solution of mild soap and water or Okite Renovator diluted as per directions, to remove dirt and grease from panels. Many cleaning compounds are harmful to the finish and should not be used. Since switchboard panels having considerable equipment on them are difficult to refinish, care must be taken in cleaning them. Wax may be used where the gloss is not objectionable.

Annually.- Repair finish and hardware and clean as necessary. Tighten bolts and screws. Check boxes and cabinets in damp locations for corrosion and rust. Clean and refinish as necessary.

2. Panel Wiring and Terminal Blocks.

Annually.- Check for general housekeeping. Vacuum out terminal cabinets and wiring and control cubicles using due care and caution around live relays and controls. Check condition of wiring, particularly observing evidence of damaged insulation. Re-mark tags for terminal blocks when needed. Tighten connection at terminal points.

3. Auxiliary and Control Relays.

Daily.- Note and report any unusual heating, vibration, or other unusual condition of relays.

Annually.- Inspect relays. Dress contacts or replace if needed. Check contact spring and wiping action. Check contact shunts, etc. Make other adjustments, alignments, etc., as required. Test relay circuits.

4. Control Switches.

Weekly.- Operate control switches for test when feasible. Make repairs as needed.

Monthly.- Test control switches and push buttons on motors of all auxiliary equipment. Make repairs as needed.

Annually.- Overhaul all control switches at least once a year, oftener if needed. Check spring action and replace all switch units having unsatisfactory action.

5. Indicating Lamps.

Daily.- Replace any burned-out pilot lights. Make repairs as found necessary.

6. Meters and Instruments.

Daily.- Observe performance of instruments, adjust and repair as needed.

Annually.- Check calibration of meters and instruments; clean, adjust and repair as necessary. Tighten connections, check wiring connections if any changes have been made in associated circuits or equipment.

7. Position Indicators.

Daily.- Observe operation of position indicators. Make adjustments, repairs, etc., as needed.

8. Protective Relays.

Daily.- Visual inspection for anything unusual about contacts, coils, or moving element. Keep targets re-set.

Annually.- Test relays as per instructions.

9. Resistors.

Biennially.- Vacuum. Make repairs as needed.

10. Test Switches or Jacks.

Annually.- Examine test switch contacts and refinish with file or abrasive if burned or corroded. Tighten connections.

(b) Low Voltage Switchgear - Busses and Cables.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Bus bars, joints, and connections	B. E.	1
Bus insulators and supports	B. E.	2
Bus enclosures and barriers	B. E.	3
Switchgear panels and enclosures	M-A	4
Locks and interlocks	M	5
Warning and safety signs	M	6
Current and potential transformers	A	7

1. Bus Bars, Joints and Connections.

Biennially.- Check bus bars, joints and connections for overheating. Tighten joint and connection bolts. Refinish joint contact surfaces. Silver plate if required on high current connections to prevent heating.

2. Bus Insulators and Supports.

Biennially.- Inspect and clean insulators or insulating block supports. Paint chip spots on porcelain with red glyptal. Tighten bolts. Check supports for rigidity. Inspect tape insulation on bus bars, if any, and re-varnish as required.

3. Bus Enclosures and Barriers.

Biennially.- Check bus enclosures and interphase barriers for tightness and adequate ventilation. Clean as required.

4. Switchgear Panels and Enclosures.

Monthly.- Inspect and clean as required with industrial type hand vacuum cleaner.

Annually.- Inspect, clean and check for loose bolts, repaint or refinish as required.

5. Locks and Interlocks.

Monthly.- Check all key locks and mechanical interlocks. Lubricate cylinder locks with powdered graphite only. Leave in proper operating position.

6. Warning and Safety Signs.

Monthly.- Check to see that adequate warning and safety signs are in place around live parts or other safety hazards.

7. Current and Potential Transformers.

Annually.- Check oil level and oil leaks in oil-filled transformers. Check for leaking compound from dry type transformers. Clean insulators. Check and tighten primary and secondary connections. See that short circuiting device on current transformer secondary is secured in the open position and that protector tubes are not bypassing current at normal loads. Check potential transformer fuses.

(c) Disconnecting Switches and Fuses.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and Mounting	B. E.	1
Insulators	A-B. E.	2
Line and ground connections	Q-B. E.	3
Blades and contacts	Q-A-B. E.	4
Locks and interlocks	Q	5
Fuse tubes and fuse links	Q	6

1. Base and Mounting.

Biennially.- Inspect for loose bolts or structure.

2. Insulators.

Annually.- Check for chipped and broken insulators. Clean as required.

Biennially.- Tighten loose assembly bolts.

3. Line and Ground Connections.

Quarterly.- Make visual inspection of line connections and where evidence of loose connections exist, tighten as required. Check condition of ground connection to assure that it is not broken and ground connection is tight.

Bi-ennially.- Inspect and tighten connections as required.

4. Blades and Contacts

Quarterly.- See that blades are properly seated in the contacts. Where necessary, adjust blades.

Annually.- Operate switch several times and see that blades are properly aligned to engage contacts.

Biennially.- Check alignment and condition of blades and contacts. Tighten bolts and screws, adjust contact pressure and maintain silver or other contact surface in good condition.

5. Locks and Interlocks.

Quarterly.- See that switches are properly locked in the open or closed position as required, by padlocks or other key-type locks or interlocks. Lubricate with powdered graphite only, from a graphite gun. No other lubricant shall be used on padlocks or cylinder locks. See that locks and keys operate as intended. Check mechanical interlocks such as between main disconnecting switch and ground switch for operation.

6. Fuse Tubes and Fuse Links.

Quarterly.- Inspect and check fuses and their holders for evidence of failure or improper conditions. When fuse trouble occurs due to high resistance contact between ferrule and holder, refinish ferrule and fuse dips. On fuses of high current rating or exposed to unfavorable atmospheric conditions it may be found desirable to silver plate the contact surfaces.

(6) Sluice Gates.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Sluice Gates	A	(a)
Seals and Guides	A	(b)

(a) Sluice Gates.

Annually.- Inspect condition of bolts, studs, batching devices, paint, or other surface treatment. Repair or replace as necessary. Check operation of gate and leakage of water through gate. Disassemble gate and make repairs if necessary to stop excessive leakage.

(b) Seals and Guides.

Annually.- Check seals and guides for wear and deterioration. Renew seals and build up guides where scored, as necessary.

(7) Flap Gates.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Flap Gates	Q	(a)

(a) Flap Gates.

Quarterly.- Flap gates should be trial operated, serviced, and lubricated to be certain they swing freely and do not bind. Caution: In order to prevent possible damage, do not allow the flaps to slam against their seats.

(8) Trash Racks.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Trash Racks	W-A	(a)

(a) Trash Racks.

Weekly.- Check trash racks for debris. See that trash and debris is removed.

Annually.- Inspect trash racks, including underwater portion so far as feasible; remove lodged debris not removed on routine cleaning. Check condition of metal work, repair as needed. Paint every 5 years unless inspection shows more frequent painting to be necessary.

(9) Gate Valves.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Gate Valves	Q	(a)
Packing	A	(b)
Gearing	A	(c)
Rising Stems	Q	(d)
Valve Seats	N. S.	(e)

(a) Gate Valves.

Quarterly.- Operate gate valves to prevent sticking.

(b) Packing.

Annually.- To eliminate excessive friction between valve stem and packing, lubricate with a few drops of graphite bearing oil. Stop leakage by tightening stuffing-box nuts. Replace packing as needed.

(c) Gearing.

Annually.- Lubricate gate valves as recommended by manufacturer.

(d) Rising Stems.

Quarterly.- Clean threads on rising-stem gate valves and lubricate.

(e) Valve Seats.

Not Scheduled.- Reface leaky gate valve seats as necessary.

(10) Painting.

Periodic painting is required of the parts of pumping plant, closure materials, and other structures that require this type of protection in order to protect metal parts from corrosive action of water and other elements. Frequency of painting varies, depending on type of paint used, methods of application, and conditions of wear. Always paint metal surfaces before corrosion becomes so severe that equipment is damaged. Prepare metal surfaces by sand blasting, if practical, or by cleaning them thoroughly with sandpaper and wire brush. Only special-prepared paints should be used on damp surfaces that will be encountered. Corrosion-preventive compounds may be used in moist or wet places where paint would not last.

d. Shut Down Procedure.- (These instructions also apply to Pumping Plants C and D.) Immediately upon final recession of floos waters, switches and sluice gates shall be restored to their normal settings. The pumping plant shall then be thoroughly cleaned and equipment thoroughly inspected, oiled and greased. After each flood period, all parts of the pumps should be checked thoroughly. The pump bowls should be checked for damage, pitting, looseness on the shaft, etc. The impellers should be checked for damage, pitting, looseness on the shaft, etc. The bearings, the oil feed piping, and other parts should be inspected for possible damage from floating debris, vibration, or excessive strain. A log of pumping plant operation shall be furnished the District Engineer following each flood.

SECTION IV

PROJECT FACILITIES

CHAPTER 4

PUMPING PLANT C

4.043. PUMPING PLANT C.

a. Description.

(1) General.- Pumping Plant C consists of a pumphouse, an adjoining intake structure, two gravity sluices through the levee, and an outlet structure.

(a) The intake structure, adjoining the pumphouse, consists of approach wingwalls and apron, a raking platform and trash racks.

(b) There are two 4' x 4' gravity sluices through the levee, with a gated control structure, and a flap gate on the outlet of each sluice. The gated control structure on the riverside of the levee consists of two 4' x 4' sluice gates operated by two hand-operated gate hoists.

(c) The outlet structure consists of a concrete headwall, wingwalls, and apron.

(d) The pumphouse consists of a concrete substructure used as a sump pit and a brick superstructure that houses two 30,000 gpm open suction centrifugal pumps. The following equipment is in the pumphouse:

1. Two 30,000 gpm, 125 h.p. vertical pumps, manufactured by Fairbanks, Morse.

2. Two 24" hand-operated gate valves.

3. Two 4' x 4' sluice gates in the sump outlet wall operated by two motor driven hoists.

4. Two 4' x 4' sluice gates in the sump inlet wall operated by two hand-operated gate hoists.

b. Operation of Facilities.- See paragraph 4.04b for instructures on Log Operation. The procedure for operating the pumping plant is as follows:

(1) Starting Proceedure.

(a) Check pumps and exciters by hand to see that they are free to turn.

(b) Check all contact points on all switches, and also check and clean the collector rings on the pump motors.

(c) Close the sluice gates on the outlet wall of the sump.

(d) Check to see that the gates on the sump inlet wall and the gate valves on the pump discharge are open.

(e) Close the two 3-pole Knife switches at the top of the control panel.

(f) Start the pumps as follows:

1. Start one exciter and adjust until the board lights are glowing brightly.

2. Start one pump and adjust the D. C. current to 15.5 amps. Full load is 134 amps at 440 volts.

3. Start the second pump if it is to be used.

(g) During operation keep trash racks free of trash and debris.

(2) Stopping Procedure.- The procedure for stopping the pumps is as follows:

(a) Stop the pumps.

(b) Close the pump discharge gate valve.

(c) After both pumps have stopped turning, pull the exciter switch.

(d) Pull the two 3-pole Knife switches at the top of the control panel.

(3) Power Failure Procedure.- The procedure to use in case of power failure is as follows:

(a) Close the pump discharge gate valve if pump reverses rotation.

(b) Check fuses in the main feeder box.

(c) Check to see if the three disconnect switches located outside the transformer bank are closed.

c. Inspections and Tests.- (See Pumping Plant B instructions.)

d. Maintenance.- (See Pumping Plant B instructions.)

e. Shut Down Procedure.- (See Pumping Plant B instructions.)

SECTION IV

PROJECT FACILITIES

CHAPTER 4

PUMPING PLANTS

4.044. PUMPING PLANT D.

a. Description.

(1) General.- Pumping Plant D consists of a pumphouse, an adjoining intake structure, two gravity sluices through the levee, and an outlet structure.

(a) The intake structure, adjoining the pumphouse consists of approach wingwalls and apron, a raking platform, and trash racks.

(b) There are two 4- x 4-foot gravity sluices through the levee with a gated control structure on the riverside of the levee and a flap gate on the outlet of each sluice. The gated control structure consists of two 4- x 4-foot sluice gates operated by two hand-operated gate hoists.

(c) The outlet structure consists of a concrete headwall, wingwalls, and apron.

(d) The pumphouse consists of a concrete substructure used as a sump pit and a brick superstructure that houses two 30,000 gpm open suction centrifugal pumps. The following equipment is in the pumphouse:

1. Two 30,000 gpm, vertical, 125 H.P. pumps, manufactured by Fairbanks, Morse, and Co.

2. Two 24" hand-operated gate valves.

3. Two 4- x 4-foot sluice gates in the sump outlet wall operated by two motor-operated gate hoists.

4. Two 4- x 4-foot sluice gates in the sump inlet wall operated by two hand-operated gate hoists.

b. Operation of Facilities.- See paragraph 4.04b for instructions on Operation Log. The procedure for operating the pumping plant is as follows:

(1) Starting Procedure.

(a) Check the pumps and exciters by hand to see if they are free to turn.

(b) Check all contact points on all the switches, and also check and clean the collector.

(c) Close the sluice gates on the sump outlet.

(d) See that the gates on the sump intake and the gate valves on the pump discharge are open.

(e) Close the two 3-pole Knife switches at the top of the control panel.

(f) Start the pumps as follows:

1. Start one exciter and adjust until board lights are glowing brightly.

2. Start one pump and adjust the D.C. current to 15.5 amps. Full load is 134 amps at 440 volts.

3. Start the second pump, if it is to be used.

(g) During operation keep trash racks free of trash and debris.

(2) Stopping Procedure.- The procedure for stopping the pumps is as follows:

(a) Stop the pump.

(b) Close the pump discharge gate valve if the pump reverses rotation.

(c) After both pumps have stopped turning, pull the exciter switch.

(d) Pull the two 3-pole Knife switches at the top of the control panel.

(3) Power Failure Procedure.- The procedure to use in case of a power failure is as follows:

(a) Close the pump discharge gate valve if the pump reverses rotation.

(b) Check the fuses in the main feeder box.

(c) Check to see if the three disconnect links located outside on the transformer bank are closed.

c. Inspection and Tests.- (See Pumping Plant B instructions.)

d. Maintenance.- (See Pumping Plant B instructions.)

e. Shut Down Procedure.- (See Pumping Plant B instructions.)

Chapter 4
PUMPING PLANTS

4.045 - PUMPING PLANT PAVAHO

a. Description.

(1) General.- The Pavaho Street pumping plant consists of a pumphouse, and adjoining discharge chamber, an inlet structure, and an outlet structure.

(a) The inlet structure consists of approach walls, guide walls, approach apron, trash racks, and a raking platform. A tile staff gage is located near the trash racks on center wall.

(b) The discharge chamber, or wet well, is a dual-purpose structure which provides access to the inlets of the box culverts during periods of either gravity flow or of pump discharge. It contains two 6- x 8-foot sluice gates in the upstream wall for control of gravity flow. Motor-operated floorstands are provided in the pumphouse to operate the gates.

(c) The sluice through the levee is a double 6- x 8-foot concrete box culvert 284 feet long, extending from the wet wall to the outlet structure.

(d) The outlet structure consists of a headwall, wing walls, and apron. Flap gates are installed on the outlets of the conduits.

(e) Electric power is supplied from three 167 KVA 13,200-480-volt transformers connected Wye-Delta. Incoming service consists of 3-500 MCM, T.B.W.P. conductors.

(f) The pumps are driven by two 440-volt, 250 h.p. vertical motors. Two metal clad switchgear cabinets house the electrical switchgear for the incoming line and the pump motors. Lighting and low voltage power is supplied through a 5 KVA 480-120/240-volt dry type transformer.

(g) The sluice gate hoist motors are controlled by pushbutton stations on the hoists or from pushbutton stations mounted on the wall next to the lighting distribution panel. Indicating lights at each position show the position of the gate - open or closed. The pushbutton stations control magnetic starters located at the floorstands. Gates are opened by pushing the "open" button. Limit switches stop the gates when they reach the fully open position. The gates may be stopped at any intermediate position by pressing the "stop" button. This will stop the motor and set the brake. The sluice gates are closed by pushing the close button. The gates are equipped with torque limit switches to stop the motor when the seal has been established or when the gates meet an obstruction as they are being closed.

(h) A tile staff gage panel built into the upstream face of the wall between the pumping plant and the discharge chamber and on the upstream side of the trash racks.

(i) The pumphouse consists of a concrete substructure used as a sump pit and a concrete superstructure that houses two 30,000 gpm vertical, axial flow pumps. The following equipment is in the pumphouse:

1. Two 30,000 gpm, 100 h.p., vertical mixed flow pumps manufactured by Economy Pumps, Inc., Philadelphia, Pa.

2. Two grease lubricating systems manufactured by the Farval Corporation, Cleveland, Ohio.

3. A water level recorder manufactured by Leupold & Stevens Instruments, Inc., Portland, Oregon. (For details, see Annex 7).

4. An 8-ton trolley type spur geared hoist with bridge.

5. A water level control manufactured by Healy Ruff Co.

6. Two motor-operated sluice gate hoists.

7. Two 6 x 8-foot sluice gates.

b. Operation of Facilities.- See paragraph 4.04b for instructions on Operation Log.

(1) Starting Procedure.- The procedure for operating the pumping plant is as follows:

(a) Check to see that the incoming line switch and the gate hoists switch on the main control panel are closed.

(b) Turn each pump by hand to see that it is free to run.

(c) Turn off pump motor heaters.

(d) Follow the instructions of the Farval Lubricators on the pumps and grease the bearings.

(e) Check the float switch to see that the tape is not binding.

(f) Check the oil level in the upper motor bearing.

(g) Pumps must be started manually as follows:

1. Close control switch for one pump. Wait until pump reaches full speed before starting second pump.

2. Start closing sluice gates. As the pumps are running, this will flush out the gate openings. When a gate reaches its closed position the hoist motor will continue to turn until a torque is set up in the drive shaft which is sufficient to operate the torque switch. This insures that the gate is firmly seated before the drive is discontinued. The amount of torque to be applied before the motor is stopped is adjustable at the torque limit switch. Moving the indicator in the torque switch housing toward the higher numbers increases the amount of torque necessary to operate the contacts and results in a tighter seal at the gate. If the gate hoist is stopped before the gate is fully closed, it is probable that an obstruction has interrrupted the gate closing.

(h) During operation of the pumps, check ammeters on pump control cabinet. Full load current should be approximately 320 amperes. If the current reads above 365 amperes continuously, the pumps should be shut down and inspected.

(i) The hoist motor heaters should be on at all times.

(j) The pump motor heaters should be on except when the pumps are running.

(k) If undue vibration occurs during operation of the pumps they should be shut down and inspected. Contact a representative of the pump manufacturing company prior to initiating any work on the pumps.

(l) During operation the trash racks should be kept free of trash and debris.

(2) Stopping Procedure.-

(a) Pumps will run until stopped automatically by opening of float switch contacts when the water decreases to elevation 386.33.

(b) Pumps may be stopped manually by moving the pump control switches to trip.

(3) Power Failure Procedure.- The procedure to be used in case of power failure is as follows:

(a) Check to see if the switches in the lower left hand side of the control panel are closed.

(b) Check the fuses in the upper left hand side of the control panel.

(c) Check to see if the three disconnect links are closed. (Located outside on the transformer bank.)

c. Inspections and Tests.

(1) Megger Tests.- Megger tests on the motors should be performed annually. A curve of minimum insulation resistance versus temperature should be obtained from the motor manufacturer and kept with the records of the insulation resistances taken each year. To measure insulation resistance, the following procedure should be used:

(a) With the motor cold and the magnetic contactor in the open position, read the insulation resistance between any one of the load contacts and the frame ground. If the megger reading falls below the minimum insulation resistance curve supplied by the manufacturer for the corresponding temperature, the motor should be disconnected from the line and the megger test repeated at the terminal box of the motor. If this megger reading is still below that of the curve, a report to the Corps of Engineers District Office should be submitted immediately. No attempt should be made to start the motor. Enter the megger reading and the temperature on the permanent record maintained for the equipment.

(b) Obtain D.C. resistance of the stator windings by impressing a D.C. voltage across the windings and reading the voltage and current. Record the circuit designations of the winding used.

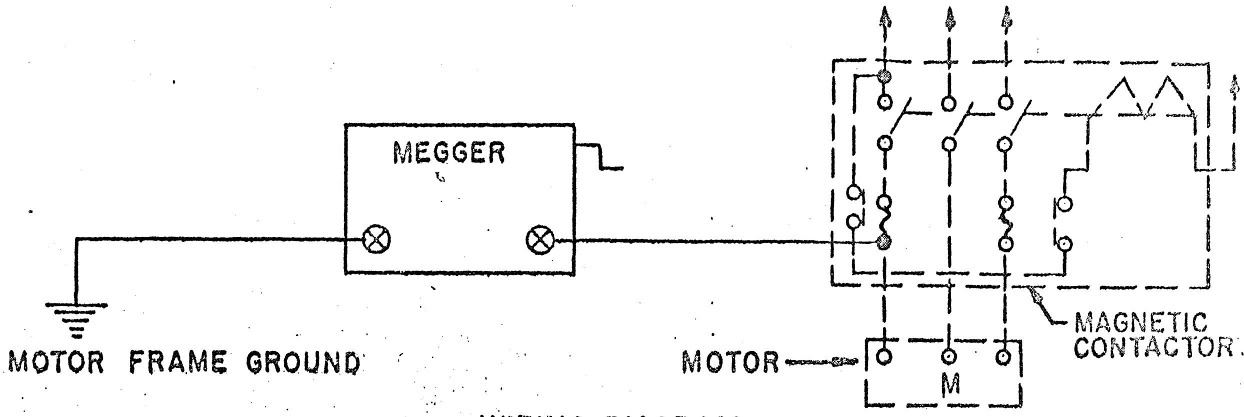
(c) Run the motor under normal load for a minimum of 15 minutes, shut down and repeat megger and D.C. resistance readings. Use the coil recorded under step 2 for the resistance measurements.

(d) By means of one of the formulae given at the end of this section, compute the temperature of the stator using the "hot" resistance obtained in step 3. Record this temperature and the megger reading on the permanent test record. If the megger reading for this temperature falls below the minimum insulation resistance curve at the same temperature, the procedure outlined in step 1 should be followed.

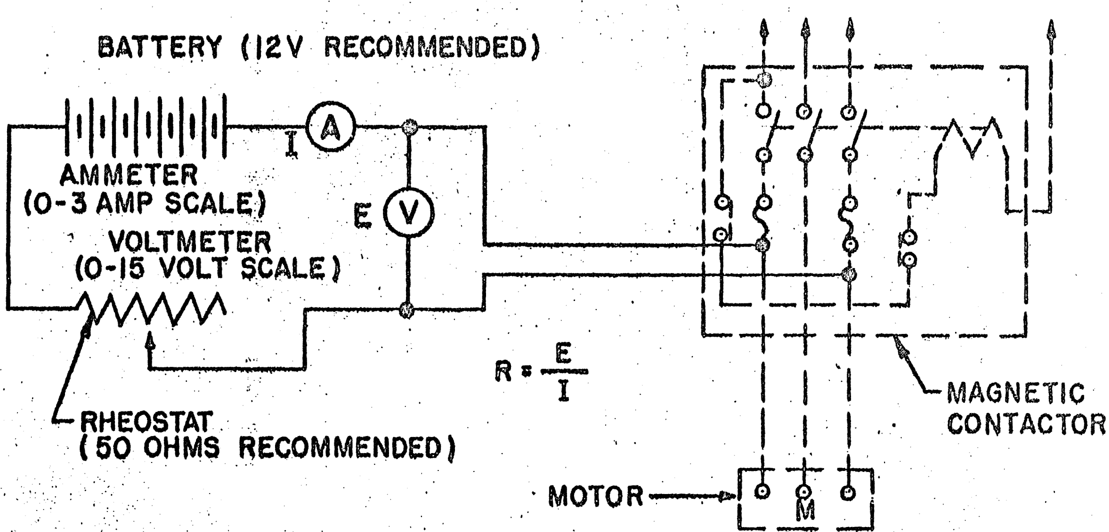
(e) On the curve of megger reading vs temperature furnished by the manufacturer locate the point found in Step 1. Through this point lay a straightedge parallel to the minimum insulation resistance curve. Record the insulation resistance in megohms found at the intersection of the straightedge and the base temperature of 75 degrees C., on the permanent test record under "Adjusted Insulations Resistance".

(f) Perform Step 5 for readings taken in Step 3. The adjusted insulation resistance for both the motor "cold" and the motor "hot" should be approximately the same.

(g) If both the "cold" and "hot" test values fall above the minimum curve, the winding is satisfactory. If they fall below, the winding insulation is deteriorating or damp. The recommended method for drying out motors is by blowing heated air across the windings. Another method in which extreme care must be exercised is by circulating a low



WIRING DIAGRAM
INSULATION RESISTANCE



WIRING DIAGRAM
STATOR WINDING RESISTANCE (D-C)

CENTIGRADE: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (234.5 + T_{COLD}) - 234.5$

FAHRENHEIT: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (390.0 + T_{COLD}) - 390.0$

R = STATOR WINDING RESISTANCE (D-C)
T_{COLD} = AIR TEMPERATURE (COLD MOTOR)
T_{HOT} = TEMPERATURE TO BE DETERMINED AT END OF RUN

FORMULA FOR COMPUTING TEMPERATURES

INSULATION RESISTANCE CONNECTION DIAGRAMS

CORPS OF ENGINEERS FORT WORTH DISTRICT

voltage current through the windings. This method should be used only by qualified personnel. An exceptionally low insulation resistance reading indicates probable contact between stator winding and frame. This condition should be corrected before any other remedial measures are initiated.

(2) Periodic Trial Runs and Tests.- All equipment including switchgear, transformers, motors, pumps, and gates shall be trial operated and checked at least once every 90 days.

(3) Inspection of Equipment and Machinery.- Pumping plants shall be inspected at intervals not to exceed 30 days during the flood season and 90 days during the off season to insure that all equipment is in order for instant use.

d. Maintenance.- To insure maximum operation during flood conditions it is important that all equipment and machinery be inspected and maintained on a regularly scheduled basis. Undue wear at any point should be reported to supervisors without delay. The inspection intervals shown for each item are considered maximum periods between inspections. Preventative maintenance should be given major consideration at all times. A complete inspection of all machinery, equipment, and facilities should be made immediately after the recession of each flood which required the use of such facilities. The legend below explains the inspection interval symbols used in the succeeding maintenance instructions.

Legend to Inspection Interval

D - Daily Inspection
SW - Semi-weekly
W - Weekly
Bi-W - BiWeekly
M - Monthly
Bi-M - Bi-Monthly

Q - Quarterly
SA - Semi-annually
A - Annually
B-E - Biennially
N.S. - Not Scheduled

(1) Buildings and Grounds.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Building	W-A	(a)
Yard and grounds	W-N.S.	(b)

(a) Buildings.

Weekly.- Check interior for cleanliness. Remove trash and fire hazards. Keep oil drips cleaned up. Keep door locks in good condition.

Annually.- Check roof, walls and floors for damage to concrete and/or masonry. Repair as needed. Check ventilators to insure proper functioning. Check for settlement of floors or foundations and/or cracks in walls.

(b) Yard and Grounds.

Weekly.- Check for fire hazards. Remove trash and debris. See that gates, buildings, etc., are locked where necessary to prevent unauthorized persons from entering or tampering with tools and equipment.

Not Scheduled.- Clear grounds of all drift and other debris after each high water period.

(2) Access Roads, Walks and Parking Areas.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Access Roads, Walks and Parking Areas	A-NS	(a)

(a) Access Roads, Walks, Parking Areas.

Annually.- Check road, walks and parking area surfaces for holes, bumps, ruts, etc. Fill, shape and/or repair as needed.

Not Scheduled.- While making routine trips over roads and in parking areas, damaged areas should be noted and repaired before extensive damage results.

(3) Pumps and Motors.

(a) Pumps.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation	M	1
Impeller	A	2
Bearing	D-A-NS	3
Packing Gland	D-M-NS	4
Coupling	A-NS	5
Lubrication	D-SA	6

1. Foundation.

Monthly.- Inspect foundation for cracks, settling, etc.

2. Impeller.

Annually.- Make annual check when condition or performance of pump indicates overhaul is necessary, then perform general overhaul maintenance. Inspect impellers and seals.

3. Bearings.

Daily.- Check lubrication of bearings.

Annually.- Change oil and/or grease in bearings and couplings.

Not Scheduled.- At general overhaul inspect bearings, make repairs if needed.

4. Packing Gland.

Daily.- Observe leakage at the gland. Take up gland as needed.

Monthly.- Inspect gland repack if needed. Inspect sleeve for wear.

Not Scheduled.- At general overhaul inspect packing gland and sleeve. Renew sleeve if needed, and make other repairs as needed.

5. Coupling.

Annual.- Lubricate coupling.

Not Scheduled.- At general overhaul, disassemble coupling and replace worn parts.

6. Lubrication.

Daily.- Check lubricating system. See that oil reservoirs are full.

Semi-Annually.- Drain and flush all oil reservoirs. Refill with oil. Remove old grease from lines and bearings and refill.

(b) Motors.

Inspection and Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation	M	1
Frame	NS	2

Item To Be Inspected (Cont'd)	Inspection Interval	Paragraph
Laminations and pole pieces	NS	3
Armature or rotor	Q	4
Air gap	A	5
Windings	Q-BE	6
Slot wedges	BE-NS	7
Couplings and gears	M-A	8
(Thrust bearings	D-Q	9
(	A-Four years	
(Guide bearings	D-2	10
(	A-Four years	
Thrust bearing oil strainer	Q	11
Painting	BE	12

1. Foundation Base or Support.

Monthly.- Note any unusual condition of foundations or supports.

2. Frame.

Not Scheduled.- Tighten bolts in stator splits and other parts.

3. Laminations and Pole Pieces.

Not Scheduled.- Tighten lamination bolts when a check indicates this should be done.

4. Armature or Rotor.

Quarterly.- Check squirrel-cage rotor bars for loose or broken bars or connections, by unusual sounds, by refusal to carry full load, or failure to build up full synchronous speed.

5. Air Gap.

Annually.- Check air gap at four quadrature positions and recenter rotor if necessary. Replace bearings or recenter as required.

6. Windings.

Quarterly.- Visual inspection for damaged insulation, dirt, oil, or moisture on winding. If required, blow out with clean dry air at low pressure, and clean winding thoroughly with a noninflammable cleaner using suitable brushes and air cleaning spray gun. Check insulation resistance.

Biennially.- Inspect the condition of the winding insulation, connections, clamps and related items. Clean thoroughly and revarnish windings if required to place in good condition. Renew any other items that have deteriorated to the point that they should be replaced. Check insulation resistance.

7. Slot Wedges.

Biennially.- Check slot wedges and replace loose ones. Tighten coils in slots by rewedging if necessary.

Not Scheduled.- If wedges become loose, rewedge, clean and paint stator.

8. Couplings and Gears.

Monthly.- Check oil level in gear cases.

Annually.- Check to see that set screws and coupling bolts are tight. Change oil in gear cases. Lubricate couplings.

9. Thrust Bearing.

Daily.- Check oil level in bearing, add oil as needed.

Quarterly.- Inspect for oil leaks.

Annually.- Change oil if analysis or condition of oil shows this to be desirable.

Four Years.- Dismantle thrust bearing. Inspect plates, smooth off sharp edges, cracks if found, lightly scrape high spots. Remove and inspect runner plate, hone if necessary. Clean springs, housing, baffles and all internal parts and area. Remove, clean, and inspect vapor ring.

10. Guide Bearings.

Daily.- Check oil level in bearings.

Quarterly.- Inspect bearing housing and piping for oil leaks.

Annually.- Change oil if analysis or condition of oil show this to be desirable.

Four Years.- Dismantle and lower bearings for inspection and cleaning. Lightly scrape bearing. Polish and hone journal. Check bearing alignment and clearance, altering same if needed.

11. Thrust Bearing Oil Strainer.

Quarterly.- Remove and clean thrust bearing oil strainer.

12. Painting.

Biennially.- Clean, inspect, touch up paint as needed.

(4) Cranes and Hoists.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Crane, rails, supports, stops	A	(a)
Crane bridge	A	(b)
Trucks	A	(c)
Bumpers	A	(d)
Hoist conductors, supports and pickup cable	A	(e)
Trolley wheels	M	(f)
Chain sheaves	W-A	(g)
Chains	W-A	(h)
Blocks and hooks	W-M	(i)
Driving gears, shafts, bearings & wheels	W-M-A	(j)

(a) Crane Rails, Supports and Stops

Annually.- Check rails for alignment and obstructions. Check supports for cracks and spalling if concrete, and for corrosion and loose rivets and bolts if steel. Repair concrete as necessary. Tighten or calk loose rivets and bolts. Check stops for security to building or rails.

(b) Crane Bridge and Carriage.

Annually.- Check frame work for looseness and cracks. Check rivets and bolts for tightness. Check girders for alignment. Examine girders for corrosion. Clean and paint as necessary.

(c) Trucks.

Annually.- Check trucks for skew and condition of wheels.

(d) Bumpers.

Annually.- Check for looseness. Examine bumpers to see that they are properly positioned. Tighten or adjust as necessary.

(e) Trolley Conductors Supports and Pickup Cable.

Annually.- Check hoist system for damaged or worn conductors, broken insulators, worn supply cable and plugs or loose connections. Repair or replace as necessary.

(f) Trolley Wheels.

Monthly.- Make visual inspection of collector system. Repair as needed.

(g) Sheaves.

Weekly.- Check sheaves for broken or chipped wheels.

Annually.- With chain removed, check for wear, chipping and corrosion. Check bearings for clearance and refit if needed.

(h) Cables or Chains.

Weekly.- Visual inspection for broken or frayed strands or broken or elongated chain links.

Annually.- Run cable or chain out and inspect carefully for frayed or broken strands, stretched or weakened links. Examine for wear and corrosion, especially down between the cable strands. Lubricate.

(i) Blocks and Hooks.

Weekly.- Inspect hook for bending and stretching.

Monthly.- Lubricate sheaves.

(j) Driving Gears, Shafts, Bearings and Wheels.

Weekly.- Check lubrication. Examine for excessive wear.

Monthly.- Lubricate sleeve and box bearings.

Annually.- Lubricate ball and roller bearings and change oil in gear cases.

(5) Electrical Equipment.

(a) Air Circuit Breakers.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation	A	1
Panels and cabinets	M	2
Bushings and insulators	M-NS	3
Bushing CT's and potential devices	A	4
Main terminals and ground connections	M-BE	5
Main contacts	A-BE	6
Contact pressure springs	BE	7
Flexible shunts	BE	8
Arc interrupter	BE	9
Crosshead	BE	10
Lift rods and guides	BE	11
Operating rods, shafts and bell-cranks	SA	12
Operating solenoids, latch and trip mechanism	Q	13
Auxiliary switches	Q	14
Position indicator	Q	15
Dashpots or snubbers	BE	16
Mechanism cabinet	A	17
Cabinet heaters and ventilators	Q	18
Power supplies and wiring	Q	19
Breaker Operation	D	20

1. Foundation.

Annually.- Inspect foundations for broken or cracked concrete.

2. Panels and Cabinets.

Monthly.- Check air circuit breaker or other panels of insulating material for cracks and cleanliness. Check condition of enclosing cabinets including hinges, latches, locks, door gaskets, and paint.

3. Bushings or Insulators.

Monthly.- Check for chipped or broken porcelain and excessive dirt film.

Not Scheduled.- As required, clean porcelain, repair chipped spots by painting with red glyptal. Tighten bolts. Check insulation resistance.

4. Bushing CT's and Potential Devices.

Annually.- Inspect terminal board, clean and tighten all connections.

5. Main Terminals and Ground Connections.

Monthly.- Visual inspection for loose connections in connecting bus work, loose or broken frame ground connections.

Biennially.- Check all bus and ground connections, refinish contact surfaces if they have been heating.

6. Main Contacts.

Annually.- Check main contact resistance from terminal to terminal with Kalvin Bridge or "Ducter" low resistance ohm meter made by James G. Biddle Company and record.

Biennially.- Overhaul as required by service and tests. Inspect main and arcing contacts. Smooth contacts if required. Adjust and align if necessary.

7. Contact Pressure Springs.

Biennially.- Check springs for loss of temper, breaks, or other deterioration.

8. Flexible Shunts.

Biennially.- Check flexible shunts for contact overheating and for fraying.

9. Arc Interrupter.

Biennially.- Check arc interrupting device for faulty or broken parts.

10. Crosshead.

Biennially.- Check contact crosshead for misalignment, breaks, bends, or looseness on lift rod.

11. Lift Rods and Guides.

Biennially.- Check contact lift rods for breaks, weakening, warping, and pulling out at ends. Check lift rod guides for alignment.

12. Operating Rods, Shafts, and Bell-Cranks.

Semi-Annual.- Check condition of operating mechanism and lubricate. It should be noted that where brass or stainless steel pins are used, little or no lubrication is required. Use flake graphite or "Aqua-dag" as a lubricant wherever possible rather than oil.

At Overhaul.- Check for loose nuts, set screws, keys, and bearings, for bent rods, shafts, etc. Clean moving parts of rust, dirt, grease, etc. Wash out bearings, pivots, and gears with CCl_4. Check and adjust according to manufacturer's instructions.

13. Operating Solenoids, Latch, and Trip Mechanism.

Quarterly.- Inspect electrically-operated solenoid mechanism. Megger closing solenoid, manually operate tripping mechanism observing that tripping section is free. Run breaker through three operating cycles, carefully observing action of mechanism.

14. Auxiliary Switches.

Quarterly.- Visual inspection. Maintain contacts as indicated.

15. Position Indicator.

Quarterly.- Check position indicator for proper indication of breaker position.

16. Dashpots or Snubbers.

Biennially.- At overhaul check for proper setting and adjust as necessary. Clean out and replenish liquid in liquid dashpots.

17. Mechanism Cabinet.

Annually.- Check condition of metal and hardware. Repaint as necessary. See that door gaskets are tight and properly exclude dust and dirt.

18. Cabinet Heaters and Ventilators.

Quarterly.- Inspect heaters, make repairs as needed to keep heaters in service. See that ventilators are not obstructed.

19. Power Supplies and Wiring.

Quarterly.- Check fuses or circuit breakers in all power and supply circuits. Maintain in their operating position.

20. Breaker Operation

Daily.- Some breakers, particularly those carrying high values of current, have a tendence to develop contact heating if left closed for long periods. Daily test for abnormal temperatures by placing a bare hand on each switch tank. Opening and closing breakers several times at intervals as system operation will permit may alleviate the heating by wiping the oxide from the contact surfaces, as well as demonstrate that the breaker is in operating condition. Then test with "Ductor" bridge through main contacts to indicate if fault condition exists in main contact circuit.

(b) Switchboards and Control Equipment.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Panels, supports, cabinets and cubicles	W-A	1
Panel wiring and terminal blocks	A	2
Auxiliary and control relays	D-A	3
Control switches and push buttons	W-M-A	4
Indicating lamps	D	5
Meters and Instruments	D-A	6
Position indicators	D	7
Protective relays	D-A	8
Resistors	B. E.	9
Test switches and jacks	A	10

1. Panels, Supports, Cabinets and Cubicles.

Weekly.- Check for general cleanliness and condition of finish. Clean off dust, dirt, and grease. Use a solution of mild soap and water or Okite Renovator diluted as per directions, to remove dirt and grease from panels. Many cleaning compounds are harmful to the finish and should not be used. Since switchboard panels having considerable equipment on them are difficult to refinish, care must be taken in cleaning them. Wax may be used where the gloss is not objectionable.

Annually.- Repair finish and hardware and clean as necessary. Tighten bolts and screws. Check boxes and cabinets in damp locations for corrosion and rust. Clean and refinish as necessary.

2. Panel Wiring and Terminal Blocks.

Annually.- Check for general housekeeping. Vacuum out terminal cabinets and wiring and control cubicles using due care and caution around live relays and controls. Check condition of wiring, particularly observing evidence of damaged insulation. Re-mark tags for terminal blocks when needed. Tighten connection at terminal points.

3. Auxiliary and Control Relays.

Daily.- Note and report any unusual heating, vibration, or other unusual condition of relays.

Annually.- Inspect relays. Dress contacts or replace if needed. Check contact spring and wiping action. Check contact shunts, etc. Make other adjustments, alignments, etc., as required. Test relay circuits.

4. Control Switches.

Weekly.- Operate control switches for test when feasible. Make repairs as needed.

Monthly.- Test control switches and push buttons on motors of all auxiliary equipment. Make repairs as needed.

Annually.- Overhaul all control switches at least once a year, oftener if needed. Check spring action and replace all switch units having unsatisfactory action.

5. Indicating Lamps.

Daily.- Replace any burned-out pilot lights. Make repairs as found necessary.

6. Meters and Instruments.

Daily.- Observe performance of instruments, adjust and repair as needed.

Annually.- Check calibration of meters and instruments; clean, adjust and repair as necessary. Tighten connections, check wiring connections if any changes have been made in associated circuits or equipment.

7. Position Indicators.

Daily.- Observe operation of position indicators. Make adjustments, repairs, etc., as needed.

8. Protective Relays.

Daily.- Visual inspection for anything unusual about contacts, coils, or moving element. Keep targets re-set.

Annually.- Test relays as per instructions.

9. Resistors.

Biennially.- Vacuum. Make repairs as needed.

10. Test Switches or Jacks.

Annually.- Examine test switch contacts and refinish with file or abrasive if burned or corroded. Tighten connections.

(c) Low Voltage Switchgear - Busses and Cables.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Bus bars, joints, and connections	B. E.	1
Bus insulators and supports	B. E.	2
Bus enclosures and barriers	B. E.	3
Switchgear panels and enclosures	M-A	4
Locks and interlocks	M	5
Warning and safety signs	M	6
Current and potential transformers	A	7

1. Bus Bars, Joints and Connections.

Biennially.- Check bus bars, joints and connections for overheating. Tighten joint and connection bolts. Refinish joint contact surfaces. Silver plate if required on high current connections to prevent heating.

2. Bus Insulators and Supports.

Biennially.- Inspect and clean insulators or insulating block supports. Paint chip spots on porcelain with red glyptal. Tighten bolts. Check supports for rigidity. Inspect tape insulation on bus bars, if any, and re-varnish as required.

3. Bus Enclosures and Barriers.

Biennially.- Check bus enclosures and interphase barriers for tightness and adequate ventilation. Clean as required.

4. Switchgear Panels and Enclosures.

Monthly.- Inspect and clean as required with industrial type hand vacuum cleaner.

Annually.- Inspect, clean and check for loose bolts repaint or refinish as required.

5. Locks and Interlocks.

Monthly.- Check all key locks and mechanical interlocks. Lubricate cylinder locks with powdered graphite only. Leave in proper operating position.

6. Warning and Safety Signs.

Monthly.- Check to see that adequate warning and safety signs are in place around live parts or other safety hazards.

7. Current and Potential Transformers.

Annually.- Check oil level and oil leaks in oil-filled transformers. Check for leaking compound from dry type transformers. Clean insulators. Check and tighten primary and secondary connections. See that short circuiting device on current transformer secondary is secured in the open position and that protector tubes are not bypassing current at normal loads. Check potential transformer fuses.

(d) Disconnecting Switches and Fuses.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and Mounting	B. E.	1
Insulators	A-B. E.	2
Line and ground connections	Q-B. E.	3
Blades and contacts	Q-A-B. E.	4
Locks and interlocks	Q	5
Fuse tubes and fuse links	Q	6

1. Base and Mounting.

Biennially .- Inspect for loose bolts or structure.

2. Insulators.

Annually.- Check for chipped and broken insulators. Clean as required.

Biennially.- Tighten loose assembly bolts.

3. Line and Ground Connections.

Quarterly.- Make visual inspection of line connections and where evidence of loose connections exist, tighten as required. Check condition of ground connection to assure that it is not broken and ground connection is tight.

Bi-ennially.- Inspect and tighten connections as required.

4. Blades and Contacts.

Quarterly.- See that blades are properly seated in the contacts. Where necessary, adjust blades.

Annually.- Operate switch several times and see that blades are properly aligned to engage contacts.

Biennially.- Check alignment and condition of blades and contacts. Tighten bolts and screws, adjust contact pressure and maintain silver or other contact surface in good condition.

5. Locks and Interlocks.

Quarterly.- See that switches are properly locked in the open or closed position as required, by padlocks or other key-type locks or interlocks. Lubricate with powdered graphite only, from a graphite gun. No other lubricant shall be used on padlocks or cylinder locks. See that locks and keys operate as intended. Check mechanical interlocks such as between main disconnecting switch and ground switch for operation.

6. Fuse Tubes and Fuse Links.

Quarterly.- Inspect and check fuses and their holders for evidence of failure or improper conditions. When fuse trouble occurs due to high resistance contact between ferrule and holder, refinish ferrule and fuse dips. On fuses of high current rating or exposed to unfavorable atmospheric conditions it may be found desirable to silver plate the contact surfaces.

(e) Lightning Arrestors.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and supports, insulators, leads, etc.	D-A-Six years	1
Arrestor-enclosure	A	2

1. Base and Supports, Insulators, Leads, Etc.

Daily.- Inspect arrester installation observing general condition.

Annually.- Clean porcelain parts, tighten loose bolts, check spring connectors, check line and ground connections, etc. Observe for evidence of high currents which might have damaged arrester internally. Make repairs as needed.

Six Years.- Check 60-cycle sparkover voltage of each section of arrestor utilizing testing transformer with suitable resistor to limit current. Compare with original manufacture, test valves for the type and voltage rating of arrester unit. If required, paint hardwares with aluminum or other suitable paint.

2. Arrestor Enclosure.

Annually.- Check protective enclosures including ground connections. Carry out maintenance as required.

(f) Storage Batteries and Chargers.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base or rack	A	1
Base pad	A	2
Separators	M	3
Electrolyte	D-M	4
Intercell connectors and terminals	M	5
Hydrometers and thermometers	D-M	6
Electronic and Metallic rectifiers	WA	7

1. Base or Rack.

Annual.- Inspect concrete base or wooden racks for deterioration. Repair or repaint with acid-resisting paint as necessary.

2. Base Pad.

Annually.- Check base pad of sheet rubber, sand, or other material, for deterioration from acid or other causes.

3. Separators.

Monthly.- Visual inspection for condition.

4. Electrolyte.

Daily.- Check electrolyte gravity of pilot cells.

Monthly.- Check electrolyte gravity of entire battery and enter on proper form. Add water of suitable purity, as instructed, and record on proper form. Check individual cell voltages and record on proper form.

5. Intercell Connectors and Terminals.

Monthly.- Neutralize acid with ammonia and clean from battery connectors and cell tops.

6. Hydrometer and Thermometer.

Monthly.- Report condition of hydrometer and thermometer if necessary.

7. Electronic and Metallic Rectifiers.

Weekly.- Visual inspection of transformers, tubes, control switches or resistors. Replace or repair any defective items. Check operations.

Annually.- Make thorough inspection of all items on the rectifier, replacing any defective equipment and tighten connections.

(g) Substation.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Lighting	A-NS	1
Conductors and busses	BE	2
Warning Signs	A	3
Hardware	M-Six years	4
Insulators	M	5

1. Lighting.

Not Scheduled.- Replace bulbs, maintain and repair as needed.

Annually.- Make operational check on all lighting circuits. See that they are in good operating condition. Clean units to remove bugs and dirt. Tighten fixtures where required.

2. Conductors and Busses.

Biennially.- Observe sag in tension busses and flexible expansion joints. Adjust if necessary to relieve strain on post-type bushings and insulators. Check joints for looseness or heating. Tighten connectors and clamps.

3. Warning Signs.

Annually.- Check to ascertain that adequate warning signs are used on equipment and that they are securely in place.

4. Hardware.

Monthly.- Make on the ground inspection for loose hardware, bolts, nuts, etc. Tighten and repair as needed.

Six Years.- Tighten all clamps and other hardware. Paint rusty spots.

5. Insulators.

Monthly.- Make a general inspection for broken, cracked or otherwise damaged insulators. Check for excessive dirt.

(h) Transformers.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation, rails, and trucks	M	1
Oil piping valves and plugs	A	2
Oil levels and gauges	A-M-A	3
Breathers and vents	M	4
Relief diaphragm	A	5
Bushings	W-BE	6
Main terminal and ground connections	M-BE	7
Core and coils	NS	8
Internal inspection	Five years	9
Insulation resistance	A	10
Oil dielectric	A	11
Oil acidity	Five years	12
Oil purification	NS	13

1. Foundation, Rails, and Trucks.

Monthly.- Check foundation for cracking and settling. See that rail stops are firmly in place to hold transformer in position on the rails. Paint metalwork as needed.

2. Oil Piping, Valves, and Plugs.

Annually.- Inspect oil piping, valves and plugs. See that all oil drains are plugged or locked to prevent unauthorized openings.

3. Oil Levels, Gauges and Relays.

Daily.- Check oil levels; if low, determine cause and take proper remedial measures.

Monthly.- Make visual inspection of gages for conditition and operation.

Annually.- Clean dirty gage glasses and connect connections, replace broken glasses, check oil-level indicators and relays for proper operation.

4. Breathers and Vents.

Monthly.- See that relief diaphragm has not opened and breathers and vents are normal, that screens and baffles are not obstructed or broken. Inspect dehydrating breathers and change chemical if needed.

5. Relief Diaphragm.

Annually.- Check relief diaphragm, its hinge, latch, and alarm switch. Relief diaphragms used may only be those furnished by the manufacturer for any particular transformer, and installed in the recommended manner.

6. Bushings.

Weekly.- Check for breaks, excessive dirt, oil level and leaks.

Annually.- Clean and paint chipped spots with red glyptal. Inspect gaskets for leaks. Tighten bolts. Add oil if necessary to bring to proper elevation.

Biennially.- Test oil, sample from bottom of bushing for dielectric strength. Replace if required.

7. Main Terminals and Ground Connections.

Monthly.- Visual inspection for safe operating condition.

Biennially.- Tighten bus and ground connections, refinish and improve contact surfaces if they have been heating. Silver plating may be desirable for high current connections to reduce heating.

8. Core and Coils.

Not Scheduled.- A transformer properly maintained and not excessively overheated and which is arranged to maintain a gas cushion over the oil or to expose a very limited amount of oil to air, should, barring an internal failure of the winding or connections, not require untanking for core and coil maintenance during its normal life. If inspection indicates that excessive sludge has formed on the winding, it should be untanked and the sludge removed by washing with clean oil. When untanked, check for loose laminations, core bolts, insulating blocks, connections and other pertinent features.

9. Internal Inspection.

Five Years.- Make a general inspection of transformer through manhole covers when provided. Conduct or schedule necessary maintenance.

10. Insulation Resistance.

Annually.- Check the insulation resistance between each winding and ground. Include only that part of loads to the first adjacent switch.

11. Oil Dielectric.

Annually.- Sample oil from transformers and bushings annually and test for dielectric strength.

12. Oil Acidity.

Five Years.- Test oil for acidity every five years.

13. Oil Purification.

Not Scheduled.- When dielectric test is below 22 KV schedule purification to bring oil test up to 26 KV minimum. Reclaim or replace when acidity is excessive.

(i) Distribution Lines.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Wood poles, crossarms, pins, braces, footings and guy anchors, guys, hardware	A	1
Warning signs	A	2
Ground wires	M-Five years	3
Insulators	M	4
Cutouts	A	5

1. Wood Poles, Crossarms, Pins, Braces, Footings and Guy Anchors, Guys, Hardware.

Annually.- Inspect, maintain and repair as required.

2. Warning Signs.

Monthly.- Maintain as required.

3. Ground Wires and Connections.

Five Years.- Check ground resistance and tighten connections.

Monthly.- Visual inspection.

4. Insulators.

Monthly.- Clean or replace as required.

5. Cutouts.

Annually.- Inspect, maintain and repair as needed.

(6) Sluice Gates.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Sluice Gates	A	(a)
Seals and Guides	A	(b)

(a) Sluice Gates.

Annually.- Inspect condition of bolts, studs, latching devices, paint, or other surface treatment. Repair or replace as necessary. Check operation of gate and leakage of water through gate. Disassemble gate and make repairs if necessary to stop excessive leakage.

(b) Seals and Guides.

Annually.- Check seals and guides for wear and deterioration. Renew seals and build up guides where scored, as necessary. Remove accumulated mineral deposit.

(7) Flap Gates.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Flap Gates	Q	(a)

(a) Flap Gates.

Quarterly.- Flap gates should be trial operated, serviced, and lubricated to be certain they swing freely and do not bind. Caution: in order to prevent possible damage, do not allow the flaps to slam against the seats.

(8) Trash Racks.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Trash Racks	W-A	(a)

(a) Trash Racks.

Weekly.- Check trash racks for debris. See that trash and debris is removed.

Annually.- Inspect trash racks, including underwater portion so far as feasible; remove lodged debris not removed on routine cleaning. Check condition of metal work, repair as needed. Paint every 5 years unless inspection shows more frequent painting to be necessary.

(9) Gages and Gage Wells.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Gages and Gage Wells	SA-A-NS	(a)

(a) Gages and Gage Wells.

Semiannually.- Flush the 3" intake pipe as follows:

1. Raise the float clear of the water and make it fast by inserting nail or small rod through the hole in the tape and allowing it to rest on table top.

2. Remove the weighted self-centering cone from the bottom of the gage well by lifting the chain which extends to the top of the well, and allow well to drain. If the river is above intake, water will flow into the well from the river and flush intake. When water from the bottom of the gage well runs clear, replace weighted self-centering cone and allow the well to fill.

3. If the river is below the intake, remove the cone and close the plug cock at entrance by turning the valve handle $\frac{1}{4}$ turn, to closed position as shown by indicator. Then wash out gage well with hose. Replace the weighted self-centering cone and fill gage well with water from hose. Open the plug cock on intake by turning valve handle $\frac{1}{4}$ turn to open position, as shown by indicator and allow water in well to drain to river, thus flushing the 3-inch intake line.

4. Remove nail or small rod from hole in the tape and lower float to water surface. Check the recording gage operation.

Annually.- Give all bearings and rubbing parts of the automatic water stage recorder a drop of oil once a year. On bearings where there are no oil holes, put a drop of oil on the side of the bearing with a fine toothpick. Use only the instrument oil provided.

Not Scheduled.- Clean the tile gage at intervals required to facilitate reading. When cleaning, check for cracking, spalling, or abrasion and when damaged, repair immediately.

(10) Painting.- Periodic painting is required of the parts of pumping plant, closure materials, and other structures that require this type of protection in order to protect metal parts from corrosive action of water and other elements. Frequency of painting varies, depending on type of paint used, methods of application, and conditions of wear. Always paint metal surfaces before corrosion becomes so severe that equipment is damaged. Prepare metal surfaces by sand blasting, if practical, or by cleaning them thoroughly with sandpaper and wire brush. Only special-prepared paints should be used on damp surfaces that will be encountered. Corrosion-preventive compounds may be used in moist or wet places where paint would not last.

e. Shut Down Procedure.- Immediately upon final recession of flood waters, switches, and sluice gates shall be restored to their normal settings. The pumping plant shall then be thoroughly cleaned and equipment thoroughly inspected, oiled and greased. After each flood period, all parts of the pumps should be checked thoroughly. The pump bowls should be checked for damage, pitting, or other damage. The impellers should be check for damage, pitting, looseness on the shaft, etc. The bearings, the oil feed piping, and other parts should be inspected for possible damage from floating debris, vibration, or excessive strain. A log of pumping plant operation shall be furnished the District Engineer following each flood.

SECTION IV

PROJECT FACILITIES

CHAPTER 4

PUMPING PLANTS

4.046. PUMPING PLANT, HAMPTON ROAD.

a. Description.

(1) General.- The Hampton Road pumping plant consists of a pumphouse, an adjoining intake structure, four discharge pipes over the levee, and an outlet structure.

(a) The intake structure, adjoining the pumphouse, consists of approach wingwalls and apron, a raking platform, and twelve trash racks approximately 3½' x 32'. A tile staff gage is located above the trash rack in the upstream wall.

(b) The discharge pipes over the levee are 42" O.D. steel pipes. Each discharge pipe is provided with a 4" air relief valve and a 7" vacuum breaker at the top of the levee. A tile staff gage is located above the trash rack in upstream wall.

(c) The outlet structure consists of a concrete headwall, wingwalls, and apron.

(d) The pumphouse consists of a reinforced concrete substructure, used as a sump pit and a brick superstructure that houses four 50,000 gpm vertical mixed flow pumps. The following equipment is in the pumphouse:

1. Four 50,000 gpm vertical, mixed flow pumps manufactured by Economy Pumps, Inc., Philadelphia, Pa., and driven by 600 h.p. 2400 V, 3 phase motors manufactured by Ideal Electric Company, Mansfield, Ohio.

2. Four grease lubricating systems manufactured by the Farval Corporation, Cleveland, Ohio.

3. An eight-ton trolley type spur geared hoist manufactured by the Yale and Towne Manufacturing Company and a top running hand-geared crane manufactured by Lypta, Incorporated, Houston, Texas.

4. A four-element float switch manufactured by Healy Ruff Company, St. Paul, Minn.

5. Six metal clad switchgear cabinets housing five oil circuit breakers, control switches and other control equipment for protection and operation of the incoming line and the four pump motors. This equipment is manufactured by Nelson Electric Manufacturing Company, Tulsa Oklahoma.

6. A 10 KVA single-phase 2400-120/240V dry type transformer manufactured by Electric Service Co., Greenville, Texas.

7. A 24 Volt battery and NEMCO GC-240 battery charger manufactured by Nelson Electric Manufacturing Co., Tulsa, Oklahoma.

(e) The oil circuit breakers are rated 2400V 3-phase 600A with 50 MVA interrupting capacity. The closing coils are supplied from a control power transformer mounted in Cubicle #2. 24V DC for the circuit breaker trip coils is supplied by the 24 V storage battery and charger.

(f) A hand-auto switch on each motor cubicle permits selection of manual or automatic operation of the pumps.

(g) The switchgear and pump motors are supplied with 115V heaters controlled from the lighting distribution panel.

(h) Auxiliary units contained in the switchgear consist of undervoltage time delay relays, instantaneous overload relays and thermal overload relays on each pump motor circuit, and time delay relays which insert delays of 30, 60 and 90 seconds, respectively, in the starting of Pumps 2, 3, and 4. During automatic operation, the time delay relays insure that two pumps do not start at the same time.

(i) An electrical substation for the pumping station consists of three 833 KVA 13200-2400V delta-delta connected transformers and protective auxiliary equipment. The incoming service consists of 2 - 500 MCM cables per phase.

b. Operation of Facilities.

(1) General.- See paragraph 4.04b for instructions on Operation Log. The pumping station may be operated manually or may be set for automatic operation.

(2) Manual Operation.- During manual operation starting and stopping of the pumps is controlled by the operator. The procedure for operating one or more of the pumps is as follows:

(a) Turn off pump motor heaters at lighting distribution panel

(b) Lubricate pump or pumps to be operated according to instructions on Farval lubricators.

(c) Check the oil levels on the upper bearings of the motors. Add oil if required.

(d) Turn all motor control HAND-AUTO selector switches to HAND.

(e) Check control cabinet battery charger. With charging switch on LOW, ammeter should read 0.3 amps voltmeter should read 27 volts.

(f) Check that all trip coil and closing coil circuit breakers are "closed". These breakers are located inside the motor control and incoming line cabinets.

(g) Start pump by switching circuit breaker control switch to CLOSE. Pump should start in less than two minutes. There are time delay and relays on motors 2, 3 and 4 which will delay their starting for 30, 60, and 90 seconds, respectively.

(h) Allow motor to reach full speed (ammeter on pump control panel should read 150 or less) before starting second pump.

(i) Start other pumps as required by placing motor circuit breaker control switches to CLOSE. Allow each pump to reach full speed before starting next pump.

(j) If any ammeter on the pump control panels reads above 155 amperes after the motors have reached full speed, shut down pump and investigate.

(k) While pumps are running keep grates clear of trash and brush.

(l) Lubricate all running motors each hour with the Farval lubricators.

(m) Record the storage elevation each hour and report to the office.

(n) To stop pumps, turn circuit breaker control switches on motor control panels to TRIP. If any breaker fails to trip, open cabinet and push breaker trip switch. This will trip breaker mechanically.

(o) Turn on all motor heaters.

(p) Check that siphon breakers on top of levee have opened. (If siphon breakers fail, water will be siphoned from the river back to the sump.) If siphon breakers fail to open, release vacuum on pump discharge conduit by opening 1" globe valves located inside the block houses on top of the levee. These valves are protected by 1" pipe caps which must be removed before valve can be operated.

(q) After releasing vacuum, close valves and replace pipe caps.

(3) <u>Automatic Operation</u>.- The pumping station may be set for automatic operation as follows:

(a) Check that all trip coil and closing coil circuit breakers are "closed". These breakers are located inside the incoming line and pump control cabinets.

(b) Check float switch to see that tape is not binding and that counter-weight has adequate clearance from the stand and the floor.

(c) Check that all cables from pump control cabinets are plugged into float switch.

(d) Place all HAND-AUTO selector switches on pump control panels to AUTO.

(e) Check control cabinet battery charger. Meters should read 0.3 amperes and 27 volts with switch on low charging rate.

(f) Pumps will be started and stopped automatically.

(g) Pumps and motors should be lubricated during operation.
lubricated during operation

(4) Power Failure Procedure.- Procedure to be followed in case of power failure:

(a) Check that main circuit breaker is closed.

(b) Check that the three disconnect links are closed. Disconnects are located on pole at electric substation 300' to the rear of the pump station.

(c) If pumps are running but low voltage power is lost, check fuses in panel above dry type transformer on pump station wall.

e. Inspections and Tests.

(1) Megger Tests.- Megger tests on the motors should be performed annually. A curve of minimum insulation resistance versus temperature should be obtained from the manufacturer and kept with the records of the insulation resistances taken each year. To measure insulation resistance, the following procedure should be used:

(a) With the motor cold and the magnetic contactor in the open position, read the insulation resistance between any one of the load contacts and the frame ground. If the megger reading falls below the minimum insulation resistance curve supplied by the manufacturer for the corresponding temperature, the motor should be disconnected from the line and the megger test repeated at the terminal box of the motor. If this megger reading is still below that of the curve, a report to the Corps of Engineers District Office should be submitted immediately. No attempt should be made to start the motor. Enter the megger reading and the temperature on the permanent record maintained for the equipment.

(b) Obtain C. C. resistance of the stator windings by impressing a D. C. voltage across the windings and reading the voltage and current. Record the circuit designations of the winding used.

(c) Run the motor under normal load for a minimum of 15 minutes, shut down and repeat megger and D. C. resistance readings. Use the coil recorded under step 2 for the resistance measurements.

(d) By means of one of the formulae given at the end of this section, compute the temperature of the stator using the "hot" reading on the permanent test record. If the megger reading for this temperature falls below the minimum insulation resistance curve at the same temperature, the procedure outlined in step 1 should be followed.

(e) On the curve of megger reading vs temperature furnished by the manufacturer locate the point found in Step 1. Through this point lay a straightedge parallel to the minimum insulation resistance curve. Record the insulation resistance in megohms found at the intersection of the straightedge and the base temperature of 75° C., on the permanent test record under "Adjusted Insulations Resistance."

(f) Perform Step 5 for readings taken in Step 3. The adjusted insulation resistance for both the motor "cold" and the motor "hot" should be approximately the same.

(g) If both the "cold" and "hot" test values fall above the minimum curve, the winding is satisfactory. If they fall below, the winding insulation is deteriorating or damp. The recommended method for drying out motors is by blowing heated air across the windings. Another method in which extreme care must be exercised is by circulating a low voltage current through the windings. This method should be used only by qualified personnel. An exceptionally low insulation resistance reading indicates probable contact between stator winding and frame. This condition should be corrected before any other remedial measures are initiated.

(2) Periodic Trial Runs and Tests.- All equipment including switchgear, transformers, motors, pumps, and gates shall be trial operated and checked at least once every 90 days.

(3) Inspection of Equipment and Machinery.- Pumping plants shall be inspected at intervals not to exceed 30 days during the flood season and 90 days during the off season to insure that all equipment is in order for instant use.

d. Maintenance.- To insure maximum operation during flood conditions it is important that all equipment and machinery be inspected and maintained on a regularly scheduled basis. Undue wear at any point should be reported to supervisors without delay. The inspection intervals shown for each item are considered maximum periods between inspections. Preventative maintenance should be given major consideration at all times. A complete inspection of all machinery, equipment, and facilities should be made immediately after the recession of each flood which required the use of such facilities. The legend below explains the inspection interval symbols used in the succeeding maintenance instructions.

Legend to Inspection Interval

D - Daily Inspection
SW - Semi-weekly
W - Weekly
Bi-W - Bi-weekly
M - Monthly
Bi-M - Bi-monthly

Q - Quarterly
SA - Semi-annually
A - Annually
B-E - Biennially
N.S. - Not Scheduled

(1) Buildings and Grounds.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Building	W-A	(a)
Yard and grounds	W-N.S.	(b)

(a) Buildings.

Weekly.- Check interior for cleanliness. Remove trash and fire hazards. Keep oil drips cleaned up. Keep door locks in good condition.

Annually.- Check roof, walls and floods for damage to concrete and/or masonry. Repair as needed. Check ventilators to insure proper functioning. Check for settlement of floors or foundations and/or cracks in walls.

(b) Yard and Grounds.

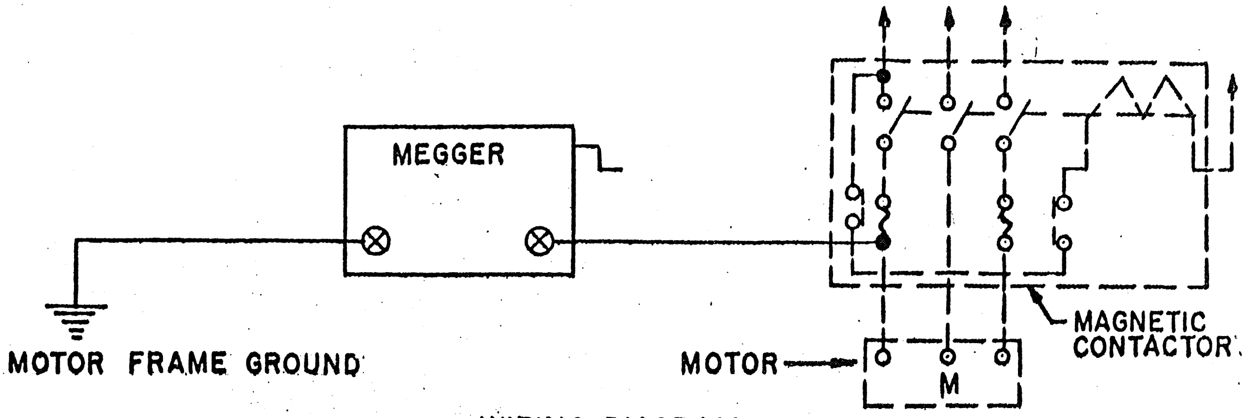
Weekly.- Check for fire hazards. Remove trash and debris. See that gates, buildings, etc., are locked where necessary to prevent unauthorized persons from entering or tampering with tools and equipment.

Not Scheduled.- Clear grounds of all drift and other debris after each high water period.

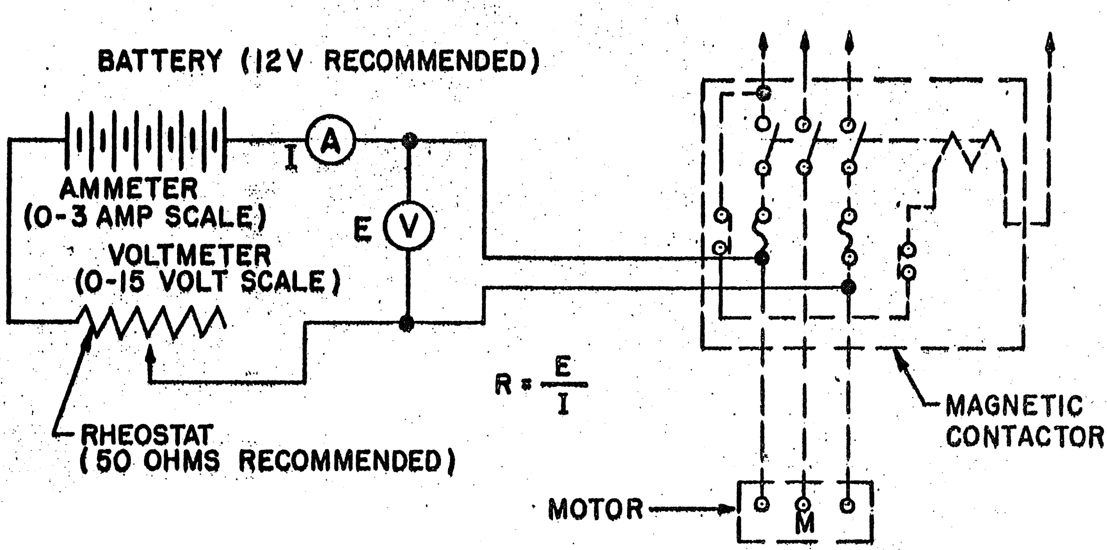
(2) Access Roads, Walks and Parking Areas.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Access Roads, Walks and Parking Areas	A-N.S.	(a)



WIRING DIAGRAM
INSULATION RESISTANCE



WIRING DIAGRAM
STATOR WINDING RESISTANCE (D-C)

CENTIGRADE: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (234.5 + T_{COLD}) - 234.5$

FAHRENHEIT: $T_{HOT} = \frac{R_{HOT}}{R_{COLD}} (390.0 + T_{COLD}) - 390.0$

R = STATOR WINDING RESISTANCE (D-C)
T_{COLD} = AIR TEMPERATURE (COLD MOTOR)
T_{HOT} = TEMPERATURE TO BE DETERMINED AT END OF RUN

FORMULA FOR COMPUTING TEMPERATURES

INSULATION RESISTANCE CONNECTION DIAGRAMS

CORPS OF ENGINEERS FORT WORTH DISTRICT

(a) Access Roads, Walks, Parking Areas.

Annually.- Check road, walks and parking area surfaces for holes, bumps, ruts, etc. Fill, shape and/or repair as needed.

Not Scheduled.- While making routine trips over roads and in parking areas, damaged areas should be noted and repaired before extensive damage results.

(3) Pumps and Motors.

(a) Pumps.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation	M	1
Impeller	A	2
Bearing	D-A-N.S.	3
Packing Gland	D-M-N.S.	4
Coupling	A-N.S.	5
Lubrication	D-SA	6

1. Foundation.

Monthly.- Inspect foundation for cracks, settling, etc.

2. Impeller.

Annually.- Make annual check when condition or performance of pump indicates overhaul is necessary, then perform general overhaul maintenance. Inspect impellers and seals.

3. Bearings.

Daily.- Check lubrication of bearings.

Annually.- Change oil and/or grease in bearings and couplings.

Not Scheduled.- At general overhual inspect bearings, make repairs if needed.

4. Packing Gland.

Daily.- Observe leakage at the gland. Take up gland as needed.

Monthly.- Inspect gland repack if needed. Inspect sleeve for wear.

Not Scheduled.- At general overhual inspect packing gland and sleeve. Renew sleeve if needed, and make other repairs as needed.

(5) Coupling.

Annual.- Lubricate coupling.

Not Scheduled.- At general overhaul, disassemble coupling and replace worn parts.

(6) Lubrication.

Daily.- Check lubricating system. See that oil reservoirs are full.

Semi-Annually.- Drain and flush all oil reservoirs. Refill with oil. Remove old grease from lines and bearings and refill.

(b) Motors.

Inspection and Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation, base, or support	M	1
Frame	NS	2
Laminations and pole pieces	NS	3
Armature or rotor	Q	4
Air gap	A	5
Windings	Q-B.E.	6
Slot wedges	B.E.-NS	7
Couplings and gears	M-A	8
(Thrust bearings	D-Q	9
(	A - Four years	
(Guide bearings	D-Q	10
(	A - Four years	
Thrust bearing oil strainer	Q	11
Painting	B.E.	12

1. Foundation Base or Support.

Monthly.- Note any unusual condition of foundations or supports.

2. Frame.

Not Scheduled.- Tighten bolts in stator splits and other parts.

3. Laminations and Pole Pieces.

Not Scheduled.- Tighten lamination bolts when a check in dicates this should be done.

4. Armature or Rotor.

Quarterly.- Check squirrel-cage rotor bars for loose or broken bars or connections, by unusual sounds, by refusal to carry full load, or failure to build up full synchronous speed.

5. Air Gap.

Annually.- Check air gap at four quadrature positions and recenter rotor if necessary. Replace bearings or recenter as required.

6. Windings.

Quarterly.- Visual inspection for damaged insulation, dirt, oil, or moisture on winding. If required, blow out with clean dry air at low pressure, and clean winding thoroughly with a noninflammible cleaner using suitable brushes and air cleaning spray gun. Check insulation resistance.

Biennially.- Inspect the condition of the winding insulation, connections, clamps and related items. Clean thoroughly and revarnish windings if required to place in good condition. Renew any other items that have deteriorated to the point that they should be replaced. Check insulation resistance.

7. Slot Wedges.

Biennially.- Check slot wedges and replace loose ones. Tighten coils in slots by rewedging if necessary.

Non Scheduled.- If wedges become loose, rewedge, clean and paint stator.

8. Couplings and Gears.

Monthly.- Check oil level in gear cases.

Annually.- Check to see that set screws and coupling bolts are tight. Change oil in gear cases. Lubricate couplings.

9. Thrust Bearing.

Daily.- Check oil level in bearing, add oil as needed.

Quarterly.- Inspect for oil leaks.

Annually.- Change oil if analysis or condition of oil shows this to be desirable.

Four Years.- Dismantle thrust bearing. Inspect plates, smooth off sharp edges, cracks if found, lightly scrape high spots. Remove and inspect runner plate, hone if necessary. Clean springs, housing, baffles and all internal parts and area. Remove, clean, and inspect vapor ring.

10. Guide Bearings.

Daily.- Check oil level in bearings.

Quarterly.- Inspect bearing housing and piping for oil leaks.

Annually.- Change oil if analysis or condition of oil show this to be desirable.

Four Years.- Dismantle and lower bearings for inspection and cleaning. Lightly scrape bearing. Polish and hone journal. Check bearing alignment and clearance, altering same if needed.

11. Thrust Bearing Oil Strainer.

Quarterly.- Remove and clean thrust bearing oil strainer.

12. Painting.

Biennially.- Clean, inspect, touch up paint as needed.

(4) Cranes and Hoists.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Crane, rails, supports, stops	A	(a)
Crane bridge	A	(b)
Trucks	A	(c)
Bumpers	A	(d)
Hoist conductors, supports & pickup cable	A	(e)
Trolley wheels	M	(f)
Chain sheaves	W-A	(g)
Chains	W-A	(h)
Blocks and hooks	W-M	(i)
Driving gears, shafts, bearings & wheels	W-M-A	(j)

(a) Crane Rails, Supports and Stops.

Annually.- Check rails for alignment and obstructions. Check supports for cracks and spalling if concrete, and for corrosion and loose rivets and bolts if steel. Repair concrete as necessary. Tighten or calk loose rivets and bolts. Check stops for security to building or rails.

(b) Crane Bridge and Carriage.

Annually.- Check frame work for looseness and cracks. Check rivets and bolts for tightness. Check girders for alignment. Examine girders for corrosion. Clean and paint as necessary.

(c) Trucks.

Annually.- Check trucks for skew and condition of wheels.

(d) Bumpers.

Annually.- Check for looseness. Examine bumpers to see that they are properly positioned. Tighten or adjust as necessary.

(e) Trolley Conductors Supports and Pickup Cable.

Annually.- Check hoist system for damaged or worn conductors, broken insulators, worn supply cable and plugs or loose connections. Repair or replace as necessary.

(f) Trolley Wheels.

Monthly.- Make visual inspection of collector system. Repair as needed.

(g) Sheaves.

Weekly.- Check sheaves for broken or shipped wheels.

Annually.- With chain removed, check for wear, chipping and corrosion. Check bearings for clearance and refit if needed.

(h) Cables or Chains.

Weekly.- Visual inspection for broken or frayed strands or broken or elongated chain links.

Annually.- Run cable or chain out and inspect carefully for frayed or broken strands, stretched or weakened links. Examine for wear and corrosion, especially down between the cable strands. Lubricate

(i) Blocks and Hooks.

Weekly.- Inspect hook for bending and stretching.

Monthly.- Lubricate sheaves.

(j) Driving Gears, Shafts, Bearings and Wheels.

Weekly.- Check lubrication. Examine for excessive wear.

Monthly.- Lubricate sleeve and box bearings.

Annually.- Lubricate ball and roller bearings and change oil in gear cases.

(5) Electrical Equipment.

(a) Substation.

Maintenance Schedule Guide

Item To Be Inspected	Inspection Interval	Paragraph
Lighting	A-NS	1
Conductors and busses	BE	2
Warning Signs	A	3
Hardware	M-6 years	4
Insulators	M	5

1. Lighting.

Annually.- Make operational check on all lighting circuits. See that they are in good operating condition. Clean units to remove bugs and dirt. Tighten fixtures where required.

2. Conductors and Busses.

Biennially.- Observe sag in tension busses and flexible expansion joints. Adjust if necessary to relieve strain on post-type bushings and insulators. Check joints for looseness or heating. Tighten connectors and clamps.

3. Warning Signs.

Annually.- Check to ascertain that adequate warning signs are used on equipment and that they are securely in place.

4. Hardware.

Monthly.- Make on the ground inspection for loose hardware, bolts, nuts, etc. Tighten and repair as needed.

6 Years.- Tighten all clamps and other hardware. Paint rusty spots.

5. Insulators.

Monthly.- Make a general inspection for broken, cracked or otherwise damaged insulators. Check for excessive dirt.

(b) Transformers.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Foundation, rails, and trucks	M	1
Oil piping valves and plugs	A	2
Oil levels and guages	D-M-A	3
Breathers and vents	M	4
Relief diaphragm	A	5
Bushings	W-A-BE	6
Main terminal and ground connections	M-BE	7
Core and coils	NS	8
Internal inspection	5 Years	9
Insulation resistance	A	10
Oil dielectric	A	11
Oil acidity	5 Years	12
Purification	NS	13

1. Foundation, Rails, and Trucks.

Monthly.- Check foundation for cracking and settling. See that rail stops are firmly in place to hold transformer in position on rails. Paint metalwork as needed.

2. Oil Piping, Valves, and Plugs.

Annually.- Inspect oil piping, valves and plugs. See that all oil drains are plugged or locked to prevent unauthorized opening.

3. Oil Levels, Guages and Relays.

Daily.- Check oil levels; if low, determine cause and take proper remedial measures.

Monthly.- Make visual inspection of gages for condition and operation.

Annually.- Clean dirty gage glasses and connections, replace broken glasses, check oil-level indicators and relays for proper operation.

4. Breathers and Vents.

Monthly.- See that relief diaphragm has not opened and breathers and vents are normal, that screens and baffles are not obstructed or broken. Inspect dehydrating breathers and change chemical if needed.

5. Relief Diaphragm.

Annually.- Check relief diaphragm, its hinge, latch, and alarm switch. Relief diaphragms used may only be those furnished by the manufacturer for any particular transformer, and installed in the recommended manner.

6. Bushings.

Weekly.- Check for breaks, excessive dirt, oil level and leaks.

Annually.- Clean and paint chipped spots with red glyptal. Inspect gaskets for leaks. Tighten bolts. Add oil if necessary to bring to proper elevation.

Biennially.- Test oil, sample from bottom of bushing for dielectric strength. Replace if required.

7. Main Terminals and Ground Connections.

Monthly.- Visual inspection for safe operating condition.

Biennially.- Tighten bus and ground connections, refinish and improve contact surfaces if they have been heating. Silver plating may be desirable for high current connections to reduce heating.

8. Core and Coils.

Not Scheduled.- A transformer properly maintained and not excessively overheated and which is arranged to maintain a gas cushion over the oil or to expose a very limited amount of oil to air, should, barring and internal failure of the winding or connections, not require untanking for core and coil maintenance during its normal life. If inspection indicates that excessive sludge has formed on the winding, it should be untanked and the sludge removed by washing with clean oil. When untanked, check for loose laminations, core bolts, insulating blocks, connections and other pertinent features.

9. Internal Inspection.

Five Years.- Make a general inspection of transformer through manhole covers when provided. Conduct or schedule necessary maintenance.

10. Insulation Resistance.

Annually.- Check the insulation resistance between each winding and ground. Include only that part of loads to the first adjacent switch.

11. Oil Dieletric.

Annually.- Sample oil from transformers and bushings annually and test for dielectric strength.

12. Oil Acidity.

Five Years.- Test oil for acidity every 5 years.

13. Oil Purification.

Not Scheduled.- When dielectric test is below 22 KV schedule purification to bring oil test up to 26 KV minimum. Reclaim or replace when acidity is excessive.

(c) Distribution Lines.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Wood poles, Crossarms, Pins, Braces, Footings, Guys and Guy anchors Hardware	A	1
Warning signs	M	2
Ground wires	M-5 years	3
Insulators	M	4
Cutouts	A	5

1. Wood Poles, Crossarms, Pins, Braces, Footings, Guys and Guy Anchors Hardware.

Annually.- Inspect, maintain and repair as required.

2. Warning Signs.

Monthly.- Maintain as required.

3. Ground Wires and Connections.

Monthly.- Visually inspect all ground wires and connections.

Five Years.- Check ground resistance and tighten connections

5. Cutouts.

Annually.- Inspect, maintain and repair as needed.

(d) Disconnecting Switches and Fuses.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and Mounting	BE	1
Insulators	A-BE	2
Line and ground connections	Q-BE	3
Blades and contacts	Q-A-BE	4
Locks and interlocks	Q	5
Fuse tubes and fuse links	Q	6

1. Base and Mounting.

Biennially.- Inspect for loose bolts or structures.

2. Insulators.

Annually.- Check for chipped and broken insulators. Clean as required.

Biennially.- Tighten loose assembly bolts.

3. Line and Ground Connections.

Quarterly.- Make visual inspection of line connections and where evidence of loose connections exist, tighten as required. Check condition of ground connection to assure that it is not broken and ground connection is tight.

Biennially.- Inspect and tighten connections as required.

4. Blades and Contacts.

Quarterly.- See that blades are properly seated in the contacts. Where necessary, adjust blades.

Annually.- Operate switch several times and see that blades are properly aligned to engage contacts.

Biennially.- Check alignment and condition of blades and contact. Tighten bolts and screws, adjust contact pressure and maintain silver or other contact surface in good condition.

5. Locks and Interlocks.

Quarterly.- See that switches are properly locked in the open or closed position as required by padlocks or other key-type locks or interlocks. Lubricate with powdered graphite only, from a graphite gun. No other lubricant shall be used on padlocks or cylinder locks. See that locks and keys operate as intended. Check mechanical interlocks such as between main disconnecting switch and ground switch for operation.

6. Fuse Tubes and Fuse Links.

Quarterly.- Inspect and check fuses and their holders for evidence of failure or improper conditions. When fuse trouble occurs due to high resistance contact between ferrule and holder, refinish ferrule and fuse dips. On fuses of high current rating or exposed to unfavorable atmospheric conditions it may be found desirable to silver plate the contact surfaces.

(e) Lightning Arrestors.

Inspection Check List

Item To Be Inspected	Inspection Interval	Paragraph
Base and supports, insulators, leads, etc.	D-A-6 Years	1
Arrestor-enclosure	A	2

1. Base and Supports, Insulators, Leads, Etc.

Daily.- Inspect arrester installation observing general condition.

Annually.- Clean porcelain parts, tighten loose bolts, check spring connectors, check line and ground connections, etc. Observe for evidence of high currents which might have damaged arrester internally. Make repairs as needed.

Six Years.- Check 60-cycle sparkover voltage of each section of arrester utilizing testing transformer with suitable resistor to limit current. Compare with original manufacture, test valves for the type and voltage rating of arrester unit. If required, paint hardware with aluminum or other suitable paint.

2. Arrester Enclosure.

Annually.- Check protective enclosures including ground connections. Carry out maintenance as required.

(f) Oil Circuit Breakers.

Maintenance Schedule Guide

Item To Be Inspected	Inspection Interval	Paragraph
Frame and Tanks	B-M-A	1.
Oil valves and plugs	BE	2

Item To Be Inspected (Cont'd)	Inspection Interval	Paragraph
Oil levels and gauges	D	3
Breathers and vents	A	4
Panels and cabinets	M	5
Bushings or insulators	M-A	6
Bushing CT's and potential devices	A	7
Main terminals & ground connections	M	8
Main contacts	A-BE	9
Contact pressure springs	BE	10
Arc interrupter	BE	11
Crosshead	BE	12
Lift rods and guides	BE	13
Operating solenoids, latch & trip mechanism	Q	14
Auxiliary switches	Q	15
Dashpots or snubbers	BE	16
Mechanism cabinets	A	17
Cabinet heaters	Q	18
Power supply and wiring	Q	19
Oil dielectric tests	SA	20
Oil purification	NS	21
Breaker operation	D	22
Control and protective relays		

1. Frame and Tanks.

Bimonthly.- Check for oil leaks and note tank temperature by touch.

Annually.- Lubricate mounting mechanism according to manufacturer's instructions.

2. Oil Valves and Plugs.

Biennially.- Check condition of paint and refinish as necessary. Inspect oil valves and plugs; stop oil leaks. See that oil drain valves are locked where plugs are not provided. Tighten bolts.

3. Oil Levels and Gauges.

Daily.- Check oil levels in gauges of tanks and oil filled bushings.

4. Breathers and Vents.

Annually.- Check for external obstructions to breathers and vents.

5. Panels and Cabinets.

Monthly.- Check panels for cracks and cleanliness. Check condition of enclosing cabinets, including hinges, locks, door gaskets, and paint.

6. Bushings or Insulators.

Monthly.- Check for chipped or broken porcelain, excessive dirt film, oil level, and oil or compound leaks.

Annually.- Clean porcelain as required. Repair chipped spots by painting with red glyptal. Inspect gasket for leaks. Tighten bolts, check insulation resistance. Inspect for foreign material and make dielectric test.

7. Bushing CT's and Potential Devices.

Annually.- Inspect terminal board. Clean and tighten all connections.

8. Main Terminals and Ground Connections.

Monthly.- Visual inspection for loose connections in connecting bus-work, loose or broken frame, ground connections.

9. Main Contacts.

Annually.- Check main contact resistance from terminal to terminal with a low resistance ohmmeter and record.

Biennially.- Overhaul as required by service and tests. Inspect main and arcing contacts. Smooth contacts as required. Adjust and align if necessary.

10. Contact Pressure Springs.

Biennially.- Check springs for loss of temper, breaks, or defects.

11. Arc Interrupter.

Biennially.- Check arc interrupting device for faulty or broken parts.

12. Crosshead.

Biennially.- Check contact crosshead for misalignment, breaks, bends, or looseness on lift rod.

13. Lift Rods and Guides.

Biennially.- Check contact lift rod for breaks, warping, pulling out at ends, and other weaknesses. Check lift rod guides for alignment.

14. Operating Solenoids, Latch and Tripping Mechanism.

Quarterly.- Inspect electrically operated solenoid mechanism. Megger manually operated tripping mechanism, observing that tripping mechanism is free. Run breaker through three operating cycles and carefully observe action.

15. Auxiliary Switches.

Quarterly.- Visual inspection. Maintain contacts as indicated.

16. Dashpots or Snubbers.

Biennially.- At overhaul check for proper setting and adjust as necessary. Clean out and replenish liquid in liquid dashpots.

17. Mechanism Cabinet.

Annually.- Check condition of metal and hardware. Repaint as necessary. See that door gaskets are tight and properly exclude dust and dirt.

18. Cabinet Heaters.

Quarterly.- Inspect heaters; make repairs as needed to keep heaters in service.

19. Power Supplies and Wiring.

Quarterly.- Check fuses or circuit breakers in all power and supply circuits. Maintain in their operating position.

20. Oil Dielectric Tests.

Semiannually.- Check dielectric strength of the insulating oil in the main tanks of oil circuit breakers and oil-filled bushings.

21. Oil Purification.

Not Scheduled.- Oil that tests under 22 kilovolts should be scheduled for purifying. Oil that tests under 20 kilovolts should not remain in use without purifying. Purified oil should test 26 kilovolts or more.

22. Breaker Operation.

Daily.- Some breakers, particularly those carrying high values of current, have a tendency to develop contact heating if left closed for long periods. Daily test for abnormal temperatures by placing a bare hand on each switch tank. Opening and closing breakers several times at intervals as system operation will permit may alleviate the heating by wiping the oxide from the contact surfaces, as well as demonstrate that the breaker is in operating condition. Then test with "Ductor" bridge through main contacts to indicate if fault condition exists in main contact circuit.

(g) Switchboards and Control Equipment.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Panels, supports, cabinets, and cubicles	W-A	1
Panel wiring and terminal blocks	A	2
Auxiliary and control relays	D-A	3
Control switches and push buttons	W-M-A	4
Indicating lamps	D	5
Meters and Instruments	D-A	6
Position indicators	D	7
Protective relays	D-A	8
Resistors	B.E.	9
Test switches and jacks	A	10

1. Panels, Supports, Cabinets, and Cubicles.

Weekly.- Check for general cleanliness and condition of finish. Clean off dust, dirt, and grease. Use a solution of mild soap and water or Okite Renovator diluted as per directions, to remove dirt and grease from panels. Many cleaning compounds are harmful to the finish and should not be used. Since switchboard panels having considerable equipment on them are difficult to refinish, care must be taken in cleaning them. Wax may be used where the gloss is not objectionable.

Annually.- Repair finish and hardware and clean as necessary. Tighten bolts and screws. Check boxes and cabinets in damp locations for corrosion and rust. Clean and refinish as necessary.

2. Panel Wiring and Terminal Blocks.

Annually.- Check for general housekeeping. Vacuum out terminal cabinets and wiring and control dubicles using due care and caution around live relays and controls. Check condition of wiring, particularly observing evidence of damaged insulation. Remark tags for terminal blocks when needed. Tighten connection at terminal points.

3. Auxiliary and Control Relays.

Daily.- Note and report any unusual heating, vibration, or other unusual condition of relays.

Annually.- Inspect relays. Dress contacts or replace if needed. Check contact spring and wiping action. Check contact shunts, etc. Make other adjustments, alignments, etc. as required. Test relay circuits.

4. Control Switches.

Weekly.- Operate control switches for test when feasible. Make repairs as needed.

Monthly.- Test control switches and push buttons on motors of all auxiliary equipment. Make repairs as needed.

Annually.- Overhaul all control switches at least once a year, oftener if needed. Check spring action and replace all switch units having unsatisfactory action.

5. Indicating Lamps.

Daily.- Replace any burned-out pilot lights. Make repairs as found necessary.

6. Meters and Instruments.

Daily.- Observe performance of instruments; adjust and repair as needed.

Annually.- Check calibration of meters and instruments; clean, adjust and repair as necessary. Tighten connections, check wiring connections if any changes have been made in associated circuits or equipment.

7. Position Indicators.

Daily.- Observe operation of position indicators. Make adjustments, repairs, etc. as needed.

8. Protective Relays.

Daily.- Visual inspection for anything unusual about contacts, coils, or moving element. Keep targets reset.

Annually.- Test relays as per instructions.

9. Resistors.

Biennially.- Vacuum. Make repairs as needed.

10. Test Switches or Jacks.

Annually.- Examine test switch contacts and refinish with file or abrasive if burned or corroded. Tighten connections.

(h) Low Voltage Switchgear - Busses and Cables.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Bus bars, joints, and connections	BE	1
Bus insulators and supports	BE	2
Bus enclosures and barriers	BE	3
Switchgear panels and enclosures	M-A	4
Locks and interlocks	M	5
Warning and safety signs	M	6
Current and potential transformers	A	7

1. Bus Bars, Joints and Connections.

Biennially.- Check bus bars, joints and connections for overheating. Tighten joint and connection bolts. Refinish joint contact surfaces. Silver plate if required on high current connections to prevent heating.

2. Bus Insulators and Supports.

Biennially.- Inspect and clean insulators or insulating block supports. Paint chip spots on porcelain with red glyptal. Tighten bolts. Check supports for rigidity. Inspect tape insulation on bus bars, if any, and revarnish as required.

3. Bus Enclosures and Barriers.

Biennially.- Check bus enclosures and interphase barriers for tightness and adequate ventilation. Clean as required.

4. Switchgear Panels and Enclosures.

Monthly.- Inspect and clean as required with industrial type hand vacuum cleaner.

Annually.- Inspect, clean and check for loose bolts; repaint or refinish as required.

5. Locks and Interlocks.

Monthly.- Check all key locks and mechanical interlocks. Lubricate cylinder locks with powdered graphite only. Leave in proper operating position.

(i) Storage Batteries and Chargers.

Item to be Inspected	Inspection Interval	Paragraph
Storage Batteries		
Base or rack	A	1
Base pad	A	2
Separators	M	3
Electrolyte	D-M	4
Intercell connectors and terminals	M	5
Hydrometers and thermometers	D-M	6
Battery Chargers		
Electronic and metallic rectifiers	W-A	7

1. Base or Rack.

Annually.- Inspect concrete base or wooden racks for deterioration. Repair or repaint with acid-resisting paint as necessary.

2. Base Pad.

Annually.- Check base pad of sheet rubber, sand, or other material, for deterioration from acid or other causes.

3. Separators.

Monthly.- Visual inspection for condition.

4. Electrolyte.

Daily.- Check electrolyte gravity of pilot cells.

5. Intercell Connectors and Terminals.

Monthly.- Neutralize acid with ammonia and clean from battery connectors and cell tops.

6. Hydrometer and Thermometer.

Monthly.- Report condition of hydrometer and thermometer if necessary.

7. Electronic and Metallic Rectifiers.

Weekly.- Visual inspection of transformers, tubes, control switches or resistors. Replace or repair any defective items. Check operations.

Annually.- Make thorough inspection of all items on the rectifier, replacing any defective equipment and tighten connections.

(6) Flap Gates.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Flap gates	Q	(a)

(a) Flap Gates.

Quarterly.- Flap gates should be trail operated, serviced, and lubricated to be certain they swing freely and do not bind. Caution: In order to prevent possible damage, do not allow the flaps to slam against the seats.

(7) Trash Racks.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Trash racks	W-A	(a)

(a) Trash Racks.

Weekly.- Check trash racks for debris. See that trash and debris is removed.

Annually.- Inspect trash racks, including underwater portion so far as feasible; remove lodged debris not removed on routine cleaning. Check condition of metal work; repair as needed. Paint every 5 years unless inspection shows more frequent painting to be necessary.

(8) Sluice Gates.

Inspection Check List

Item to be Inspected	Inspection Interval	Paragraph
Gate valves	Q	(a)
Packing	A	(b)
Gearing	A	(c)
Rising stems	Q	(d)
Valve seats	N.S.	(e)

(a) Gate Valves.

Quarterly.- Operate gate valves to prevent sticking.

(b) Packing.

Annually.- To eliminate excessive friction between valve stem and packing, lubricate with a few drops of graphite bearing oil. Stop leakage by tightening stuffing-box nuts. Replace packing as needed.

(c) Gearing.

Annually.- Lubricate gate valves as recommended by manufacturer.

(d) Rising Stems.

Quarterly.- Clean threads on rising-stem gate valves and lubricate.

(e) Valve Seats.

N.S.- Reface leaky gate valve seats as necessary.

(9) Painting.- Periodic painting is required of the parts of pumping plant, closure materials, and other structures that require this type of protection in order to protect metal parts from corrosive action of water and other elements. Frequency of painting varies, depending on type of paint used, methods of application, and conditions of wear. Always paint metal surfaces before corrosion becomes so severe that equipment is damaged. Prepare metal surfaces by sandblasting, if practical, or by cleaning them thoroughly with sandpaper and wire brush. Only special-prepared paints should be used on damp surfaces that will be encountered. Corrosion-preventive compounds may be used in moist or wet places where paint would not last.

e. Shut Down Procedure.- Immediately upon final recession of flood waters, switches, and sluice gates shall be restored to their normal settings. The pumping plant shall then be thoroughly cleaned and equipment thoroughly inspected, oiled, and greased. After each flood period, all parts of the pumps should be checked thoroughly. The pump bowls should be checked for damage, pitting, or other damage. The impellers should be checked for damage, pitting, looseness on the shaft, etc. The bearings, the oil feed piping, and other parts should be inspected for possible damage from floating debris, vibration, or excessive strain. A log of pumping plant operation shall be furnished the District Engineer following each flood.

SECTION IV

PROJECT FACILITIES

CHAPTER 5

PRESSURE CONDUITS

4.05. PRESSURE CONDUITS.

a. Description.- There are five pressure conduits located within the Dallas County Flood Control District. They provide a means for the removal of interior runoff from land side of the levees. The facilities that are used in conjunction with these pressure conduits vary with the location and purpose of the particular unit. The pressure conduits are located as follows:

Designation	Location
Turtle Creek	Station 194+13, East Levee
Dallas Branch	Station 154+33, East Levee
Belleview	Station 59+93, East Levee
Coombs Creek	Station 93+57, West Levee
Lake Cliff	Station 75+92, West Levee

b. General Instructions.

(1) Reports of Unusual Incidents.- A written report will be made to the District Engineer of each instance of major damage to the facilities such as flood damage, extensive vandalism, and/or sabotage. Incidents which prevent the pressure conduit from removing interior runoff will be reported to the District Engineer by telephone. Telephoned reports will be confirmed by written reports.

c. Operation, Inspection, and Maintenance.- Pressure conduits and related facilities and equipment will be operated as required in the succeeding subparagraphs on individual units.

SECTION IV

PROJECT FACILITIES

CHAPTER 5

PRESSURE CONDUITS

4.051. TURTLE CREEK.

a. Description.- The Turtle Creek Pressure Sewer consists of a diversion dam with spillway, an intake structure, a conduit varying in shape from an 18.5-foot semi-elliptical section to a 16-foot modified horseshoe and a gated outlet structure. The 175-foot concrete emergency spillway with a crest elevation at 419.5 is located adjacent to the pressure sewer intake. A trash rack having a net area of 460 square feet is provided at the intake to prevent the passage of trash and debris of sufficient size to interfere with the outlet gate operation or cause obstructions in the pressure sewer. The intake invert is at elevation 395.0. The pressure sewer is gate-controlled at the downstream end. Four 8- x 10-foot sluice gates with sills at elevation 377.0 are located in a gate well at the outlet end of the pressure sewer on the riverside of the levee. The outlets terminate in four 10-foot diameter openings at the outlet portal. Four circular flap gates are installed in the portal head wall. The control tower has four hand-operated gate hoists located on the operation deck at elevation 431.5. However, these can be operated by a portable power hoist.

b. Operation.

(1) The sluice gates in the outlet structure will normally be kept in an open position. They will be closed during emergencies. Standard hand-operated floorstands are provided for operation of the gates. However, a portable gasoline powered hoist, mounted on wheels, is provided which will close each gate in approximately 6 minutes.

(2) Flap gates capable of withstanding 50 feet of head are installed in the channel end of the outlet structure.

c. Inspection.

(1) Quarterly inspections should be made to insure that inlet and outlet channels are kept open, and that trash, drift, or debris is not allowed to accumulate near the drainage structure.

(2) The condition of the equipment and the control tower should be inspected quarterly to be certain that gates and operating mechanism are in good condition.

(3) Whenever high water conditions impend, all gates should be inspected a short time before water reaches the invert and any object which might prevent closure of the gate removed.

(4) An annual inspection of trash racks should be made, including underwater portion so far as feasible. Lodged debris not removed on routine cleaning should be removed. The condition of the metal work should be checked and repaired as needed. Trash racks should be painted every 5 years unless inspection shows more frequent painting to be necessary.

(5) An annual inspection of gates should be made. The condition of bolts, studs, latching devices, paint, or other surface treatment should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be disassembled and repaired if necessary to stop excessive leakage. Seals and guides should be checked for wear and deterioration. Seals should be renewed and guides built up where scored, as necessary. Accumulated mineral deposit should be removed from seals and guides. Seal and guide alinement should be checked.

(6) A monthly inspection of the hoist should be made. The condition of the hoist should be checked, observing gears, bearings, seals, hooks, chains, and lubrication. Worn or defective parts should be repaired and parts should be lubricated when needed. Hoist should be painted when necessary in order to maintain it in good condition.

d. Maintenance.

(1) Flap gates and hoist-operated gates should be examined, oiled, and trial-operated at least once every ninety days.

(2) Portable Hoist maintenance will be performed as follows:

Weekly.- Operate the hoist at least 15 minutes each week. Under load if possible. Check for signs of tampering, damage, or injury such as loosened accessories. Check accessories and drives for loose connections or mountings. Check for signs of fuel or oil leaks. During operation check for poor engine performance such as lack of usual power, misfiring, unusual noise, stalling, overheating, or excessive exhaust smoke. Check air cleaner. Inspect electrical wiring.

Quarterly.- Lubricate variable speed drive assembly.

Annually.- Check distributor. Clean and replace parts as necessary. Change oil in air cleaner. Check and see that carburetor, choke throttle, linkage, and governor are in good condition.

Not Scheduled.- When performance or trouble reports indicate, have the unit overhauled.

SECTION IV

PROJECT FACILITIES

CHAPTER 5

PRESSURE CONDUITS

4.052. LAKE CLIFF.

a. Description.- About 1877 feet of the total length consists of a 7.0-foot diameter conduit and about 275 feet will consist of a 6- x 8-foot box section. A drop inlet, circular type intake structure was provided in Lake Cliff. The crest of the intake is at elevation 443.5 and has a diameter of 22.0 feet. There are two circular sluice gates in the intake, one 18" in diameter and one 24" in diameter, with hand-operated floorstands with provisions for attaching a portable hoist. A gated outlet structure is provided at the levee. This consists of a triple 6- x 8-foot sluice gate on the pressure sewer and two 6- x 8-foot sluice gates on the gravity sluices on either side of the pressure sewer. Standard hand-operated floorstands are provided to operate the gates with provision to attach the portable hoist operating unit. Two 8-foot diameter flap gates are provided on the outlets of the two gravity sluices. The pressure sewer outfall is provided with stop log slots.

b. Operation.

(1) The circular spillway well has gates at centerline elevations of 420.0 and 438.50 to permit draining of the Lake Cliff reservoir. These gates are normally kept closed.

(2) The 6- x 8-foot gates in the outlet structure will normally be kept open. These gates will be closed during emergencies.

c. Inspection.

(1) Quarterly inspections should be made to insure that inlet and outlet channels are kept open, and that trash, drift, or debris is not allowed to accumulate near the drainage structure.

(2) The condition of the equipment and the control tower should be inspected quarterly to be certain that gates and operating mechanism are in good condition.

(3) Whenever high water conditions impend, all gates should be inspected a short time before water reaches the invert and any object which might prevent closure of the gate removed.

(4) An annual inspection of trash racks should be made, including underwater portion so far as feasible. Lodged debris not removed on routine cleaning should be removed. The condition of the metal work should

be checked and repaired as needed. Trash racks should be painted every 5 years unless inspection shows more frequent painting to be necessary.

(5) An annual inspection of gates should be made. The condition of bolts, studs, latching devices, paint, or other surface treatment should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be disassembled and repaired if necessary to stop excessive leakage. Seals and guides should be checked for wear and deterioration. Seals should be renewed and guides built up where scored, as necessary. Accumulated mineral deposit should be removed from seals and guides. Seal and guide alignment should be checked.

(6) A monthly inspection of the hoist should be made. The condition of the hoist should be checked, observing gears bearings, seals, hooks, chains, and lubrication. Worn or defective parts should be repaired and parts should be lubricated when needed. Hoist should be painted when necessary in order to maintain it in good condition.

d. Maintenance.

(1) Flap gates and hoist-operated gates should be examined, oiled, and trial-operated at least once every ninety days.

SECTION IV

PROJECT FACILITIES

CHAPTER 5

PRESSURE CONDUITS

4.053. COOMBS CREEK.

a. Description.- The Coombs Creek Diversion Facility consists primarily of a 100-foot emergency spillway, a 6-foot diameter storm sewer, and an 18.5-foot semi-elliptical conduit of about 1600 feet in length. The intake of the 18.5-foot pressure sewer has a 40-foot trash rack to prevent passage of trash and debris. The intake invert is at elevation 392.5. A transition is provided from the 18.5-foot semi-elliptical conduit to four 8- x 10-foot gate passages discharging into a gate well located near the riverside toe of the levee. Four 9- x 11-foot passages are provided from the gate well to the outlet. The four-gate passages are controlled by 8- x 10-foot slide gates located in the gate well and stoplog slots are provided at the outfall. The four slide gates are provided with hand-operated floorstands; however, they may be operated with the portable hoist provided for the Turtle Creek Pressure Sewer. The 6-foot storm sewer consists of a gated control with a 72" diameter sluice gate and a hand-operated hoist. Also an 8' diameter flap gate on the outlet. The inlet to the storm sewer consists of two 7' x 8' vertical intakes protected by trash racks.

b. Operation.- The sluice gates in the outlet structure including the gate for the pressure sewer, the gates for the gravity sluices, and the gate on the 6-foot diameter storm sewer will normally be open. All gates will be closed during emergencies.

c. Inspection.

(1) Quarterly inspections should be made to insure that inlet and outlet channels are kept open, and that trash, drift, or debris is not allowed to accumulate near the drainage structure.

(2) The condition of the equipment and the control tower should be inspected quarterly to be certain that gates and operating mechanism are in good condition.

(3) Whenever high water conditions impend, all gates should be inspected a short time before water reaches the invert and any object which might prevent closure of the gate removed.

(4) An annual inspection of trash racks should be made, including underwater portion so far as feasible. Lodged debris not removed on routine cleaning should be removed. The condition of the metal work should be checked and repaired as needed. Trash racks should be painted every 5 years unless inspection shows more frequent painting to be necessary.

(5) An annual inspection of gates should be made. The condition of bolts, studs, latching devices, paint or other surface treatment should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be disassembled and repaired if necessary to stop excessive leakage. Seals and guides should be checked for wear and deterioration. Seals should be renewed and guides built up where scored, as necessary. Accumulated mineral deposit should be removed from seals and guides. Seal and Guide alinement should be checked.

(6) A monthly inspection of the hoist should be made. The condition of the hoist should be checked, observing gears, bearings, seals, hooks, chains, and lubrication. Worn or defective parts should be repaired and parts should be lubricated when needed. Hoist should be painted when necessary in order to maintain it in good condition.

d. Maintenance.- Flap gates and hoist-operated gates should be examined, oiled, and trial-operated at least once every ninety days.

NOTE: Occurrence of the design flood with the flow in the Trinity River at 90,000 second-feet (maximum flood of record modified by operation of the upstream reservoirs) would produce some flooding in the upper portions of Coombs Creek, in the vicinity of the Sylvan Street Crossing.

SECTION IV

PROJECT FACILITIES

CHAPTER 5

PRESSURE CONDUITS

4.054. DALLAS BRANCH.

a. Description.- The 12-foot Dallas Branch Pressure sewer is controlled by a gated control structure which consists of one gate 12' -6" x 13' made of WF beams and rubber "J" seals. Two floorstands, interconnected, are used to operate the gate. They may be operated manually or with a portable power hoist.

b. Operation.- Usually the gate will be open; however, if a break in the sewer occurs, the gate will be closed to prevent backflow through the sewer.

c. Inspection.

(1) Quarterly inspections should be made to insure that inlet and outlet channels are kept open, and that trash, drift, or debris is not allowed to accumulate near the drainage structure.

(2) The condition of the equipment and the control tower should be inspected quarterly to be certain that gates and operating mechanism are in good condition.

(3) Whenever high water conditions impend, all gates should be inspected a short time before water reaches the invert and any object which might prevent closure of the gate removed.

(4) An annual inspection of gates should be made. The condition of bolts, studs, latching devices, paint, or other surface treatment should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be disassembled and repaired if necessary to stop excessive leakage. Seals and guides should be checked for wear and deterioration. Seals should be renewed and guides built up where scored, as necessary. Accumulated mineral deposit should be removed from seals and guides. Seals and Guide alignment should be checked.

(5) A monthly inspection of the hoist should be made. The condition of the hoist should be checked, observing gears, bearings, seals, hooks, chains, and lubrication. Worn or defective parts should be repaired and parts should be lubricated when needed.

d. Maintenance.- Hoist-operated gates should be examined, oiled, and trial-operated at least once every ninety days.

4.055. BELLEVIEW.

a. Description.- The Belleview Pressure Sewer is a modified horseshoe section having a width of 16 feet and a height of 12.8 feet. The storm sewer is controlled by a gated control structure which consists of 12- x 17-foot gate made of WF beams and using rubber "J" seals. The gate is operated by two floorstand-type hoists that are interconnected. They may be operated manually or with a portable power hoist.

b. Operation.- The gate will normally be open, however, if a break in the sewer occurs, the gate will be closed to prevent backflow through the sewer.

c. Inspection.

(1) Quarterly inspections should be made to insure that inlet and outlet channels are kept open, and that trash, drift, or debris is not allowed to accumulate near the drainage structure.

(2) The condition of the equipment and the control tower should be inspected quarterly to be certain that gate and operating mechanism are in good condition.

(3) Whenever high water conditions impend, all gates should be inspected a short time before water reaches the invert and any object which might prevent closure of the gate removed.

(4) An annual inspection of gates should be made. The condition of bolts, studs, latching devices, paint, or other surface treatment should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be inspected and repaired or replaced as necessary. The operation of gate and leakage of water through the gate should be checked. The gate should be disassembled and repaired if necessary to stop excessive leakage. Seals and guides should be checked for wear and deterioration. Seals should be renewed and guides built up where scored, as necessary. Accumulated mineral deposit should be removed from seals and guides. Seal and Guide alignment should be checked.

(5) A monthly inspection of the hoist should be made. The condition of the hoist should be checked, observing gears, bearings, seals, hooks, chains, and lubrication. Worn or defective parts should be repaired and parts should be lubricated when needed. Hoist should be painted when necessary in order to maintain it in good condition.

d. Maintenance.- Hoist operated gates should be examined, oiled and trial-operated at least once every ninety days.

SECTION V

SECTION IV

PROJECT FACILITIES

CHAPTER 6

DRAINAGE STRUCTURES

4.06. DRAINAGE STRUCTURES.

a. Description.- Drainage structures within the Dallas County Flood Control District have to be operated, inspected, and maintained by the District. Seven of these drainage structures are designated and located as follows:

Designation	Location
Elm Fork Sluice	Station 601+32, East Levee
Grauwyler Road Culvert	Intersection of Grauwyler Road and Old Elm Fork Channel
Ledbetter Sluice and Dyke	Intersection of Kilgore and Ledbetter Dr. (Bernal)
Eagle Ford Sluice	Station 479+72, West Levee
24" Sluice	Station 17+60, Northwest Levee
36" Sluice	Station 53+40 Northwest Levee
36" Sluice	Station 117+65 Northwest Levee

b. General Instructions.

(1) Reports of Incidents.- A telephone report will be made to the District Engineer at any time any one of the drainage structures ceases to function as designed to the point that flooding of adjacent areas is imminent. This telephone report will be followed by a detailed written report.

c. Operation, Inspection, and Maintenance.- Drainage structures and related facilities will be operated, inspected, and maintained as required in the succeeding subparagraphs on drainage structures.

SECTION IV

PROJECT FACILITIES

CHAPTER 6

DRAINAGE STRUCTURES

4.061. MISCELLANEOUS DRAINAGE STRUCTURES.

a. Description.- The Eagle Ford sluice and the three sluices located in the Northwest Levee each have an automatic flap gate and a hand operated sluice gate; consequently, the operation, inspection, and maintenance will be similar on each of them.

b. Operation.- Whenever high water conditions impend, all gates shall be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gates shall be removed. Manually operated gates shall be closed as necessary to prevent inflow of flood water.

c. Inspection.- Frequent inspections will be made of each drainage structure during periods of high water in order to insure that flap gates are working properly, that sluice gates are not leaking, and that seepage is not allowed to develop around headwalls. During low water periods each drainage structure will be inspected every ninety days.

d. Maintenance.- Necessary measures will be taken to insure that inlet and outlet structures are kept open. Flap gates and sluice gates will be examined, oiled, and trial operated at least every ninety days. Periodic inspections will be made every ninety days during low water periods to insure that:

(1) Pipe, gates, operating mechanisms, riprap and headwalls are in good condition.

(2) Inlet and outlet channels are open.

(3) Trash and debris is not allowed to accumulate near the structure.

(4) No fires are built near concrete walls and/or pipes.

(5) Erosion is controlled adjacent to the structures.

SECTION IV

PROJECT FACILITIES

CHAPTER 6

DRAINAGE STRUCTURES

4.062. GRAUWYLER ROAD CULVERT.

a. Description.- The Grauwyler Road Culvert is located at the intersection of Grauwyler Road and the Old Elm Fork Channel. It consists of a 60-inch concrete pipe culvert with invert at elevation 394.4. It is equipped with a 60-inch manually operated sluice gate.

b. Operation.- Normally the sluice gate remains open to elevation 396.4. During periods of heavy interior runoff the gate will be fully opened when required.

c. Inspection.- During periods of heavy interior runoff, the sluice gate and culvert will be inspected frequently in order to insure free flow of water. During low water periods the culvert and appurtenances will be inspected at ninety day intervals.

d. Maintenance.- The sluice gate shall be manually examined, oiled, and operated at least every ninety days. Perodic inspection of the entire facility will be made at least every ninety days to insure that:

(1) Pipe, gate, operating mechanism, riprap, and headwalls are in good condition.

(2) Inlet and outlets are open.

(3) Trash and debris have not accumulated near the structure and inside the pipe.

(4) Fires are not allowed near concrete walls and/or other facilities.

(5) Erosion is controlled adjacent to the structure.

SECTION IV

PROJECT FACILITIES

CHAPTER 6

DRAINAGE STRUCTURES

4.063. ELM FORK SLUICE.

a. Description.- The Elm Fork Sluice consists of a 36-inch diameter gate-controlled sluice through the East Levee at about station 601+32 in the vicinity of Backman Lake and is used to provide water from the Elm Fork for the Brook Hollow Golf Club.

b. Operation.- The sluice gate will normally be closed except when water is needed by the Brook Hollow Golf Club.

c. Inspection.- Frequent inspections will be made of the structure and gate in order to insure that there is no leakage of water to the land side of the levee. Periodic inspections will be made of the entire facility every ninety days during low water periods.

d. Maintenance.- The sluice gate which is manually operated will be examined and opened and closed every ninety days. Necessary lubrication will be done at this time. Every ninety days the entire facility will be inspected to insure that:

(1) That pipe, gate, operating mechanism, riprap and headwalls are in good condition.

(2) Inlet and outlet channels are open.

(3) Trash and debris has not accumulated adjacent to the structure.

(4) Fires are not allowed near headwalls, pipe, or gate.

(5) Erosion is controlled adjacent to the structure.

SECTION IV

PROJECT FACILITIES

CHAPTER 6

DRAINAGE STRUCTURES

4.064 LEDBETTER SLUICE AND DIKE.

a. Description.- The Ledbetter Sluice and dike is located in the old channel of the West Fork adjacent to intersection of Kilgore Street and Ledbetter Drive (Bernal). It consists of an earth dike with a maximum height of 30 feet with a 10' crown, seal coated, and three to one side slopes, double 48" x 72" concrete sluice and hand-operated hoists for the gates.

b. Operation.- Normally the sluice gates remain open, the gates will be closed only in case of a pumping plant failure to prevent excessive accumulation of water in the Pavaho area.

c. Inspection.- During periods of heavy interior runoff the sluice gates and culvert will be inspected frequently in order to insure free flow of water. During low water periods the culvert and appurtenances will be inspected at ninety-day intervals.

d. Maintenance.- The sluice gates shall be manually examined, oiled and operated at least every ninety days. Periodic inspection of the entire facility will be made at least every ninety days to insure that:

(1) Gates, operating mechanism and headwalls are in good condition.

(2) Inlet and outlets are open.

(3) Trash and debris have not accumulated near and inside the sluice.

(4) Fires are not allowed near concrete walls and/or other facilities.

(5) Erosion is controlled adjacent to the structure.

SECTION IV

PROJECT FACILITIES

CHAPTER 7

EMERGENCY CONTROL FACILITIES

4.07. EMERGENCY CONTROL FACILITIES.

a. Description.- There are two emergency control facilities within the Dallas County Flood Control District. They provide a means of closing two sanitary sewer lines which traverse the East Levee in the event of excessive leakage or failure during periods of high water. The emergency control facilities are designated and located as follows:

Designation	Location
36" Bypass	Station 81+34, East Levee
60" Emergency Control Station	Station 622+18, East Levee

b. Operation, Inspection and Maintenance.- The operation, inspection and maintenance of the emergency control facilities will be performed in accordance with the instructions in the succeeding subparagraphs.

PROJECT FACILITIES

CHAPTER 7

EMERGENCY CONTROL FACILITIES

4.071. THIRTY-SIX-INCH BYPASS.

a. Description.- The 36" bypass control facility consists of a manually operated, 36-inch rising stem gate valve in an existing sanitary sewer which crosses under the East Levee at about Station 81+34. The valve and gate stem are enclosed in a concrete structure which has an operating deck, floor-stand and fence at Elevation 427.4. This structure is situated on the riverside of the crown of the levee.

b. Operation.- Usually the 36-inch gate valve will remain open. It will only be closed should there be a break in the sewer line or in the event of excessive leakage from the sewer line.

c. Inspection.- Frequent inspections will be made of this facility during high water periods in order to determine if the sewer line is still in good order. A general inspection of the facility will be made at 90 day intervals.

SECTION IV

PROJECT FACILITIES

CHAPTER 7

EMERGENCY CONTROL FACILITIES

4.072. SIXTY-INCH EMERGENCY CONTROL STRUCTURE.

a. Description.- An emergency control structure was constructed at a 60" sanitary sewer crossing that flows under the East Levee. A concrete bulkhead, that may be lowered into closure position if excess leakage or failure occurs during periods of high water, has been installed. The chain hoist is stored at the headquarters.

b. Operation.- Flow through the 60" sewer will not be bulkheaded unless excess leakage or damage occurs to the line.

c. Inspection.- The area adjacent to the structure shall be checked continuously during times of high water for possible blowout of the sewer line.

d. Maintenance.- Periodic inspection of the emergency control structure shall be made by the Superintendant to be certain that:

(1) Trash or debris is not obstructing the bulkhead slot.

(2) Bulkhead and hoist are in serviceable condition.

(3) Trial closure of the structure will be made biennially.

SECTION IV

PROJECT FACILITIES

CHAPTER 8

FLOOD WALL

4.08. FLOODWALL.

a. Description - A 1334 linear foot concrete flood wall was constructed about 1930 at the downstream end of the East Levee and adjacent to the Swift and Co. packing plant. There are four stoplog closures in this flood wall which provide for railroad entrances into the area. This flood wall is now incorporated into the Dallas Floodway facilities.

b. Operation.- The flood wall shall be continuously patrolled during high water periods for the purpose of locating leaks and/or seepage.

c. Inspection.- A general inspection will be made of the flood wall each year just prior to the flood season which usually begins in April. An inspection will also be made following each period of high water where the water level reaches the flood wall.

d. Maintenance.- Such periodic inspections as are necessary to insure proper maintenance will be made. Such inspections should be made after periods of high water and at intervals not exceeding 90 days during other periods. Such inspections should make certain that:

(1) No undue settlement has occurred which affects the stability of the wall or its water tightness.

(2) The concrete has not undergone cracking, chipping, or breaking to such an extent that the stability of the wall or its water tightness might be affected.

(3) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning during times of high water.

(4) No fires are being built adjacent to the wall.

(5) No bank caving conditions exist on the stream side of the wall that might endanger its stability.

SECTION IV

PROJECT FACILITIES

CHAPTER 9

STOPLOG CLOSURES

4.09. STOPLOG CLOSURES.

a. Description.- Four concrete stoplog structures were constructed about 1930 in the floodwall adjacent to the Swift & Co., packing plant at the downstream end of the East Levee. Creosoted timber and metal removable posts are stored in a concrete structure adjacent to the closure structures as follows:

Structure No. 1

STRUCT. REMOVED DURING CONST. OF DART BRIDGE (1996) REPLACED WITH EARTH FILL

1 removable post

20 planks 4" x 9" x 8'-9"

20 planks 2¼" x9½" x 8'-9"

Strcture No. 2

3 removable posts

20 planks 4" x 9" x 8'-9"

20 planks 2¼" x 9½" x 8'-9"

20 planks 4" x 9" x 6'-10½"

20 planks 2¼" x 9½" x 6'-10½"

Structure No. 3

3 removable posts

20 planks 4" x 9" x 8'-9"

20 planks 2¼" x 9½" x 8'-9"

20 planks 4" x 9" x 6'-10½"

20 planks 2¼" x 9½" x 6'-10½"

Structure No. 4 STRUCT. REMOVED

1 removable post

20 planks 4" x 9" x 8'-9"

20 planks $2\frac{1}{4}$" x $9\frac{1}{2}$" x 8'-9"

b. Operation.- When runoff in Elm Fork and West Fork, Trinity River, indicates a probable Commerce Street gage height of 51.0 or more the stoplogs will be placed at each of the railroad passages through the floodwall.

c. Inspection.- The closure structure shall be inspected frequently during floods to ascertain that no undue leakage is occurring.

d. Maintenance.- Inspection of each closure structure shall be made every 90 days to be certain that:

(1) No parts are missing.

(2) Metal parts are in satisfactory working order.

(3) Proper closure can be made promptly when necessary.

(4) Sufficient materials are on hand for the erection of the stoplog closures and that materials and tools are stored adjacent to the closure structures.

(5) Tools and parts shall not be removed for other use.

(6) Trial erection of one closure structure shall be made annually.

SECTION V

SPECIAL REQUIREMENTS

DURING HIGH WATER PERIODS

Chapter 1

5.01. General.- This section of the manual is supplementary in nature and consists of general statements of standard practice that have been used to advantage on levees during high-water emergencies. Most of the methods described herein have been developed during years of experience with the various problems that often come up during periods of high water and they are not intended to restrict the Superintendent, or others concerned to a rigid set of rules for every condition that may arise. Although certain treatments apply also to concrete flood walls, the remarks are primarily concerned with the earthen portions of the levee system. If problems not covered by these suggestions arise, where the Superintendent is in doubt as to the procedure to be taken, he will be expected to consult the District Engineer, Corps of Engineers, and to follow sound engineering methods in meeting emergency situations. It should be noted that it is much better to be over-prepared for periods of high water than to find at the last moment that preparations were incomplete or unsatisfactory. Confidence of the protected population and industry is a valuable asset that should not be carelessly lost through inefficient operation of the protection system in time of emergency.

5.02. Levee System.- The levee system may be subjected to certain dangers during high-water periods from current or wave action. These dangers diminish with the degree of maintenance that the levee system receives during normal water periods. Properly constructed levees, if properly maintained, should hold throughout any major flood. However, certain unexpected conditions that arise during flood periods tend to threaten the levee system but may be met with assurance if prompt action is taken and proper methods of treatment are used. Measures to cope with sand boils, seepage, sloughs, wave wash, scour and possible overtopping of neglected low spots in the levee are described herein. It cannot be stressed too greatly that maintenance requirements met promptly with proper measures will result in minimizing the necessity for such operations during high-water periods.

5.03. Preparedness.- It will be noted in the following paragraphs that various materials and equipment are required to combat such unforeseen conditions as may arise during a flood emergency. It is far better to know in advance just where such materials and equipment as described herein may be secured in times of emergency even though such emergencies may possibly never arise. It is human nature to wait until the last moment to attempt to locate such items and it may then be too late. The essential element in a flood emergency is time, and there is no better time than now to prepare a list of concerns or organizations from which the necessary labor, lumber, hardware, rolling stock, bags, suitable earth for sacking, equipment, etc., can readily be secured to cover any emergency that may arise. Such items should be provided as rapidly as is possible by the responsible parties when those who have had experience with flood emergencies in the past should deem their immediate procurement and use necessary.

5.04. Sacked Earth or Loose Earth.- Sacks filled with earth can be used in almost every phase of emergency high-water work. Loose earth (not wet), confined by boards as in a box levee, may be more economically placed and is more impervious, when compacted, than is sacked earth. Loose earth may be used when the point of placement is readily accessible by truck. It is advisable to use sacked earth under other conditions. Sacks should be filled about two-thirds full with the material shaken down into the sack loosely and should never be tamped. Sacks need not be tied or sewn together at the top if used for capping or on the land side of the levee. Earth filled sacks used for wave wash or as weights should be filled and the ends tied. Sand should be used only if earth is not available or if the time element is an important factor as in the distance required for hauling.

5.05. Sacks.- Sacks used for this type of work are usually of burlap and are about 19 inches by 36 inches in dimensions when unfilled. When two-thirds full they hold about one cubic foot of earth. Any type and suitable size of sack can be used if that specified above is not available.

5.06. Methods of Treatment - General.- After the above preliminary organizations and precautions have been completed, the various method of combatting the emergencies that may arise in flood fighting are ready to be employed. The methods of combatting various defects in the earthen levee described in the following paragraphs have proven effective during many years of use by the Corps of Engineers. It should be emphasized that it is of extreme importance that the value of any part of the protection works should not be underestimated. It is the coordinated function of the entire protection works that protects the district against floods.

5.07. Seepage.- Seepage is the percolation of water through the earthen levee. Although not dangerous in itself it may menace the stability of the levee by saturating the soil and causing sloughing of the landside slope. In order to prevent sloughing of the levee where the slope is steep and saturated, small V-shaped seep drains should be cut in the landside slope to remove the seepage water. If the levee should become saturated over a relatively large area, it may become necessary to take the measures outlined in paragraph 5.08 below to prevent sloughing. (See Annex 5-1).

5.08. Sloughing.- Sloughing is in the slipping or flowing out of position of a portion of the landside slope of the levee due to its being saturated through seepage to the point where that part of the levee becomes unstable. If there are reaches in the levee where the material in the levee section is of such nature that prolonged high stages of the river may cause sloughing conditions on the landside slope, then such soft areas should be thoroughly drained. After this operation, a single layer of willow brush, if obtainable, or any small trees or limbs, should be laid up and down the slope, laying the butts upward and tops downward, and weighted with earth filled sacks. Wood strips may be used if willows, small trees, or limbs are not available. If the slope begins to slough down, a log or heavy timber should be laid on top of the willows at the toe of the material sloughed off and this log or timber fastened to long stakes which have been driven several feet into the ground. A buttress of earth filled sacks should then be built at the toe and extended up the slope. The buttress at the toe should be built in the shape of a small banquette. Sandbags or weights should not be placed more than two-thirds of the distance from the toe of the material sloughed off to the bottom of the slough. (See Annex 5-2).

5.09. Sand Boils.- A sand boil is a definite stream of seepage water issuing from the earth, usually near the landside toe of the levee. The source of this seep water is usually from pervious materials underlying the levee. These danger spots are serious in any location and should be watched closely, especially those within 100 feet of the levee toe. A sand boil which discharges clear water in a small steady flow usually is not a serious menace to the safety of the levee and ordinarily need not be ringed. However, if the flow increases or carries a material load of sand and silt, corrective action should be taken immediately to prevent possible levee failure. A sand boil - if not attended properly - may gradually undermine a levee and cause failure by subsidence of the levee.

5.10. Sacked Earth Rings.- The accepted method of treating a sand boil is to construct a watertight ring of sacked earth around the boil, building up a head of water within the ring sufficient to check the velocity of flow through the boil so that no more material is displaced and the boil runs clear. (See Annex 5-3). The ring should not be built to a height which stops the flow of water completely because of the probability that the excessive local pressure head thus created may cause additional failures and boils nearby. The base of the sack ring is prepared by clearing the ground of debris, sod, loose sand or other objectionable material, to a width sufficient for the base of the ring. The base should then be thoroughly scarified to provide a watertight bond between the natural ground and the sack ring.

5.11. Scour.- Current scour is the erosion of the riverside slope of the levee by abnormally high current velocities. Current conditions which have a scouring effect may be detected by the appearance of eddies and general turbulence of the water. If erosion is evident, immediate steps should be taken to protect the levee against current scour. Ordinarily current scour can be prevented or arrested by the use of sack paving, board panels, or by vertical board deflection. These methods may be used in cases where there are minor current attacks and the depth of water is not great. These types of current protection should extend as far under water as practicable in an attempt to restore the original levee cross section.

5.12. Deflection Dikes.- Where sack paving or vertical board protection are not satisfactory, brush deflection dikes are generally used and are constructed of brush, but tree tops may be substituted. (See Annex

5-4). A double line of 4 x 4-inch or 3 x 6-inch posts is driven on four-foot centers, the lines of posts being about four feet apart and at the required angle to deflect the current away from the levee. The posts should be driven to the maximum practicable penetration, with their tops approximately two feet above the anticipated high-water surface. The posts should be well braced as conditions warrant with cross members and wiring and downstream bracing. Additional anchorage may be provided if required by use of cable or heavy wire placed at an angle of 45 degrees and tied to stakes in the slope. The brush dike frame is filled with alternate layers of willow, or some other suitable brush, and sacked gravel or large stone, which is used to hold the brush in place. The first layer of filler should consist of earth or gravel filled sacks, being so placed as to take out irregularities at the bottom and to provide a smooth base for the brush filler. Bundles of brush filler are laid so as to form a solid mat. The brush should be rammed tightly into place. Each layer of brush should be about one foot in thickness and weighted down with one or two layers of sacked earth or stone. The brush and sack filler should extend about one foot above the anticipated high-water surface. The outer end of dike is revetted with a mat of earth or gravel filled sacks to retard scour at that point.

5.13. Overtopping.- Overtopping of a levee is the flowing of the water over the levee crown. This may occur at points in the levee depressed through failure to maintain the original profile of the top of the levee. No matter to what small extent it may occur, the danger from overtopping cannot be overestimated. Once a breach has been opened in the levee by the water flowing over the crown and thus washing the material away it is very difficult, if not impossible, to close it. It is therefore imperative that overtopping be prevented. It can be prevented by increasing the height of the levee, or a section of the levee which is depressed due to settling or other causes, by capping or topping. The topping may be done (a) by sacked earth, (b) by flashboard and earth, or (c) with mud boxes. (See Annex 5-1 and 6). Where the height is less than three feet and minor wave action is expected, sack topping may be used. If severe wave action is anticipated, flashboards should be used and earthfill or sacked earth placed behind it. Capping in excess of three feet in height usually requires mud box construction. The height to which any type of topping should be carried for any point along the levee can best be established by running a line of levels and setting grade stakes so that a topping profile parallel to a predicted high-water profile can be constructed. Any of the types of capping need only be built to a height sufficient to take care of a predicted river profile plus about two feet of freeboard.

5.14. Sack Topping.- Sack topping consists of constructing a small banquette on the crown of the existing levee. The sod should be stripped from the crown of the levee to the required width as described herein. The crown of the levee is scarified by plowing furrows, or by other means, to a depth of two or more inches and to within one foot of the riverside edge of the levee crown. This step is very important as it provides a good bond between the levee crown and the capping. Additional bonding can be obtained by digging a trench to accommodate a row of sandbags parallel to the crown of the levee. (See Annex 5-5). The sacked earth is then placed to within one foot of the riverside edge of the crown to the desired height. The sacks should be placed close together, each succeeding row of sacks shall overlap the preceding row like shingles on a roof with joints staggered. Each layer of sacks should be laid in alternate directions with the bottom layer lengthwise of the levee (the next layer crosswise). All sacks should be well tramped or tamped into place after each layer has been placed. The topping should have sufficient base width to prevent failure. The face should have a slope of approximately 1 on 1 or steeper if the sack topping is placed on an earth levee (1 on $2\frac{1}{2}$ if placed on a smooth base such as concrete or asphalt), but in no case should the base be less than three times the height. The top layer of sacks should be at least 3 feet wide. If the wave action increases in severity, gravel filled sacks should be placed against the front facing of the sacked earth topping.

5.15. Hydrologic Reporting Network.- A hydrologic reporting network was established on the upper Trinity River Basin in connection with the operation of Benbrook, Grapevine, Lavon and Garza-Little Elm Reservoirs. (See Annex I.) Plate 37 shows rainfall, river stage and reservoir level stations. Rainfall reports from the reporting network stations are collected by the U. S. Weather Bureau Office at Amon Carter Field and relayed to the Hydraulic Section of the Fort Worth District Office, Corps of Engineers. There are presently six rain gages maintained in the City of Dallas by Southwestern Division Corps of Engineers personnel in cooperation with the Weather Bureau. Reports from these stations are made available to the U. S. Weather Bureau Office at Love Field. There are also eleven rain gages maintained by the local newspapers at various locations in the City of Dallas. River stage data are reported directly to the Hydraulic Section at the Fort Worth District Office by telephone from selected stations, whenever the stage is above a predetermined level. The stream gages at Grand Prairie, Dallas and Carrolton are equipped with telemark facilities and additional readings may be obtained from these gages as required. Reservoir levels and other hydrologic data for Corps of Engineers' reservoirs are available in the Fort Worth District Office by about 0900 hours daily. Reservoir levels and rainfall amounts for Bridgeport, Eagle Mountain, Lake Worth and Marine Creek Reservoirs are furnished daily to the Corps of Engineers by the Tarrant County Water Control and Improvement District No. 1, Fort Worth. Reservoir levels for other reservoirs in the area are available from the appropriate operating agencies

5.16. Drainage Area.- The Dallas Floodway is located at the confluence of the Elm Fork and West Fork of the Trinity River, Texas. The combined drainage area at the confluence is 6,080 square miles, 2,578 on the Elm Fork and 3,502 on the West Fork. The drainage area at the Commerce Street gage in downtown Dallas is 6,120 square miles. See Annex I, Plate 37 for watershed map.

5.17. Additional Rainfall and Staff Gages Required.

a. Dallas County Flood Control District shall make arrangements with the U. S. Weather Bureau, the U. S. Geological Survey and other observers to receive rainfall, river stage and reservoir level readings whenever predetermined amounts of rainfall, river stages or reservoir levels are reached or exceeded.

b. Dallas County Flood Control District shall arrange for establishing rainfall gages at the following locations in the Metropolitan Dallas area:

(1) Highland Park, in the vicinity of the Highland Park City Hall.

(2) At or near the Stevens Park Golf Course.

(3) At Pumping Plant "D".

(4) At or north of Marsalis Zoo.

(5) Near the Northwood Club.

c. Arrangements should be made by the Superintendent to receive reports from these stations whenever one inch or more of rainfall occurs in a period of twenty-four hours or less and for these reports to continue every six hours until the rainfall ceases. It is recommended that these stations be established in cooperation with the U. S. Weather Bureau with a regular observation time at 0700 or 0800 hours daily. Detailed records should be maintained of the rainfall at these stations.

d. Dallas County Flood Control District shall arrange for constructing staff gages and obtaining readings at the following locations in order to furnish record of water levels at these locations:

(1) Lake Cliff.

(2) Turtle Creek Pressure Sewer (about 100 feet above the intake structure).

(3) Coombs Creek Diversion Facilities (about 100 feet above intake structure).

(4) Sump above Plant "D" (Trinity Portland).

(5) Sump above Grauwyler Road Drainage Structure above Plant "B".

5.18. Required Reports.- Whenever the Trinity River is above a 30-foot stage on the Commerce Street gage at Dallas or whenever a 3-inch rain is reported in the Dallas area, the following reports will be made to the Hydraulic Section, Corps of Engineers, Fort Worth District Office, before 1000 hours daily:

a. River stage at Pumping plants "A" and Pahavo Street as of 0800 hours.

b. Sump level at all pumping plants as of 0800 hours.

c. Number of hours pumps operated at each plant during the preceding 24-hour period.

d. Water level above the intake of Turtle Creek, Coombs Creek and Lake Cliff pressure sewers.

e. Rainfall amounts at gages maintained by the Dallas County Flood Control District.

f. Piezometer readings, and West Levee Vicinity of Pavaho Pump Station will be made at flood stage at each five-foot increment of river level above flood stage on both rising and falling stages.

5.19. **Special Requirements at Pumping Plants During High Water Periods.**

a. General.

(1) During high water periods the pumping stations should be manned on a 24-hour basis. The sump level at each plant at 0800 hours and the number of times the pumps were operated during the preceding 24-hour period should be reported as soon as practicable after 0800 hours each day. Additional readings may be required during such high water periods.

(2) In order to maintain the prevailing sump levels when runoff producing rains occur, all pumping plants affected will be placed in operation until the full capacity of each pumping plant is reached.

b. Pumping Plant B and Hampton Road Pumping Plant Areas.

(1) Three sump areas are provided in connection with the Pumping Plant B and Hampton Road Pumping Plant areas. The Turtle Creek area drains to the river through the pressure sewer except during floods approaching design conditions when the overflow drains to the Hampton-Oaklawn sump. The Nobles Branch area drains into the Record crossing sump through a 60-inch gated culvert at Grauwyler Road. The gate of this culvert is fixed so that it can be closed only to an opening equivalent to that of a 36-inch culvert. The Hampton Road pumping plant serves the Record Crossing area and Pumping Plant B serves the Hampton-Oaklawn area. A gated 6.5- x 6.5-foot culvert is provided at Hampton Road for controlling the interchange of flow between the Record Crossing and Hampton-Oaklawn sumps.

(2) The plan of operation for the gated structures between sumps and for Pumping Plant B and the Hampton Road pumping plant is as follows: Whenever runnoff producing rain occurs on the watershed

(a) Leave gated culvert at Hampton Road closed until the sumps above and below have peaked or until flow occurs down Irving Boulevard (at elevation 403.5).

(b) When either of these conditions occurs, open the gates at Hampton Road. This will allow the sumps above and below Hampton Road to be evacuated simultaneously by the two pumping plants.

(c) The gate on the structure at Grauwyler Road will remain at the minimum setting until the sumps in the Record Crossing and Hampton-Oaklawn areas have receded to elevation 403.5, after which the gate will be fully opened. During floods when the sump levels in either of the two lower sub-areas do not reach elevation 403.5, the gate at the Grauwyler Road will be opened after all of the three sumps have peaked.

c. Pumping Plant D and Pavaho Street Pumping Plant Area.

(1) The drainage area served by the D and Pavaho Street pumping plants is divided into five sub-areas, each with its own sump.

(2) The Eagle Ford area is provided with a gravity sluice to the river. When gravity flow is blocked and the Eagle Ford sump reaches elevation 410.0, excess water from this sump flows into the Trinity-Portland sump through a 42-inch drop inlet (control at elevation 410.0).

(3) The Trinity-Portland area sump drains into the Frances Street sump through two 6.0- x 4.0-foot sluices.

(4) The Frances Street area sump drains into the sump below Westmoreland Road through one 72-, one 54-, and one 36-inch pipe culverts.

(5) The area below Westmoreland Road is served by pumping plant D. The area below Hampton Road is served by the Pavaho Street pumping plant. The sumps for these two areas are connected by a 10- by 8-foot box culvert under Hampton Road.

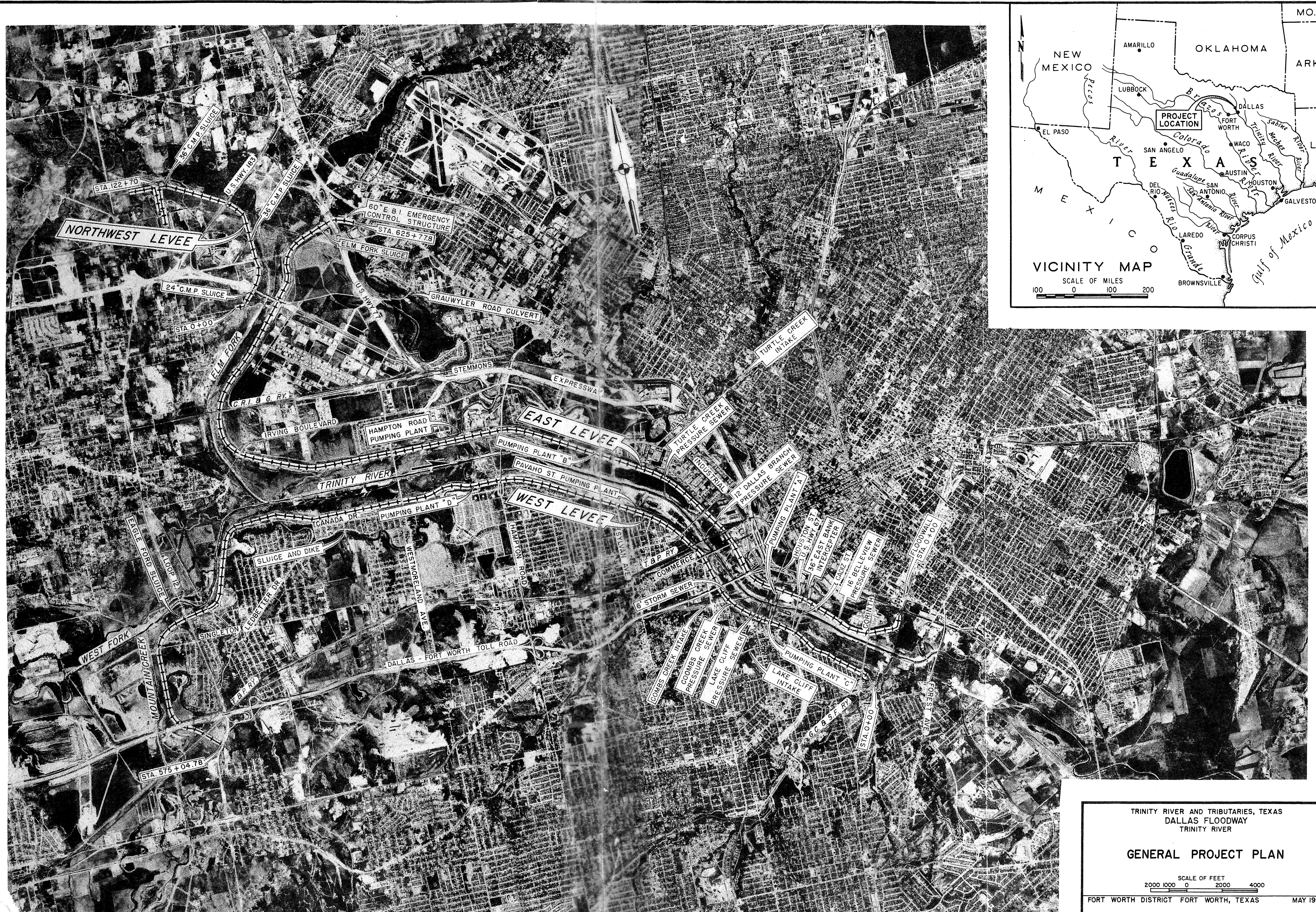
(6) The plan of operation for the gated structure between Trinity-Portland and Frances Street sump areas and for the pumping plant D and the Pavaho Street pumping plant is as follows: When runoff producing rain occurs on the watershed

(a) The gates in the structure below Trinity-Portland sump will remain in their normal open position throughout this operation. The gates will be operated only in the case of a pumping plant failure to prevent water from stacking from either area.

5.20. Pressure Conduits.- Reports of the 0800-hour readings of the water levels above the pressure conduits at Turtle Creek, Coombs Creek and Lake Cliff will be required daily. These readings will be reported as soon as practicable after 0800 hours. More frequent readings may be required during high water periods.

CORPS OF ENGINEERS

U. S. ARMY



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

GENERAL PROJECT PLAN

SCALE OF FEET
2000 1000 0 2000 4000

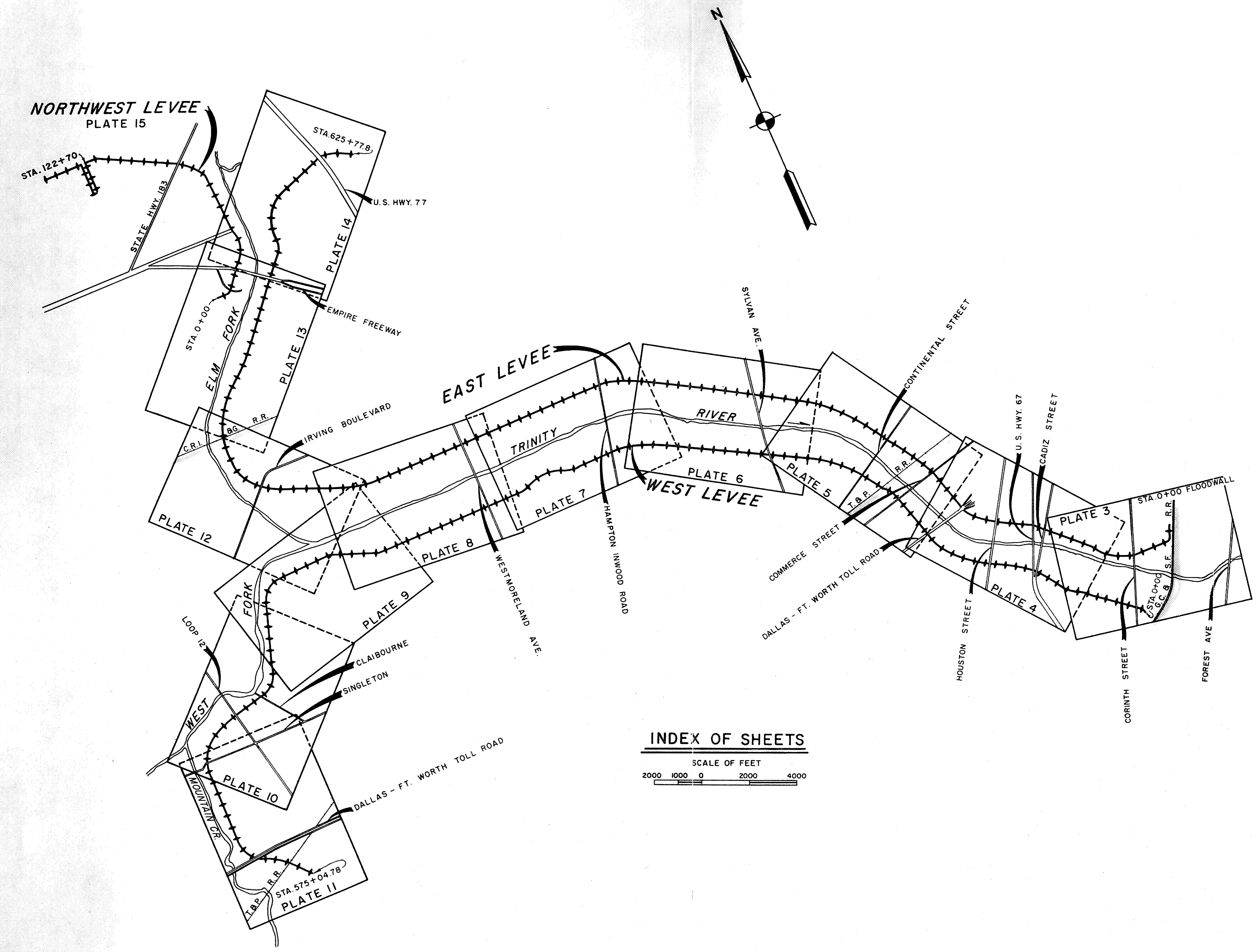
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE I

CORPS OF ENGINEERS

U.S. ARMY



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

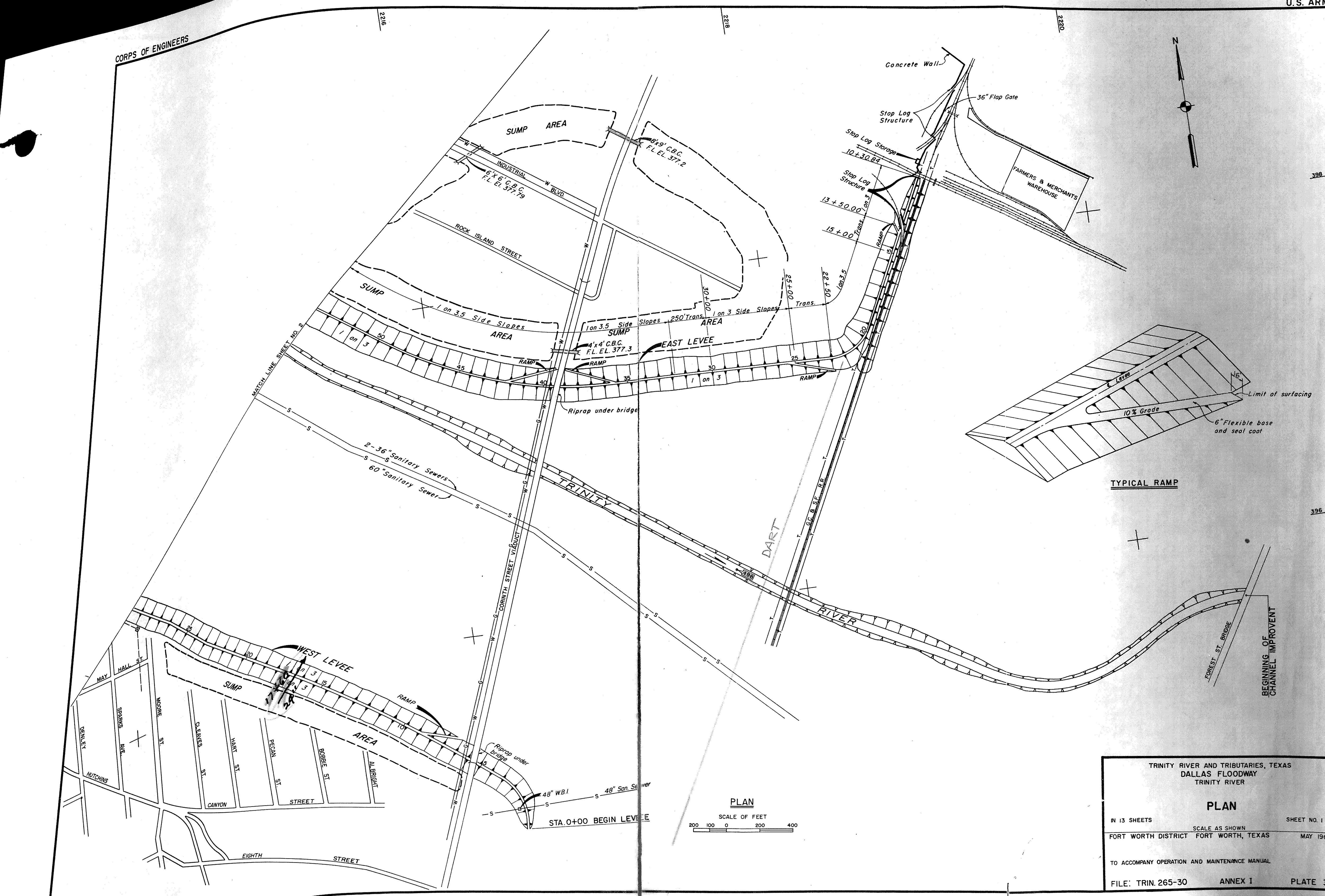
INDEX OF SHEETS

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 2



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

PLAN

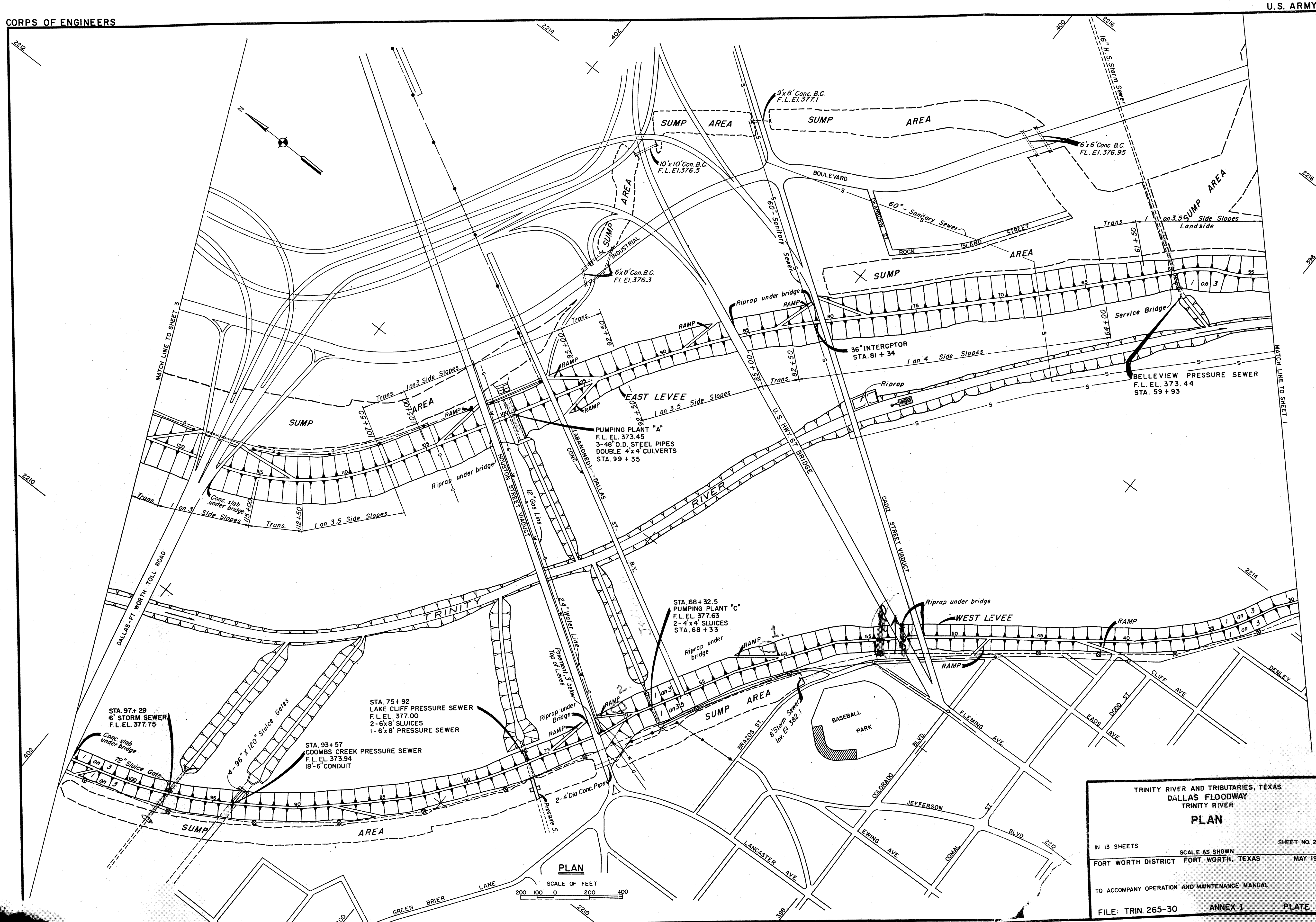
IN 13 SHEETS | SCALE AS SHOWN | SHEET NO. 1

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 3

U.S. ARMY
CORPS OF ENGINEERS



PIEZOMETER DATA TABLE

PIEZOMETER	LOCATION STATION	El. "A"	El. "B"	SCREEN SIZE
A	146+50	422.1	400.0	120-Mesh
B	151+60	422.9	390.0	60-Mesh
C	156+50	422.9	393.0	120-Mesh
D	161+30	420.6	393.0	120-Mesh
E	165+90	418.4	388.8	120-Mesh
F	177+90	413.6	390.0	60-Mesh
G	184+60	411.4	393.0	60-Mesh
H	196+40	407.3	389.0	60-Mesh

PIEZOMETER TUBE

NOT TO SCALE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

PLAN

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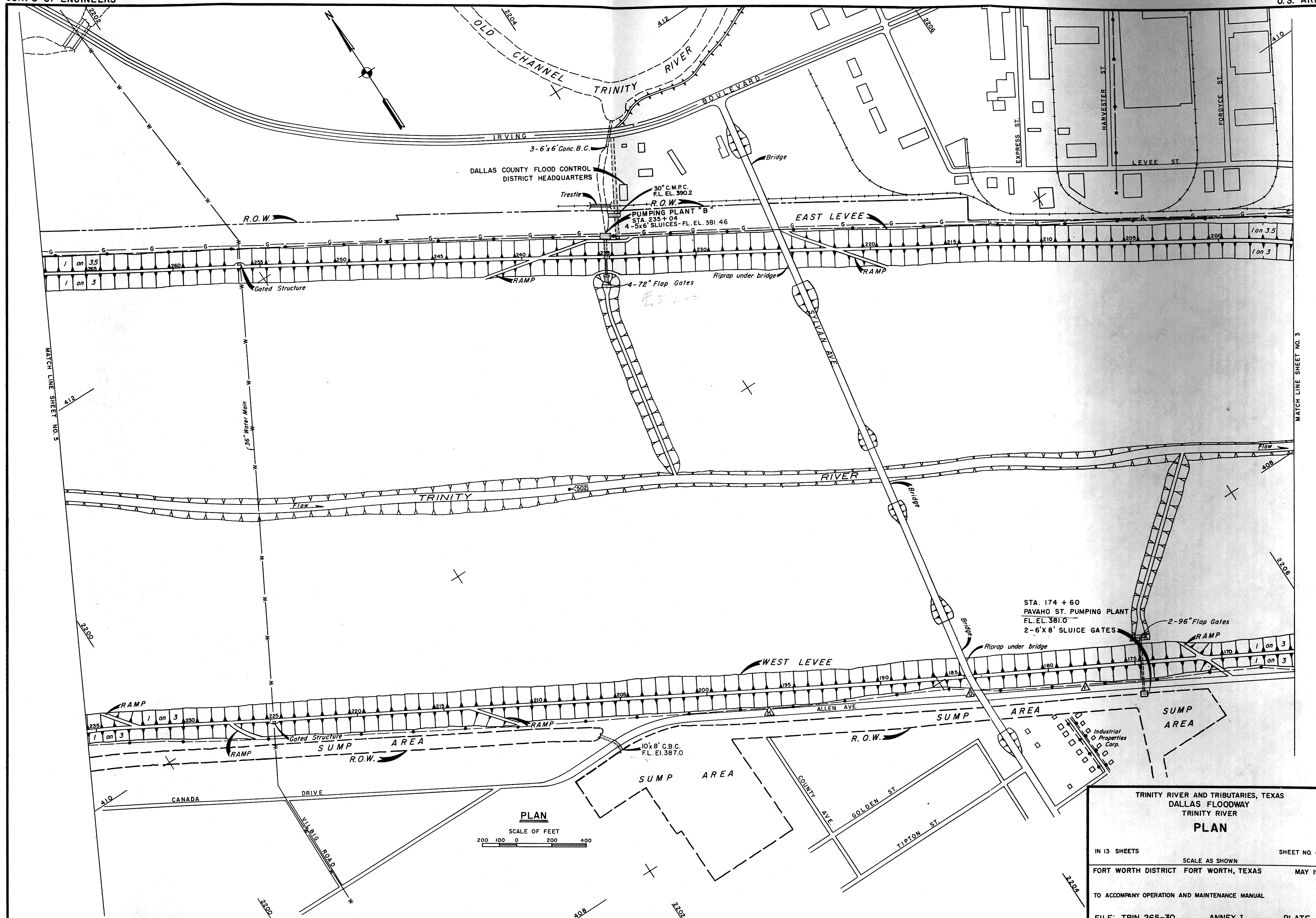
SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 5



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

PLAN

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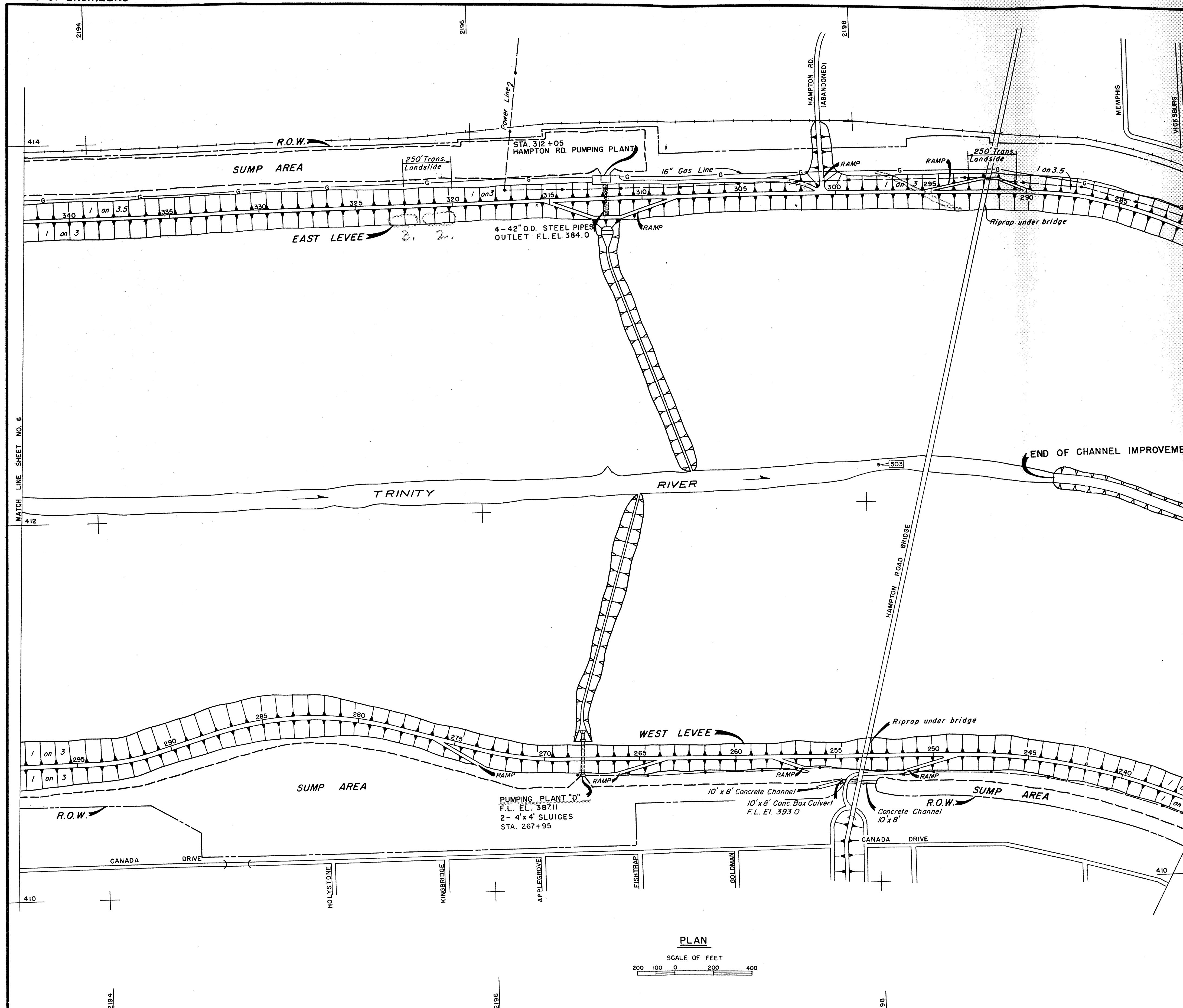
FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 — ANNEX I — PLATE 6

CORPS OF ENGINEERS

U.S. ARMY



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

PLAN

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FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MANTENACE MANUAL

FILE: TRIN. 265-30 — ANNEX I — PLATE 7

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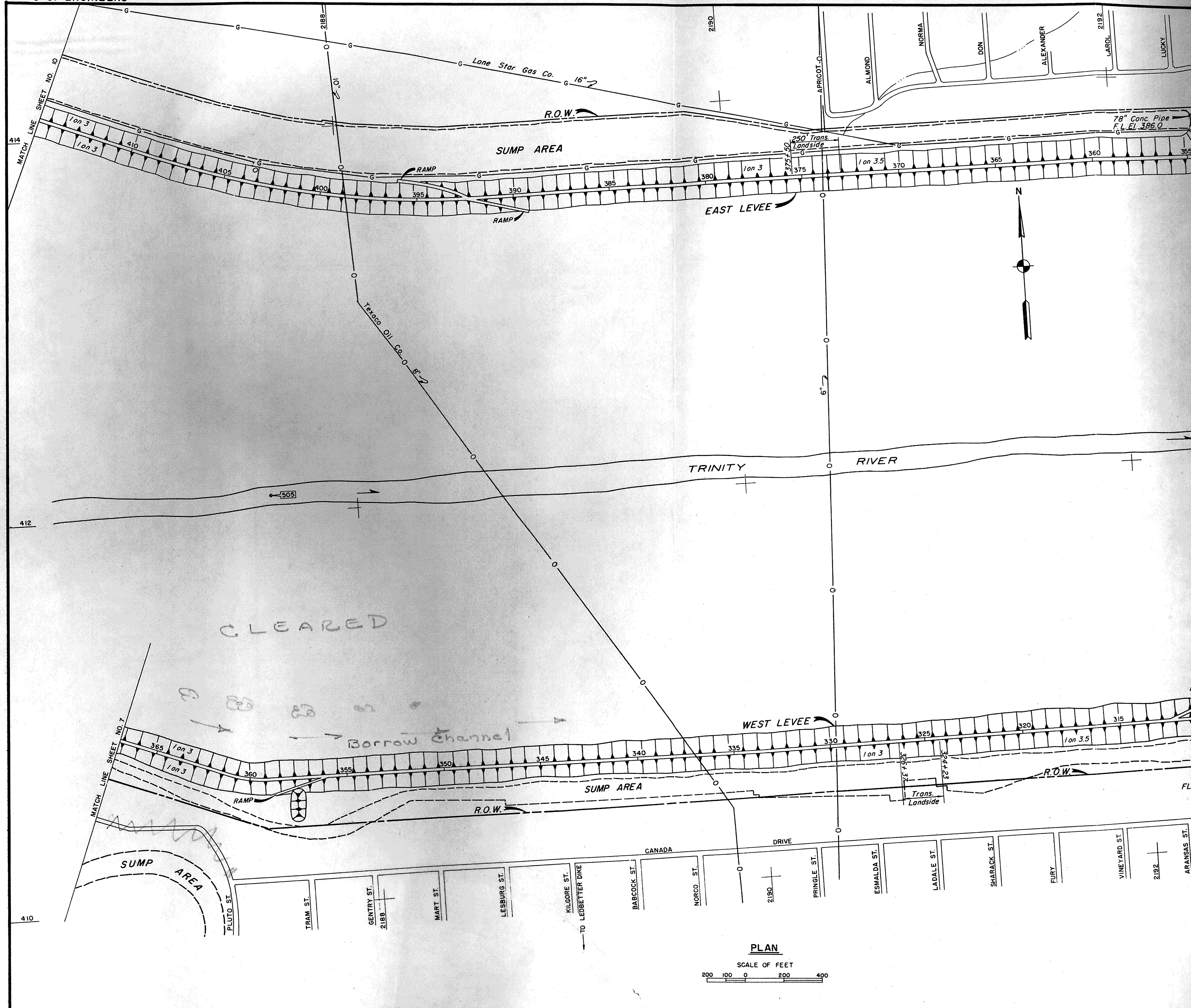


TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

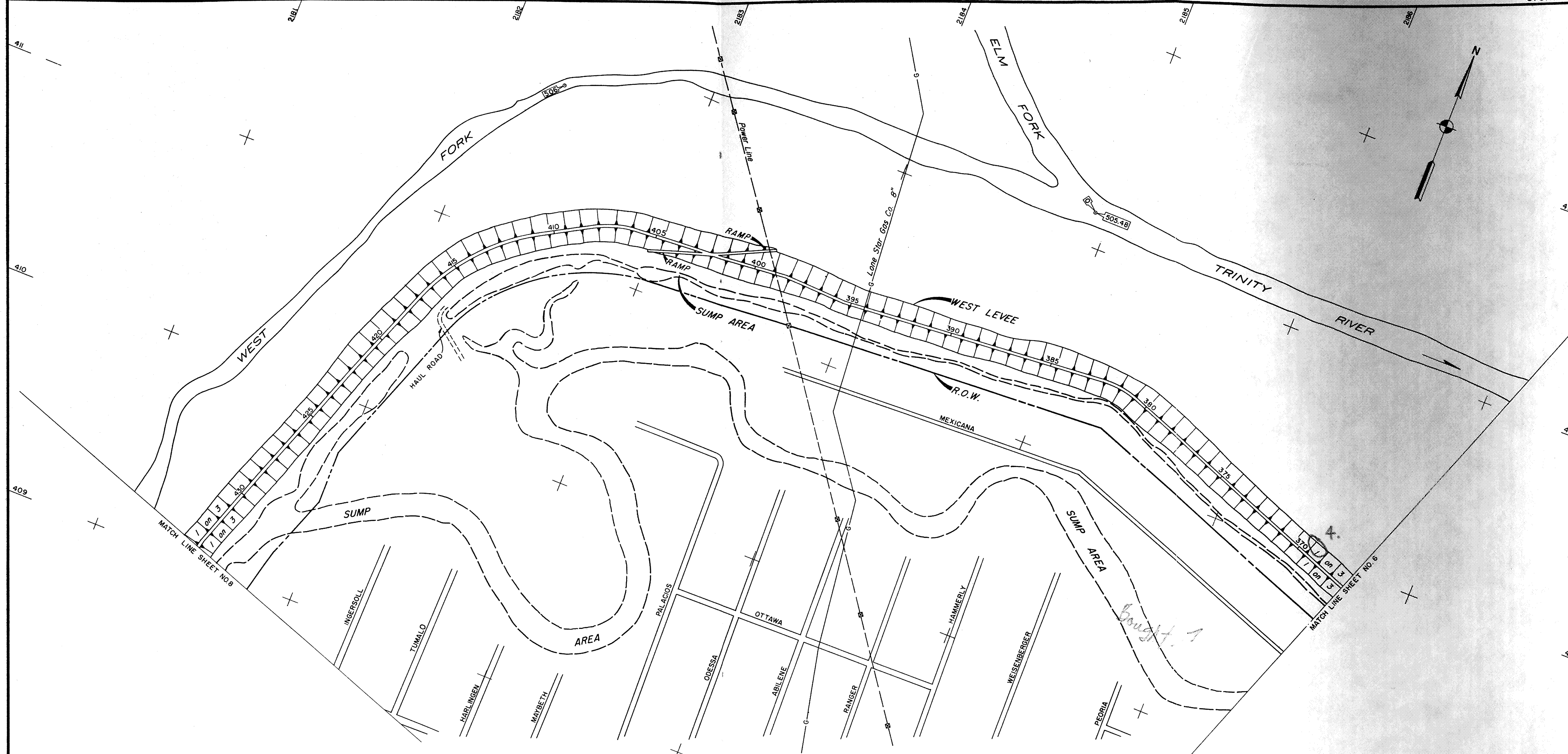
PLAN

IN 13 SHEETS SCALE AS SHOWN SHEET NO. 6

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 8



PLAN

SCALE OF FEET

200 100 0 200 400

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
WEST FORK, TRINITY RIVER

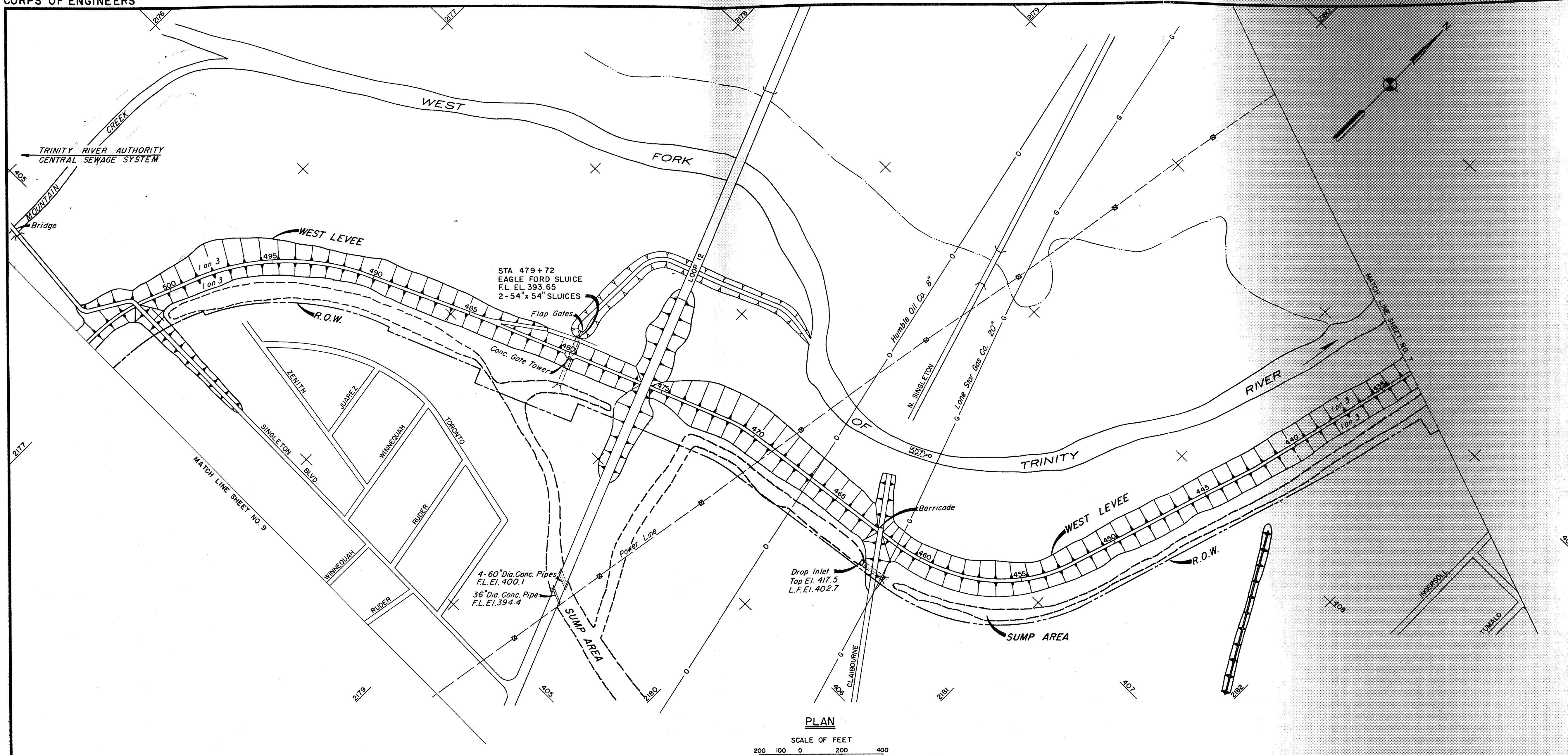
PLAN

IN 13 SHEETS SHEET NO. 7
SCALES AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 9



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
WEST FORK, TRINITY RIVER

PLAN

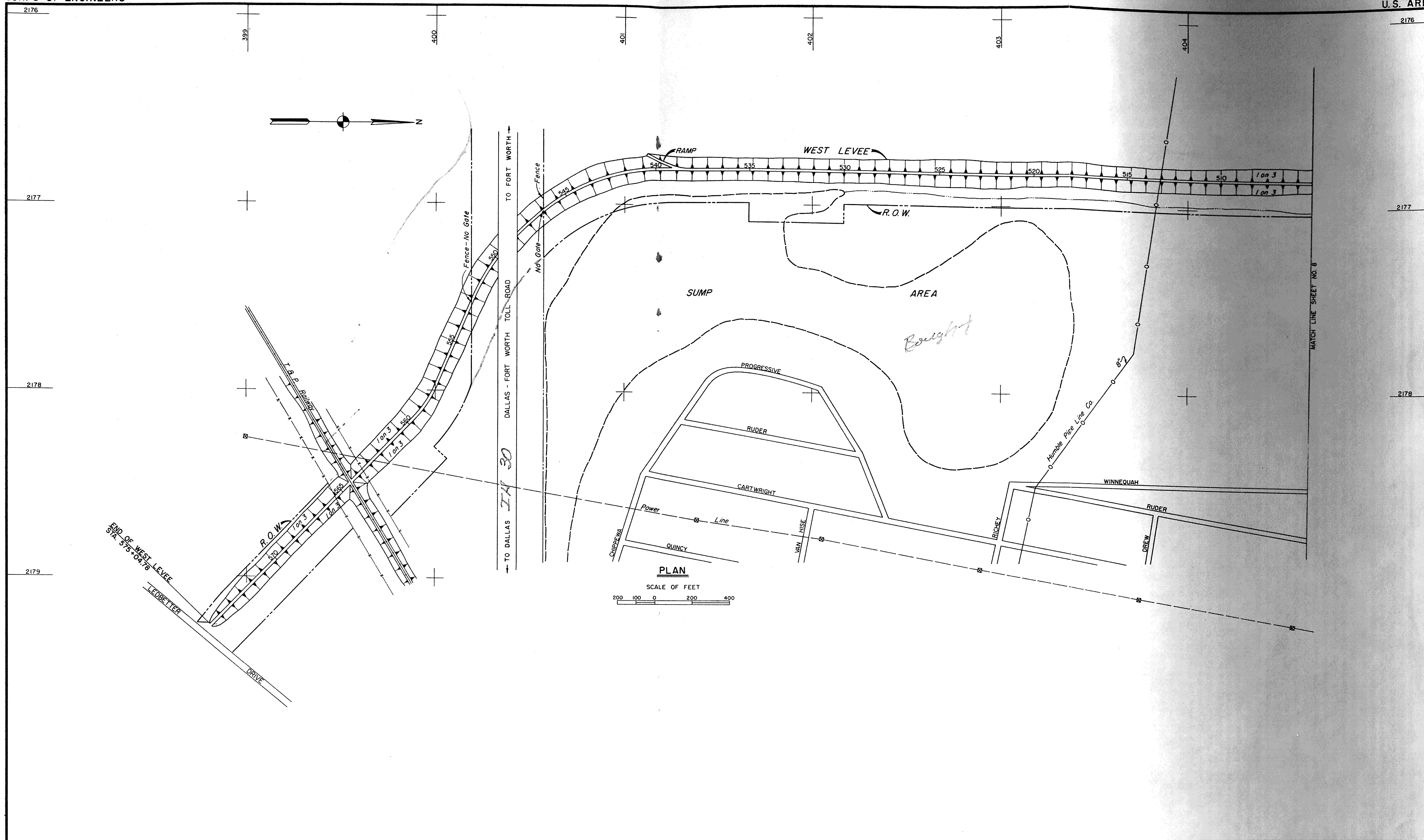
IN 13 SHEETS | SCALE AS SHOWN | SHEET NO. 8

FORT WORTH DISTRICT FORT WORTH, TEXAS | MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 | ANNEX I | PLATE 10

CORPS OF ENGINEERS U.S. ARMY



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
WEST FORK, TRINITY RIVER

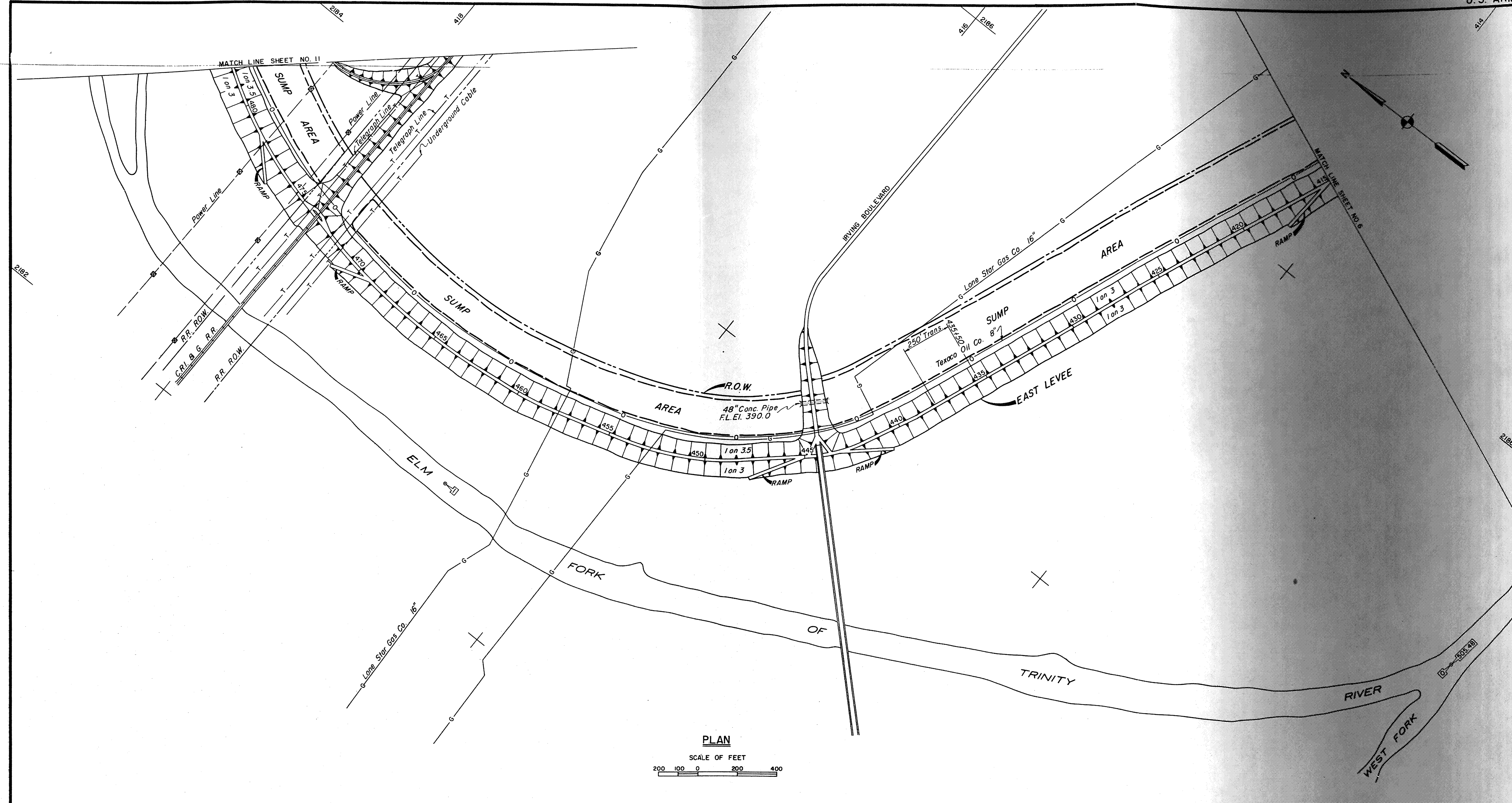
PLAN

IN 13 SHEETS SHEET NO. 9
SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 11



PLAN

SCALE OF FEET

200 100 0 200 400

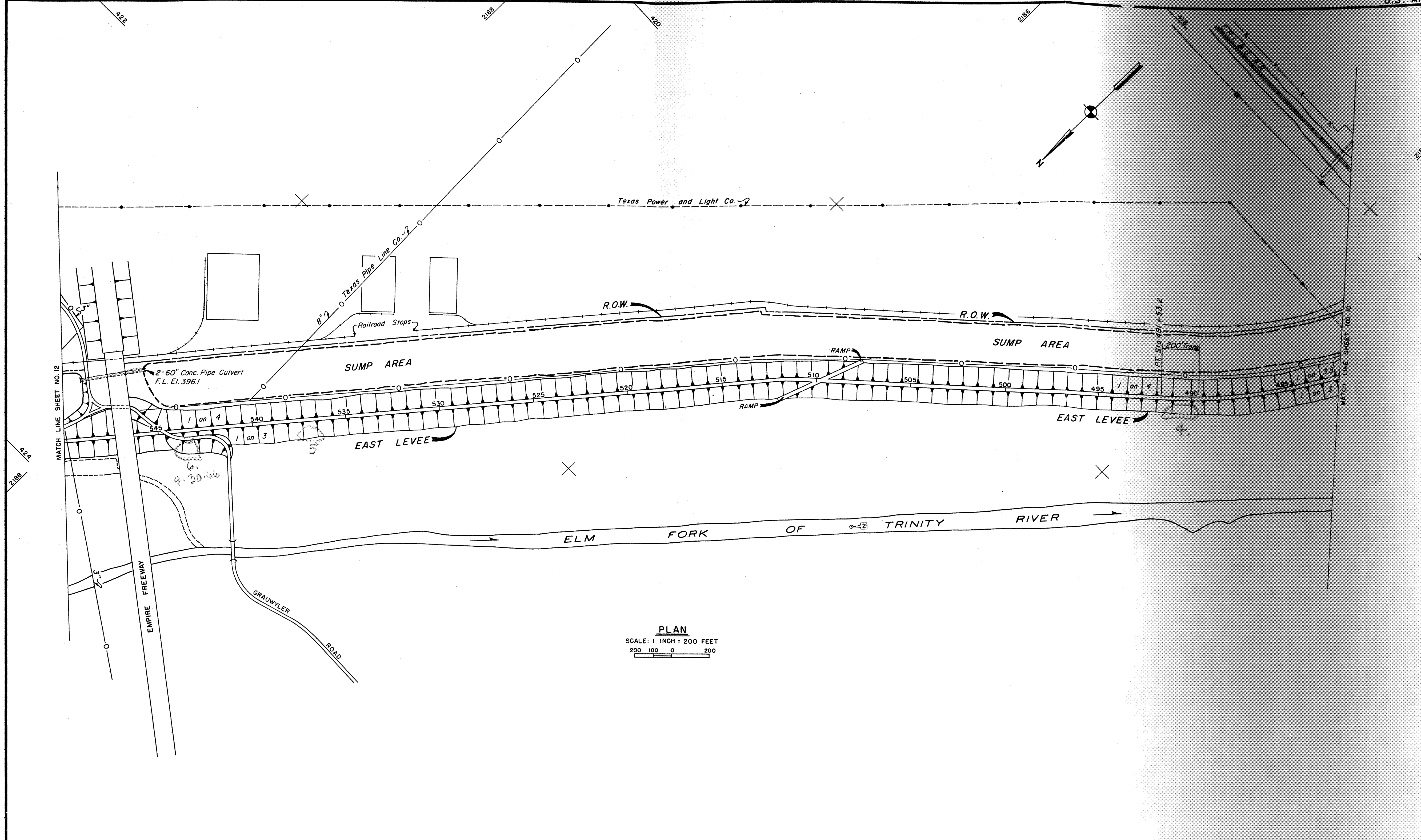
TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
ELM FORK, TRINITY RIVER

PLAN

IN 13 SHEETS	SCALE AS SHOWN	SHEET NO. 10
FORT WORTH DISTRICT FORT WORTH, TEXAS		MAY 1960
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL		
FILE: TRIN. 265-30	ANNEX I	PLATE 12

CORPS OF ENGINEERS

U.S. ARMY



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
ELM FORK, TRINITY RIVER

PLAN

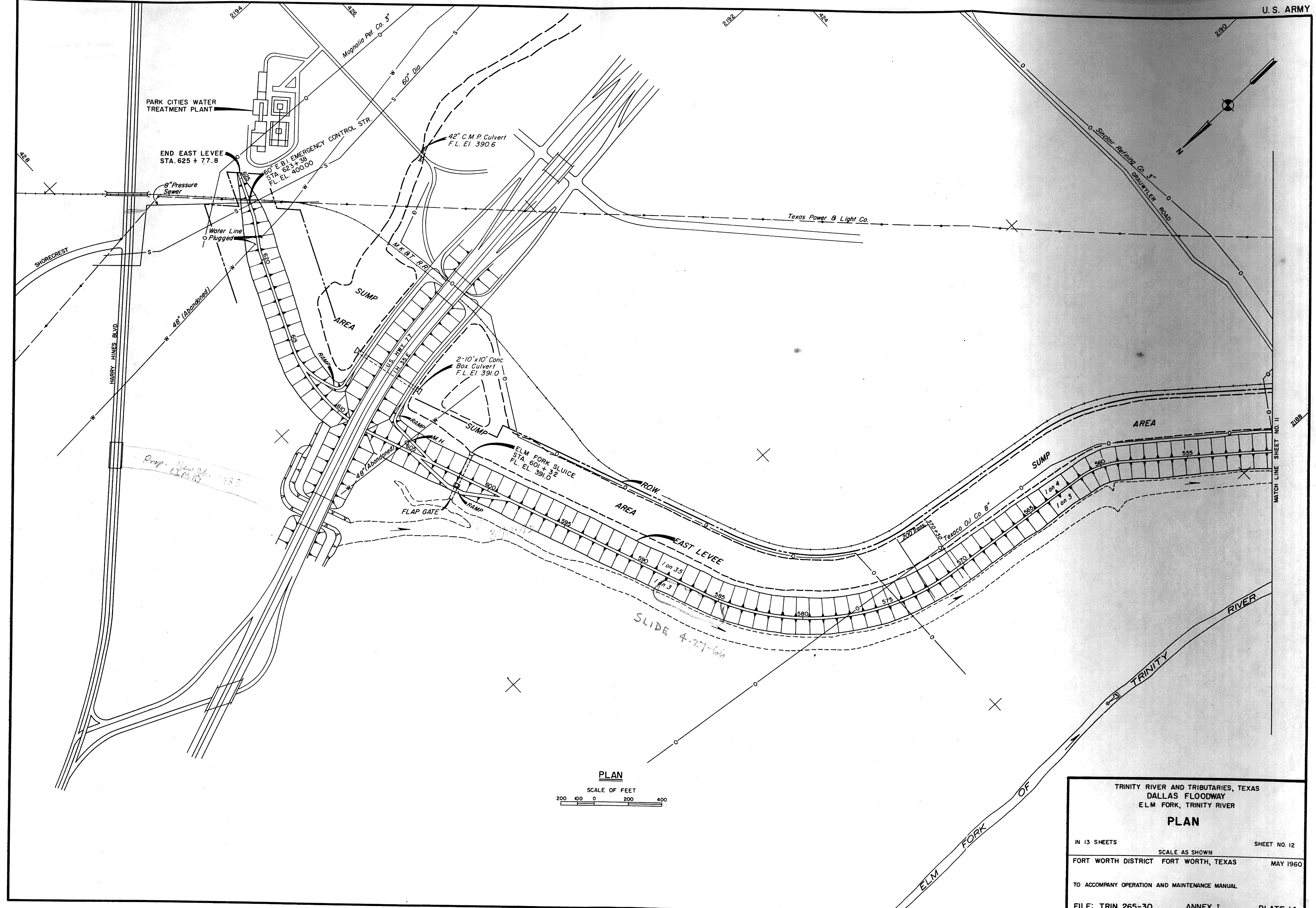
IN 13 SHEETS — SCALE AS SHOWN — SHEET NO. 11

FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

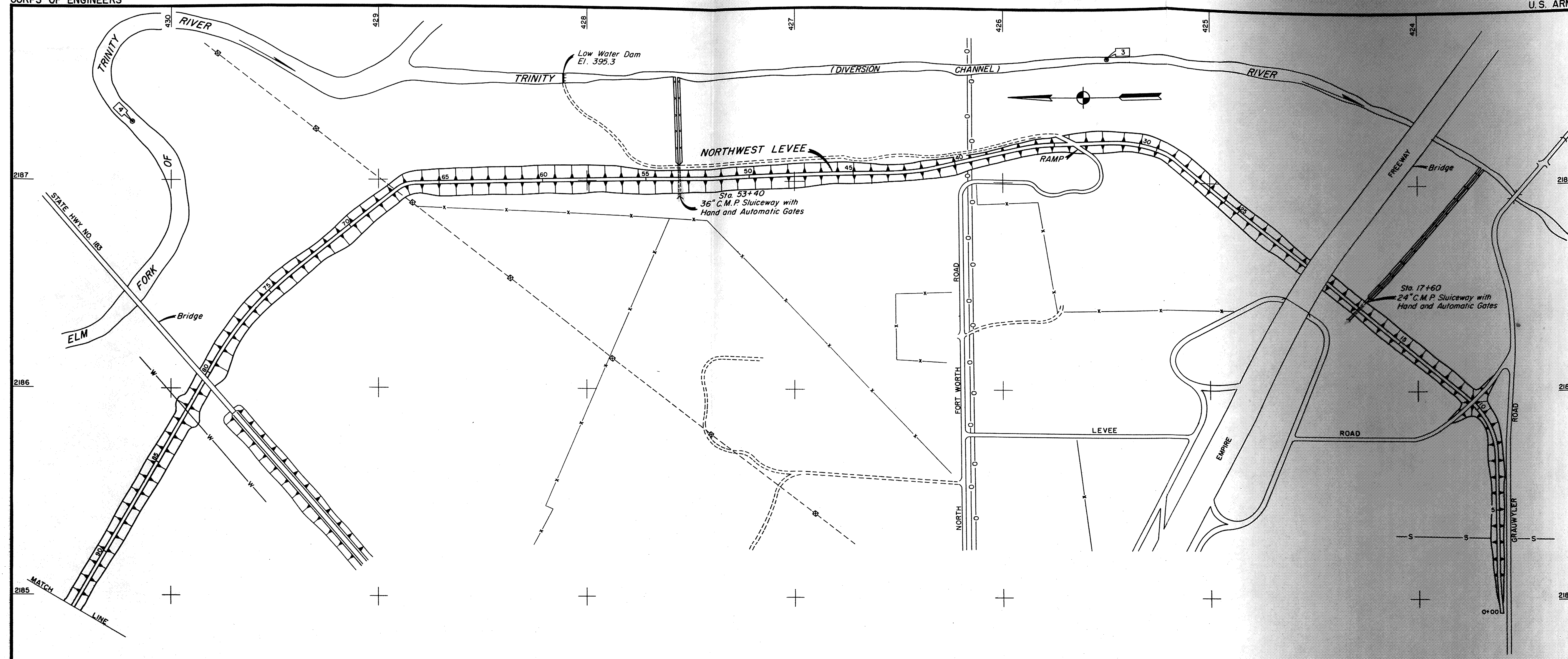
FILE: TRIN. 265-30 — ANNEX I — PLATE 13

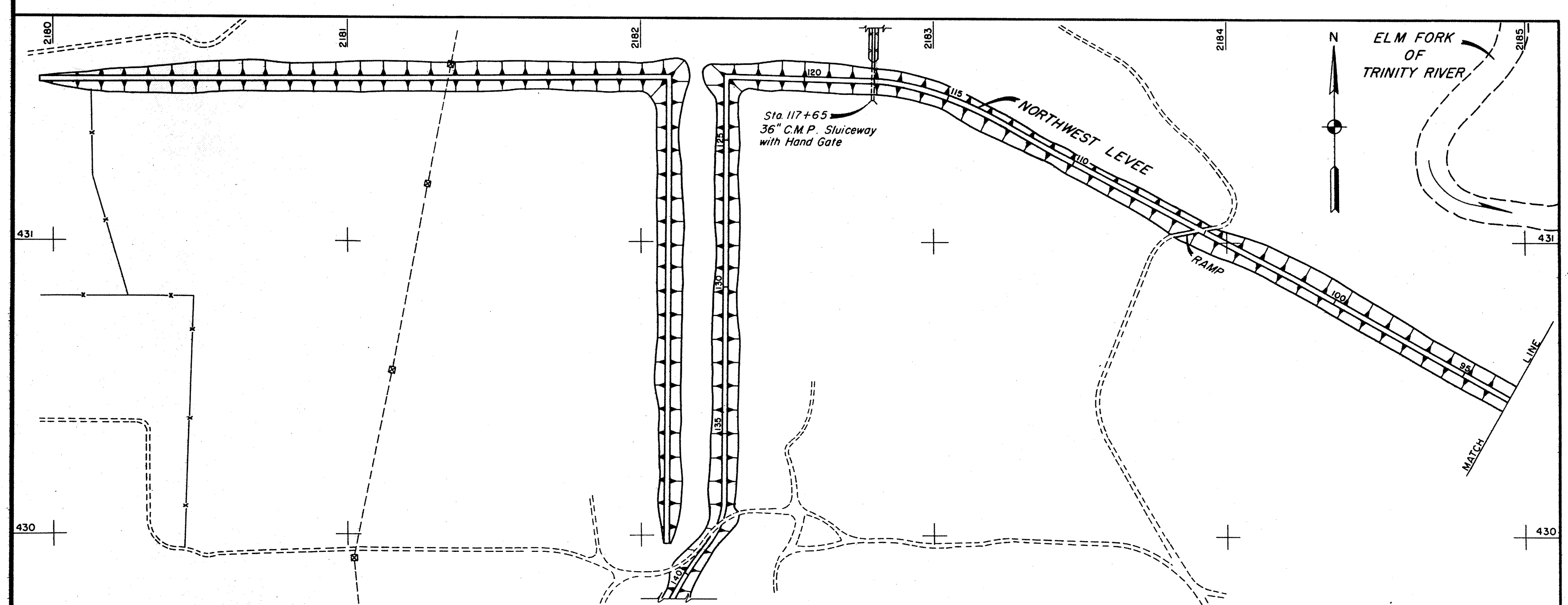
CORPS OF ENGINEERS U.S. ARMY



CORPS OF ENGINEERS

U.S. ARMY





SCALE IN FEET

200 100 0 200 400

TRINITY RIVER AND TRIBUTARIES, TEXAS

DALLAS FLOODWAY

ELM FORK, TRINITY RIVER

NORTHWEST LEVEE
PLAN

IN 13 SHEETS — SCALE AS SHOWN — SHEET NO. 13

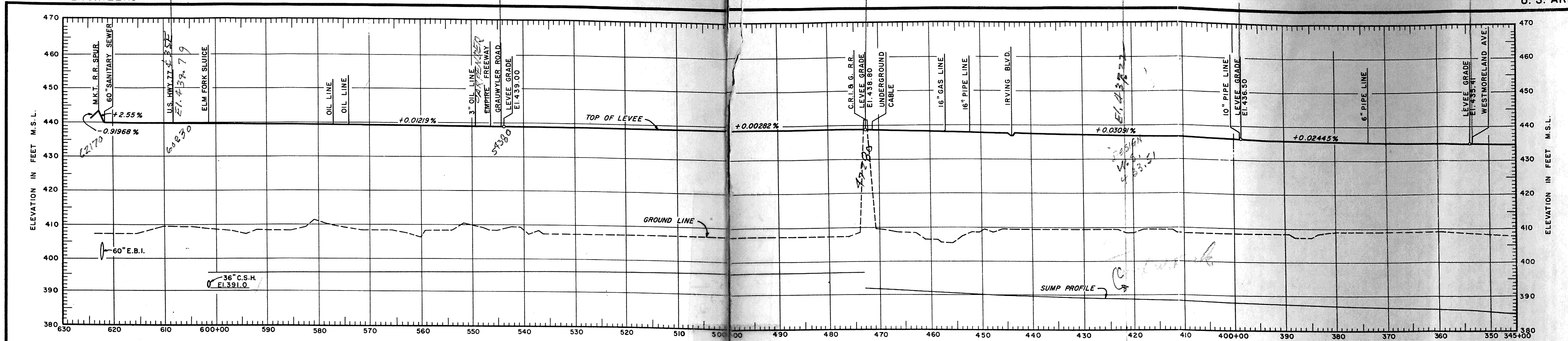
FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

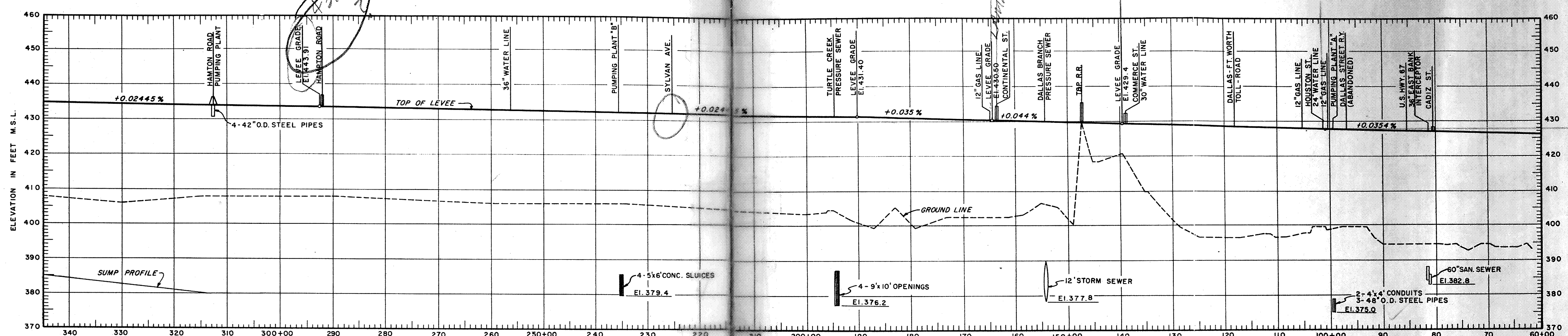
FILE: TRIN. 265-30 — ANNEX I — PLATE 15

CORPS OF ENGINEERS

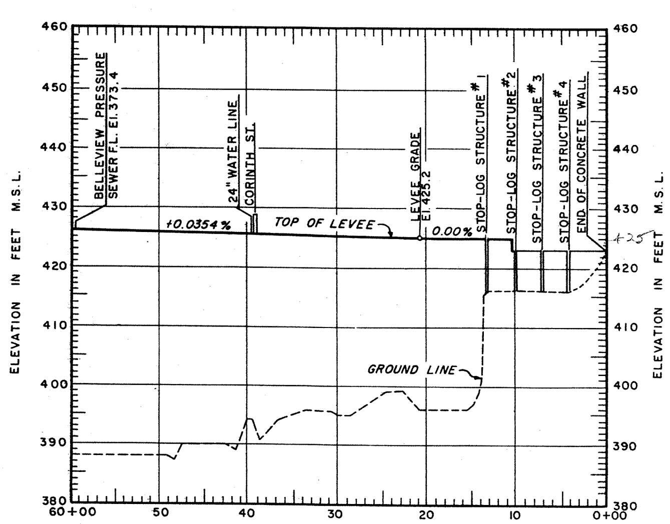
U. S. ARMY



EAST LEVEE PROFILE



EAST LEVEE PROFILE



EAST LEVEE PROFILE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

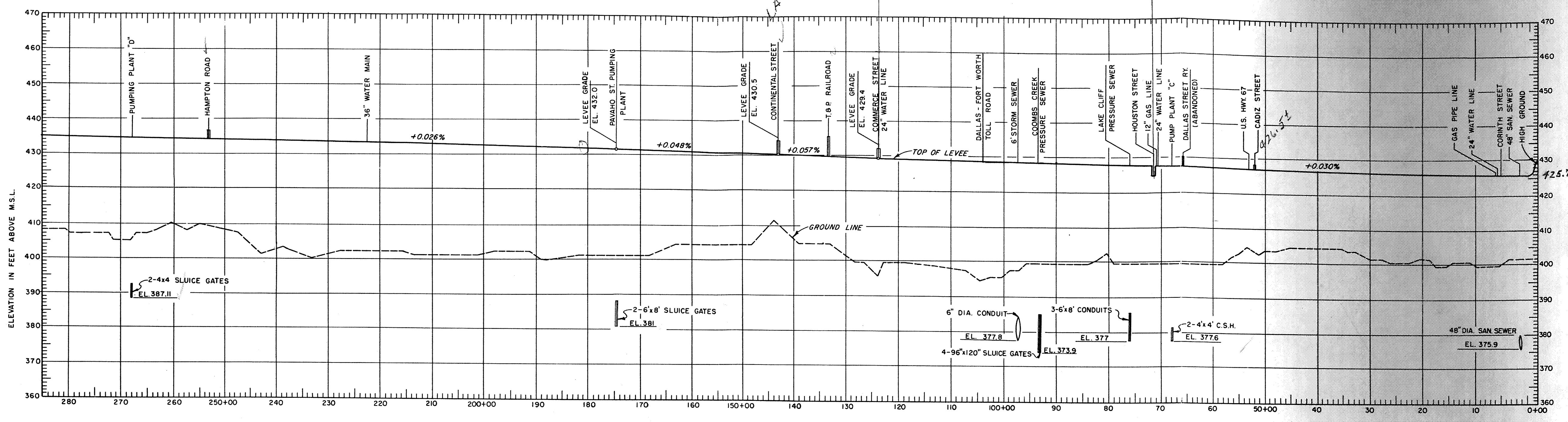
EAST LEVEE PROFILE

SCALES AS SHOWN

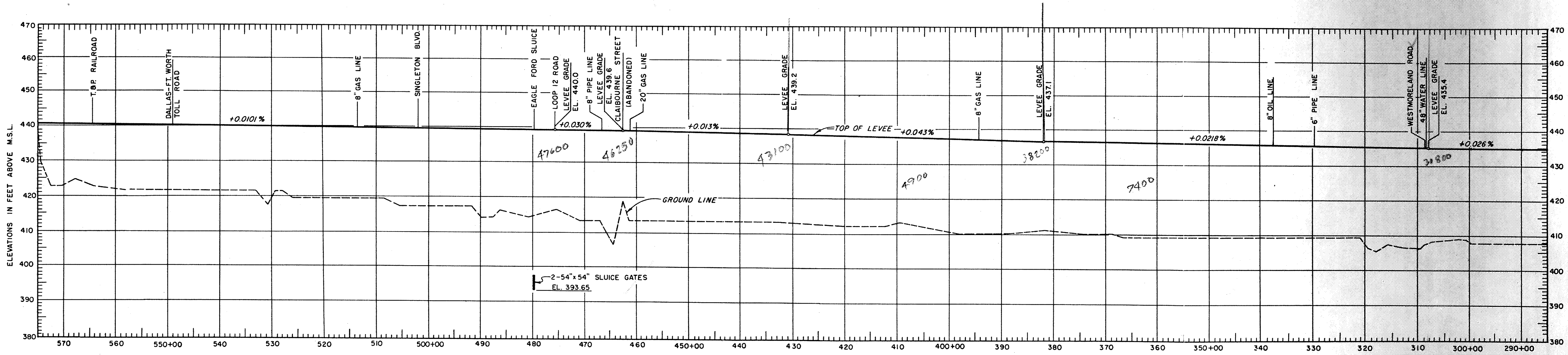
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 16



WEST LEVEE PROFILE



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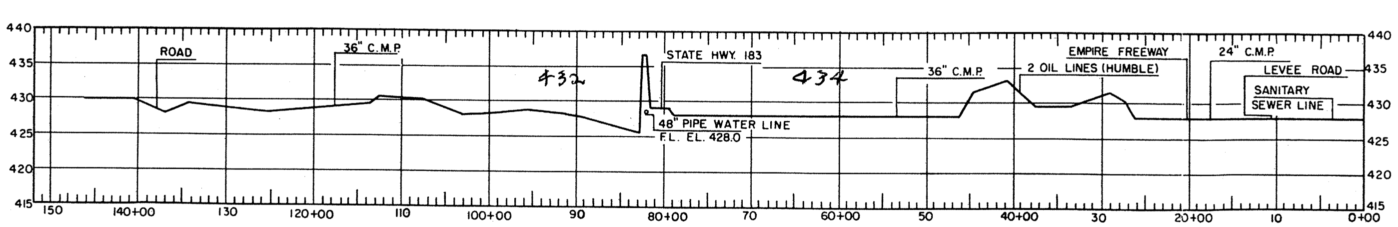


NORTHWEST LEVEE PROFILE

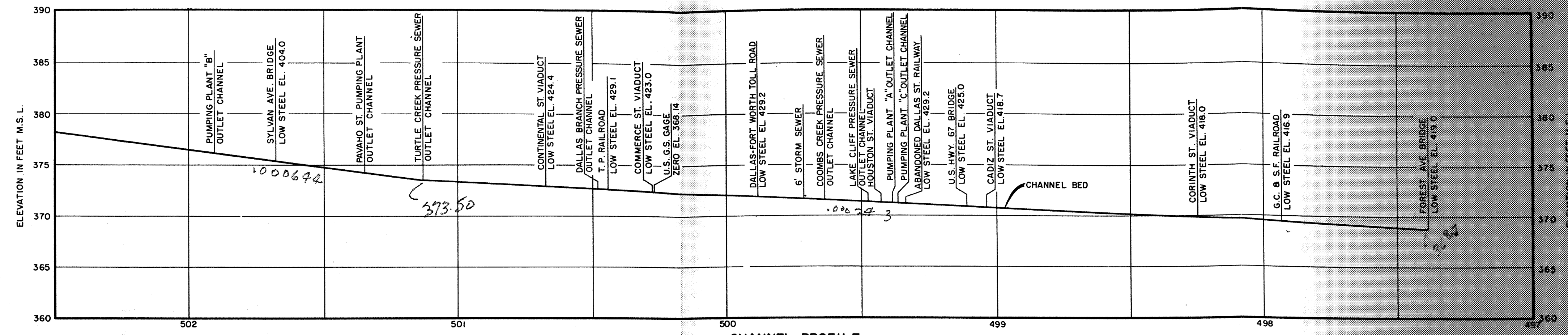
TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

WEST AND NORTHWEST LEVEE PROFILE

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

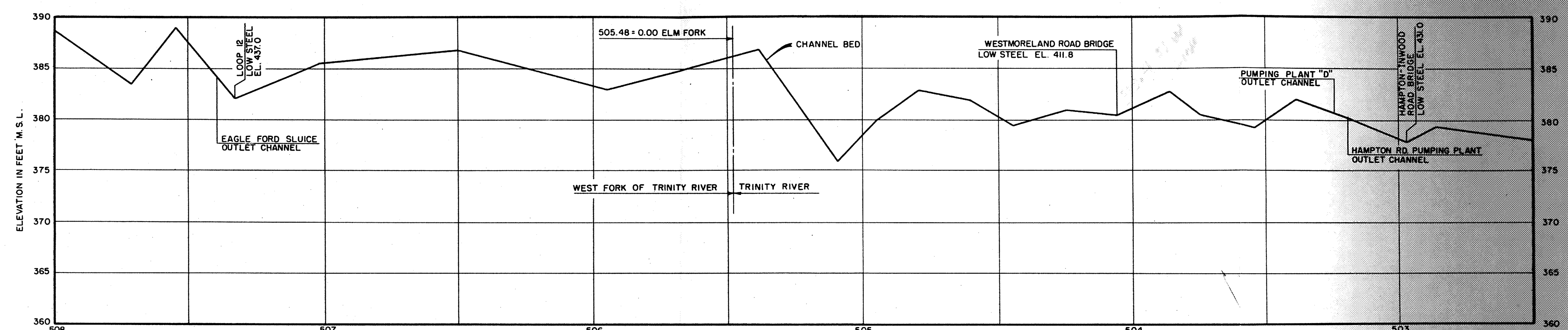
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 17



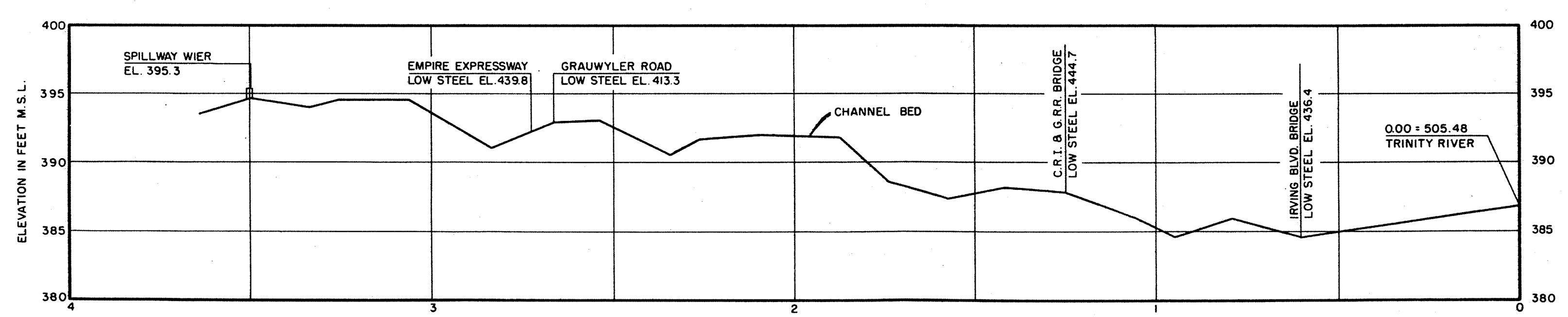
CHANNEL PROFILE

RIVER MILES



CHANNEL PROFILE

RIVER MILES



PROFILE ELM FORK

RIVER MILES

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
ELM FORK, TRINITY RIVER

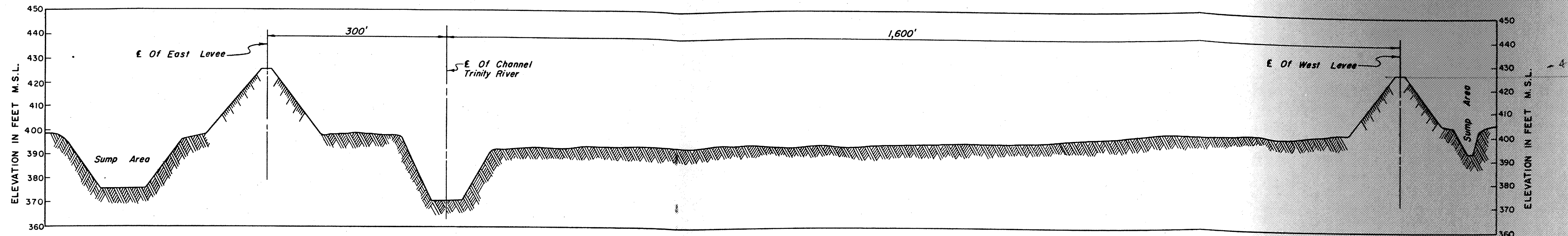
CHANNEL PROFILES

SCALE AS SHOWN

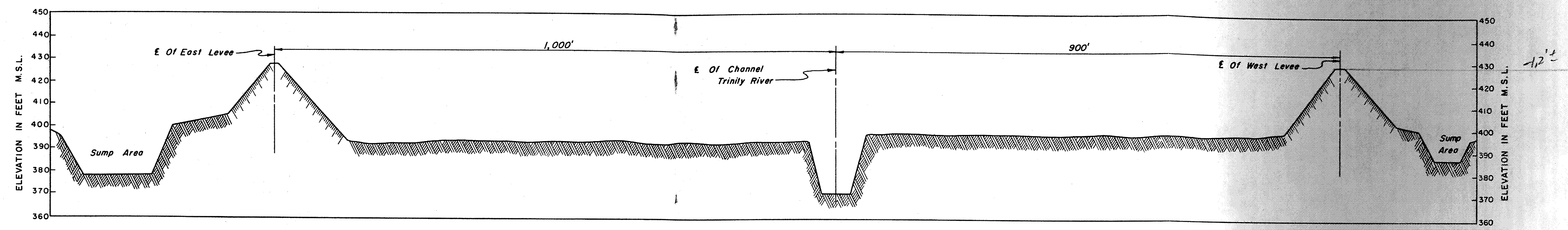
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

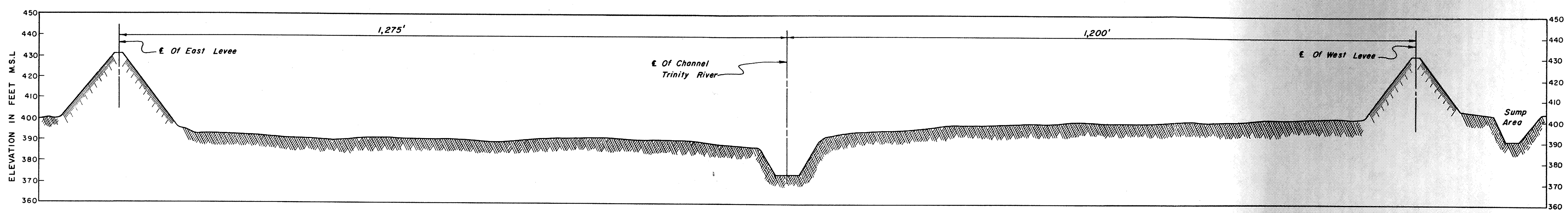
FILE: TRIN. 265-30 ANNEX I PLATE 18



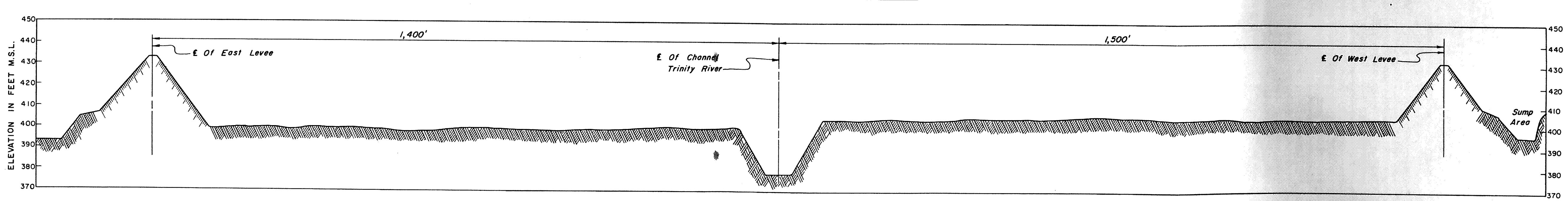
SECTION AT RIVER MILE 498.5



SECTION AT RIVER MILE 500



SECTION AT RIVER MILE 501.5



SECTION AT RIVER MILE 502.75

SCALE OF FEET
80 0 80 160

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

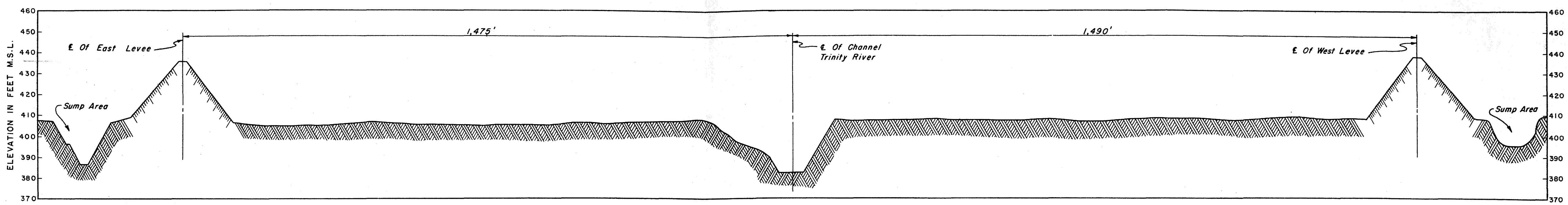
FLOODWAY SECTIONS

SCALES AS SHOWN

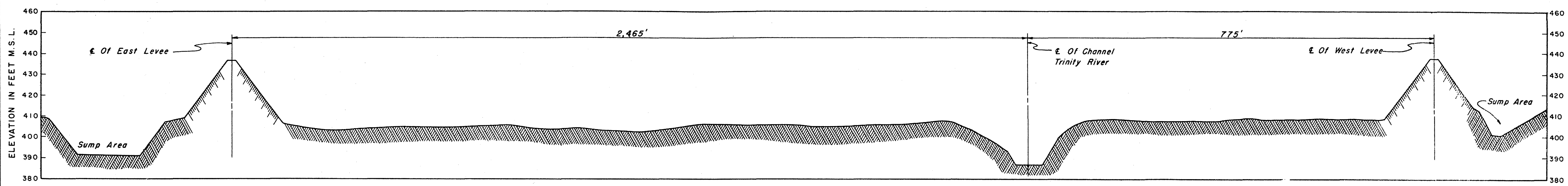
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

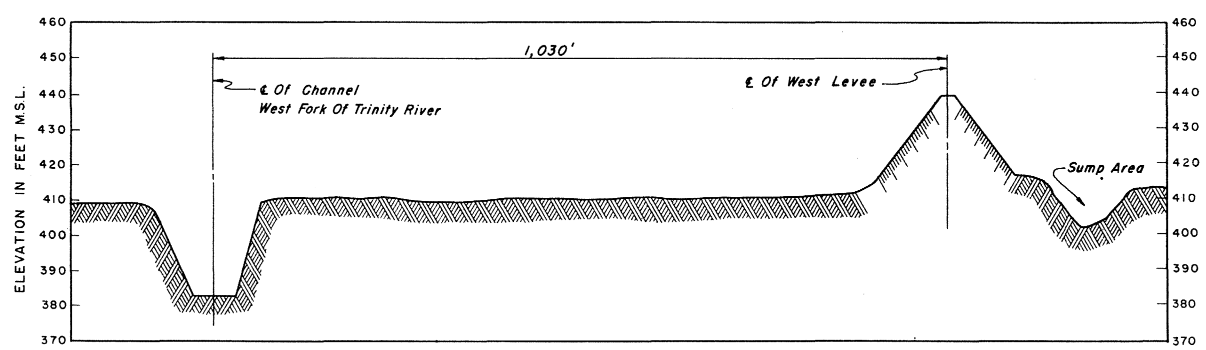
FILE: TRIN. 265-30 ANNEX I PLATE 19



SECTION AT RIVER MILE 504.25



SECTION AT RIVER MILE 0



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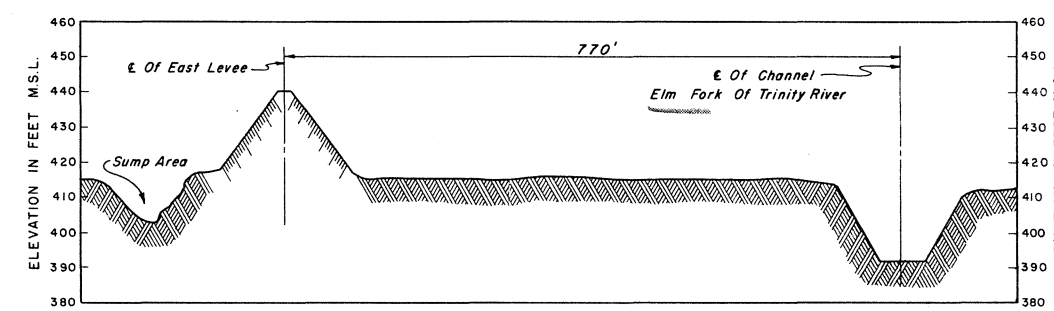
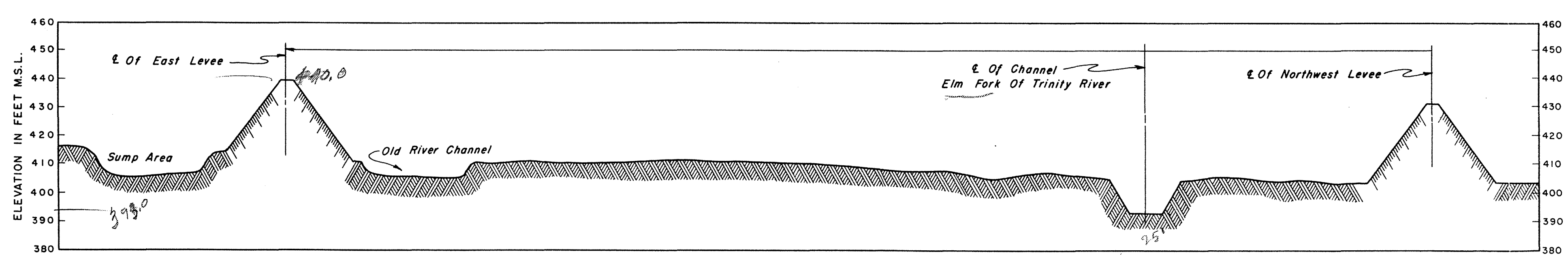


SECTION AT RIVER MILE 2



SECTION AT RIVER MILE 3

SCALE OF FEET
80 0 80 160

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

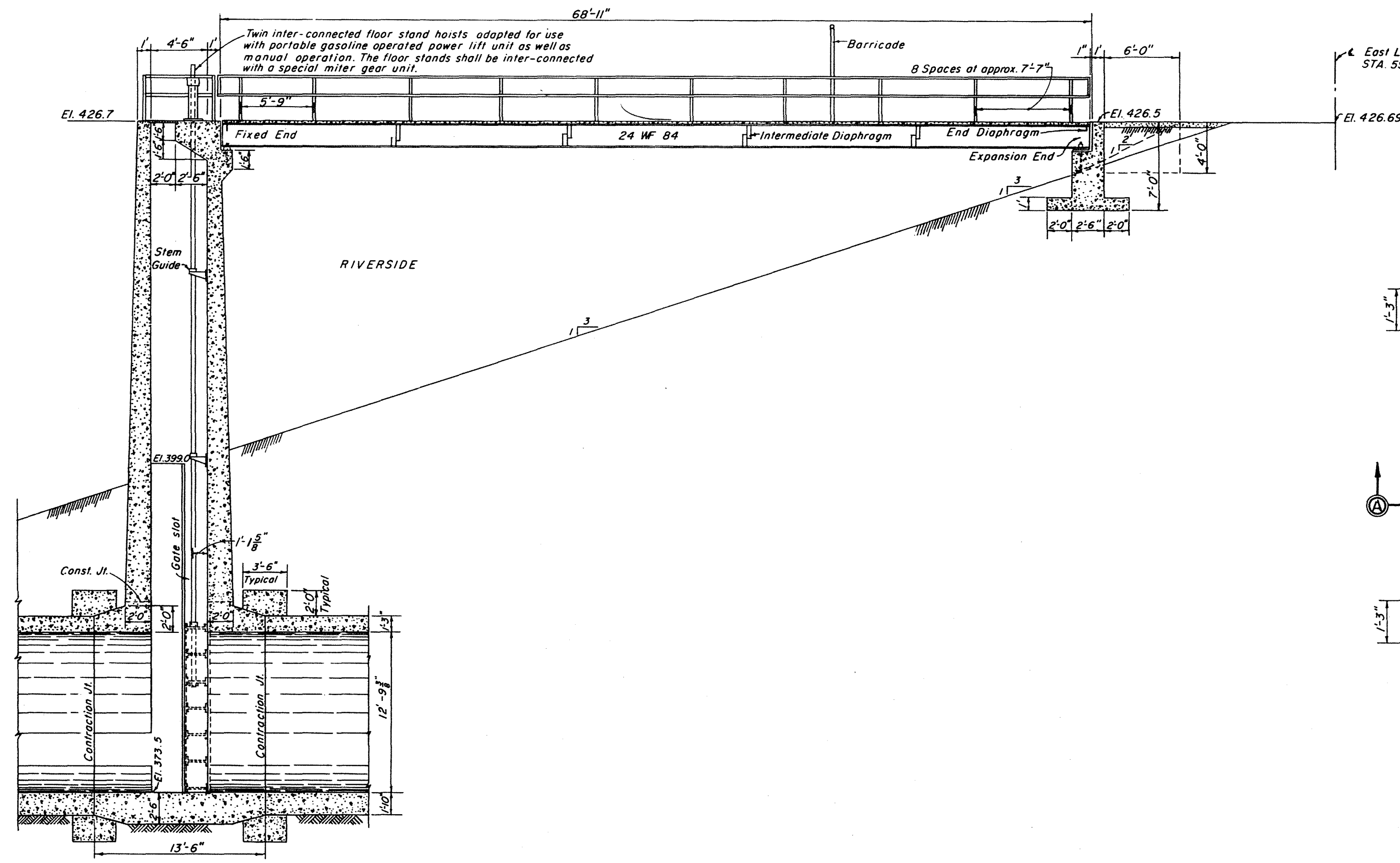
FLOODWAY SECTIONS

SCALES AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

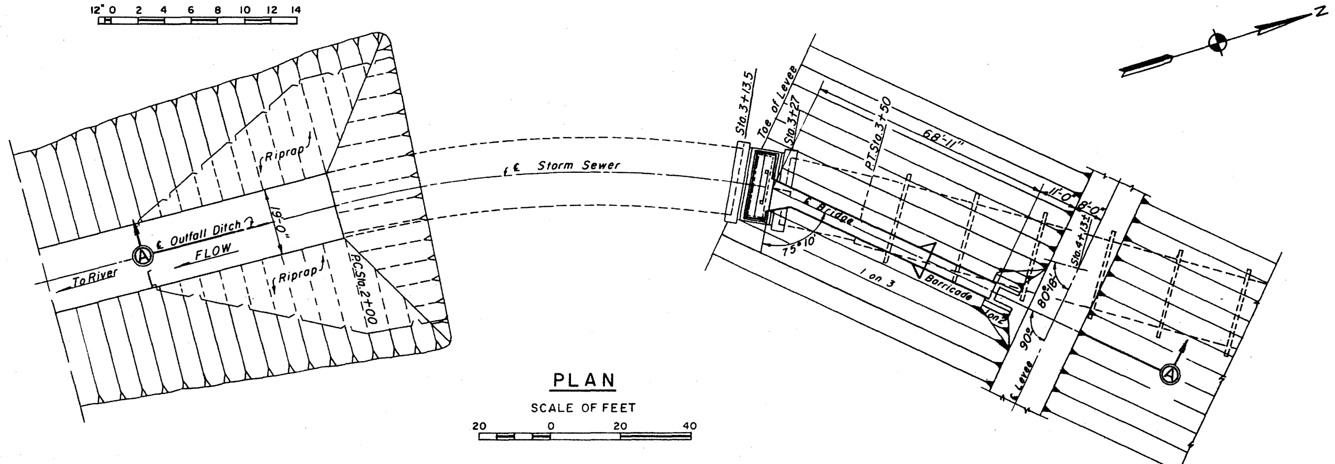
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 20



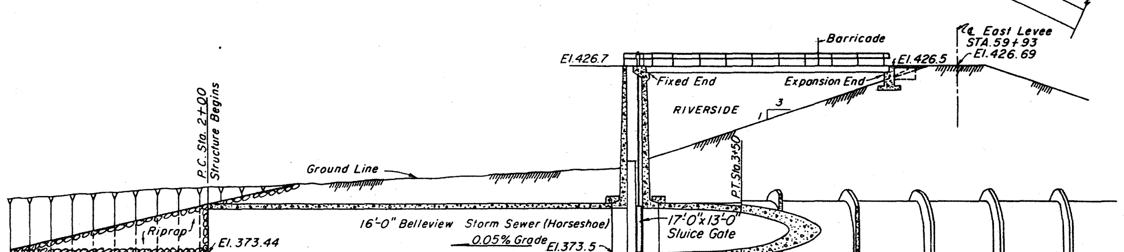
LONGITUDINAL SECTION THRU TOWER AND BRIDGE

SCALE OF FEET



PLAN

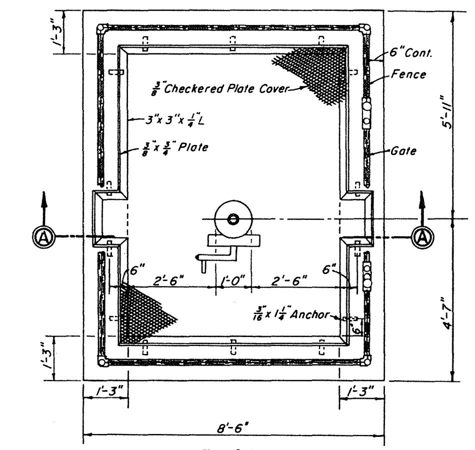
SCALE OF FEET



SECTION A-A

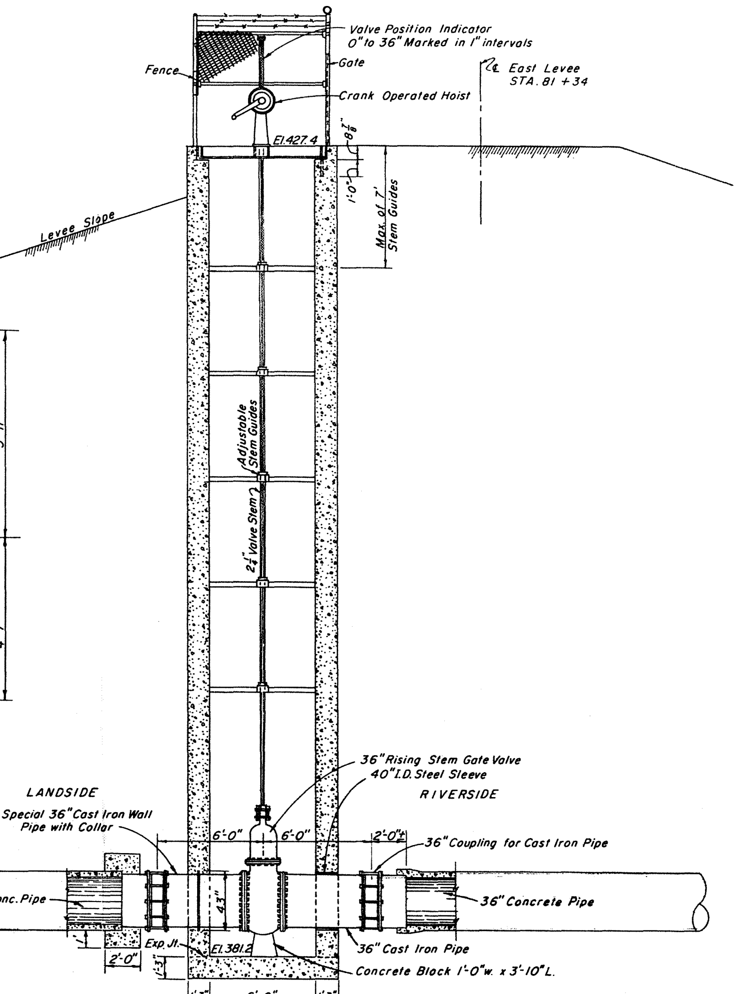
SCALE OF FEET

BELLEVIEW PRESSURE SEWER



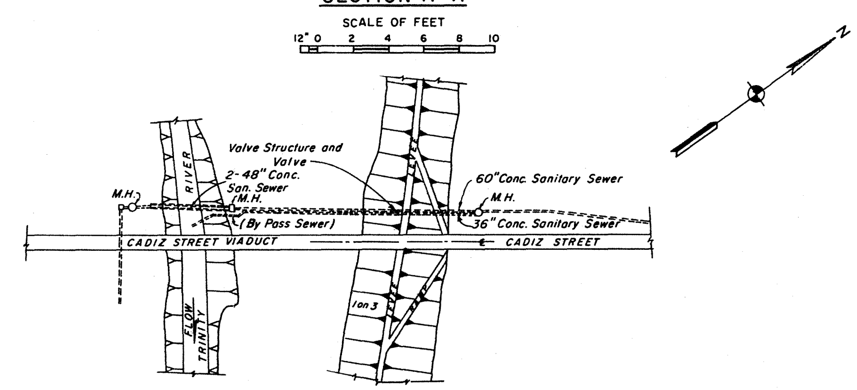
PLAN

SCALE OF FEET



SECTION A-A

SCALE OF FEET



PLAN

SCALE OF FEET

36" EAST BANK INTERCEPTOR

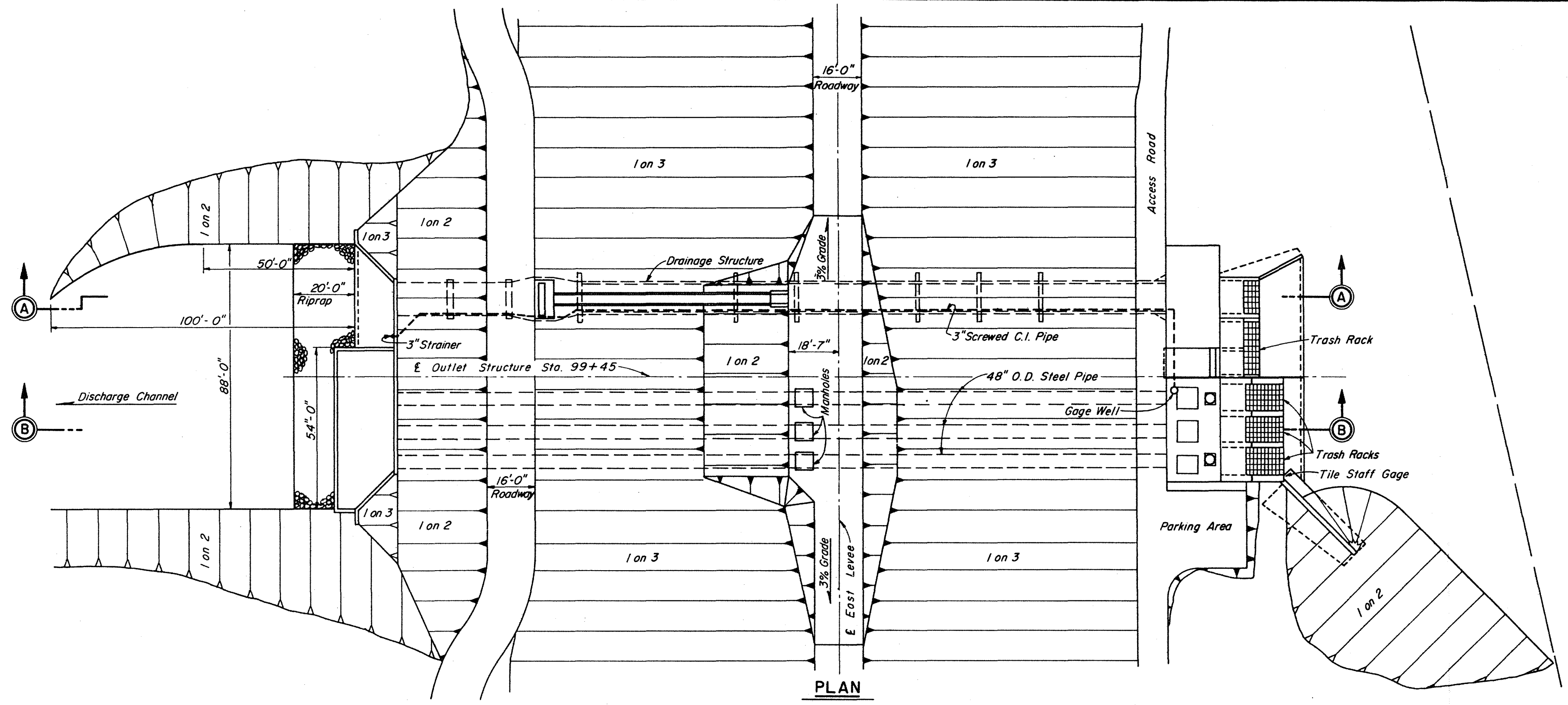
TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

BELLEVIEW PRESSURE SEWER
AND 36" EAST BANK INTERCEPTOR
PLANS AND SECTIONS
SCALES AS SHOWN

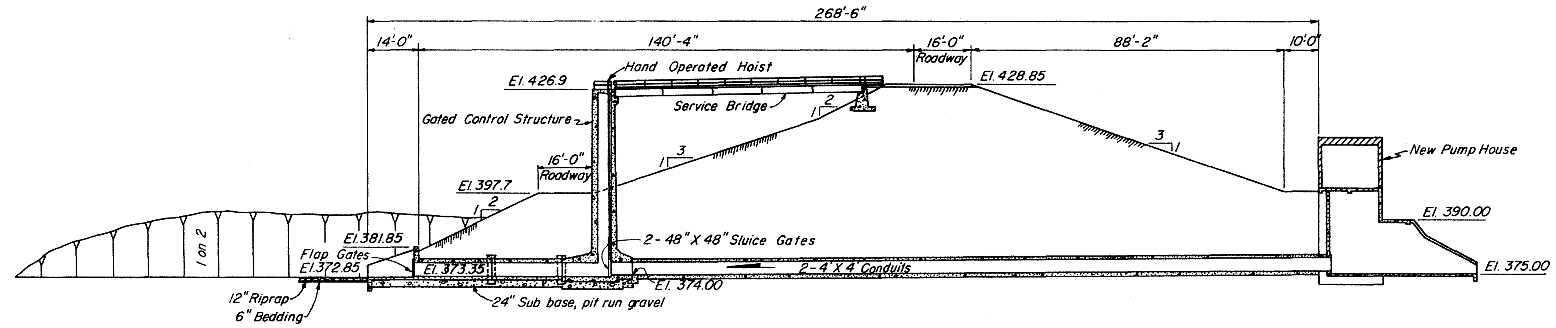
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

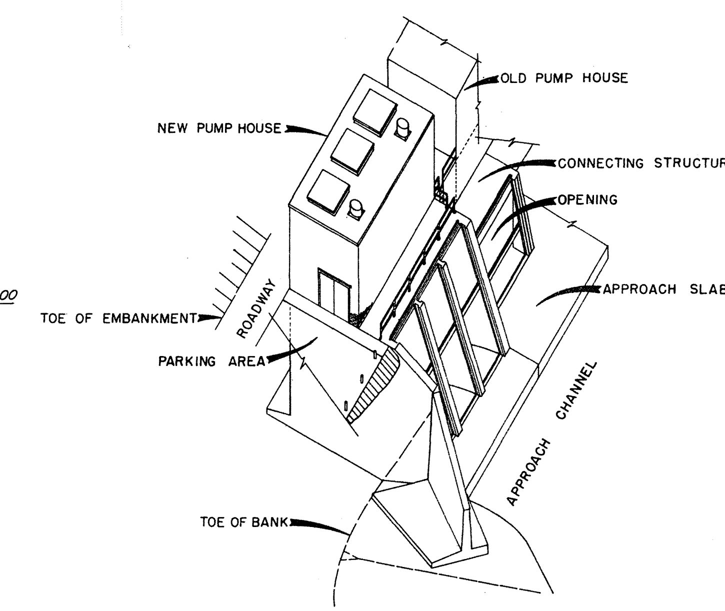
FILE: TRIN. 265-30 ANNEX I PLATE 21



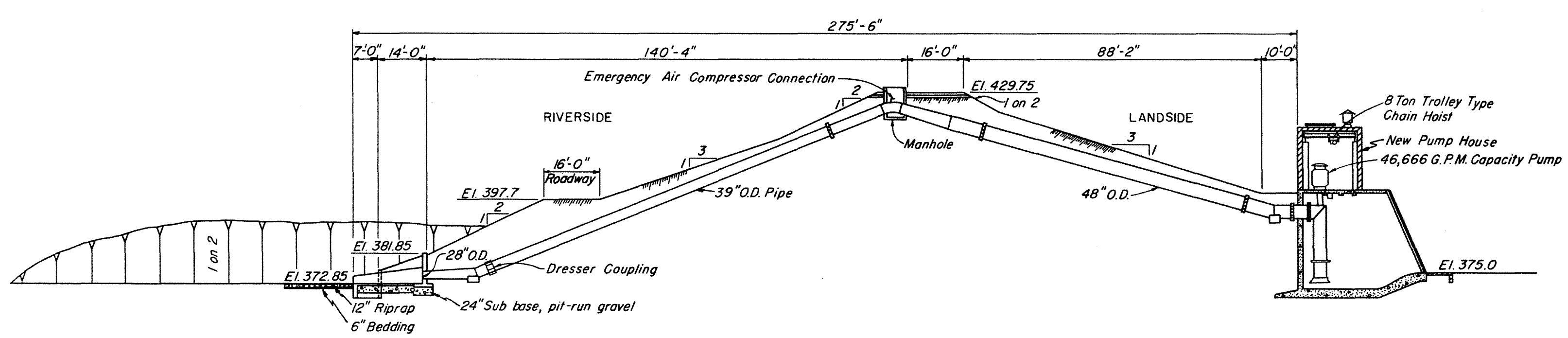
PLAN



SECTION A-A



ISOMETRIC VIEW



SECTION B-B

SCALE OF FEET

20 0 20 40

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

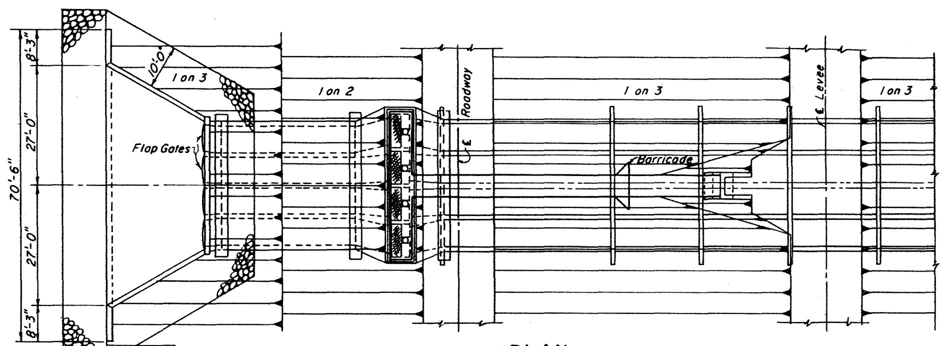
PUMPING PLANT "A"
PLAN AND SECTIONS

SCALE AS SHOWN

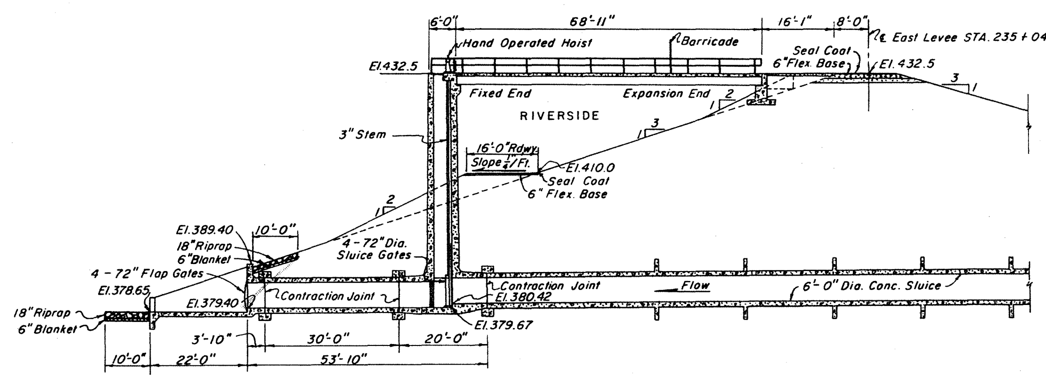
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 22



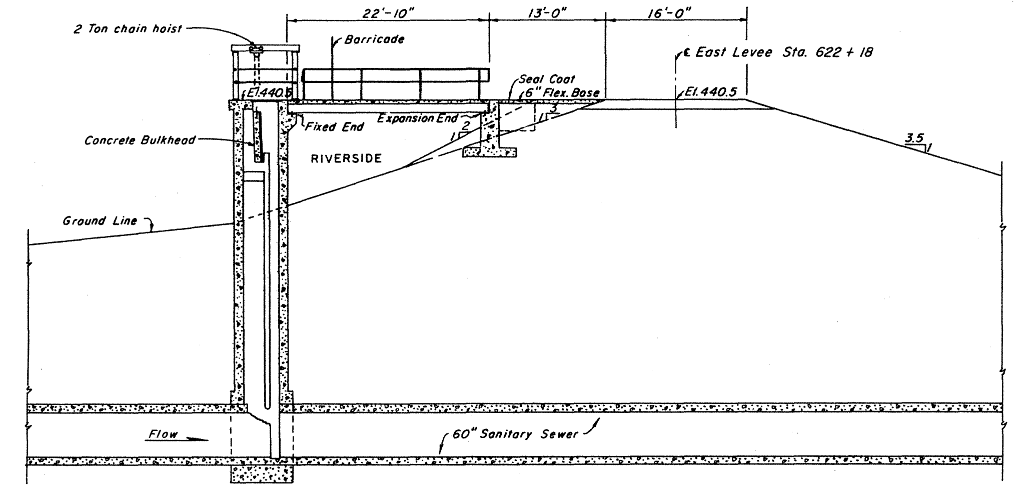
PLAN



LONGITUDINAL SECTION

SCALE OF FEET
12 0 8 16 24 32 40

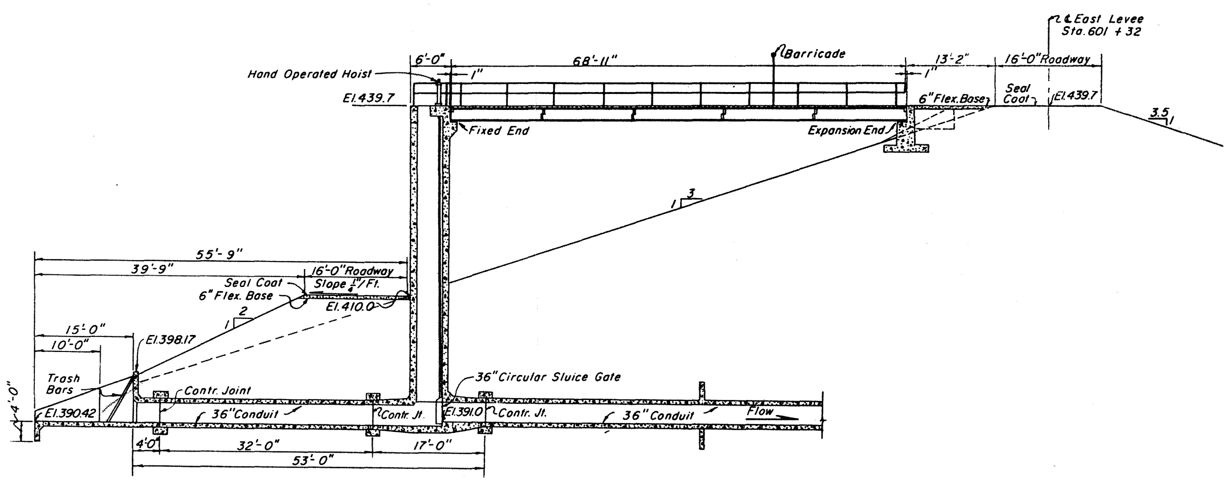
PUMPING PLANT "B"



LONGITUDINAL SECTION

SCALE OF FEET
12 0 4 8 12 16 20

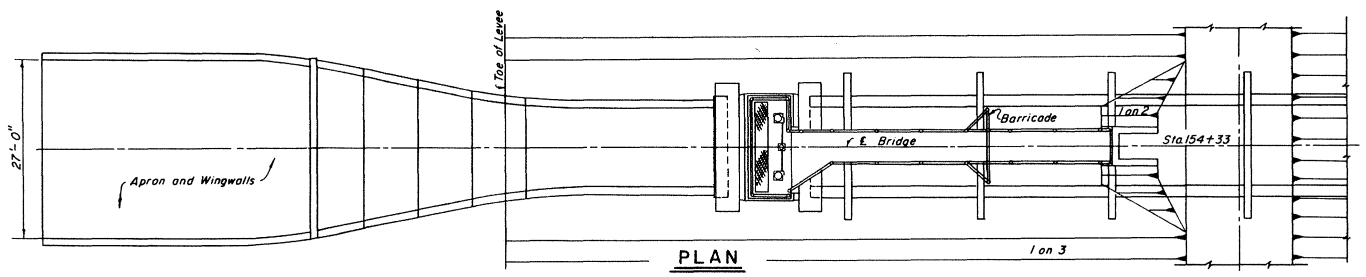
60" E.B.I. EMERGENCY CONTROL STRUCTURE



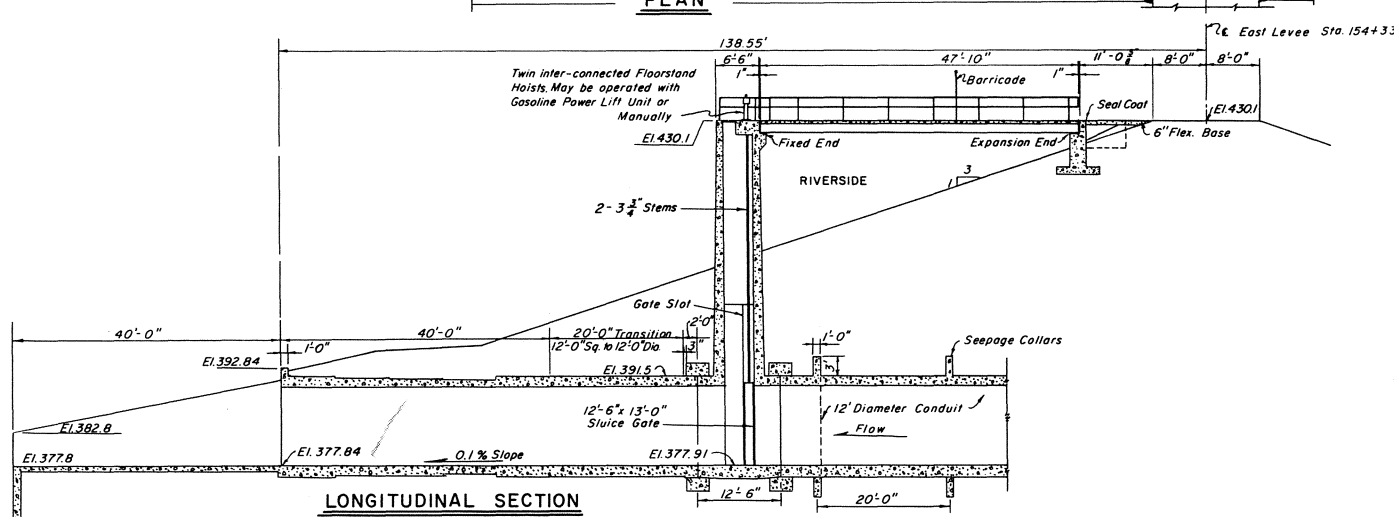
LONGITUDINAL SECTION

SCALE OF FEET
12 0 4 8 12 16 20 24 28

ELM FORK SLUICE



PLAN



LONGITUDINAL SECTION

SCALE OF FEET
12 0 4 8 12 16 20 24 28

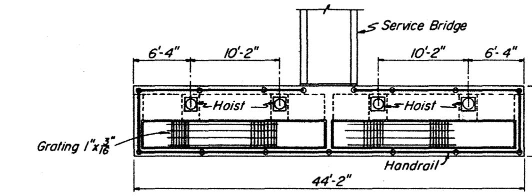
DALLAS BRANCH PRESSURE SEWER

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER
ELM FORK SLUICE
PUMPING PLANT "B"
DALLAS BRANCH PRESSURE SEWER
60" E.B.I. EMERGENCY CONTROL STRUCTURE
SCALES AS SHOWN

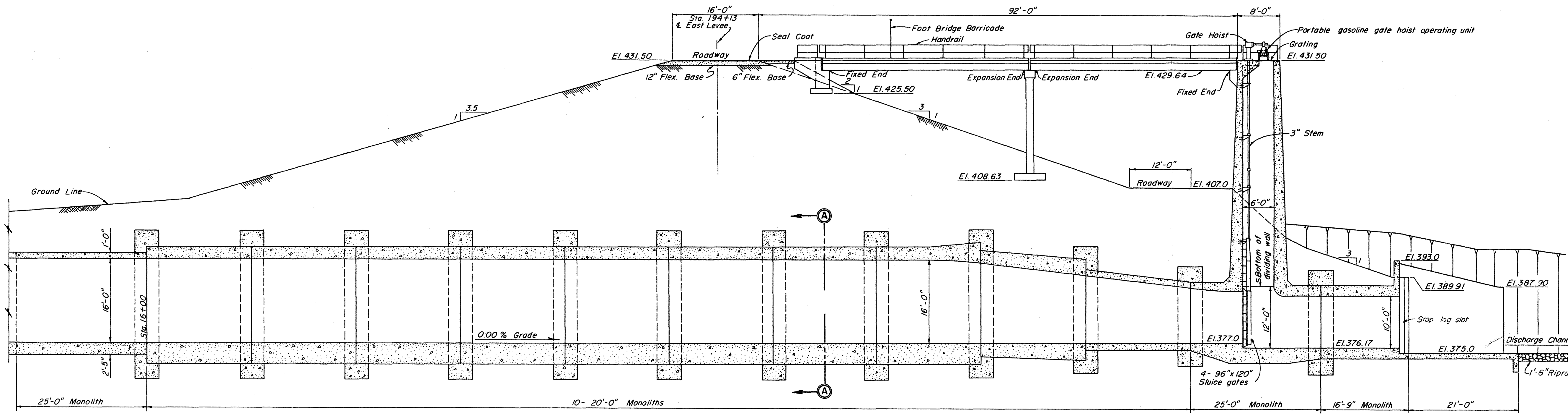
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 23



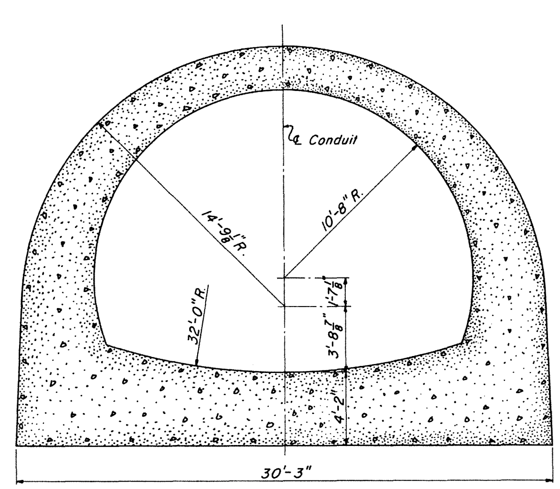
PLAN
TOP OF TOWER



LONGITUDINAL SECTION

SCALE OF FEET

12" 0 4 8 12 16 20



SECTION A-A

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

TURTLE CREEK PRESSURE SEWER
PLAN AND PROFILE I

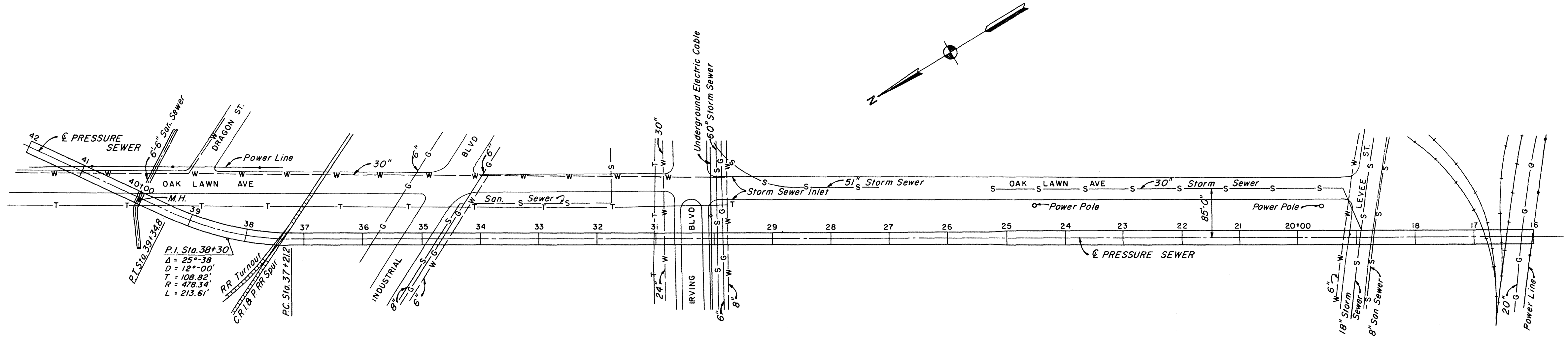
IN 4 SHEETS SHEET NO. 1

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

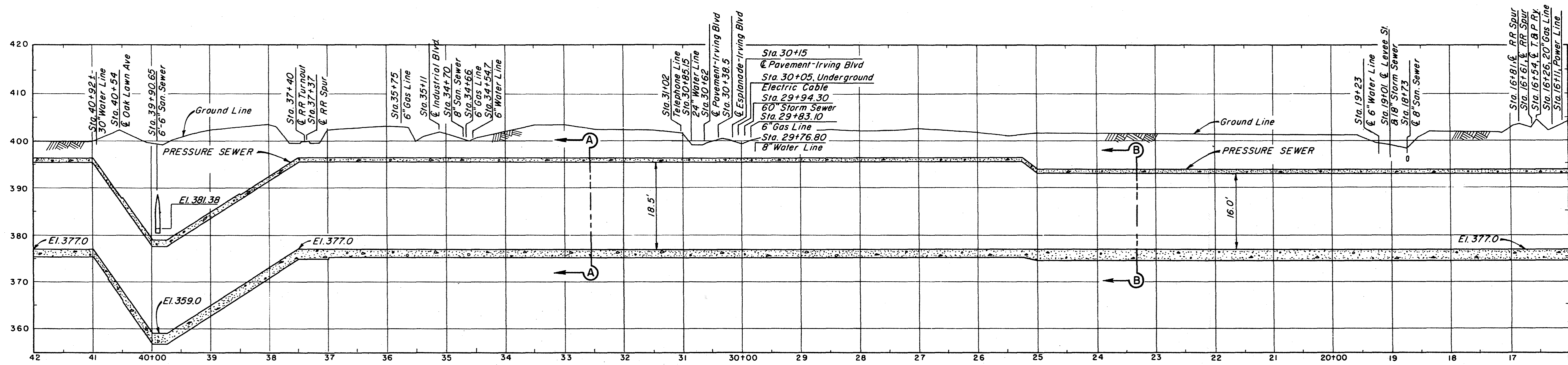
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 24

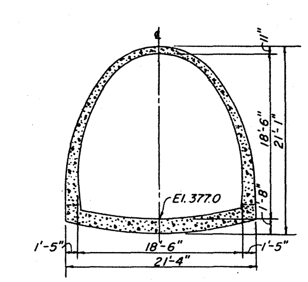


PLAN

SCALE OF FEET

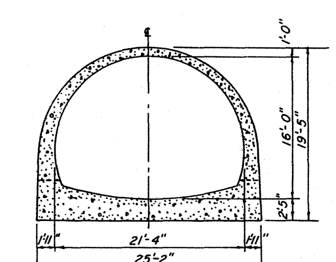


PROFILE



SECTION A-A

NOT TO SCALE



SECTION B-B

NOT TO SCALE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

TURTLE CREEK PRESSURE SEWER

PLAN AND PROFILE II

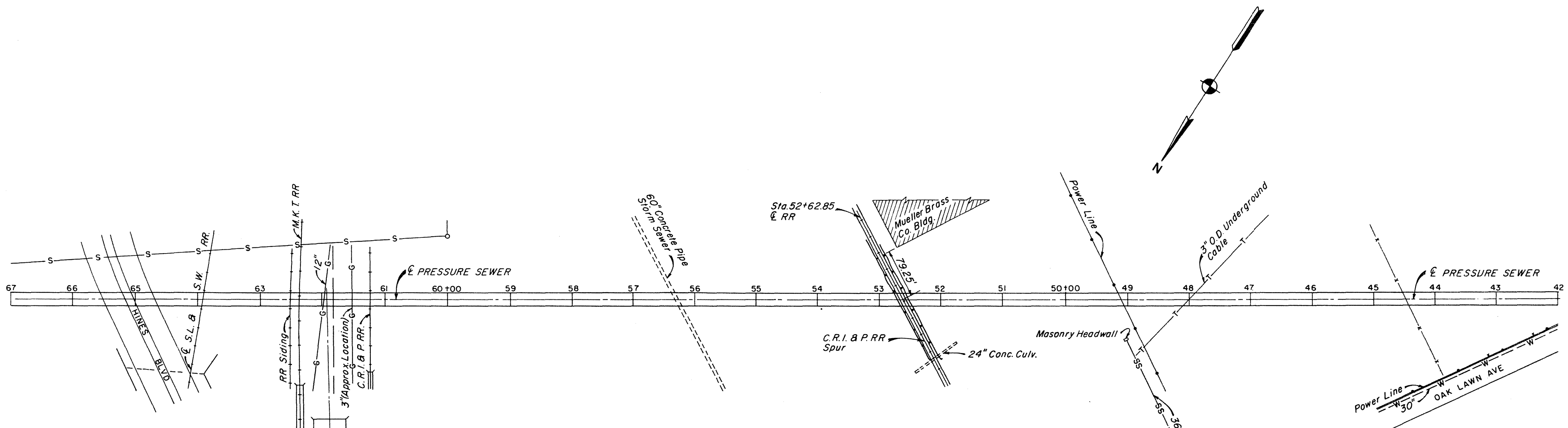
IN 4 SHEETS SHEET NO. 2

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

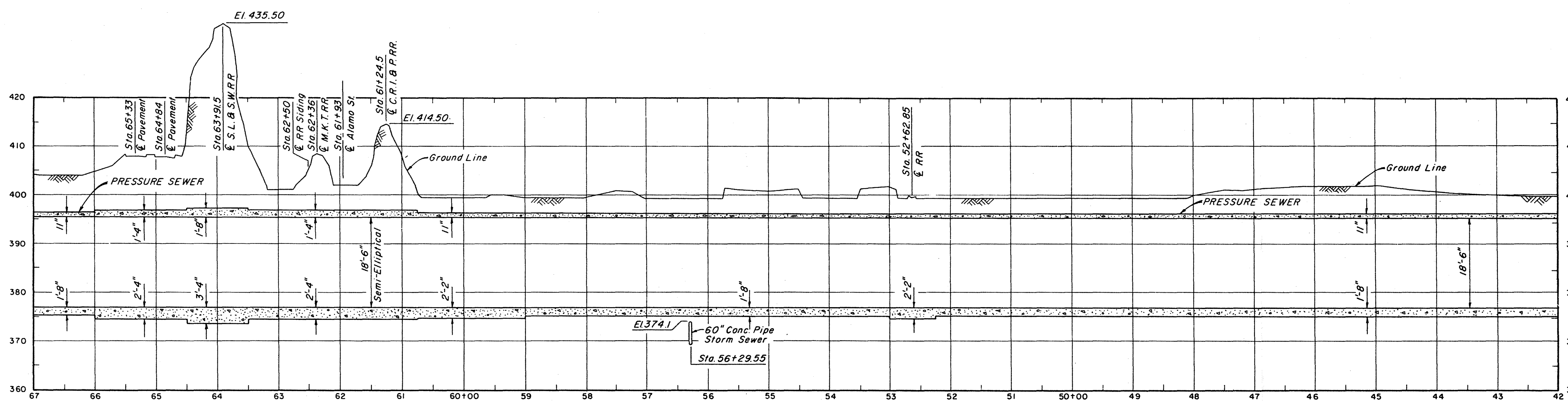
FILE: TRIN. 265-30 ANNEX I PLATE 25



PLAN

SCALE OF FEET

80 0 80 160



PROFILE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

TURTLE CREEK PRESSURE SEWER

PLAN AND PROFILE III

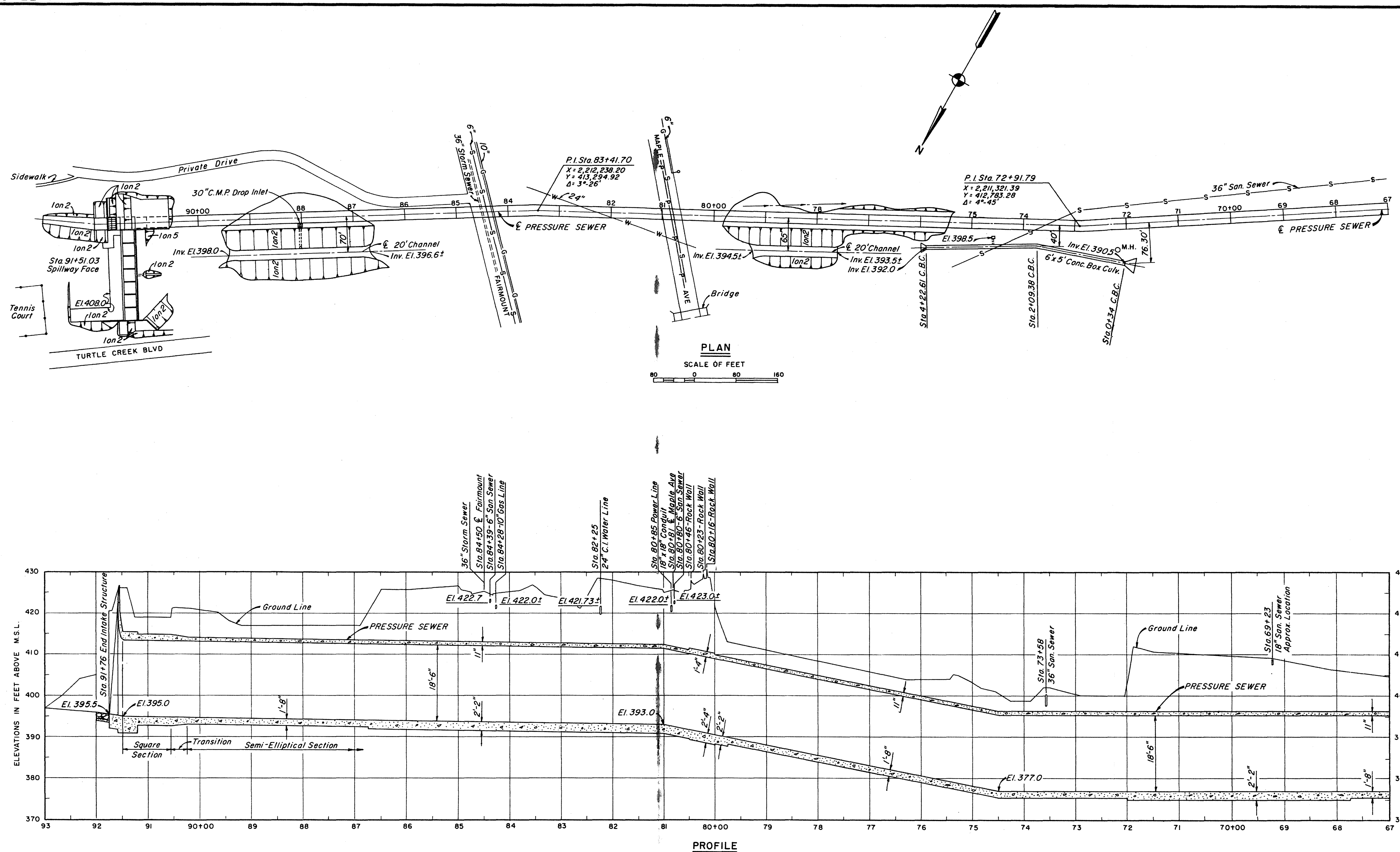
IN 4 SHEETS SHEET NO. 3

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 26



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

TURTLE CREEK PRESSURE SEWER
PLAN AND PROFILE IV

IN 4 SHEETS SHEET NO. 4
SCALES AS SHOWN

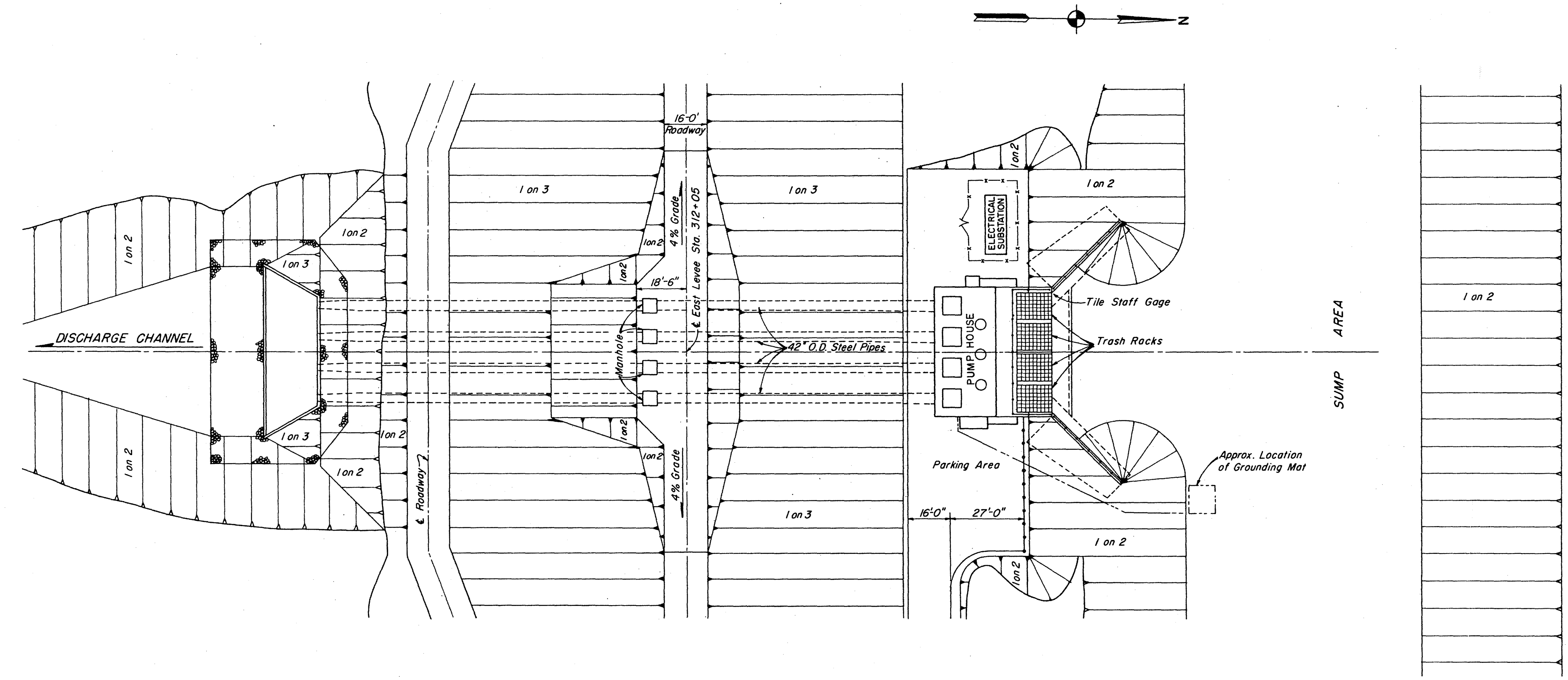
FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

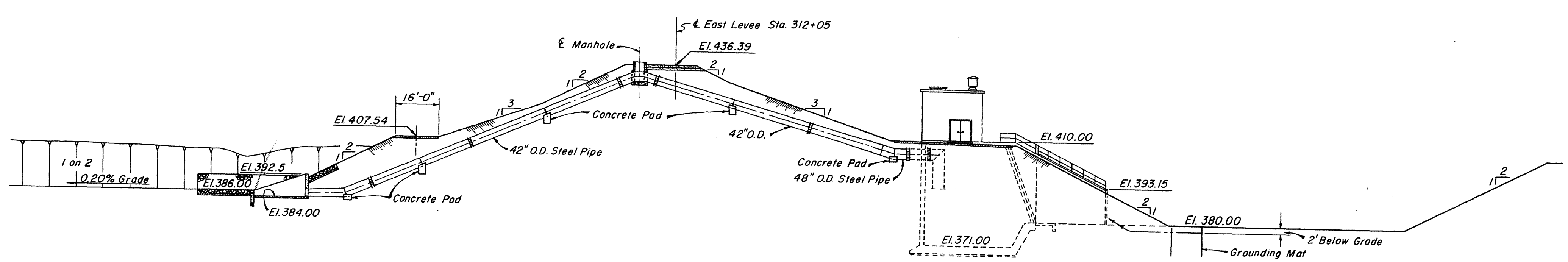
FILE: TRIN. 265-30 ANNEX I PLATE 27

CORPS OF ENGINEERS

U. S. ARMY



PLAN



LONGITUDINAL SECTION

SCALE OF FEET

20 0 20

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

HAMPTON ROAD PUMPING PLANT

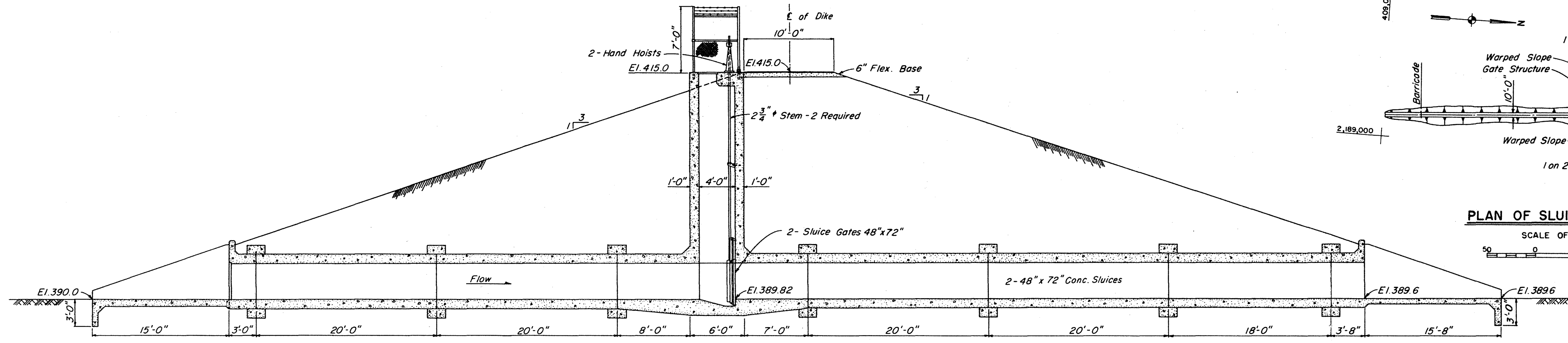
PLAN AND SECTION

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 28

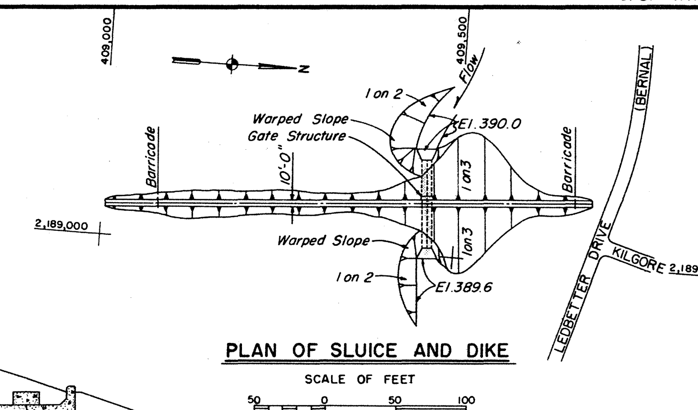


SLUICE AND DIKE NEAR LEDBETTER DRIVE

LONGITUDINAL SECTION

SCALE OF FEET

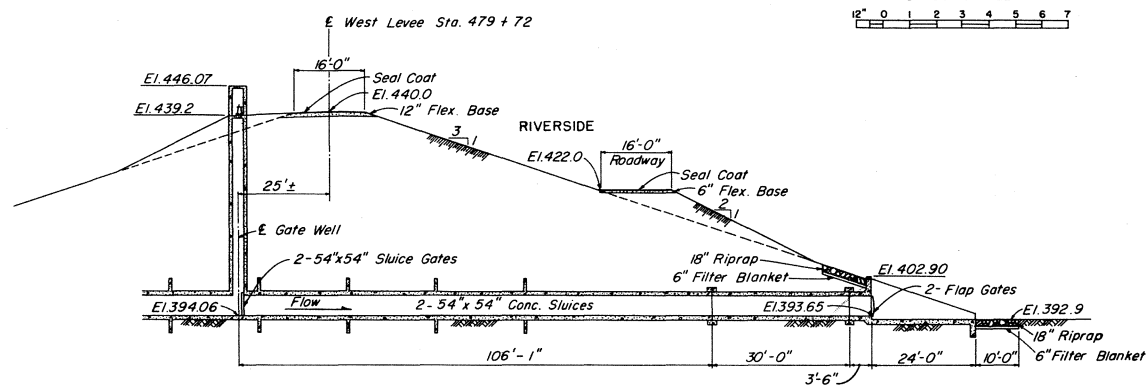
12" 0 1 2 3 4 5 6 7



PLAN OF SLUICE AND DIKE

SCALE OF FEET

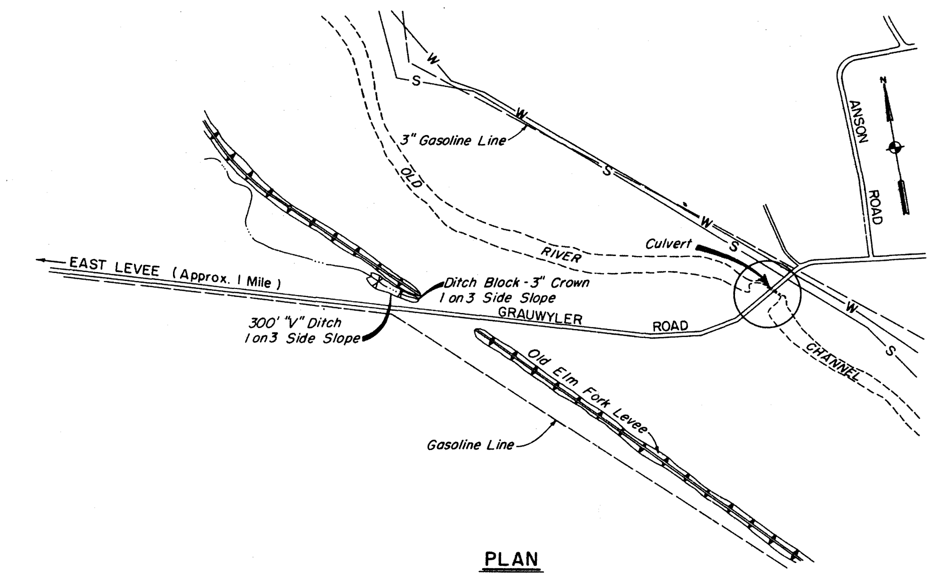
50 0 50 100



EAGLE FORD SLUICE

LONGITUDINAL SECTION

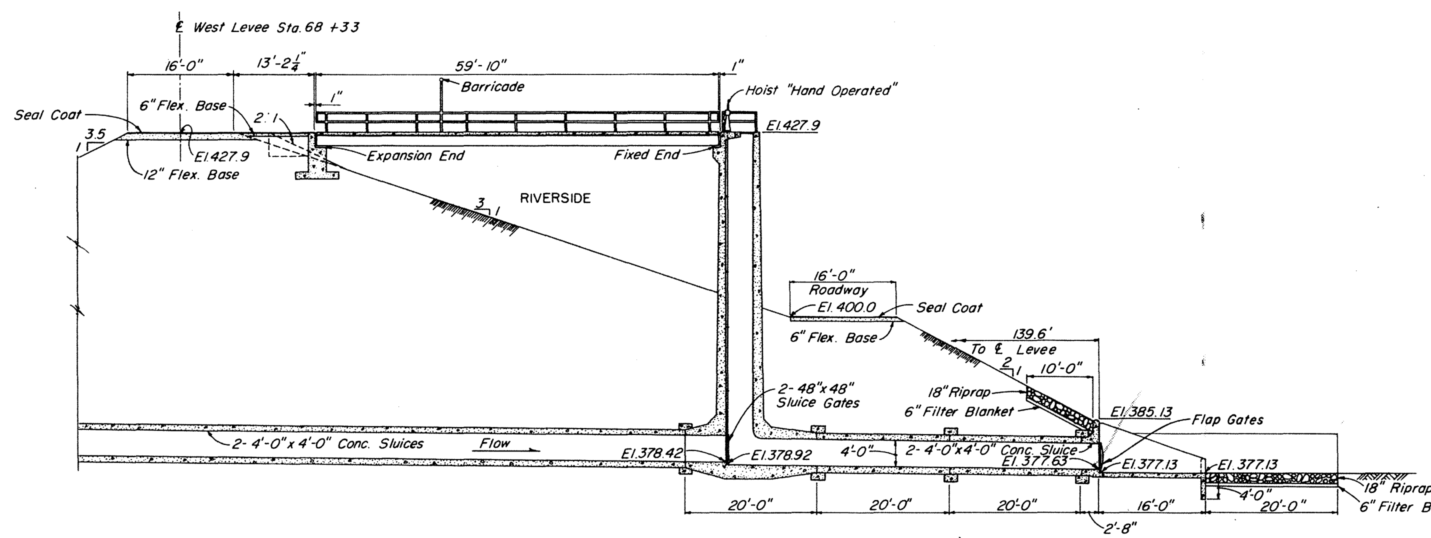
NOT TO SCALE



PLAN

SCALE OF FEET

400 0 400 800

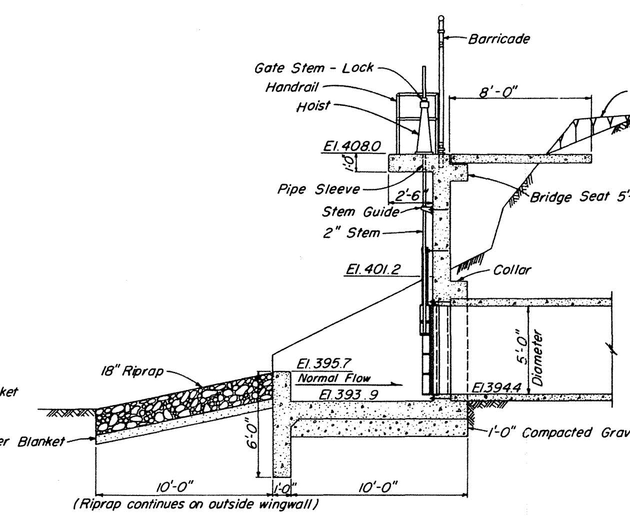


PUMPING PLANT "C" CONDUIT

LONGITUDINAL SECTION

SCALE OF FEET

12" 0 2 4 6 8 10 12 14



GRAUWYLER ROAD CULVERT

LONGITUDINAL SECTION

SCALE OF FEET

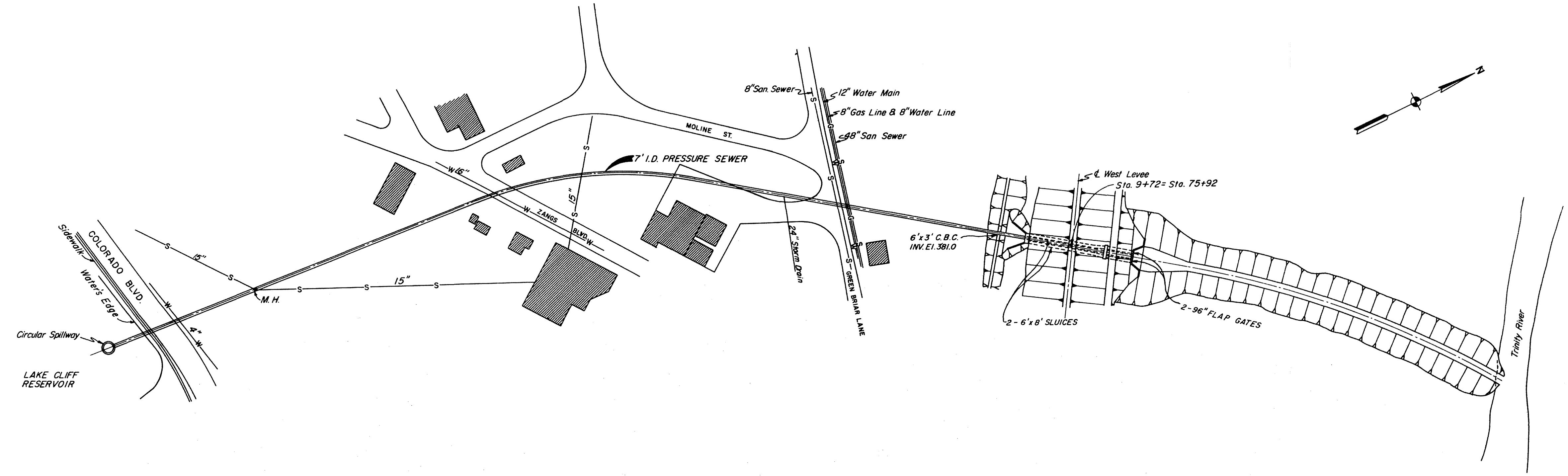
12" 0 1 2 3 4 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER
PUMPING PLANT "C" CONDUIT
EAGLE FORD SLUICE
SLUICE AND DIKE NEAR LEDBETTER DRIVE
GRAUWYLER ROAD CULVERT
SCALES AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

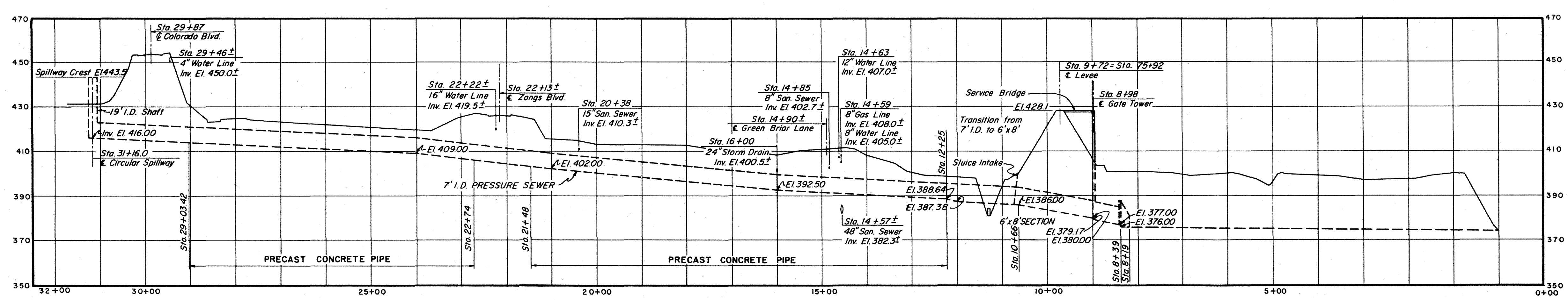
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 29



PLAN

SCALE OF FEET



PROFILE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

LAKE CLIFF PRESSURE SEWER

PLAN AND PROFILE

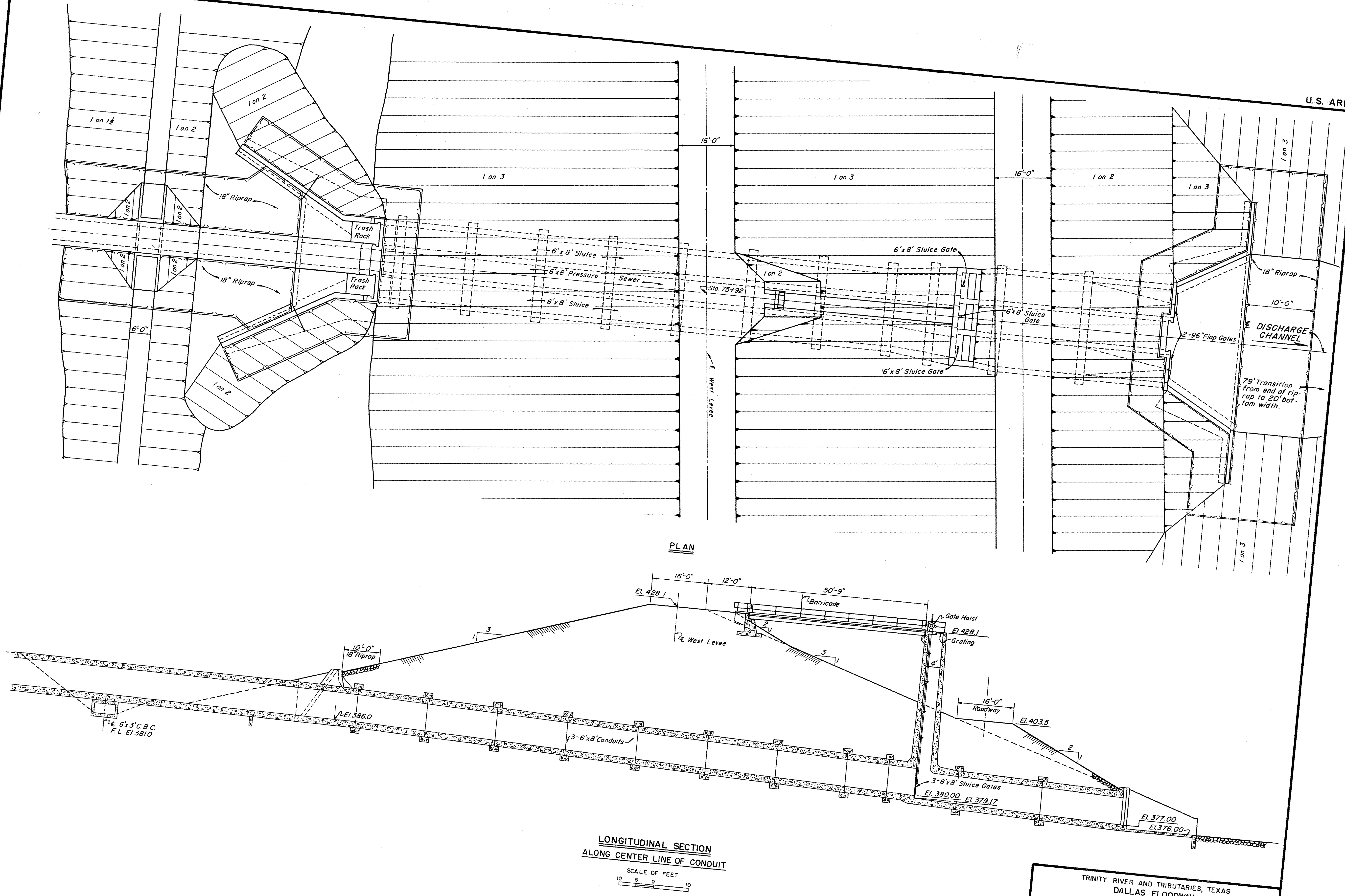
IN 2 SHEETS — SHEET NO. 1

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 — ANNEX I — PLATE 30



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

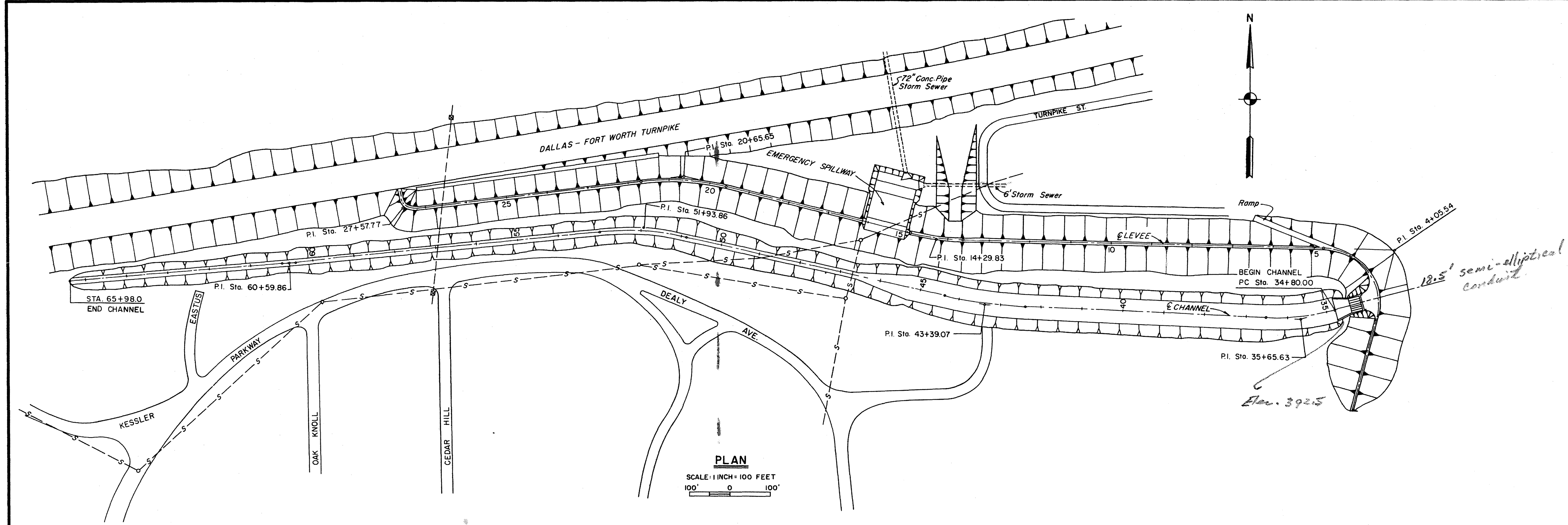
LAKE CLIFF PRESSURE SEWER
PLAN AND SECTION

IN 2 SHEETS
SCALES AS SHOWN
SHEET NO. 2

FORT WORTH DISTRICT FORT WORTH, TEXAS
MAY 1960

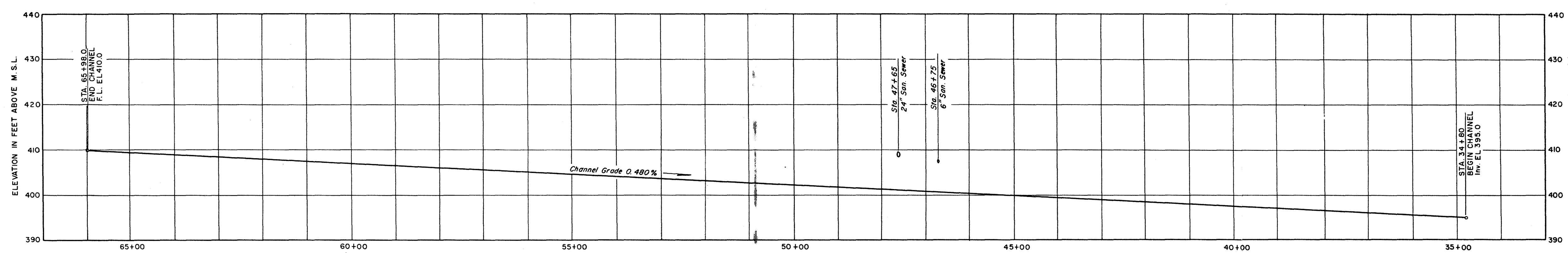
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30
ANNEX I
PLATE 31

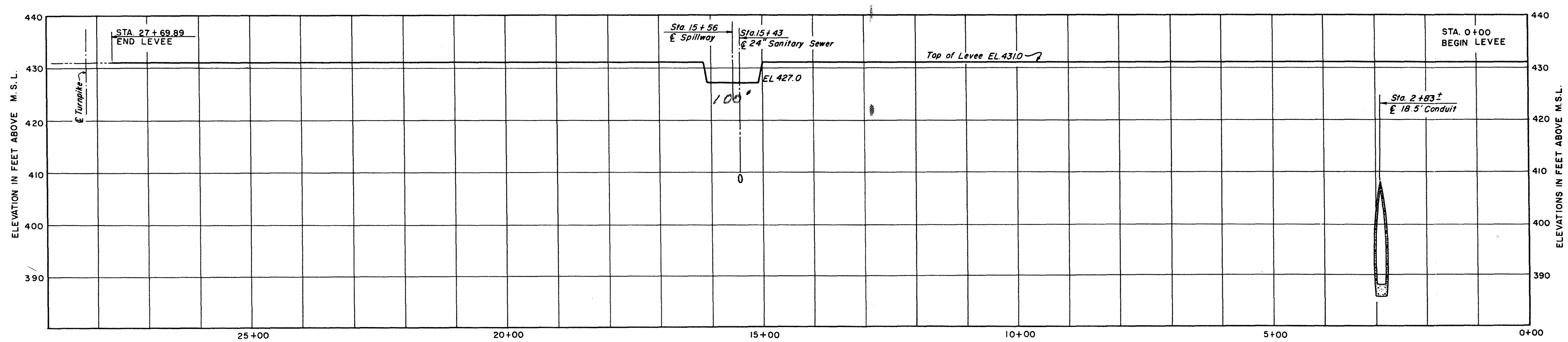


PLAN

SCALE: 1 INCH = 100 FEET



CHANNEL PROFILE



LEVEE PROFILE

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

COOMBS CREEK DIVERSION FACILITIES

CHANNEL AND LEVEE

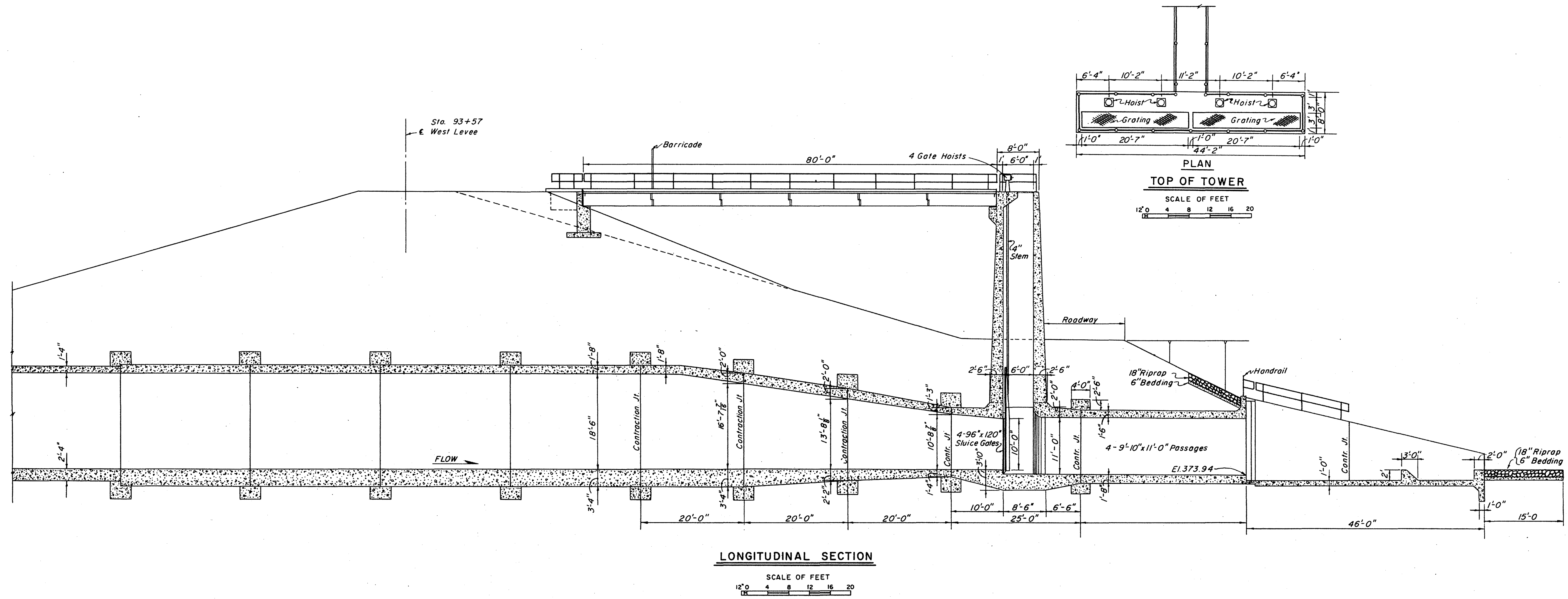
IN 2 SHEETS SHEET NO. 1

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 32



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

COOMBS CREEK DIVERSION FACILITIES

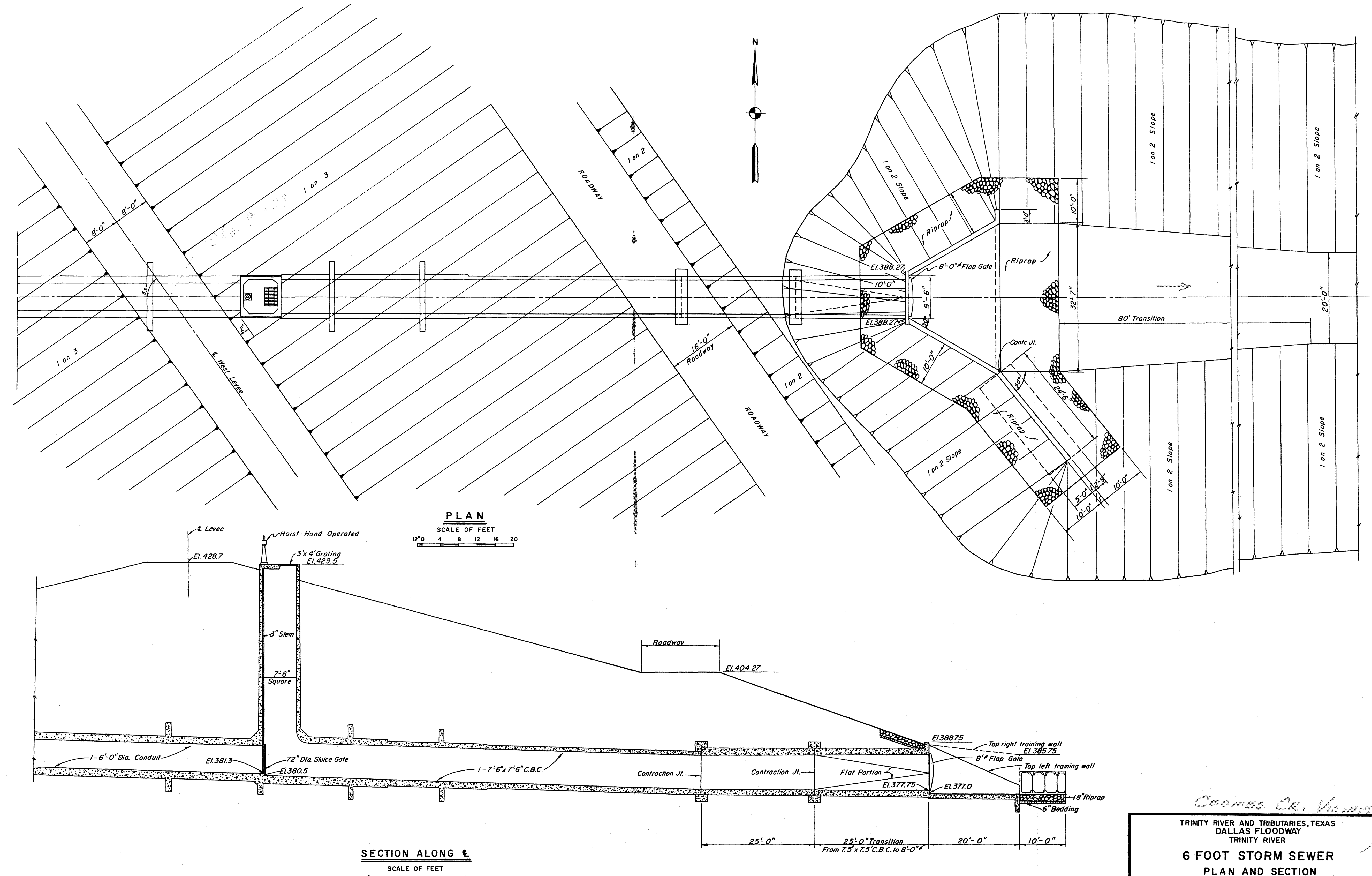
IN 2 SHEETS — SHEET NO. 2

SCALES AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS — MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 — ANNEX I — PLATE 33



COOMBS CR. VICINITY

TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

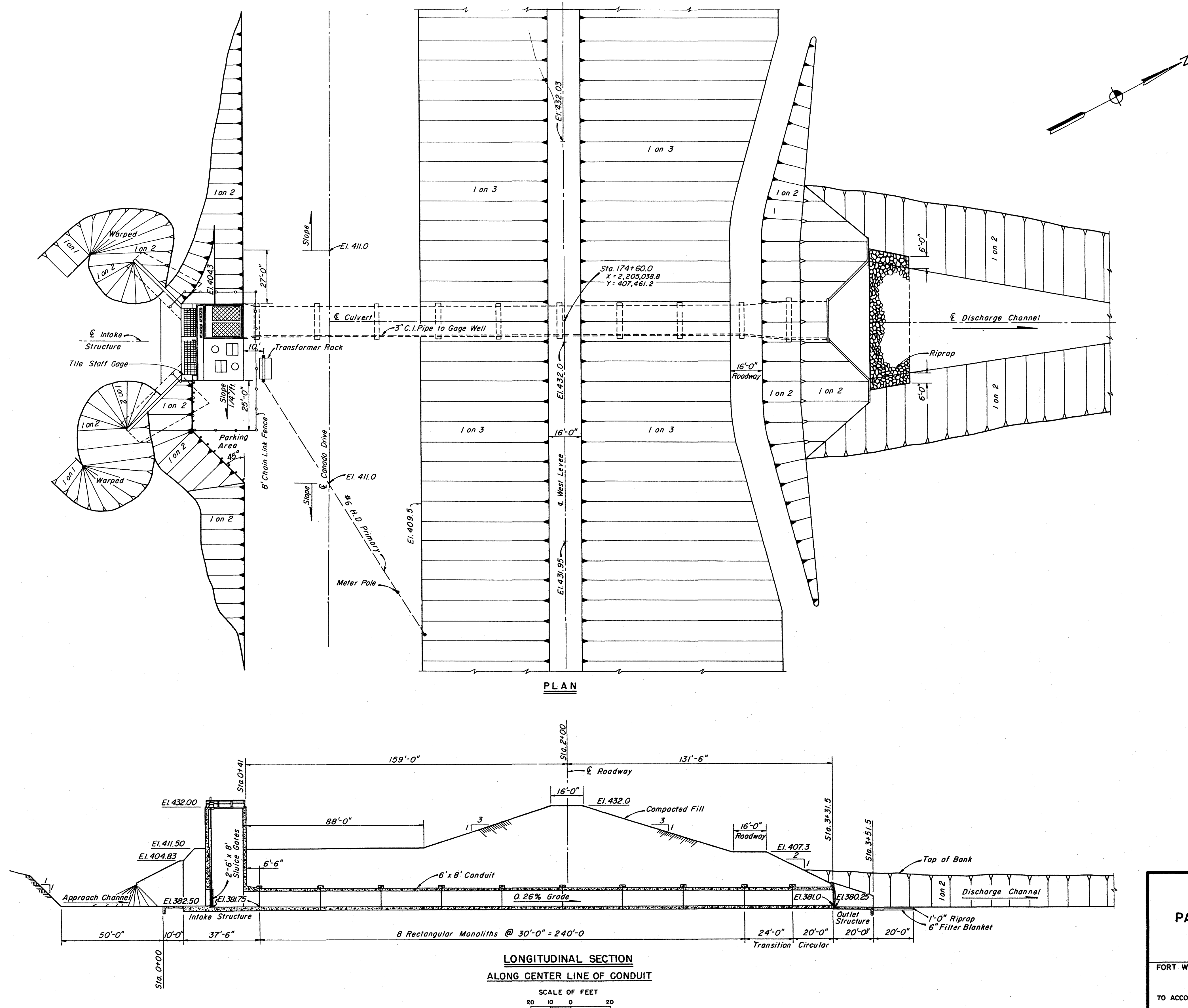
6 FOOT STORM SEWER
PLAN AND SECTION

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 34



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

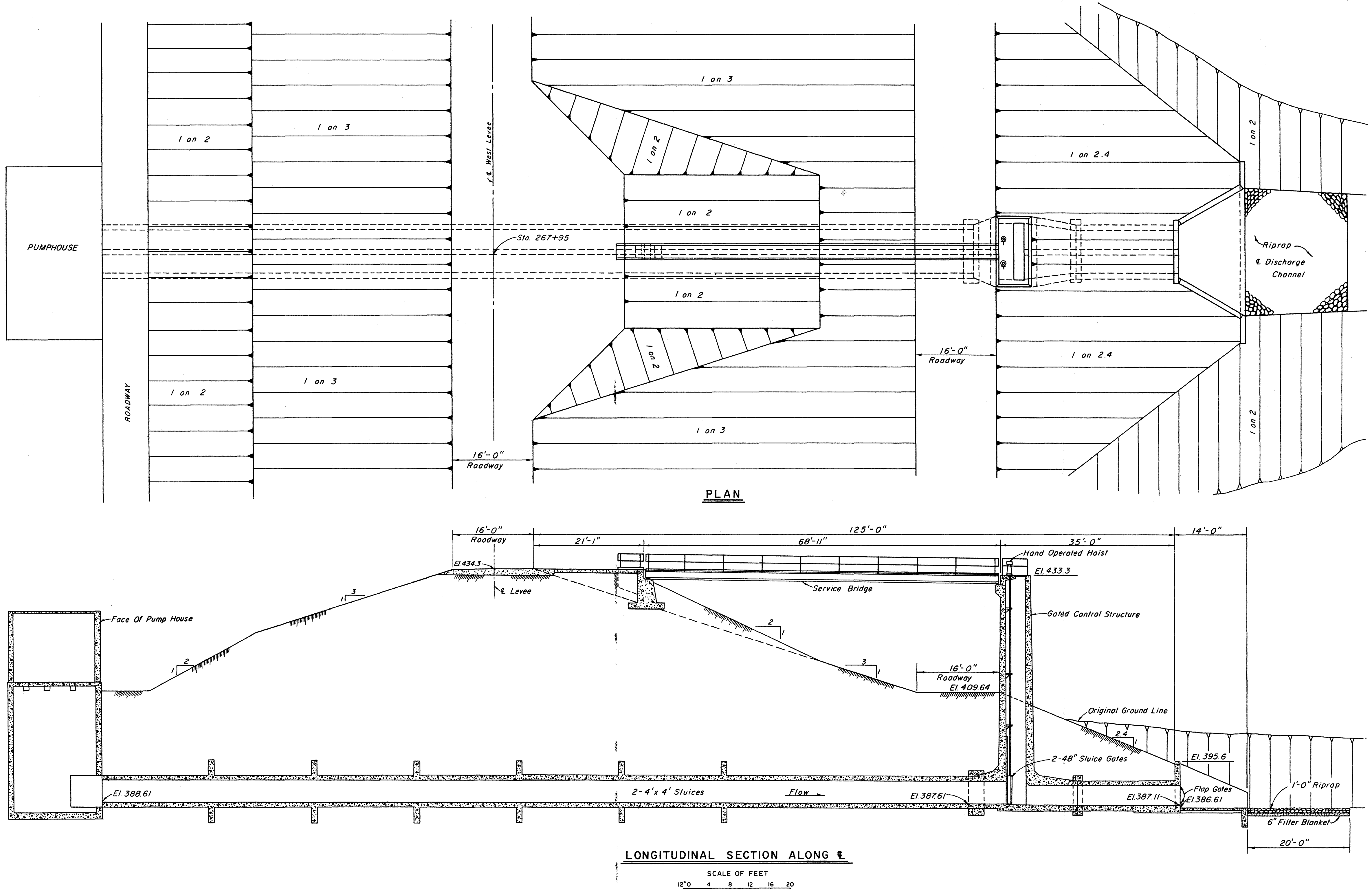
PAVAHO STREET PUMPING PLANT
PLAN AND SECTION

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 35



TRINITY RIVER AND TRIBUTARIES, TEXAS
DALLAS FLOODWAY
TRINITY RIVER

PUMPING PLANT "D"

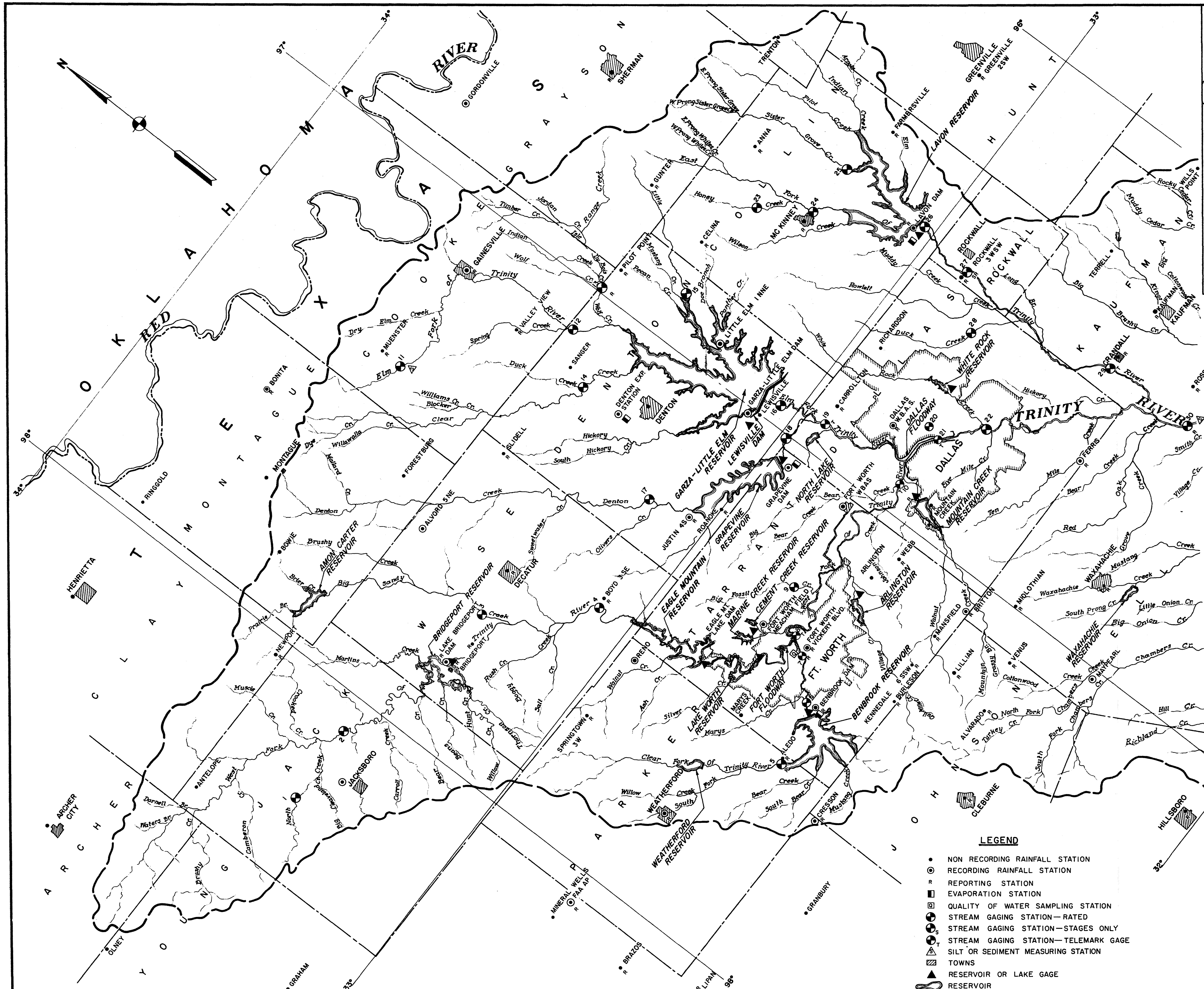
PLAN AND SECTION

SCALE AS SHOWN

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

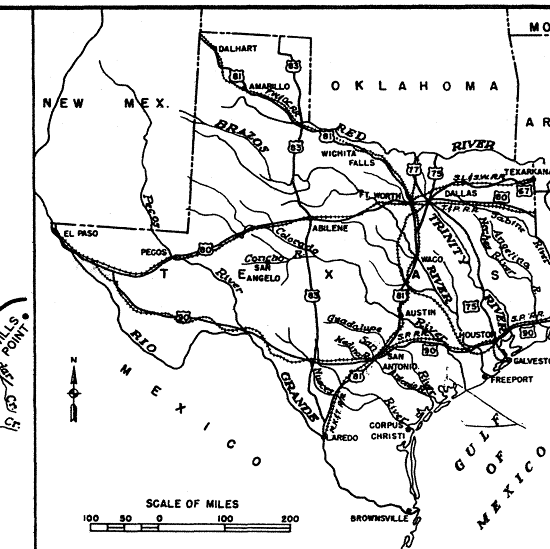
TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 36



LEGEND

- NON RECORDING RAINFALL STATION
- RECORDING RAINFALL STATION
- R REPORTING STATION
- EVAPORATION STATION
- QUALITY OF WATER SAMPLING STATION
- STREAM GAGING STATION—RATED
- S STREAM GAGING STATION—STAGES ONLY
- T STREAM GAGING STATION—TELEMARK GAGE
- SILT OR SEDIMENT MEASURING STATION
- TOWNS
- RESERVOIR OR LAKE GAGE
- RESERVOIR



VICINITY MAP

LIST OF RIVER GAGES

1. NORTH CREEK NEAR JACKSBORO, TEXAS.
2. WEST FORK TRINITY RIVER NEAR JACKSBORO, TEXAS.
3. BIG SANDY CREEK NEAR BRIDGEPORT, TEXAS.
4. WEST FORK TRINITY RIVER NEAR BOYD, TEXAS.
5. CLEAR FORK TRINITY RIVER NEAR ALEDO, TEXAS.
6. CLEAR FORK TRINITY RIVER NEAR BENBROOK, TEXAS.
7. CLEAR FORK TRINITY RIVER AT FORT WORTH, TEXAS.
8. WEST FORK TRINITY RIVER AT FORT WORTH, TEXAS.
9. BIG FOSSIL CREEK NEAR HALTOM CITY, TEXAS.
10. WEST FORK TRINITY RIVER AT GRAND PRAIRIE, TEXAS.
11. ELM FORK TRINITY RIVER NEAR MUENSTER, TEXAS.
12. ELM FORK TRINITY RIVER NEAR SANGER, TEXAS.
13. ISLE DU BOIS CREEK NEAR PILOT POINT, TEXAS.
14. CLEAR CREEK NEAR SANGER, TEXAS.
15. LITTLE ELM CREEK NEAR AUBREY, TEXAS.
16. ELM FORK TRINITY RIVER NEAR LEWISVILLE, TEXAS.
17. DENTON CREEK NEAR JUSTIN, TEXAS.
18. DENTON CREEK NEAR GRAPEVINE, TEXAS.
19. ELM FORK TRINITY RIVER NEAR CARROLLTON, TEXAS.
20. TURTLE CREEK AT DALLAS, TEXAS.
21. TRINITY RIVER AT DALLAS, TEXAS.
22. TRINITY RIVER BELOW DALLAS, TEXAS.
23. HONEY CREEK NEAR McKINNEY, TEXAS.
24. EAST FORK TRINITY RIVER NEAR McKINNEY, TEXAS.
25. SISTER GROVE CREEK NEAR PRINCETON, TEXAS.
26. EAST FORK TRINITY RIVER NEAR LAVON, TEXAS.
27. EAST FORK TRINITY RIVER NEAR ROCKWALL, TEXAS.
28. DUCK CREEK NEAR GARLAND, TEXAS.
29. EAST FORK TRINITY RIVER NEAR CRANDALL, TEXAS.
30. TRINITY RIVER NEAR ROSSER, TEXAS.

TRINITY RIVER AND TRIBUTARIES, TEXAS

DALLAS FLOODWAY

WATERSHED MAP AND HYDROLOGIC NETWORK

SCALE OF MILES

5 0 5 0

FORT WORTH DISTRICT FORT WORTH, TEXAS MAY 1960

TO ACCOMPANY OPERATION AND MAINTENANCE MANUAL

FILE: TRIN. 265-30 ANNEX I PLATE 37

TITLE 33—NAVIGATION AND NAVIGABLE WATERS

Chapter II—Corps of Engineers, War Department

PART 208—FLOOD CONTROL REGULATIONS

MAINTENANCE AND OPERATION OF FLOOD CONTROL WORKS

Pursuant to the provisions of section 3 of the Act of Congress approved June 22, 1936, as amended and supplemented (49 Stat. 1571; 50 Stat. 877; and 55 Stat. 638; 33 U. S. C. 701c; 701c-1), the following regulations are hereby prescribed to govern the maintenance and operation of flood control works:

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities*—(a) *General.* (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations.

(b) *Levees*—(1) *Maintenance.* The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Tow drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days, and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation.* During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls.*—(1) *Maintenance.* Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) The drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation.* Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance.* Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures*—(1) *Maintenance.* Closure structures for traffic openings shall be inspected by the superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants*—(1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways* — (1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities* — (1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (49 Stat. 1571, 50 Stat. 877; and 55 Stat. 638; 33 U.S.C. 701c; 701c-1) (Regs. 9 August 1944, CE SPEWF)

[SEAL] J. A. ULIO,
Major General,
The Adjutant General.

[F. R. Doc. 44-12285; Filed August 16, 1944; 9:44 a. m.

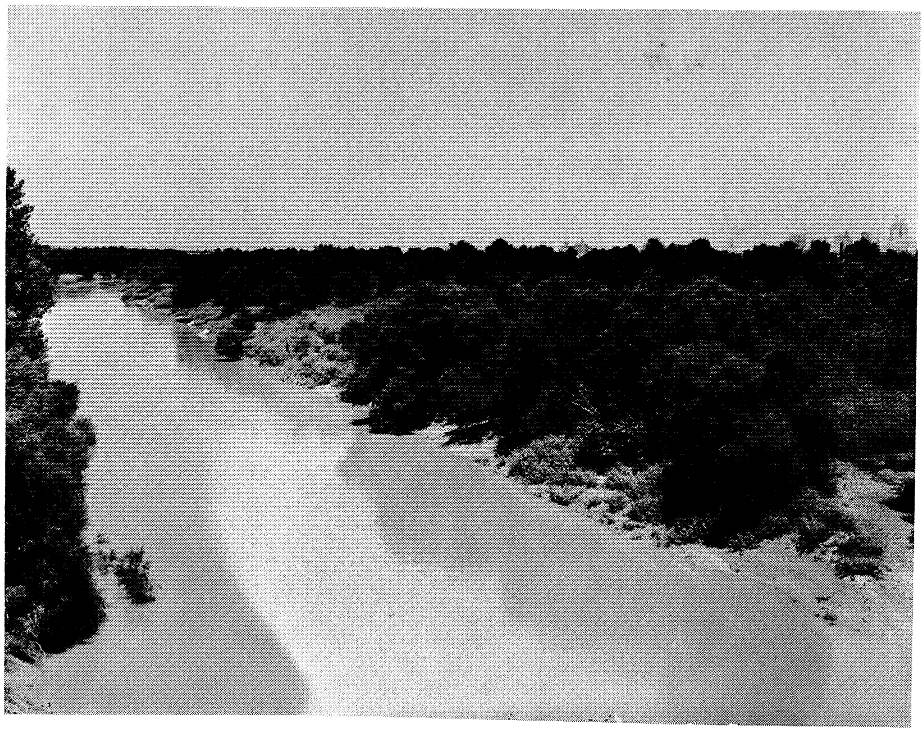
Dallas County Flood Control District — Date ______________

SEMIANNUAL REPORT FOR LOCAL PROTECTION WORKS
Dallas Floodway - Dallas, Texas

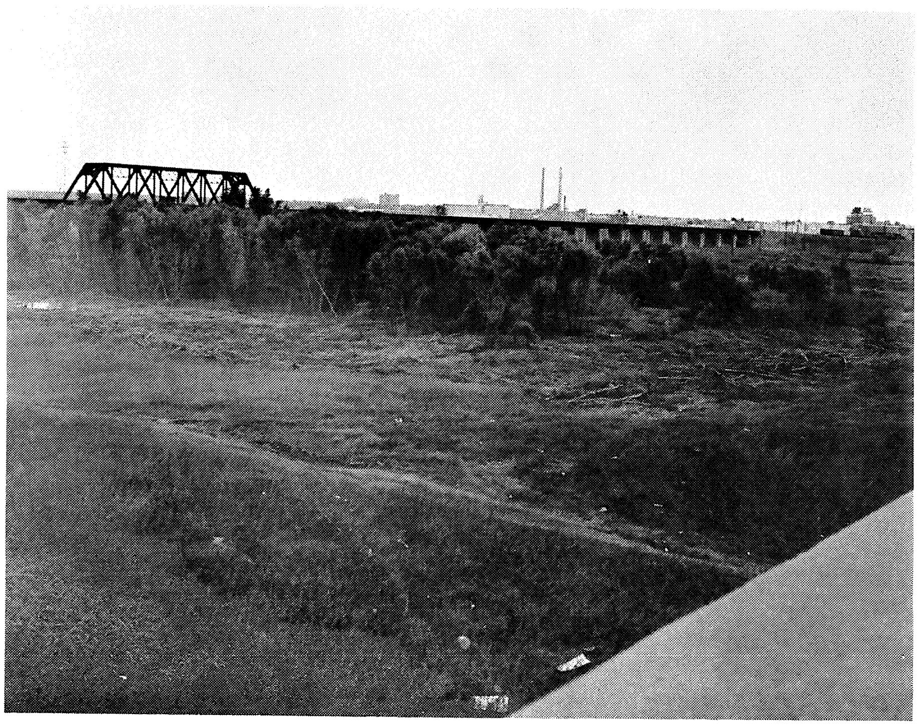
	Amount Expended or Man Days	Remarks
Mowing or Poisoning		
Clearing		
Drainage (hillside or interior)		
Removal of Trash		
Equipment (rental, etc.)		
Flood Emergency Equipment		
Minor Repairs		
Pump Stations		
Inspections		

____
Superintendent

ANNEX 3

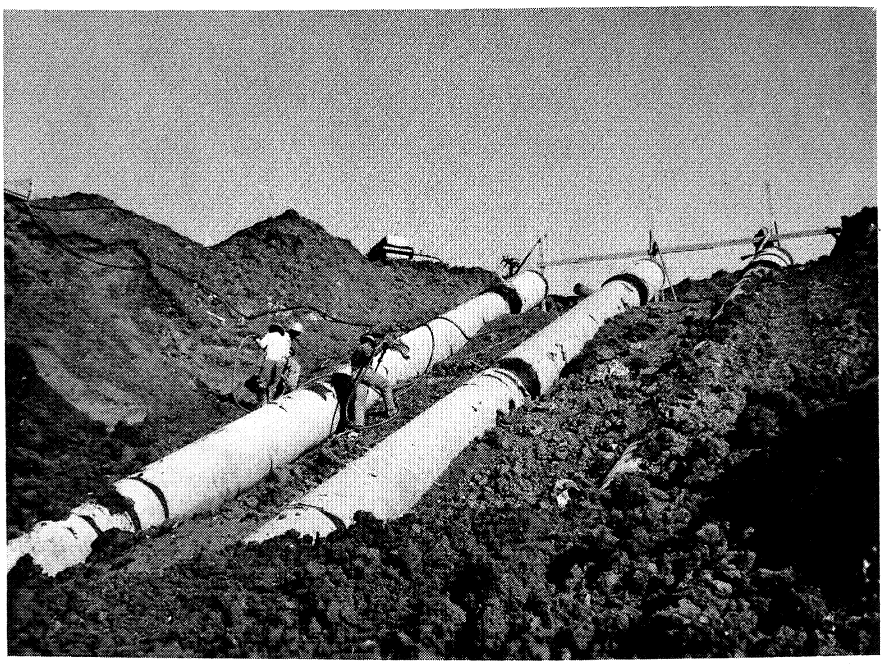


Prior to Clearing Operations 8 August 1950

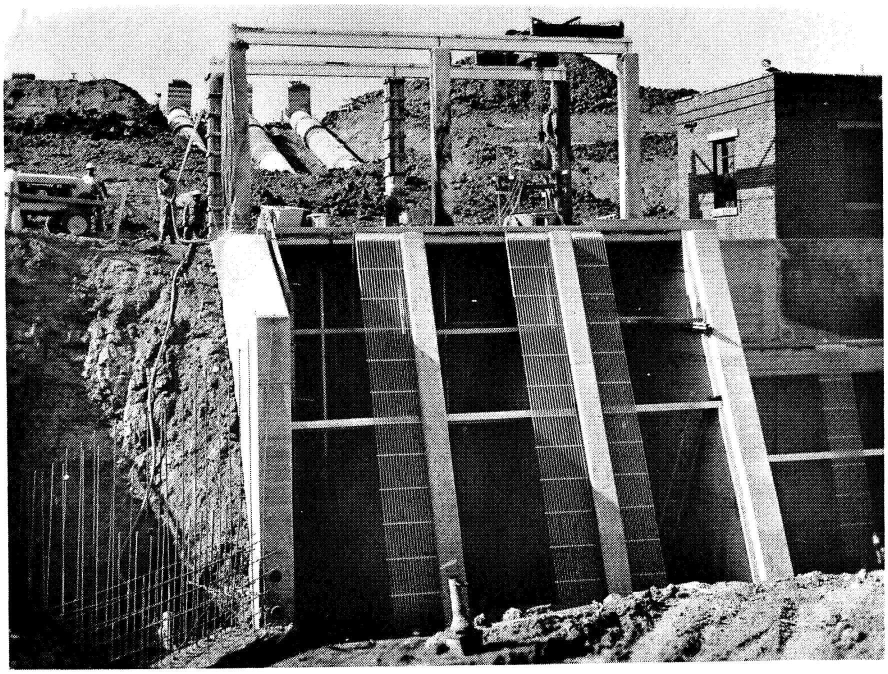


Clearing Operations 3 November 1950

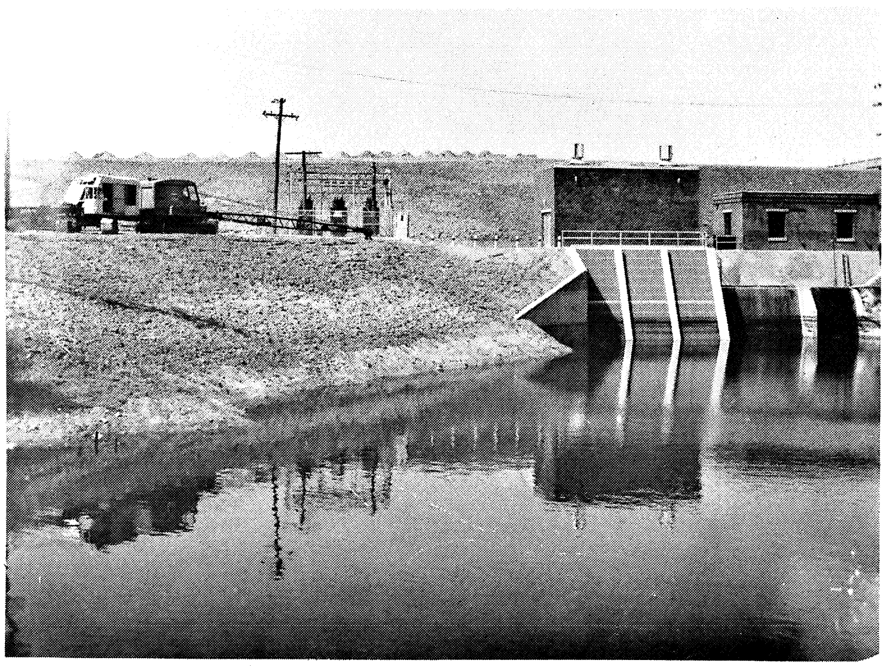
Completed Clearing 4 January 1951



Pumping Plant A, Installation of Discharge Pipes 16 December 1953

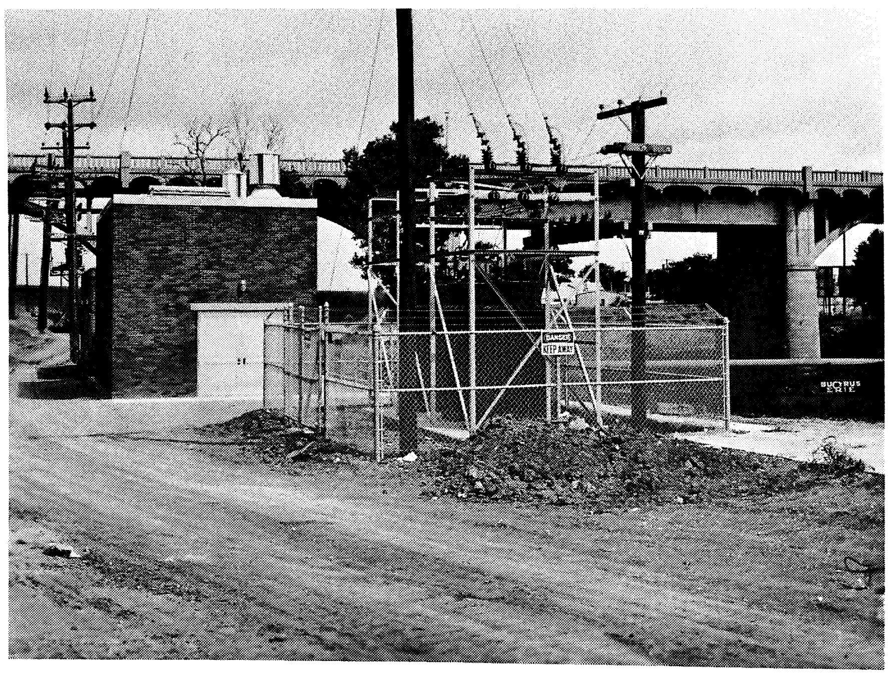


Pumping Plant A, Construction of Intake 9 March 1954



Pumping Plant A, New and Old 8 June 1954

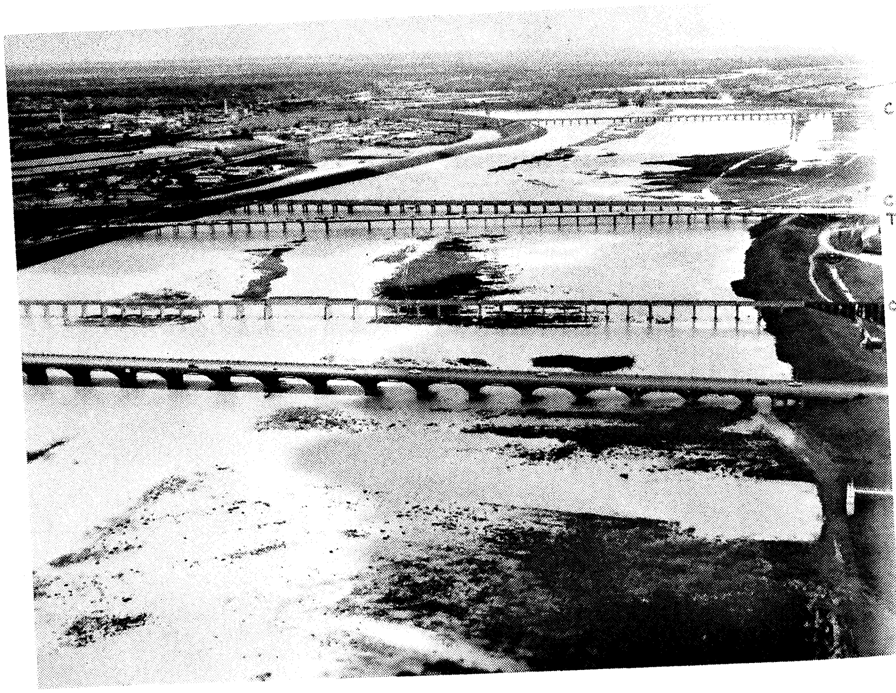
East Levee, Completed Embankment and
Excavation of Sump "A" Area 9 March 1954



Pumping Plant A 8 June 1954

25 April 1957

Corinth Street



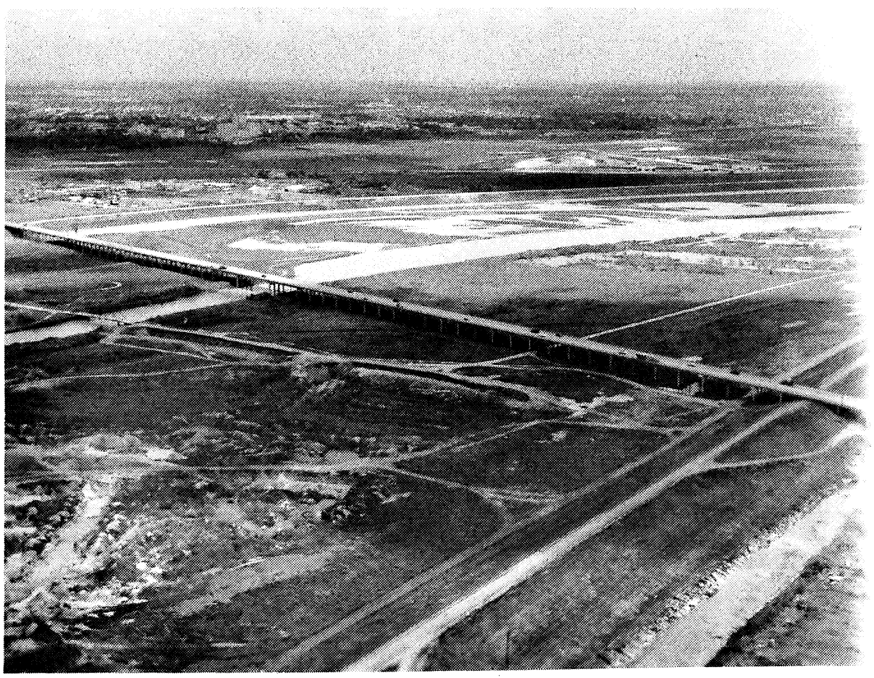
25 April 1957

Houston Street

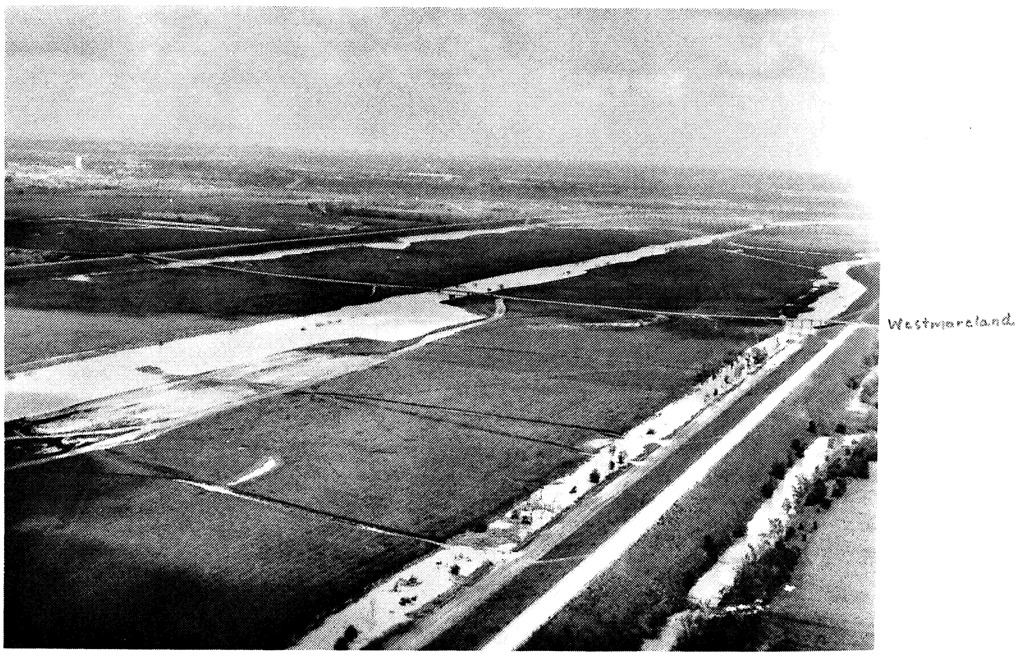
Continental Street 25 April 1957

Commerce Street 25 April 1957

Sylvan Street Bridge 25 April 1957

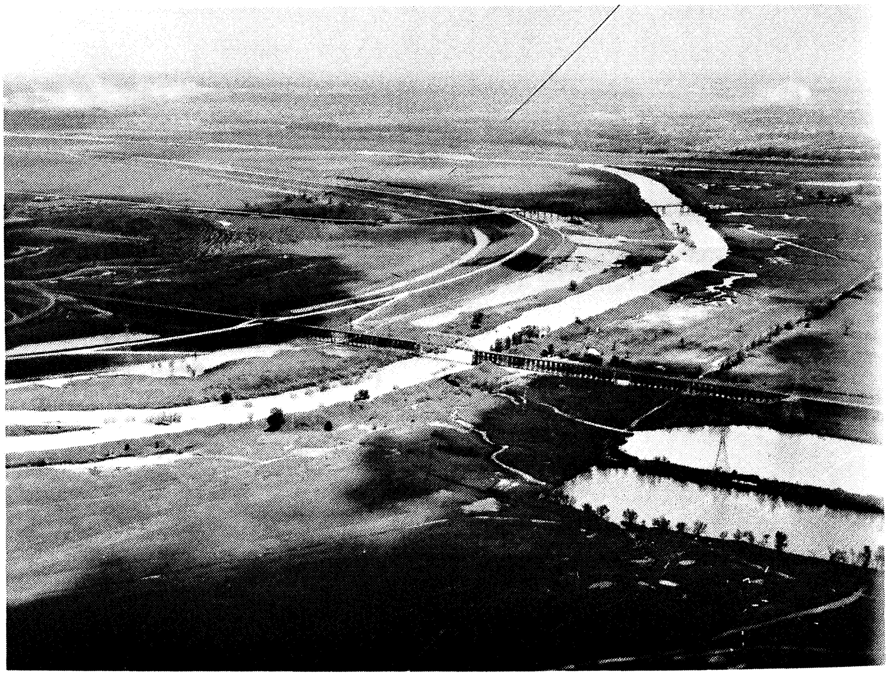


Hampton-Inwood 25 April 1957

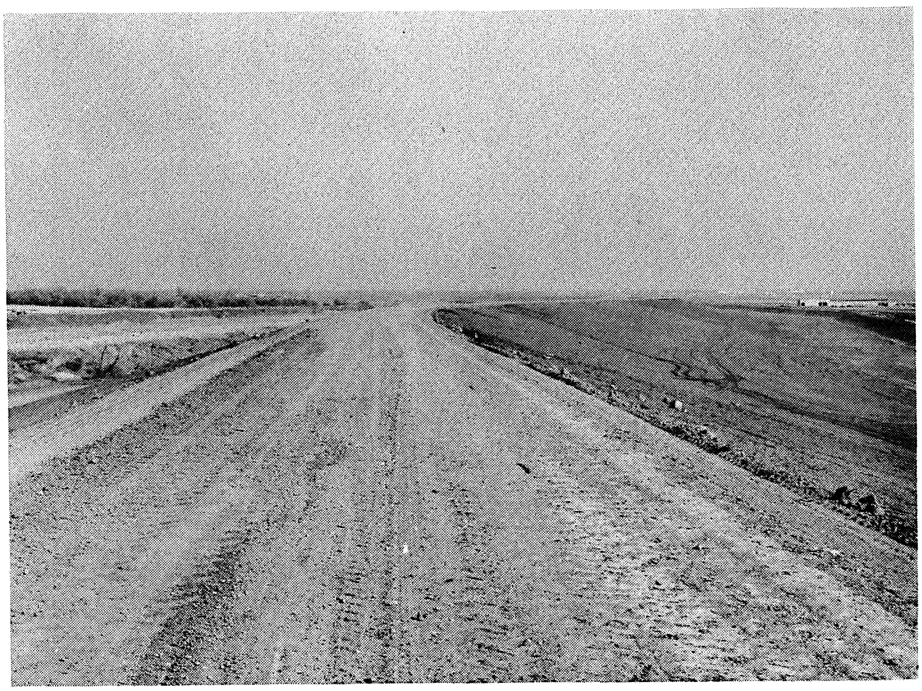


Westmoreland Street Bridge 25 April 1957

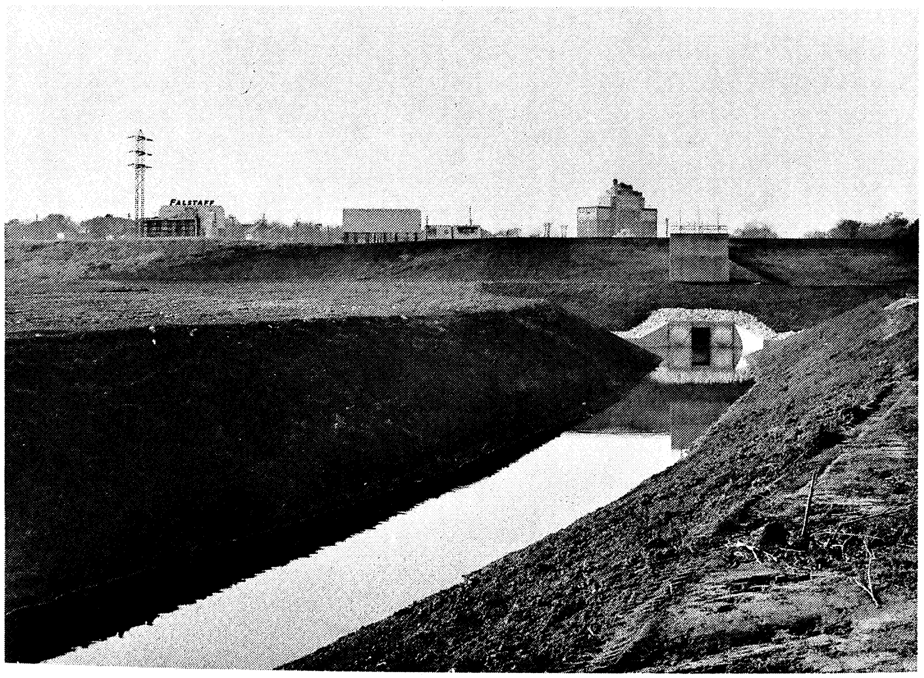
Irving Bridge, Note Confluence (Elm Fork and West Fork) 25 April 1957



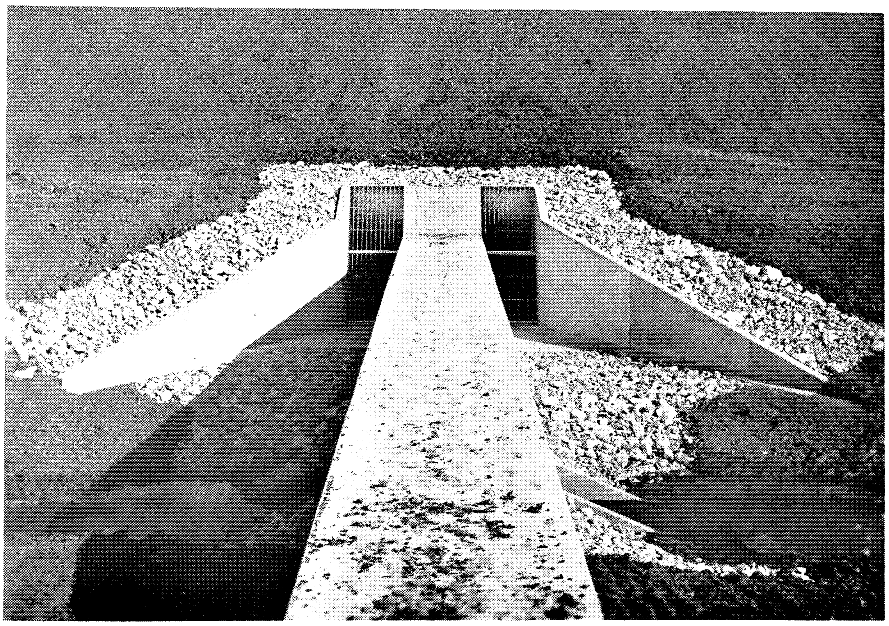
East Levee, CRI&P RR 25 April 1957



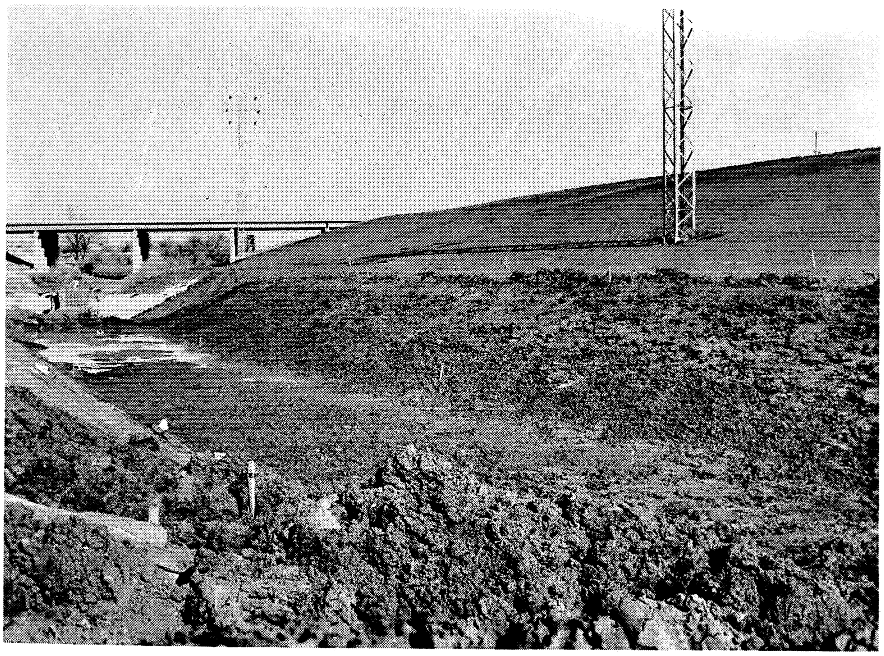
East Levee, Looking Upstream, CRI&P RR 12 December 1955



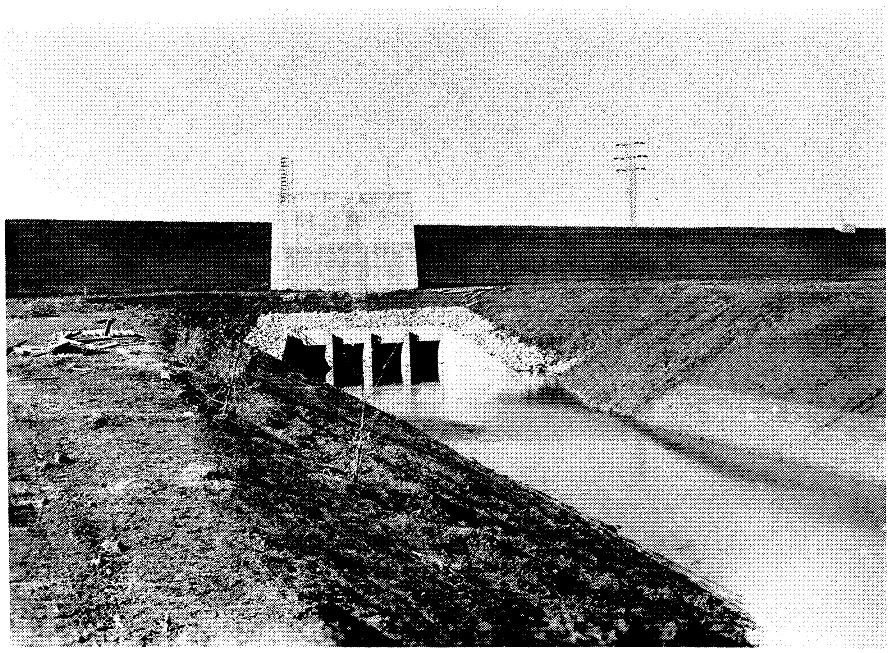
Lake Cliff, Outlet, Pressure Sewer 12 December 1955



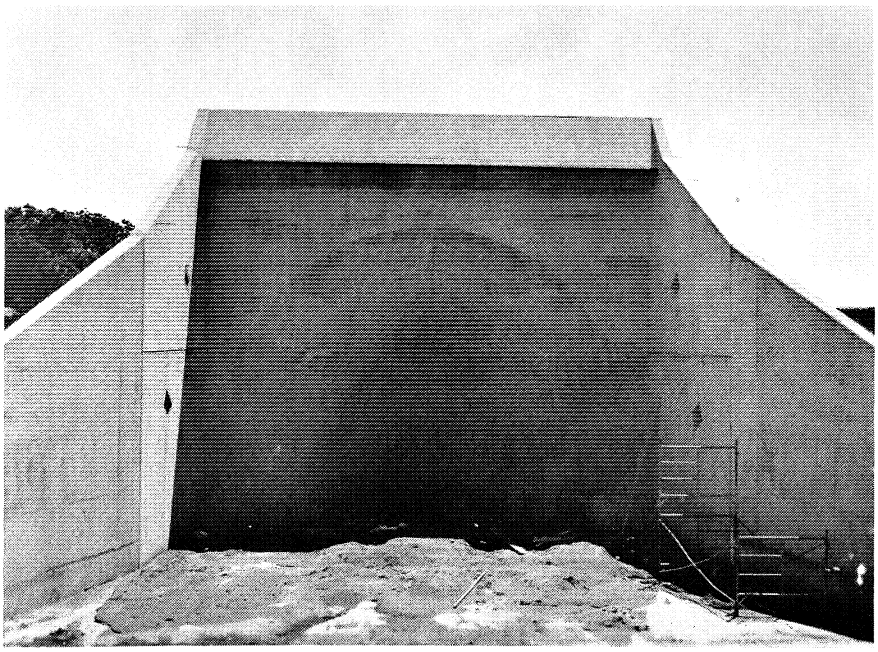
Lake Cliff, Sump Inlet 12 December 1955



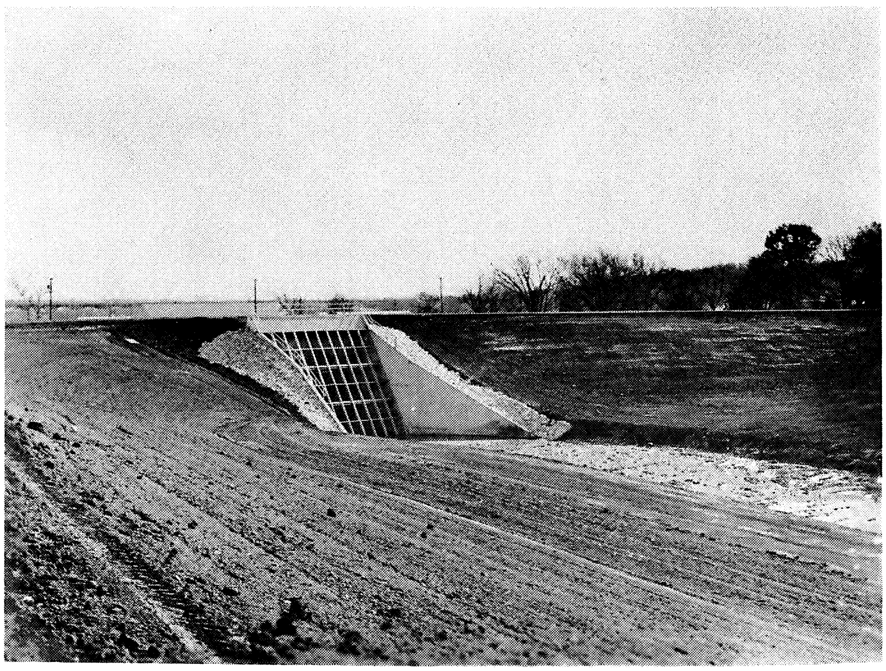
Coombs Creek, Sump Intake 10 December 1956



Coombs Creek, Outlet 10 December 1956



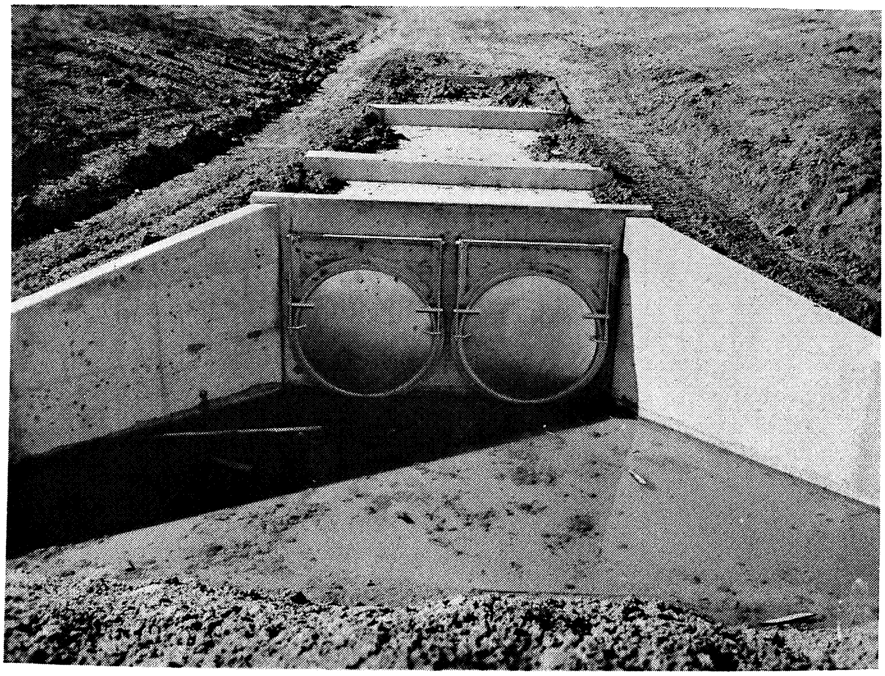
Coombs Creek, Intake 6 June 1956



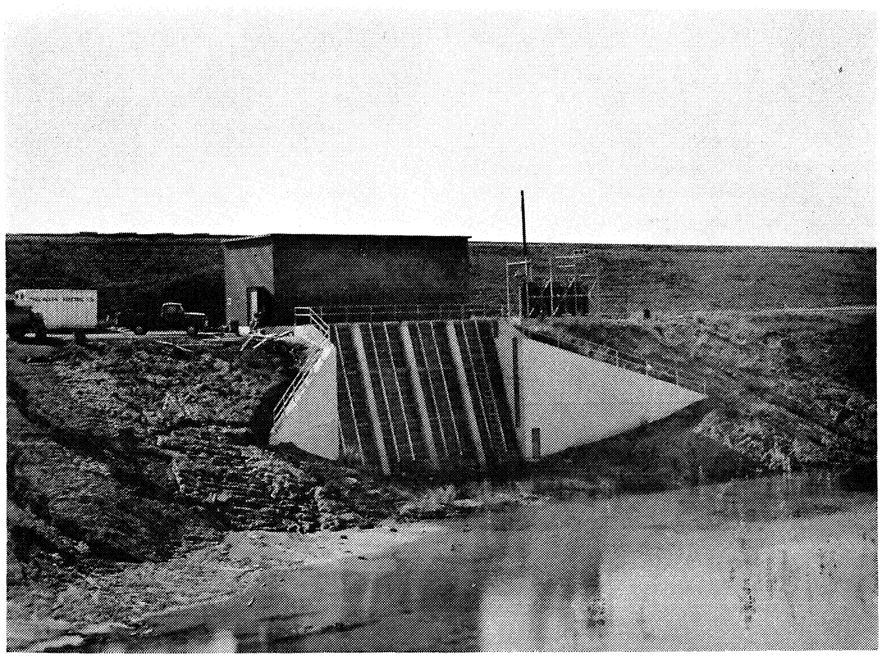
Coombs Creek, Intake and Levee 10 December 1956

Lake Cliff, Excavated Outlet Channel 6 June 1955

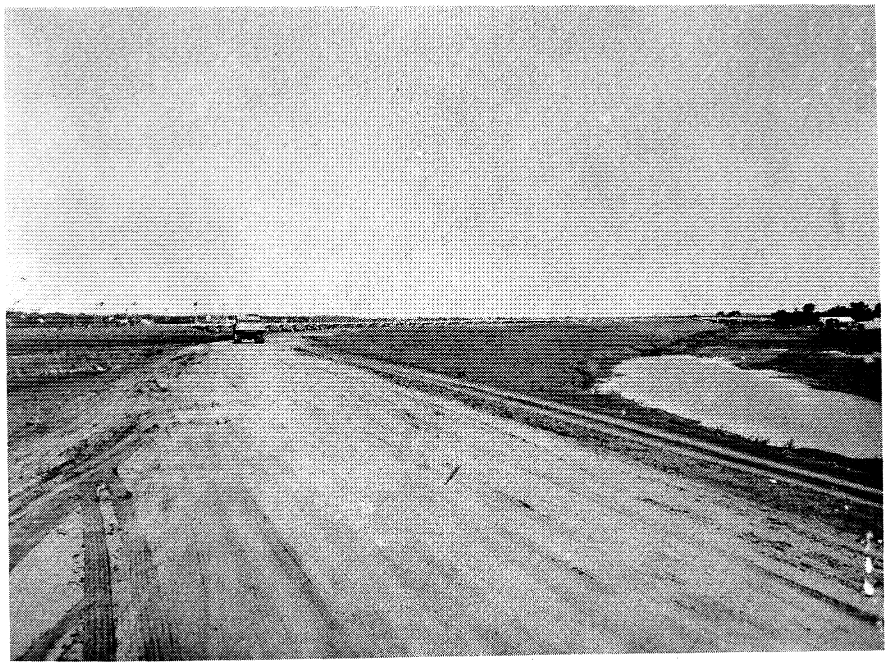
Typical Completed Riprap Protection 10 December 1956



Pavaho, Outlet, 8' Flap Gates 4 March 1955



Pavaho, Inlet and Completed Structure 10 December 1956

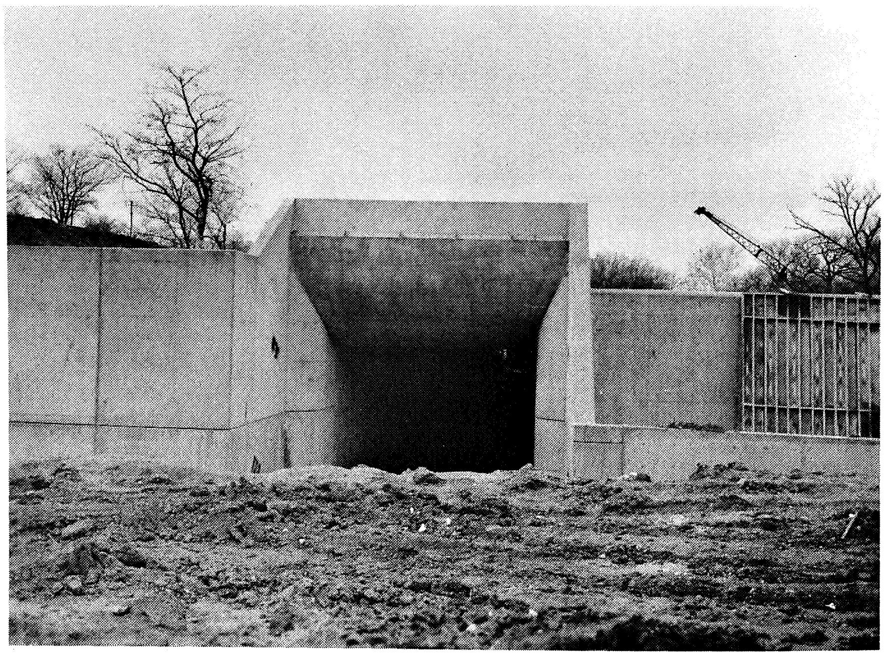


East Levee and Sump 6 June 1955

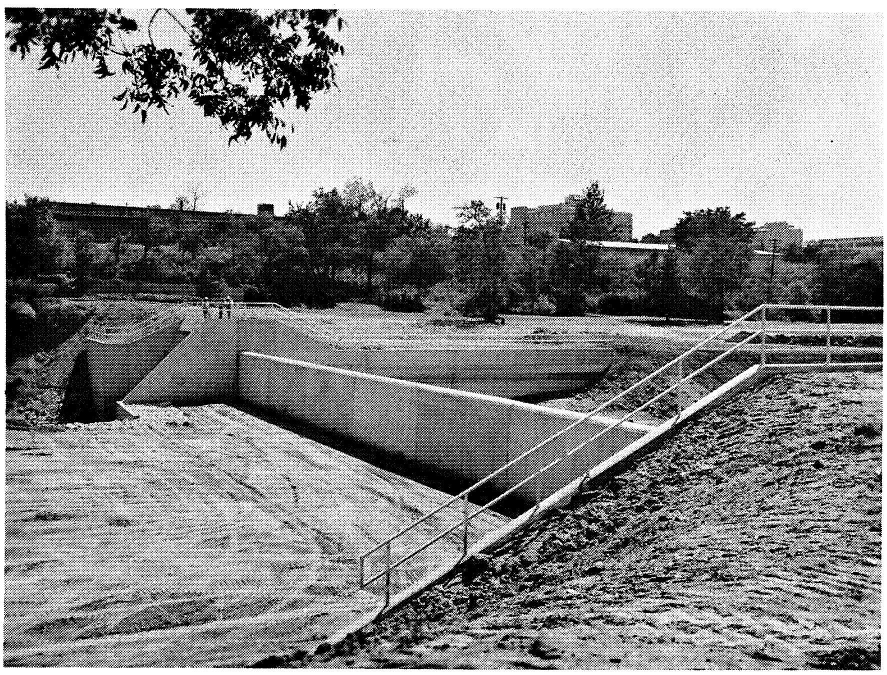
East Levee and Sump above Irving Blvd. 16 March 1956

East Levee, Irving Blvd. 16 March 1956

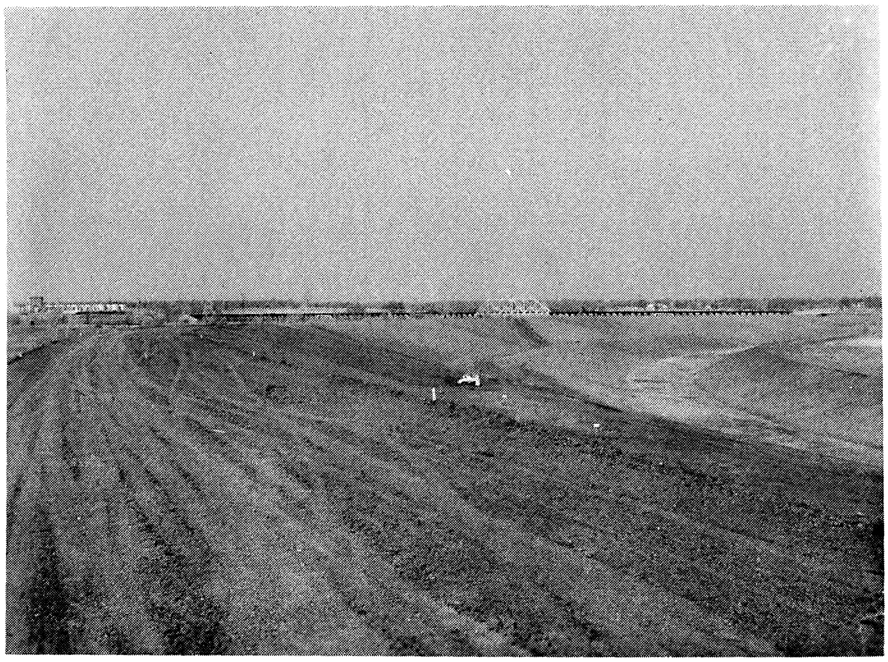
East Levee, Upstream from Westmoreland 10 December 1956



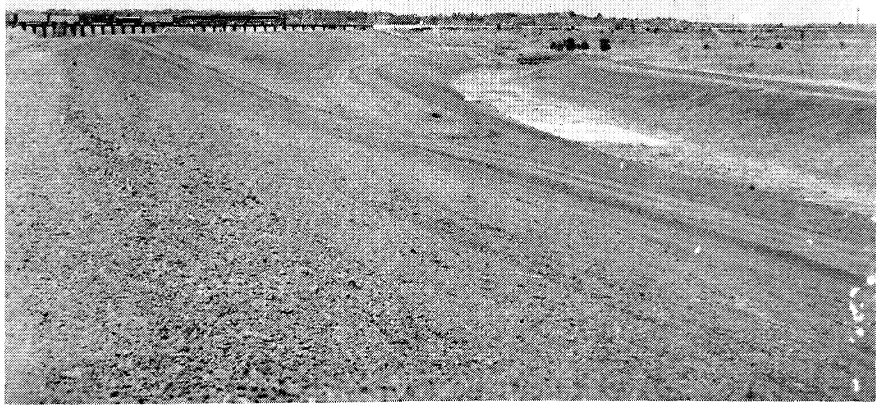
Turtle Creek, Intake Structure 13 March 1957



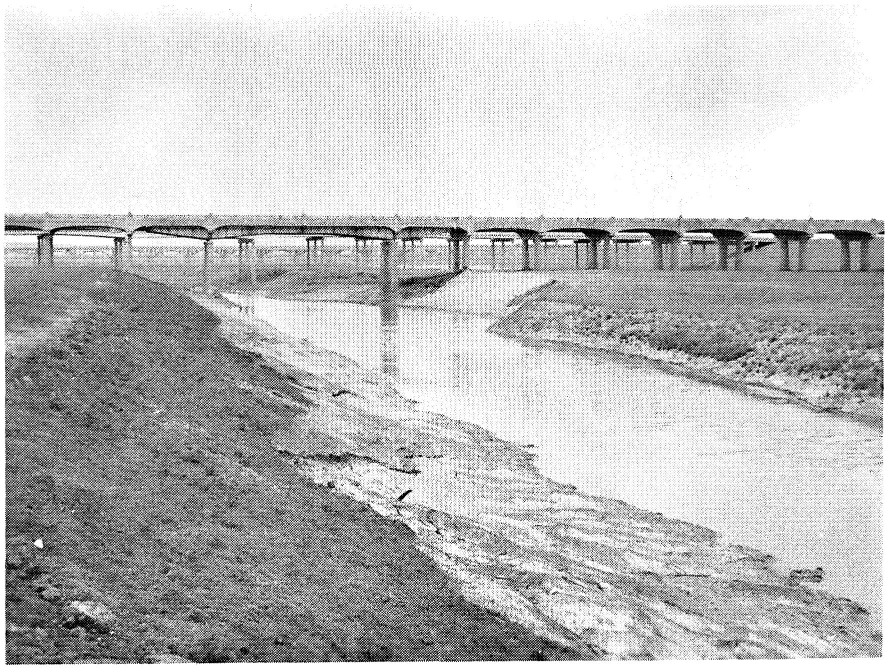
Turtle Creek, Overflow Section 10 September 1957



East Levee, Looking Upstream, Irving Blvd. 12 December 1955

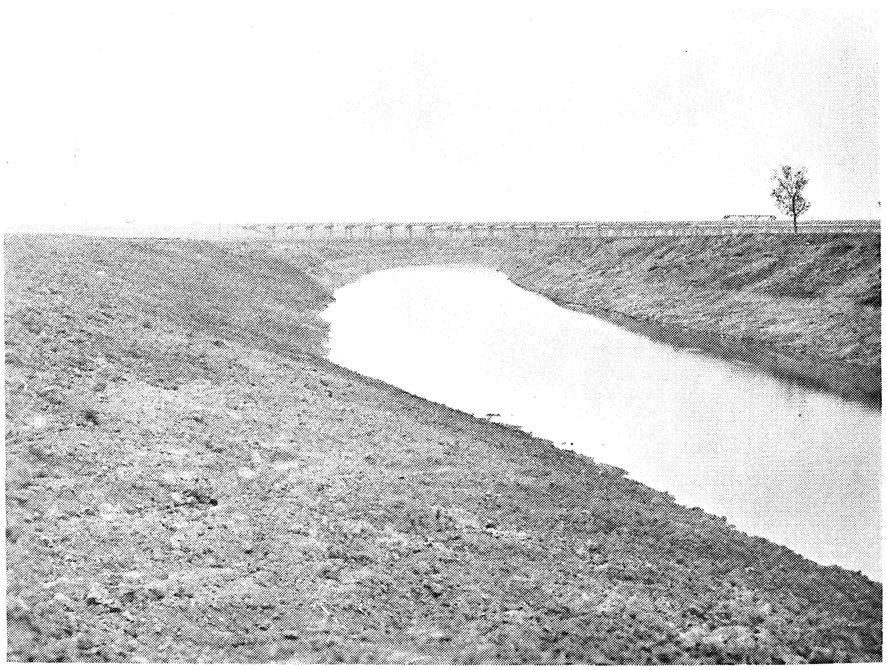


East Levee and Sump below Irving Blvd. 12 September 1955



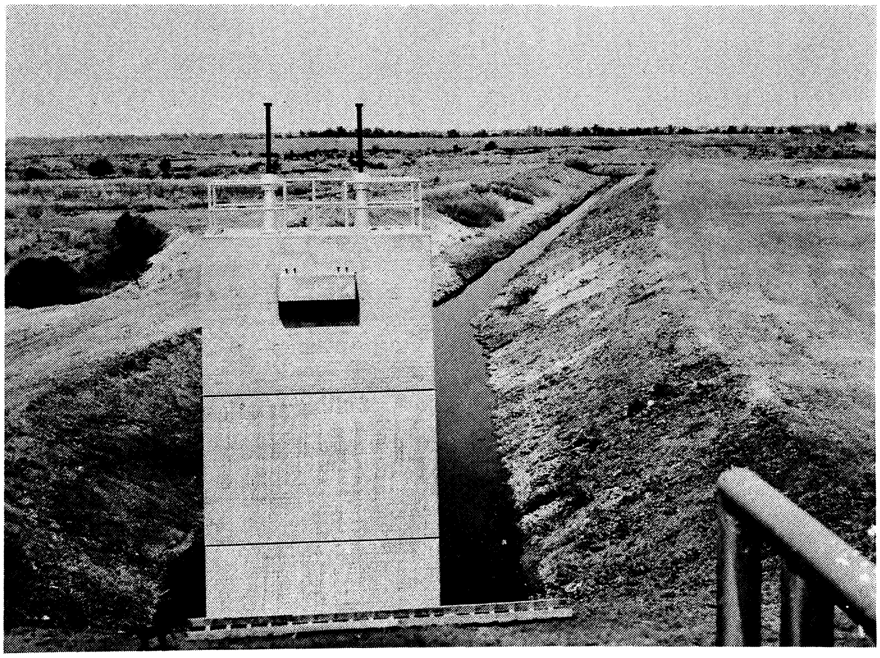
Channel Improvement, Completed Channel,
Downstream from Cadiz Street

5 May 1959

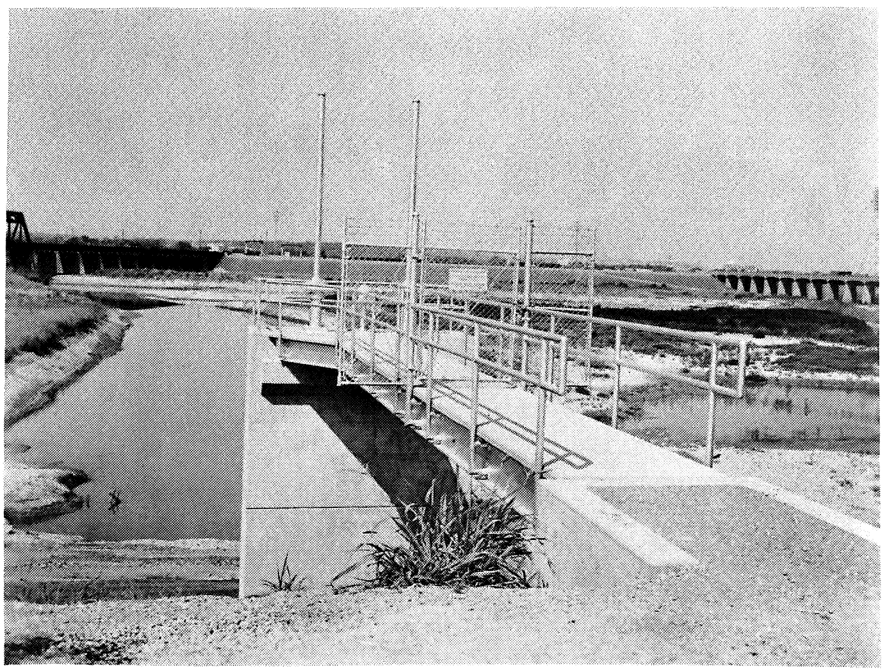


Channel Improvement, Looking Downstream
Towards Continental Street Bridge

5 May 1959



Pumping Plant D, Excavated Channel 12 September 1955



Belleview, Gate Structure 6 June 1958

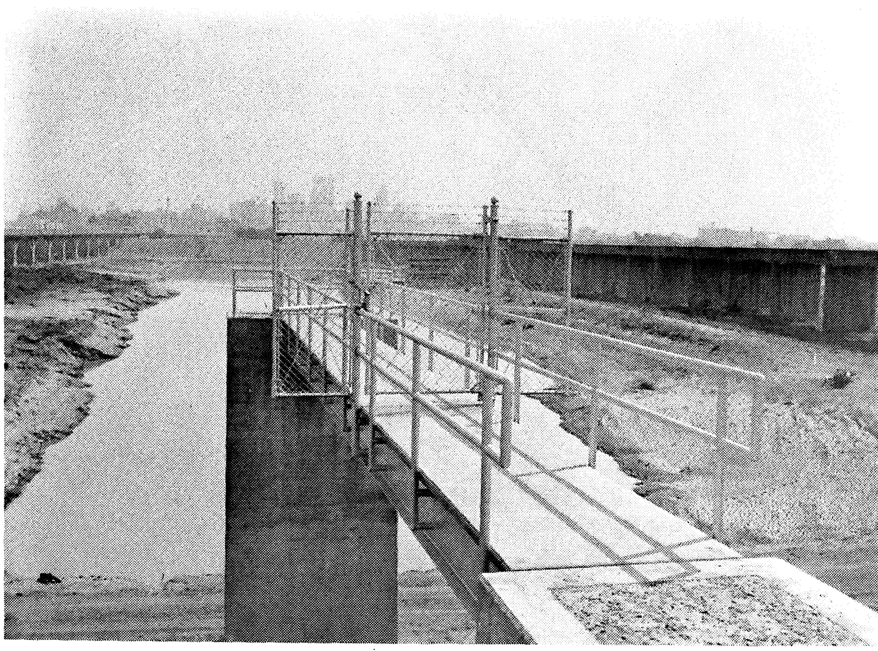
West Levee, Select Material Placed on Completed Embankment — 6 June 1958

West Levee and Ramp — 6 June 1958

West Levee, Looking Downstream Towards
Corinth Street

25 September 1958

Houston

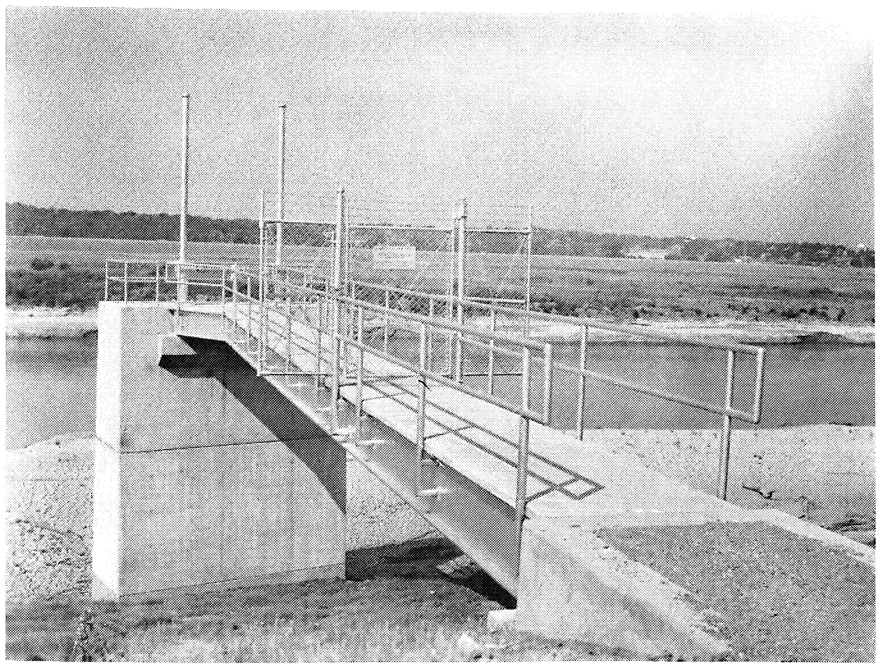


Oak Cliff
Viaduct

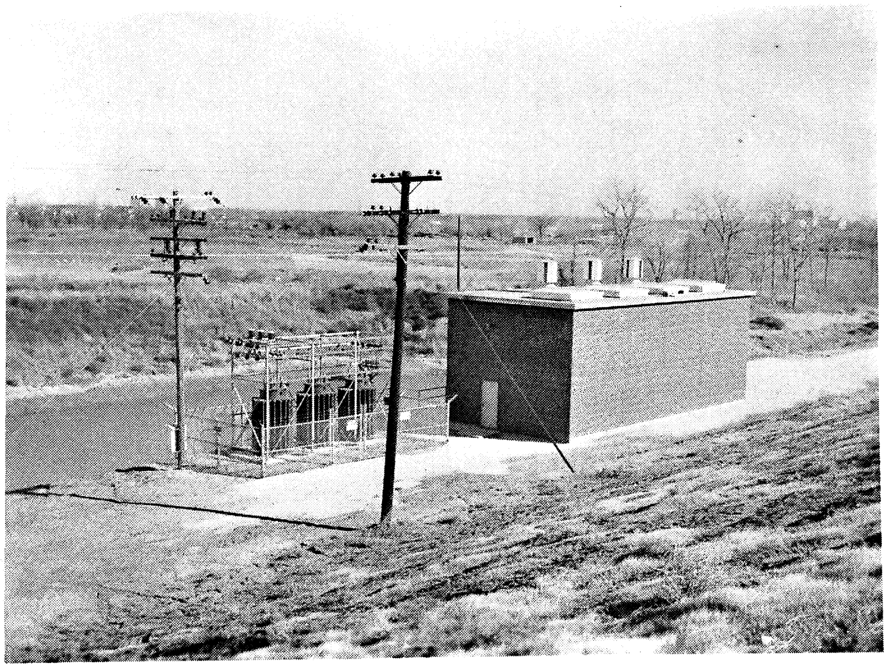
Pumping Plant C, Outlet Gate Structure

6 June 1958

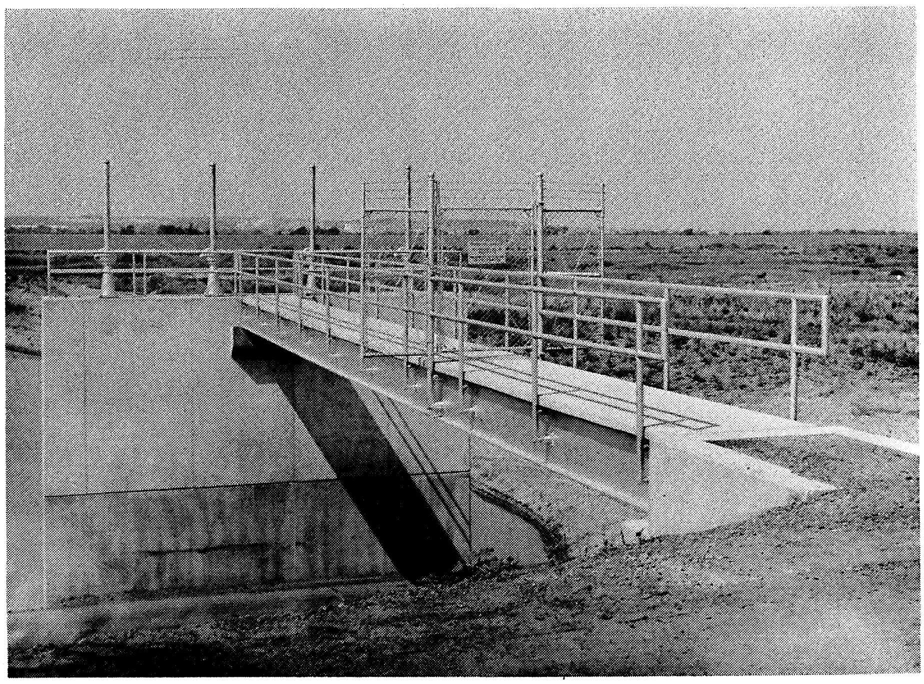
Elm Fork, Sluice 6 June 1958



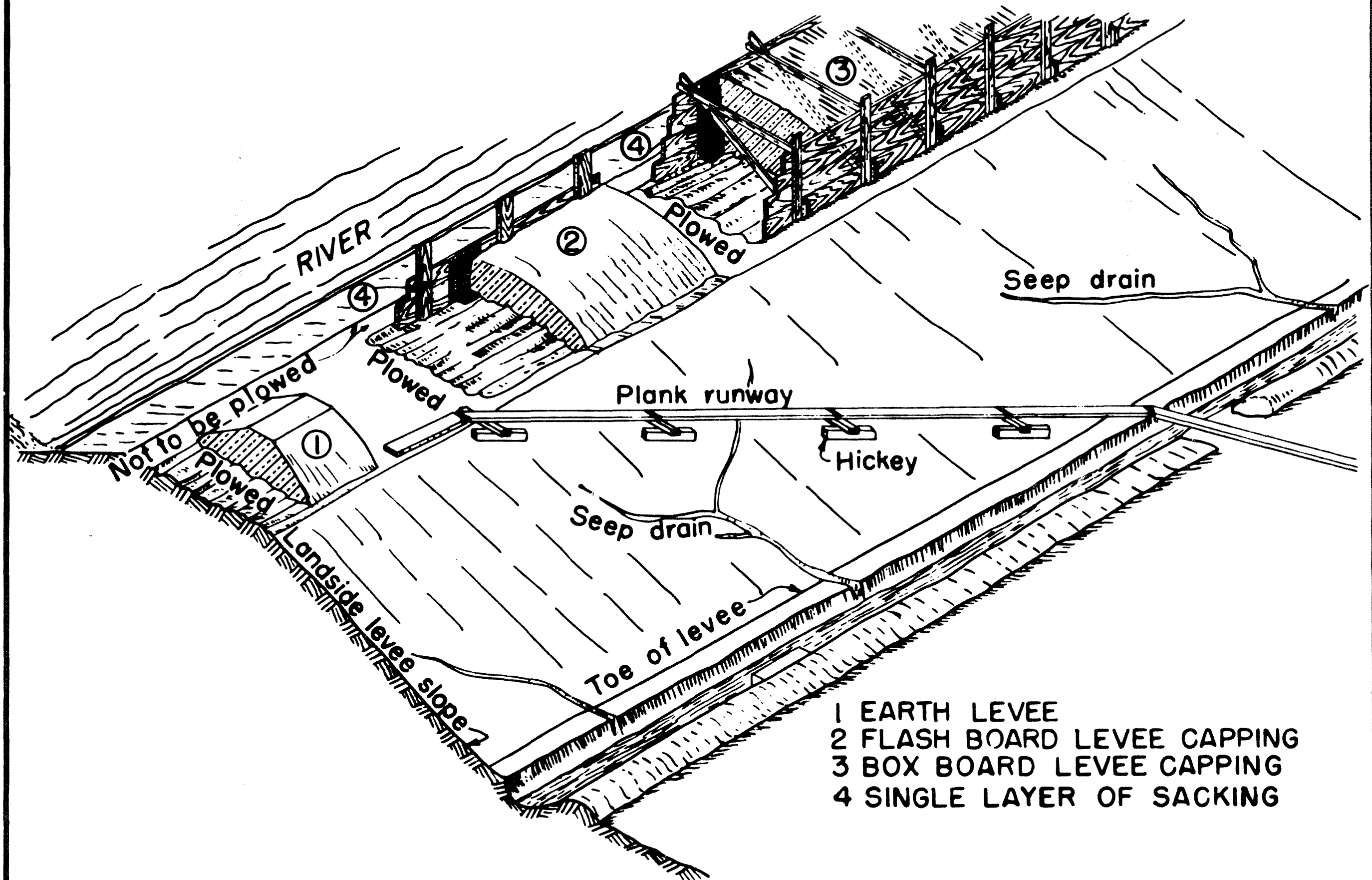
Dallas Branch, Gate Structure 6 June 1958



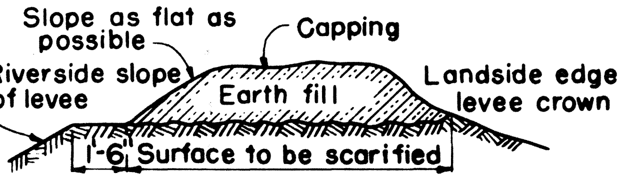
Hampton Pumping Station 18 December 1957



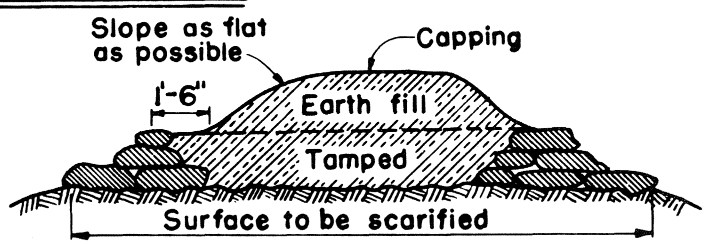
Pumping Plant B, Outlet Gate Structure 6 June 1958



TYPES OF LEVEE CAPPING



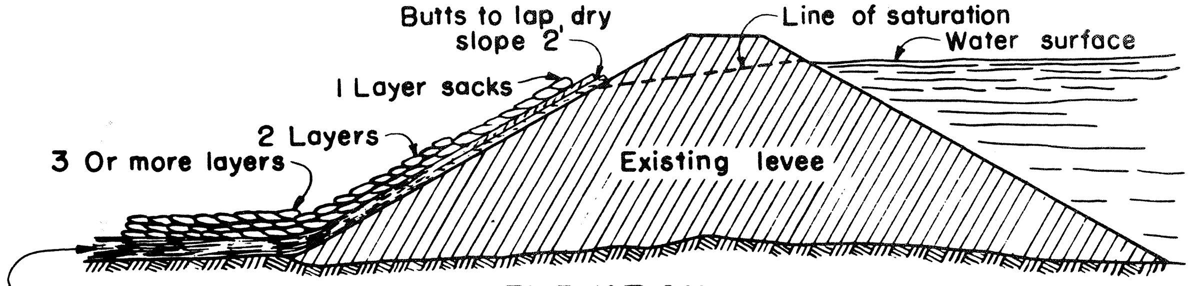
TYPICAL SECTION
LEVEE CAPPING



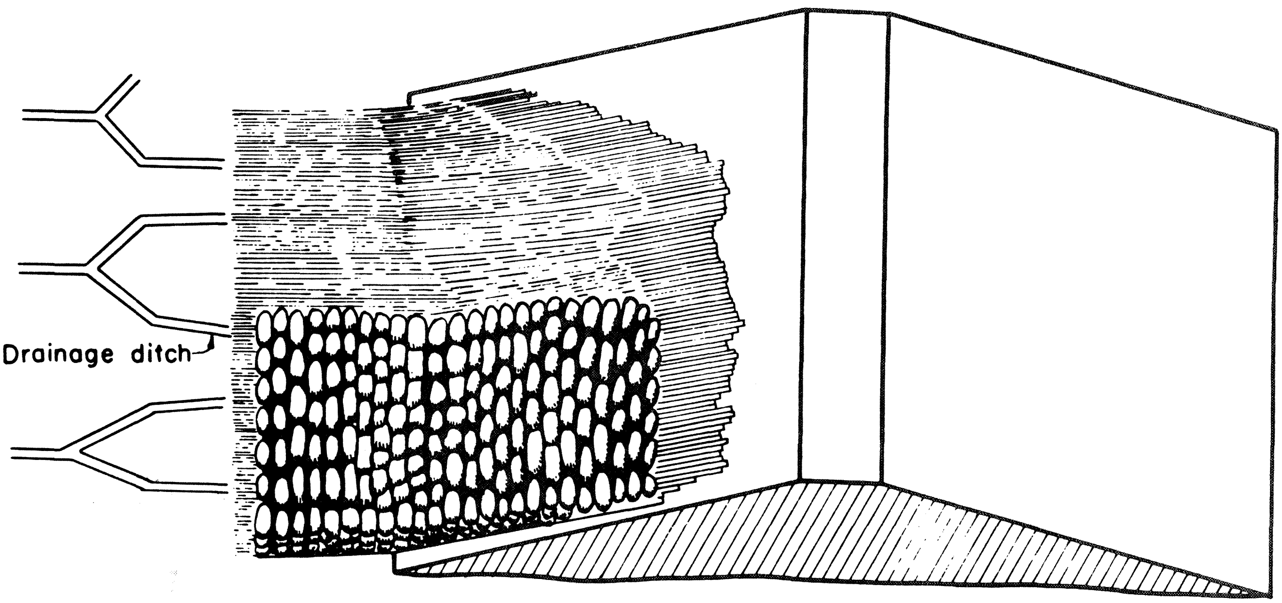
TYPICAL SECTION
AT RAMP OR OTHER DEPRESSION

EARTH CAPPING

INSTRUCTION
FOR
HIGH-WATER MAINTENANCE
EARTH & LEVEE CAPPING
CORPS OF ENGINEERS FORT WORTH, TEXAS
FILE: TRIN. 265-30 MAY 1960



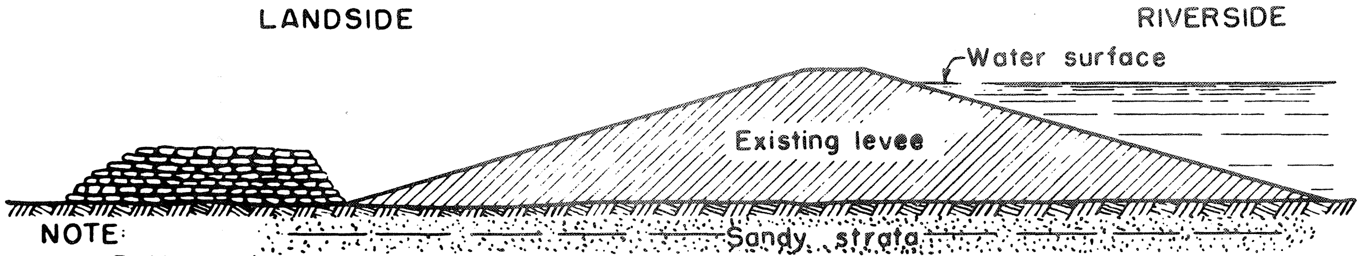
ELEVATION



PERSPECTIVE

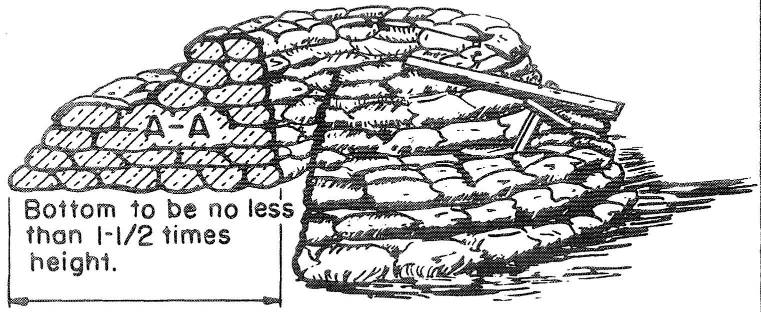
BRUSHING AND SACKING SLOUGHS

INSTRUCTION FOR HIGH-WATER MAINTENANCE BRUSHING AND SACKING
CORPS OF ENGINEERS FORT WORTH, TEXAS
FILE: TRIN. 265-30 MAY 1960

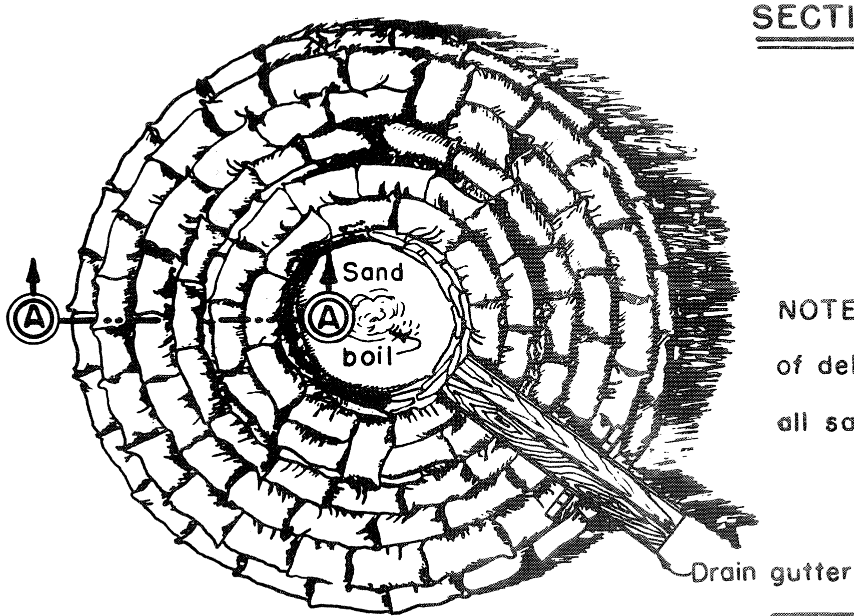


NOTE:
Bottom width to be no less than 1-1/2 times height.
Be sure to clear sand discharge.
Tie into levee if boil is near toe.

ELEVATION



SECTIONAL ELEVATION



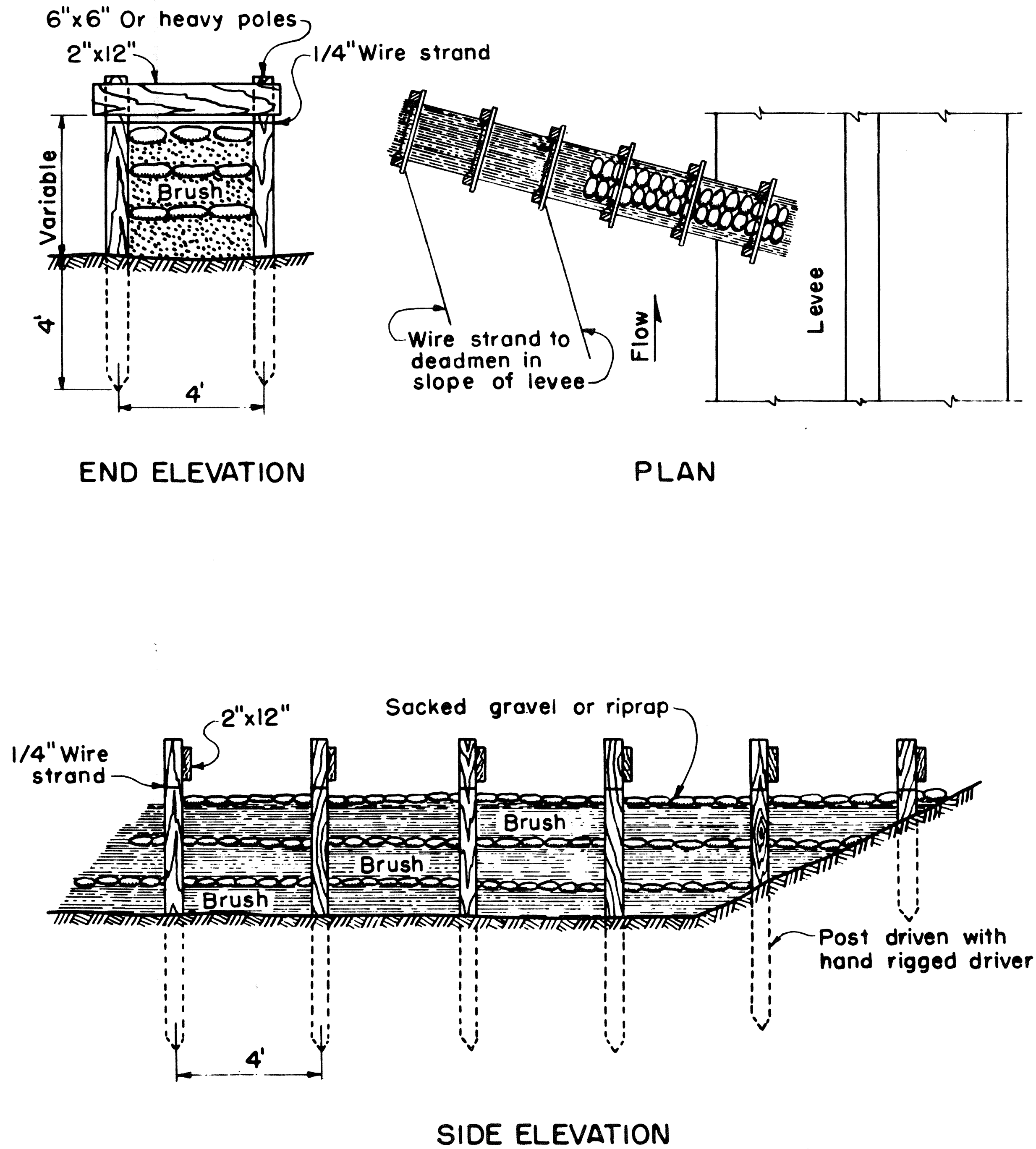
NOTE:
Entire base to be cleared of debris and scarified.
Loose earth to be used between all sacks.
All joints to be staggered.

PLAN

INSTRUCTION
FOR
HIGH-WATER MAINTENANCE
SAND BOILS

CORPS OF ENGINEERS FORT WORTH, TEXAS

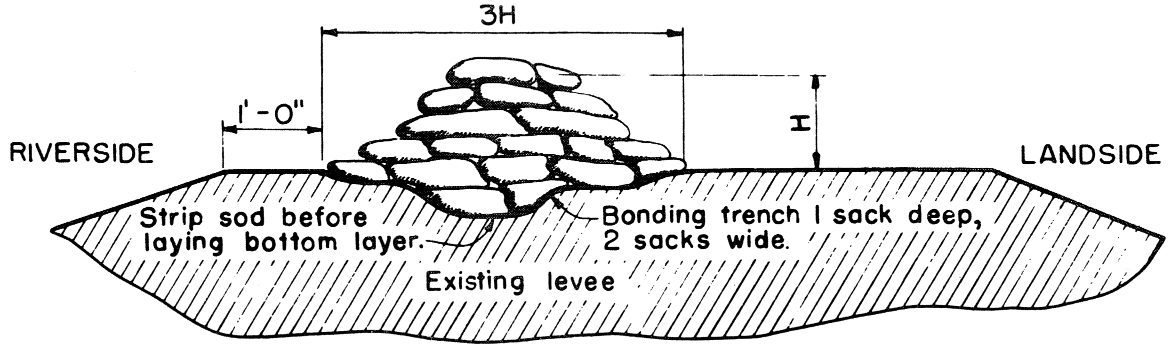
FILE: TRIN. 265-30 MAY 1960



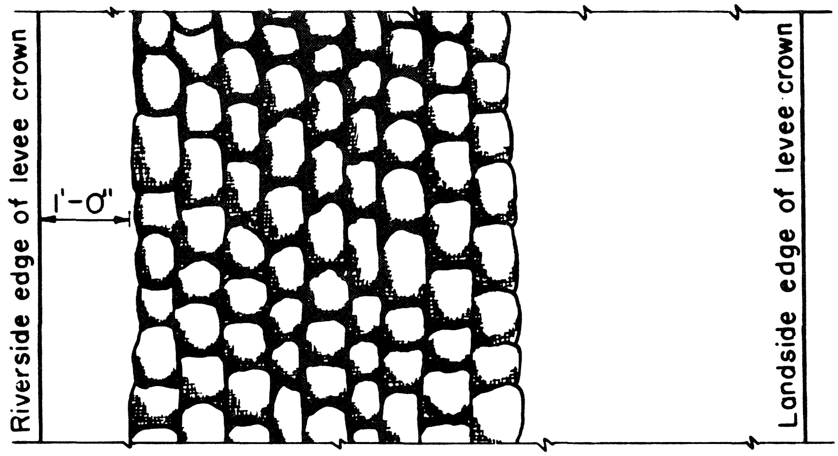
DEFLECTION DYKE

INSTRUCTION
FOR
HIGH-WATER MAINTENANCE
DEFLECTION DYKE
CORPS OF ENGINEERS FORT WORTH, TEXAS

FILE: TRIN. 265-30 MAY 1960



SECTION



PLAN OF BOTTOM LAYER

NOTE:

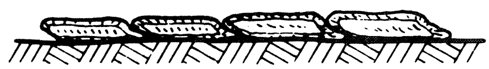
Alternate direction of sacks with bottom layer lengthwise of levee, next layer crosswise, etc.

Lap unfilled portion under next sack.

Tying or sewing sacks not necessary.

Tamp thoroughly in place.

Sacks should be approximately 1/2 full of clay, silt or sand.



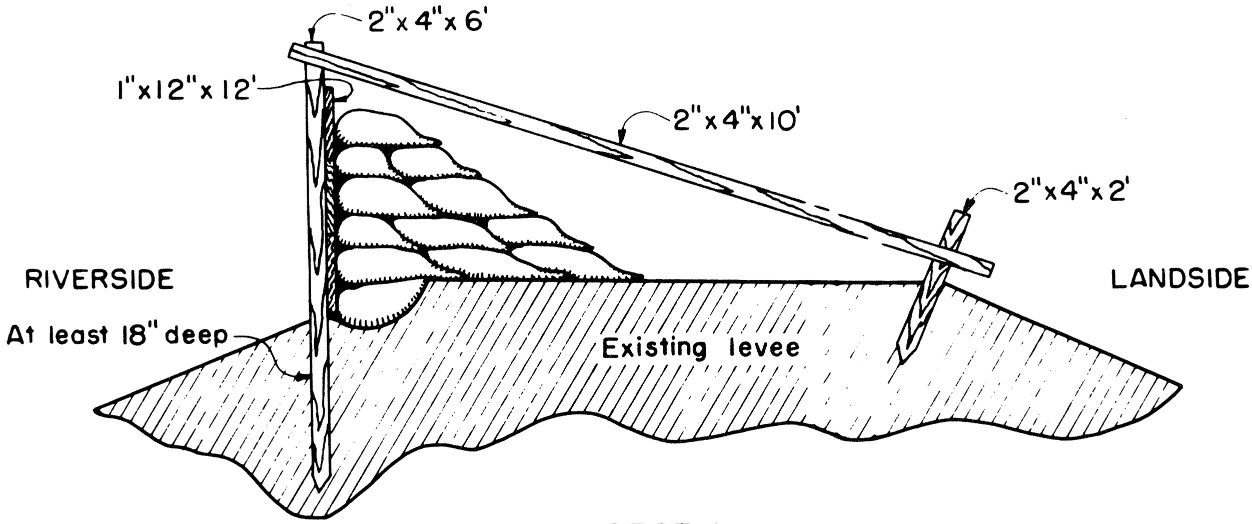
METHOD OF LAPPING SACKS

BAGS REQUIRED FOR 100 LINEAR FEET OF LEVEE	
HEIGHT ABOVE LEVEE	BAGS REQUIRED
1 FOOT	800
2 FEET	2,000
3 FEET	3,400

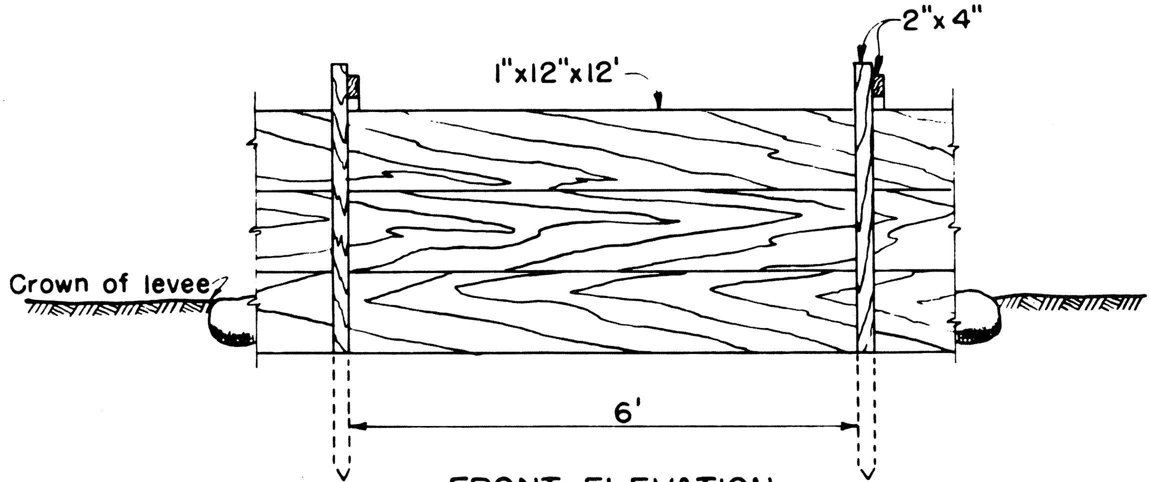
INSTRUCTION
FOR
HIGH-WATER MAINTENANCE
SACK TOPPING

CORPS OF ENGINEERS FORT WORTH, TEXAS

FILE: TRIN. 265-30 MAY 1960



SECTION



FRONT ELEVATION

LUMBER AND SACK TOPPING

INSTRUCTION
FOR
HIGH-WATER MAINTENANCE
LUMBER & SACK TOPPING
CORPS OF ENGINEERS FORT WORTH, TEXAS

FILE: TRIN. 265-30 MAY 1960

GAGES AND GAGE WELLS

PUMPING PLANT A

1. Automatic Water Stage Recorders.- Two automatic water stage recorders were installed in the new Plant "A" pump house to furnish continuous records of sump levels and stages in the Trinity River opposite Pumping Plant A. The sump gage is located near the right wall about 9 feet upstream from the right downstream corner of the new pump house and utilizes an 18-inch float well which is connected to the sump by two 3-inch pipe intakes. The river gage is located in the right upstream corner of the new pump house and utilizes an 18-inch float well which is connected to the river by a 3-inch pipe intake. The sump gage is known as Pumping Plant A at Dallas and the river gage is known as Trinity River at Pumping Plant A at Dallas.

2. Float Wells.

a. Both float wells are constructed of 18-inch O.D. welded steel pipe, are suspended from the operating floor by steel flanges bolted to the floor and are fastened to the intake wall with iron anchor straps. Both wells have funnel shaped swedges welded on the bottom with 3-inch holes centered at the bottom of the float wells. These holes are plugged with weighted self-centering cones. Chains, extending to the tops of the wells, are attached to the cones to permit their removal in order to clean out the wells.

b. The float well for the sump gage is connected to the sump by two 3-inch pipe intakes. Each intake is 51 feet long. The lower intake enters the well at elevation 378.0 and the upper intake at 380.0. Both intakes are provided with three way iron cocks at the right downstream corner of the new intake structure where the line from the flush tank enters the intake lines. The three way cocks are controlled by stems extending through the pump house floor. The flush tank is provided to permit flushing the float wells. A one-inch water line, equipped with a single seated tank float valve to maintain the desired level in the flush tank, supplies city water to the tank. The three-inch line from the flush tank to the two intake lines is controlled by a 3-inch butterfly valve located midway between the pump house floor and the flush tank. The inlets to both intakes are located in a recess on the face of the downstream wing wall of the intake structure and are provided with 3-inch bronze strainers. The lower and upper inlets are at elevation 377.0 and 379.0, respectively.

c. The float well for the river gage is connected to the river by a 3-inch pipe intake 286 feet long. This intake enters the float well at elevation 379.0 and is equipped with a 3-inch cock at the entrance to the well with stem extended to floor above. From the float well the intake extends upstream into the intake of the old pumping plant. From there it extends to the river attached to the inside of the old drainage structure or culvert. It is embedded in the wall of the culvert extension to the river. The inlet to the intake pipe is located in the outlet headwall downstream from the portal of the culvert extension with invert at elevation 375.72.

The intake is provided with a 3-inch bronze strainer. A cleanout is provided in the intake structure of the old pumping plant with additional cleanouts provided at 75-foot intervals in the pipe located in the old culvert from the old pumping plant to the extension of the culvert.

3. Staff Gages.- Staff gages are provided to check the automatic water stage recorders. These gages are located as follows:

Sump gage 375-396.7 - This gage is in three sections and is fastened to the downstream wall of the intake structure upstream from the trash rack. It consists of enameled metal sections and letters fastened to 2 x 12 timbers.

River gage 401-424 - Enameled metal sections and letters fastened to 2 x 12 timber near the downstream side of the landside face of the new control structure.

GAGES AND GAGE WELL

PUMPING PLANT PAVAHO

1. Automatic Water Stage Recorder.- One automatic water stage recorder was installed in the Pavaho Street pumping plant to furnish continuous records of river stage opposite the plant. This gage is known as Trinity River at Pavaho Street Plant at Dallas.

2. The float well is constructed of 18-inch O.D. steel pipe and is located in the right upstream corner of the Pavaho Street Pumping Plant. The float well is suspended from the floor by a steel flange bolted to the floor and is connected to the river by a 3-inch pipe intake. This intake is about 380 feet long and enters the well at elevation 384.25 feet MSL. It is equipped with a plug valve at entrance to well and a strainer at invert. This intake is built into the concrete wall of the pumping plant and into the downstream wall of the outlet structure. The inlet is in the downstream wing wall of the outlet structure and center line is at elevation 382.25 feet MSL. The float well has a funnel shaped swedge welded to the bottom of it with a 3-inch hole in the center of the swedge. A weighted self-centering cone fits in the funnel shaped bottom and closes the 3-inch hole. A bronze chain is attached to the cone and extends out the top of the gage well.

3. The automatic waterstage recorder may also be used to obtain a continuous record of sump stages. To use for this purpose the plug cock can be turned to closed position and the weighted self-centering cone removed from the bottom of the gage well.

4. Tile Staff Gage.- Elevation 383-410. One section of tile gage, block, tile numbers on white tile background has been provided. This gage is set in the upstream face of the center wall of the intake structure just outside of the trash racks.

SHOP DRAWINGS

(The Shop Drawings listed below were furnished the Dallas County Flood Control District in May 1960.)

1. PUMPING PLANT A.

a. Peerless Pump Division, Los Angeles, California.

Drawing No.	Title
2708025	Pump Assembly, 48" PH
2703685	Oil Assembly
2707851	Hydrofoil Pump
2702950	Mixed Flow Pump
No. 59	Instruction Pamphlet

b. General Electric Co., Schenectady, N.Y.

163B595	Motor Outline
154D780	Assembly
GE11 - 1145E	Instruction Pamphlet - Induction

c. R & M Hoist & Crane, Springfield, Ohio.

609-119	8-Ton Hoist
4185	Repair parts

d. Armco Inc., Denver, Colorado.

2-1979	48" x 48", Model 50-10 Gate

e. Multiplex Co., Berwick, Pennsylvania.

308	Airvalve

f. Westinghouse Electric Corp., Houston, Texas.

81153	Panelboard

g. Westinghouse Electric Corp., Sharon, Pennsylvania.

36-300	HV Power Fuses
30-930	Circuit Breaker Panelboards
44-600	Dist. Transformers

h. Delaney Co., Houston, Texas.

20864	Discharge Piping

i. Burndy Engr. Co., New York, N.Y.

Drawing No.	Title
SD 15789	Ground Clamp

j. Dallas Power and Light Co., Dallas, Texas.

B-12379	Substation

k. Nelson Elec. Mfg., Tulsa, Oklahoma.

HD-1000 R-4	Assembly HV Switchgear
112	Operating Instructions, HV Switchgear
HK-74	Wiring Diagram

l. National Screw & Mfg. Co., Lisbon, Ohio.

H 552	Pamphlet Chester Hoist

m. Leopold & Stevens, Portland Oregon.

Bulletin 18	Electric Gages
Bulletin 12	Water Level Recorders

n. Frank T. Harris, Lodi California.

Pamphlet	Siphon Breaker

o. U. S. Rubber Co., Dallas, Texas.

822-S	RR Underground Cable

2. PAVAHO PUMP STATION.

a. Conflo Engr. & Mfg Co., Houston, Texas.

295	72" x 96" Model F

b. Armco Co., Denver, Colorado.

A-9071	96" Flap Gate

c. Economy Pump Inc., Hamilton, Ohio.

AC-4270	Grease Line Installation
AC-4430	Compressor, etc.
AC-4710	Assembly for Safv Pump
AC-5629	External Grease Line
AC-5663	Outline 26 x 36 Safv Pump
	Diagrammatic Details for Circuits Nos. C2, C3, and C4

d. Ideal Electric Co., Mansfield, Ohio.

Drawing No.	Title
2500-37	Dimension of Vertical Sq. Cage Motors

e. Cyclone Fence Division, Dallas, Texas.

WDX-340-A1	Safeguard Fence

f. Belco Co., New Haven, Conn.

Three Pamphlets	Metal Details

g. Westinghouse Electric Corp., Sharon, Pennsylvania.

Bulletin 30-930	Circuit Breakers
Bulletin 38-140	Lighting Arresters
Bulletin 46-100-S	Transformers
Pamphlet	Transformers
Pamphlet	Switchgear
68855	Wiring Diagram
63974	Type E Transformer
HV-4A887	Low Voltage Meter
36-A-1666	DX Fuse Cutout
HU-7c016-1	Panelboard
Hu-4B342	Wiring Diagram
54-C-1182	Distribution Transformer
25-D-6453	Type E Enclosed Transformer
26-D-9601	Type LV Auto Valve

h. The Farval Corporation, Cleveland, Ohio.

Pamphlet	Lubrication System

i. Philadelphia Gear Works, Philadelphia, Pennsylvania.

Manual

j. Brown and Brown, Lima, Ohio.

90-S-1649A	Flap Gates
90-S-1427A	Gate Frame 36"
90-S-1315B	Gate Shutter 36"
90-S01648	Hinge Link 36"
90-S-1647	Hinge Pins
90-S-1616A	Hinge Post
90-S-1748	Gate Lock Nuts

3. Hampton Road Pumping Station.

a. Economy Pumps, Inc., Hamilton, Ohio.

Drawing No.	Title
AC-4270	Grease Line Installation
AC-5629	Grease Line Installation
AC-6001	Outline Dimensions

b. The Ideal Electric & Manufacturing Co., Mansfield, Ohio.

19077	Outline Drawing

c. Valve and Primer Corp., Chicago, Ill.

S-1118	Negative Pressure Valve

d. Nelson Electric Manufacturing Co., Tulsa, Oklahoma.

Pamphlet	Operating Instructions
DB-96	Wiring Diagram
HD-1377-RI	Assembly HV Switchgear
HD-1377-RO	Assembly HV Switchgear
HK-331 R1	Wiring Diagram, HV Switchgear
GC-240 Ro	Assembly - Battery Charger & Battery

e. Hall-Allen Electric Co., Dallas, Texas.

Pamphlet 36-300	Switchgear (Westinghouse)

f. Electrical Service Co., Greenville, Texas.

936	Transformer Outline

g. Southern Marble & Tile, Dallas, Texas.

	Staff Gage Tile

h. Briggs-Weaver Machinery Company., P.O. Box 9098, Ft. Worth, Texas.

BWD-856	Beam, Rail & End Stop Details 8-Ton Crane

i. Atlas Roofing & Supply Co., Dallas, Texas.

	Ventilators

4. LAKE CLIFF PRESSURE CONDUIT.

a. Gifford - Hill - American, Inc., Dallas, Texas.

Drawing No.	Title
4-1374-1	Pipe Section and Design

b. Morse Bros. Machinery Company, Perkul Gate Div, Denver, Colorado.

G-327-2	18" Sluice Gate
G-388	24" Sluice Gate
G-403-2	Stem and Coupling Details
G-563-4	Stem Guide
G-585-2	Stem and Guide Schedule
G-1015	Model 8-A Enclosed Lift
G-1043-2	Indicator
G-1135	Gear Ratio - 4:1
G-1138-2	Indicator Assembly
G-1138-2A	Indicator Assembly
G-1139-4	Stem Cover

c. Rodney Hunt Machine Co., Orange, Mass.

C-2456	72" x 96" Sluice Gate
C-2472	72" x 96" Sluice Gate
C-2473	72" x 96" Sluice Gate
D-3683	72" x 96" Sluice Gate
D-3686	S-5160A Floorstand
E-2366A	Stem Guide Range
E-2994-D	Section
E-3030	Anchor Bolt List
E-3565	Pipe Cover Indicator
D-3683	72" x 96" Sluice Gate

5. TURTLE CREEK PRESSURE CONDUIT.

a. Rodney Hunt Machine Co., Orange, Mass.

	Operations Manual
C-2149	96" x 120" Sluice Gate
C-2151	96" x 120" Sluice Gate
C-2248	Portable Hoist
D-2939	Floorstand
D-3087	Stem Guide
D-3097	Hoist

6. COOMBS CREEK DIVERSION FACILITIES.

a. Rodney Hunt Machine Co., Orange, Mass.

F-4611	Stem Design

Rodney Hunt Machine Co., Orange, Mass. (Cont'd)

Drawing No.	Title
E-2095	Type S5054A Hoist
C-2712	72" Sluice Gate
E-2366-A	Stem Guide
2-3388	96" Diameter Flapgate
C-2696	96" x 120" Sluice Gate
C-2695	Installation 96" x 120"

7. MISCELLANEOUS STRUCTURES.

a. Rodney Hunt Machine Co., Orange, Mass.

C-3102	Assembly Interconnected Hoists (Belleview)
C-3107	"
C-3105	Installation - 60" Sluice Gate
C-3108	Install Interconnected Hoists
C-3111	Installation - 72" x 48" Sluice Gate
C-3113	Install 72" Sluice Gate
C-3115	Install 36" Sluice Gate
C-3119	Install 48" x 48" Sluice Gate
C-3206	Assembly 72" Flap Valve
D-4473	Assembly Sluice Gate - 60"
D-5229	Assembly - 72" x 48" Sluice Gate
D-5242	Assembly 72" Sluice Gate
D-5268	Assembly Sluice Gate 48" x 48"
D-5265	Assembly 36" Sluice Gate
D-5226	Installation - Hoist & Stem for Gate Valve 36"
D-5394	Install 72" Flap Valve
E-2092	Type S-5012 A Hoist
E-2095	Type S-5054A Hoist
E-2348	Stem Guide
E-2366A	Assembly Stem Guide
E-2366B	Assembly Stem Guide
E-2413	Type S-5020A Hoist
E-3131-A	Pipe Cover
E-3207-C	Torque Plate
F-4148	Assembly Guides
F-5005	Stem Design

b. Armco Drainage & Metal Products, Inc., Hardesty Div., Denver, Colo.

Drawing No.	Title
2-2992	48" x 48" Sluice Gate

c. Iowa Valve Company, Oskaloosa, Iowa.

3623	36" Std O.S. & Y. Gate Valve
3627-F-S	Sliding Stem

Dallas Floodway during the 1990 flood (City of Dallas)

Appendix D

1929 Construction Drawings

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STATE OF TEXAS

CITY AND COUNTY OF DALLAS LEVEE IMPROVEMENT DISTRICT

AND

DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

DETAILED PLANS

FOR

FLOOD PROTECTION WORKS

SUPPLEMENTARY TO THE

PLAN OF RECLAMATION

DISTRICT ENGINEER
MYERS, NOYES & FORREST

CONSULTING ENGINEER
MORGAN ENGINEERING CO.

JULY 1, 1929

Approved:
MYERS, NOYES & FORREST
By [illegible]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer
Approved: Ned H. Sayford
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF

DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

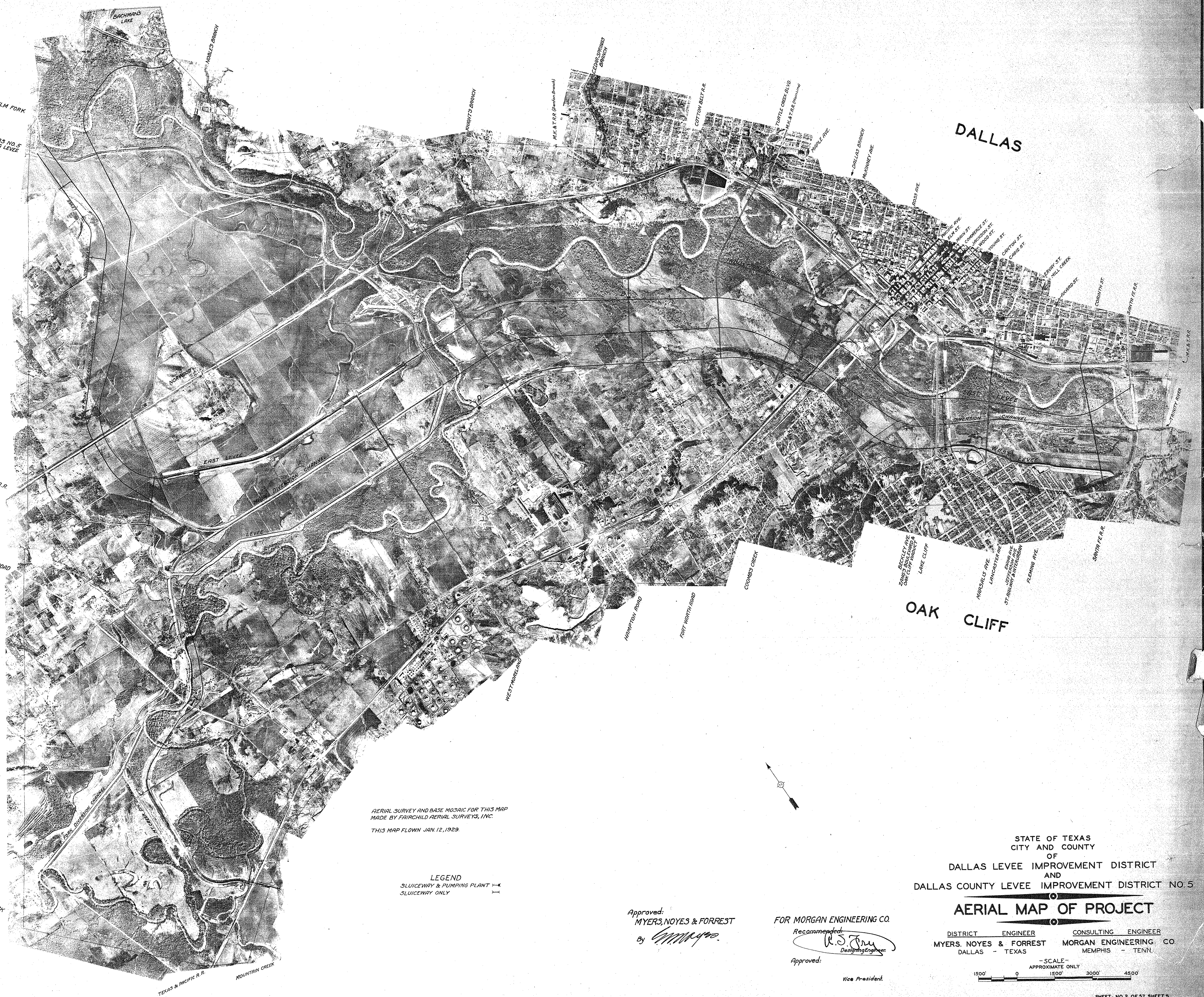
INDEX TO PLANS

—JULY 1, 1929—

Approved:
MYERS, NOYES & FORREST
By M. Noyes.

FOR MORGAN ENGINEERING CO.
Recommended: R. S. Fry
Designing Engineer
Approved: Ned H. Buford
Vice President

SHEET NO. 1 OF 57 SHEETS



AERIAL SURVEY AND BASE MOSAIC FOR THIS MAP
MADE BY FAIRCHILD AERIAL SURVEYS, INC.

THIS MAP FLOWN JAN. 12, 1929.

LEGEND
SLUICEWAY & PUMPING PLANT
SLUICEWAY ONLY

Approved:
MYERS, NOYES & FORREST
By G.M. Myers

FOR MORGAN ENGINEERING CO.
Recommended:
R. S. Fry
Designing Engineer.
Approved:

Vice President.

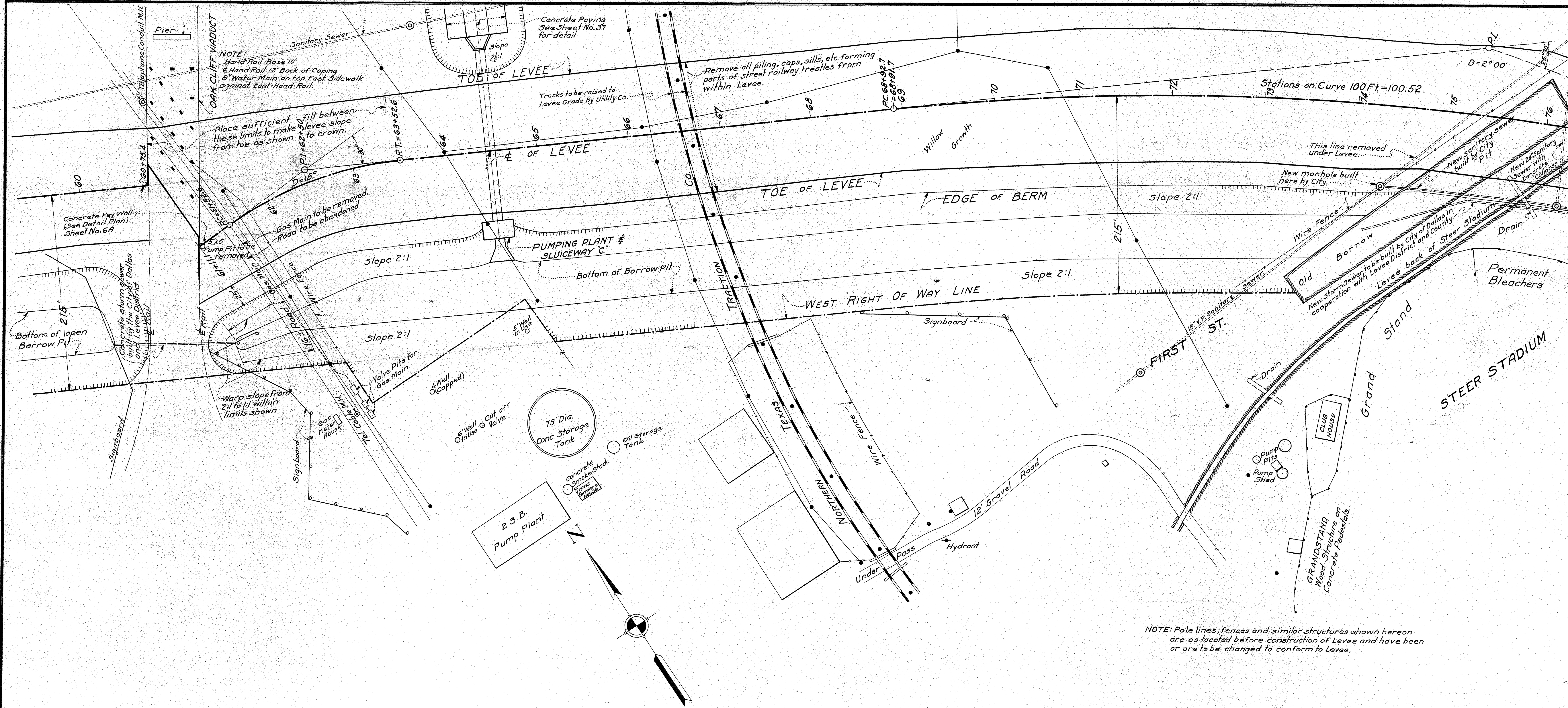
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

AERIAL MAP OF PROJECT

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS. NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

-SCALE-
APPROXIMATE ONLY
1500' 0 1500' 3000' 4500'

SHEET NO. 2 OF 57 SHEETS



-LEGEND-

- POLE LINE
- POWER LINE
- TOWER-POWER LINE
- MANHOLE-EXISTING
- MANHOLE-TO BE CONSTRUCTED
- UNDERGROUND SEWER-EXISTING
- UNDERGROUND SEWER-TO BE INSTALLED
- GAS PIPE
- WATER PIPE
- HYDRANT
- FENCE-WIRE
- FENCE-BOARD
- CENTER LINE OF LEVEE
- TOE OF LEVEE
- EDGE OF BERM
- RIGHT OF WAY LINE
- STREET CAR & INTERURBAN LINE
- RAILROAD
- SWITCH STAND
- BUILDINGS - FRAME 1 STORY (1F)
- BUILDINGS - FRAME 2 STORY (2F)
- BUILDINGS - BRICK 1 STORY (1B)

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE-SECTION NO. 1

~OAK CLIFF DIVISION~

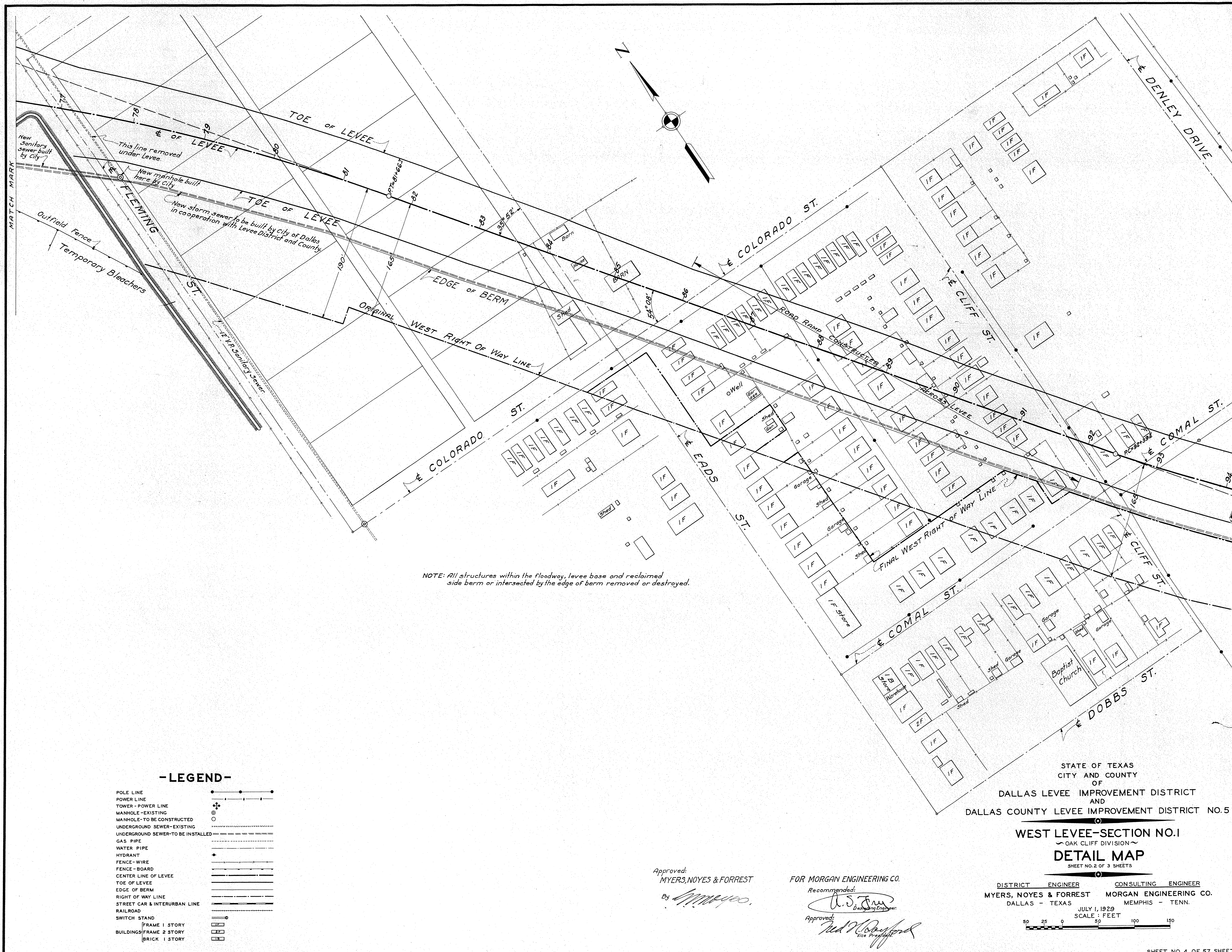
DETAIL MAP

SHEET NO 1 OF 3 SHEETS

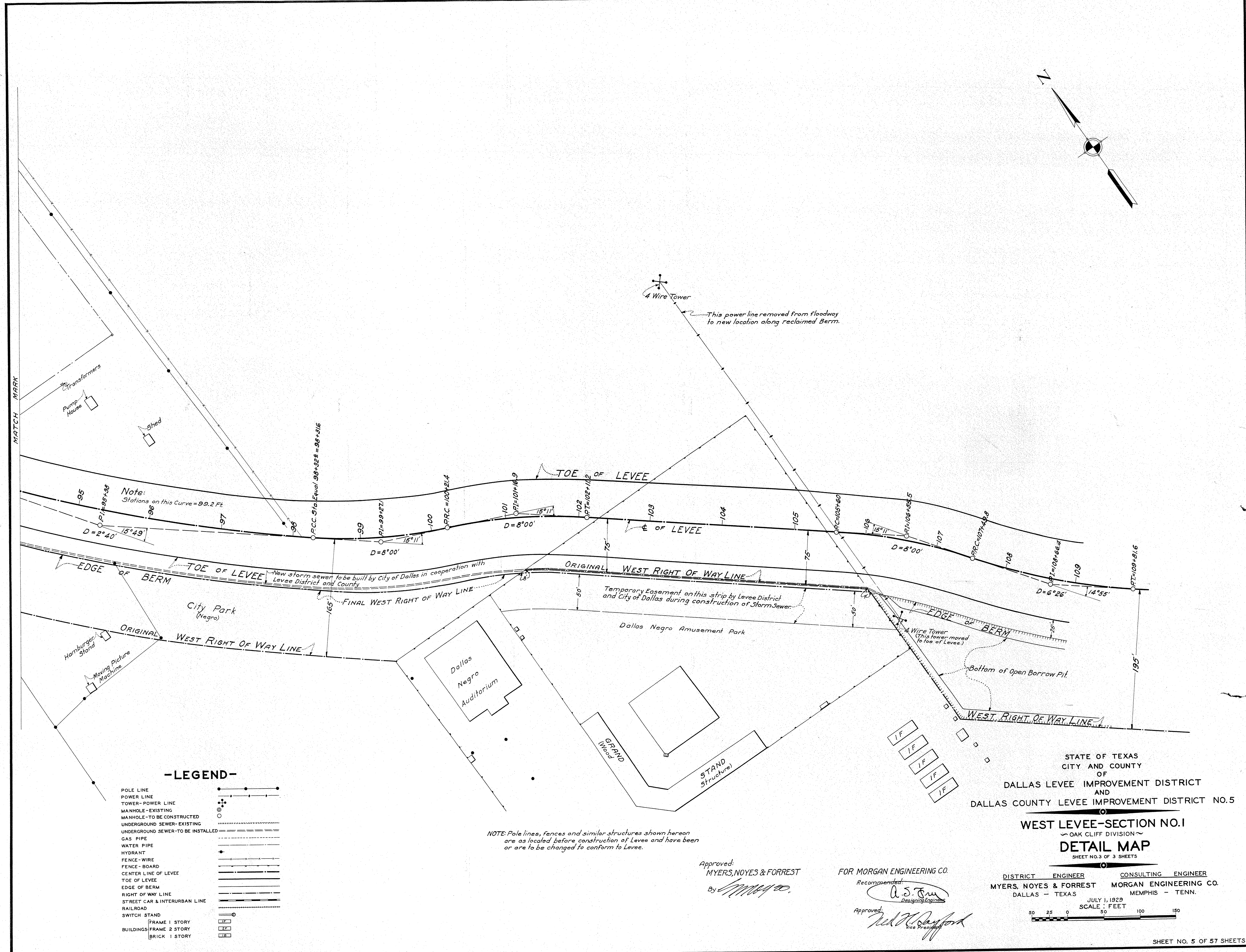
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

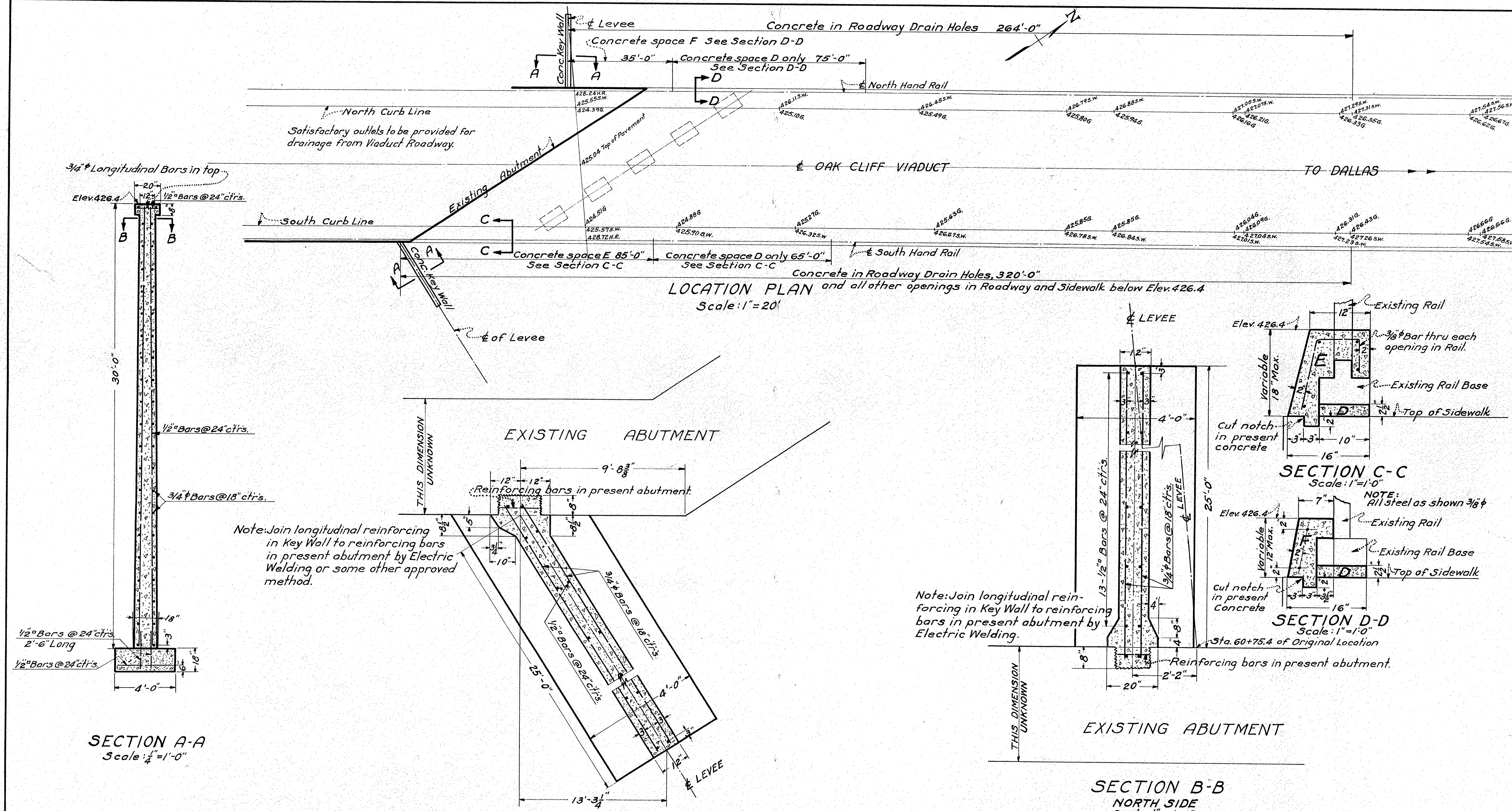
JULY 1, 1929
SCALE: FEET
50 25 0 50 100 150

W.E.G. Sept. 1928



MATCH MARK
TOE OF LEVEE
℄ OF LEVEE
New Sanitary sewer built by City
This line removed under Levee
New manhole built here by City
New storm sewer to be built by City of Dallas in cooperation with Levee District and County
℄ FLEMING ST.
Outfield Fence
Temporary Bleachers
12" V.P. Sanitary Sewer
EDGE OF BERM
ORIGINAL WEST RIGHT OF WAY LINE
℄ COLORADO ST.
℄ EADS ST.
℄ CLIFF ST.
℄ COMAL ST.
℄ DOBBS ST.
℄ DENLEY DRIVE
ROAD RAMP CONSTRUCTED ACROSS LEVEE
FINAL WEST RIGHT OF WAY LINE
Barn
Shed
Well
Garage
1F Store
Baptist Church
1B Store
Warehouse
2F
NOTE: All structures within the floodway, levee base and reclaimed side berm or intersected by the edge of berm removed or destroyed.
-LEGEND-
POLE LINE
POWER LINE
TOWER-POWER LINE
MANHOLE-EXISTING
MANHOLE-TO BE CONSTRUCTED
UNDERGROUND SEWER-EXISTING
UNDERGROUND SEWER-TO BE INSTALLED
GAS PIPE
WATER PIPE
HYDRANT
FENCE-WIRE
FENCE-BOARD
CENTER LINE OF LEVEE
TOE OF LEVEE
EDGE OF BERM
RIGHT OF WAY LINE
STREET CAR & INTERURBAN LINE
RAILROAD
SWITCH STAND
BUILDINGS FRAME 1 STORY
FRAME 2 STORY
BRICK 1 STORY
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
WEST LEVEE-SECTION NO. 1
OAK CLIFF DIVISION
DETAIL MAP
SHEET NO. 2 OF 3 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: FEET
50 25 0 50 100 150
SHEET NO. 4 OF 57 SHEETS
H.E.G. Sept. 1928


STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
WEST LEVEE-SECTION NO. I
OAK CLIFF DIVISION
DETAIL MAP
SHEET NO. 3 OF 3 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE : FEET
50 25 0 50 100 150
SHEET NO. 5 OF 57 SHEETS
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President
NOTE: Pole lines, fences and similar structures shown hereon are as located before construction of Levee and have been or are to be changed to conform to Levee.
-LEGEND-
POLE LINE
POWER LINE
TOWER-POWER LINE
MANHOLE-EXISTING
MANHOLE-TO BE CONSTRUCTED
UNDERGROUND SEWER-EXISTING
UNDERGROUND SEWER-TO BE INSTALLED
GAS PIPE
WATER PIPE
HYDRANT
FENCE-WIRE
FENCE-BOARD
CENTER LINE OF LEVEE
TOE OF LEVEE
EDGE OF BERM
RIGHT OF WAY LINE
STREET CAR & INTERURBAN LINE
RAILROAD
SWITCH STAND
BUILDINGS FRAME 1 STORY
FRAME 2 STORY
BRICK 1 STORY
MATCH MARK
Transformers
Pump House
Shed
Note: Stations on this Curve = 99.2 Ft.
P.C.C. Sta. Equal 98+32.9 = 98+31.6
TOE OF LEVEE
℄ OF LEVEE
EDGE OF BERM
TOE OF LEVEE
New storm sewer to be built by City of Dallas in cooperation with Levee District and County
FINAL WEST RIGHT OF WAY LINE
ORIGINAL WEST RIGHT OF WAY LINE
Temporary Easement on this strip by Levee District and City of Dallas during construction of Storm Sewer.
City Park (Negro)
Hamburger Stand
Moving Picture Machine
Dallas Negro Auditorium
Dallas Negro Amusement Park
GRAND (Wood
STAND Structure)
4 Wire Tower
This power line removed from floodway to new location along reclaimed Berm.
4 Wire Tower (This tower moved to toe of Levee.)
Bottom of Open Borrow Pit.
WEST RIGHT OF WAY LINE
D = 2°40'
D = 8°00'
D = 6°26'
15°49'
15°11'
14°55'
N



NOTE: Levee embankment shall be constructed around each concrete key wall by an approved method which will not damage the key walls and shall be placed in a manner to secure a compact, water-tight fill. The embankment material shall be deposited in layers and each layer shall be thoroughly consolidated by tamping.
The fill shall be maintained on both sides of the key wall at practically the same elevation.

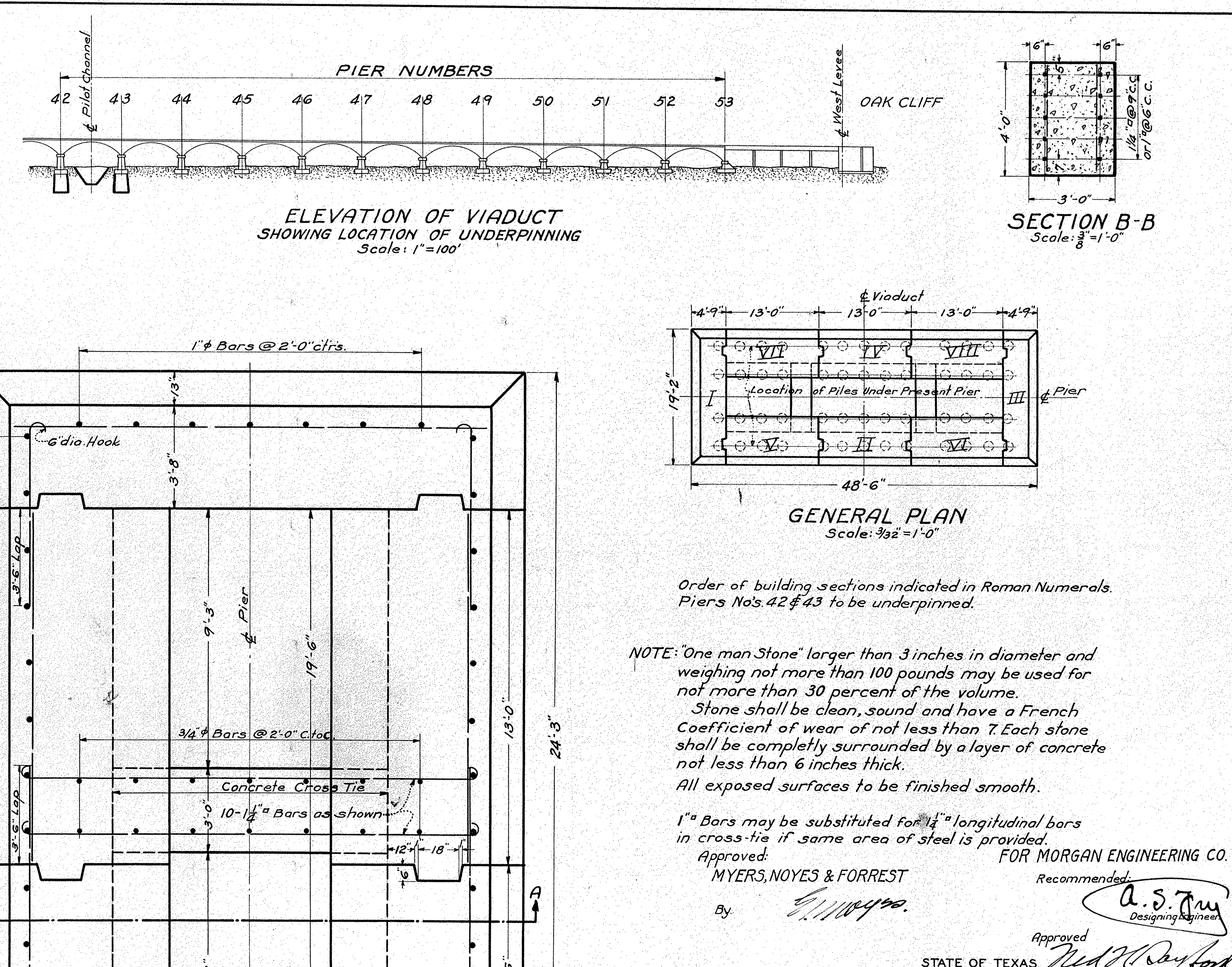
Approved:
MYERS, NOYES & FORREST
By [signature]

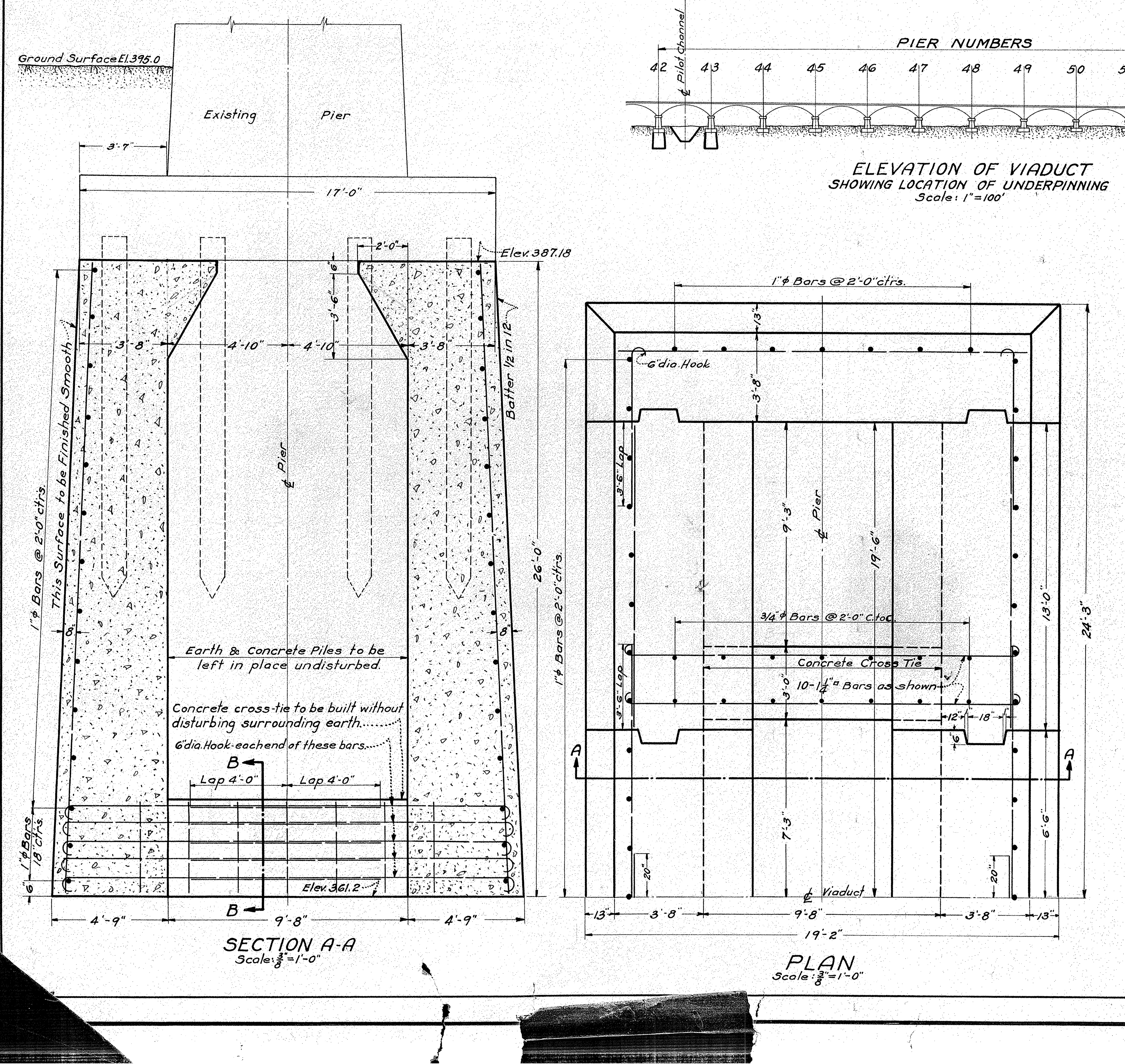
FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry, Designing Engineer.
Approved: Ned H. Rayford, Vice President.

STATE OF TEXAS
CITY AND COUNTY OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE SECTION NO. 1
OAK CLIFF DIVISION
LEVEE CONNECTION TO OAK CLIFF VIADUCT

DISTRICT ENGINEER: MYERS, NOYES & FORREST, DALLAS - TEXAS
CONSULTING ENGINEER: MORGAN ENGINEERING CO., MEMPHIS - TENN.
JULY 1, 1929
SHEET NO. 6-A OF 57 SHEETS





Order of building sections indicated in Roman Numerals.
Piers No's. 42 & 43 to be underpinned.

NOTE: "One man Stone" larger than 3 inches in diameter and weighing not more than 100 pounds may be used for not more than 30 percent of the volume.
Stone shall be clean, sound and have a French Coefficient of wear of not less than 7. Each stone shall be completly surrounded by a layer of concrete not less than 6 inches thick.
All exposed surfaces to be finished smooth.

1" Bars may be substituted for 1¼" longitudinal bars in cross-tie if same area of steel is provided.

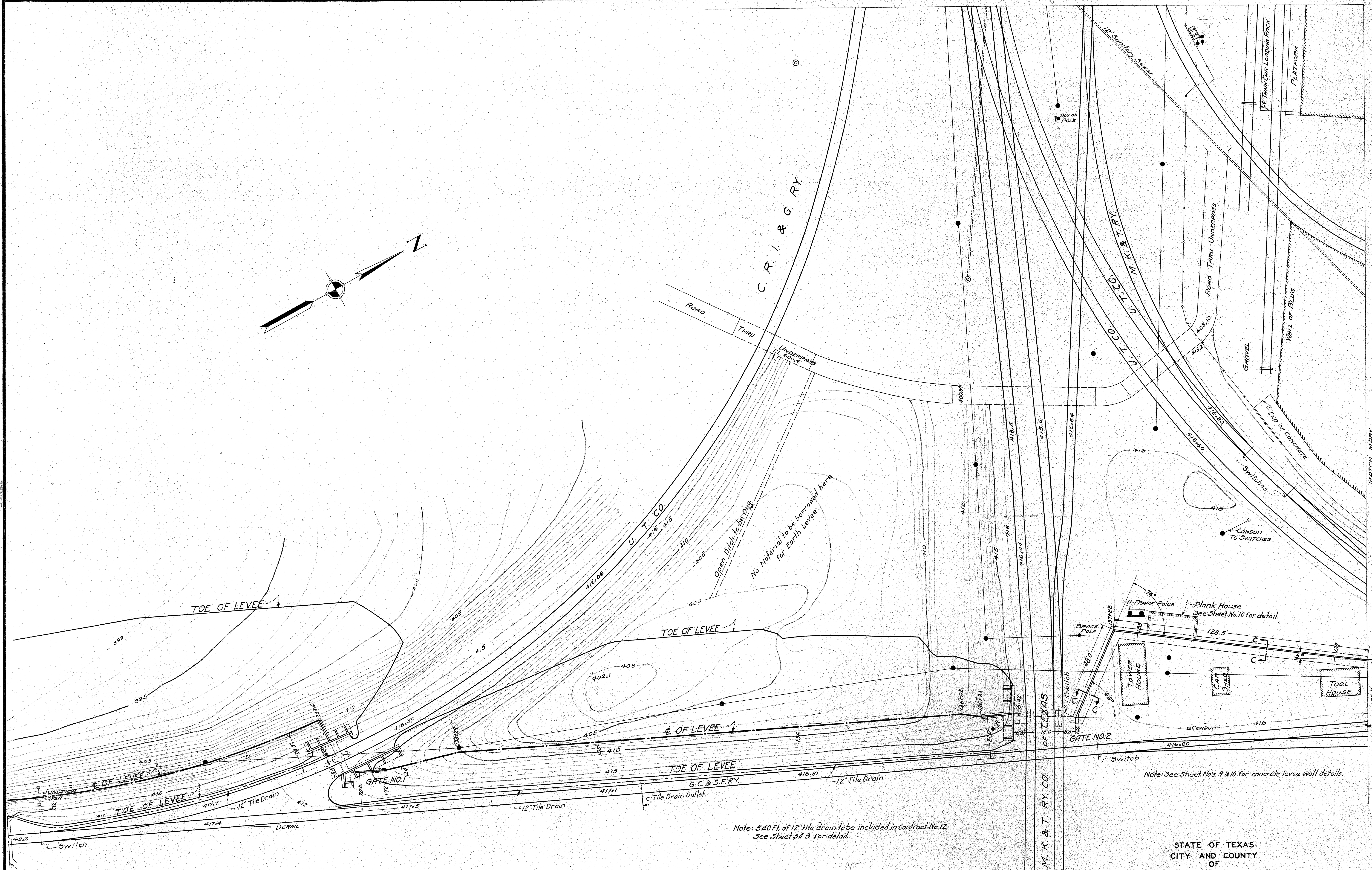
Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry, Designing Engineer.
Approved: Ned H. Rayford, Vice President.

STATE OF TEXAS
CITY AND COUNTY OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

OAK CLIFF VIADUCT UNDERPINNING

DISTRICT ENGINEER: MYERS, NOYES & FORREST, DALLAS - TEXAS
CONSULTING ENGINEER: MORGAN ENGINEERING CO., MEMPHIS - TENN.
JULY 1, 1929
SHEET NO. 6-B OF 57 SHEETS



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE—SECTION NO. 1

~CADIZ ST. DIVISION~

DETAIL MAP NEAR SANTA FE R. R.

SHEET NO. 1 OF 2 SHEETS

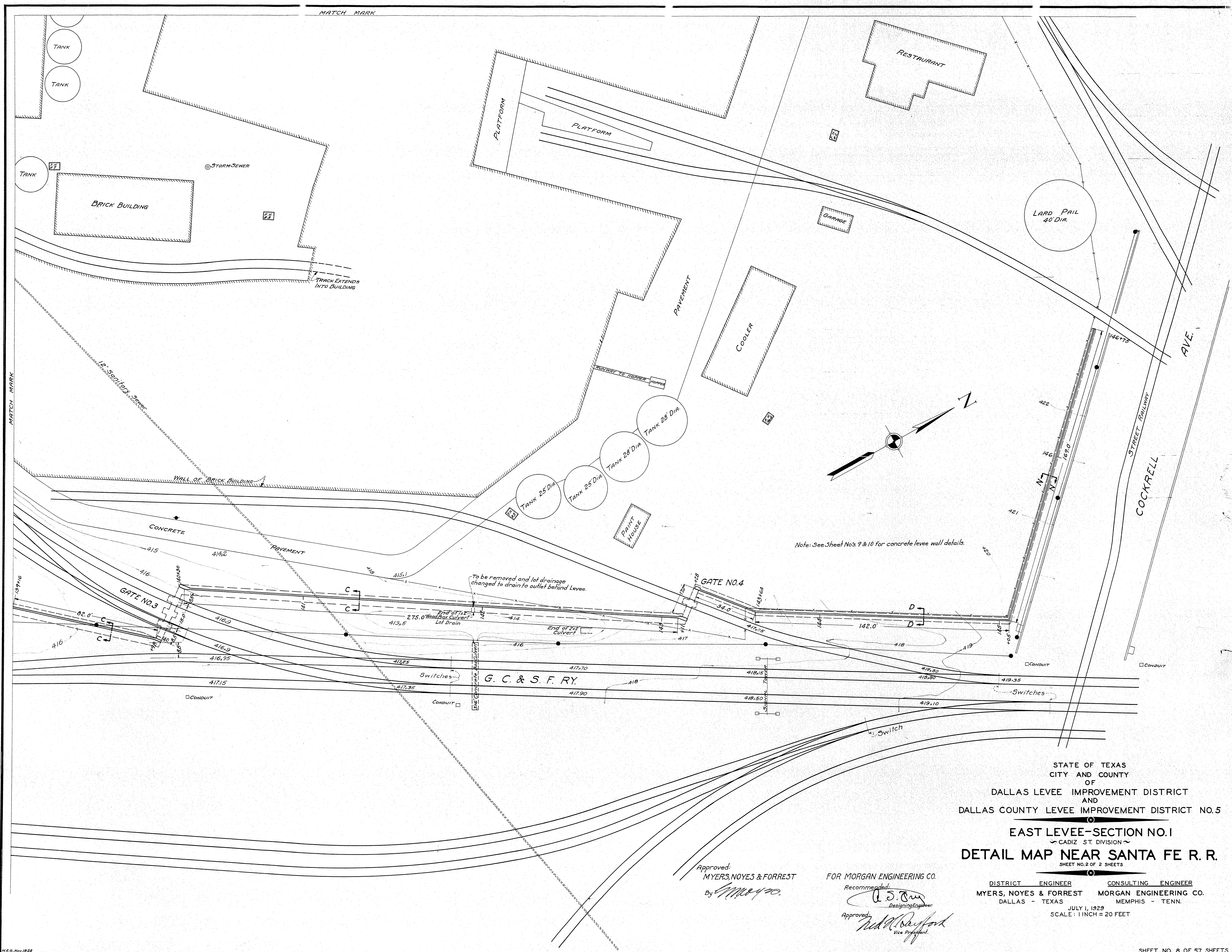
Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer
Approved: Ned H. Bayford
Vice President

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929
SCALE: 1 INCH = 20 FEET



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

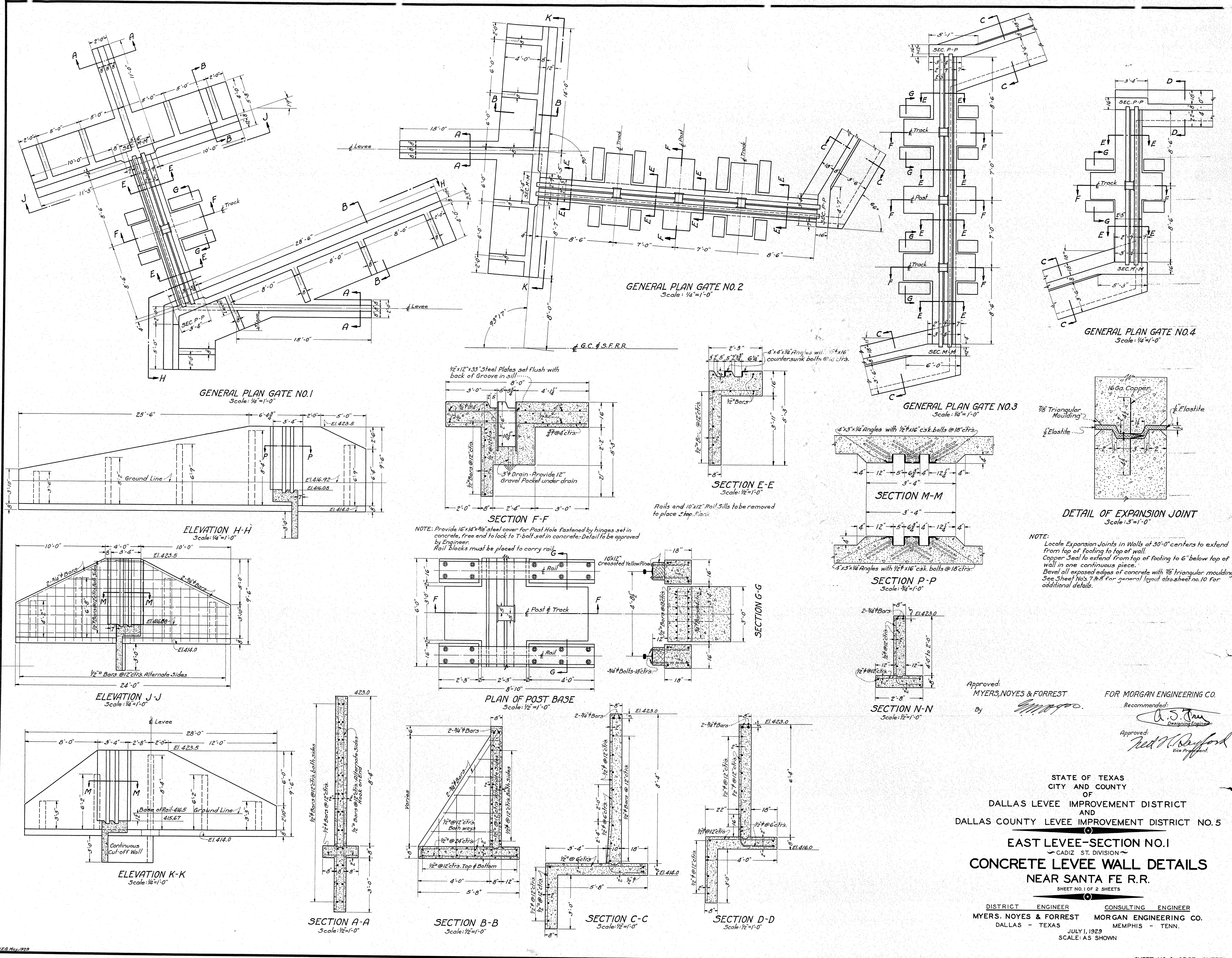
EAST LEVEE-SECTION NO. 1
CADIZ ST. DIVISION

DETAIL MAP NEAR SANTA FE R. R.

SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: 1 INCH = 20 FEET



NOTE: Provide 16"x14"x3/8" steel cover for Post Hole fastened by hinges set in concrete, free end to lock to T-bolt set in concrete:- Detail to be approved by Engineer.
Rail blocks must be placed to carry rail.

NOTE:
Locate Expansion Joints in Walls at 30'-0" centers to extend from top of footing to top of wall.
Copper Seal to extend from top of footing to 6" below top of wall in one continuous piece.
Bevel all exposed edges of concrete with 7/8" triangular moulding.
See Sheet No's. 7 & 8 for general layout also sheet no. 10 for additional details.

Approved:
MYERS, NOYES & FORREST
By

FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer.
Approved:
Vice President.

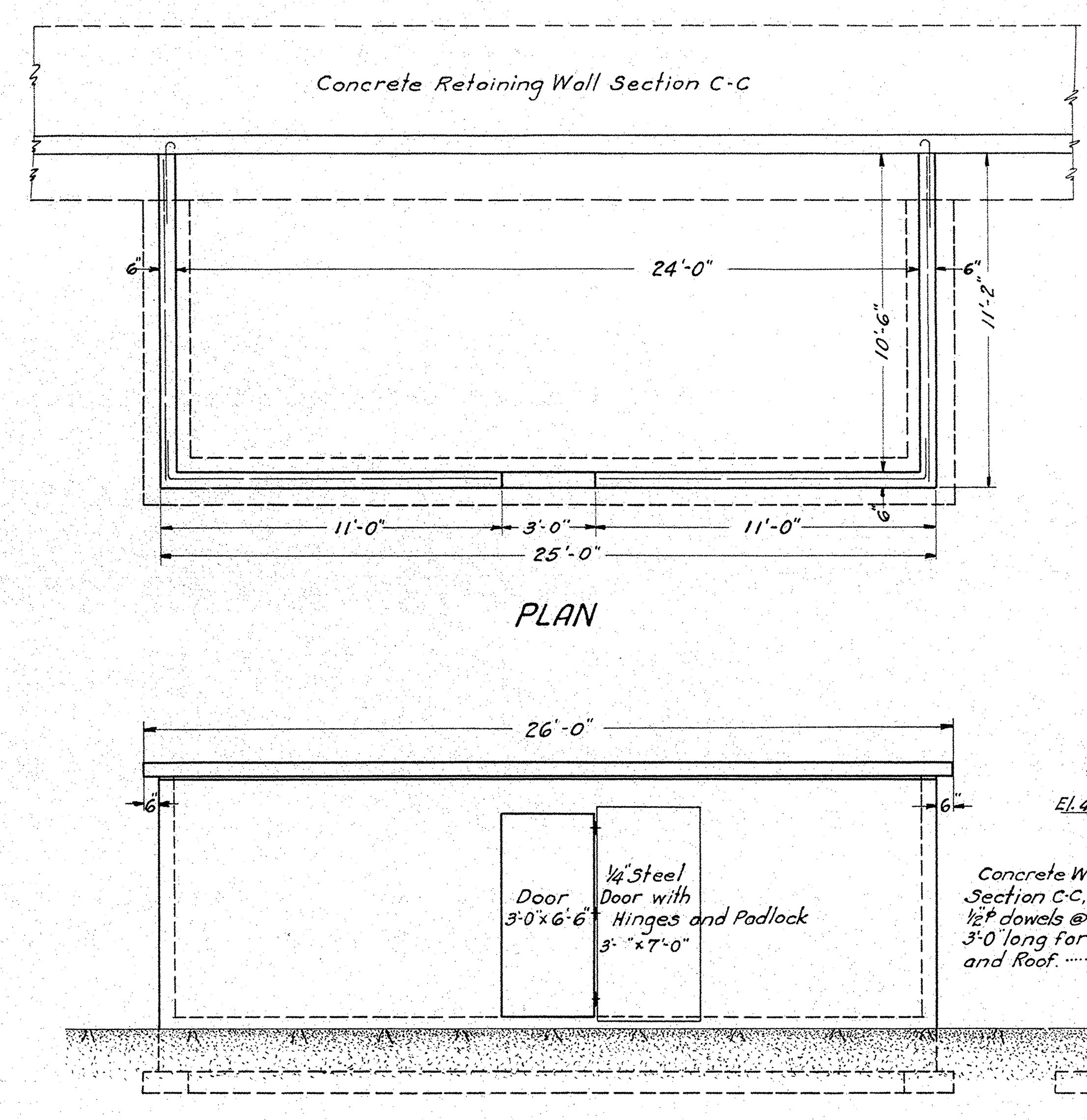
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE-SECTION NO. 1
~CADIZ ST. DIVISION~

CONCRETE LEVEE WALL DETAILS
NEAR SANTA FE R.R.
SHEET NO. 1 OF 2 SHEETS

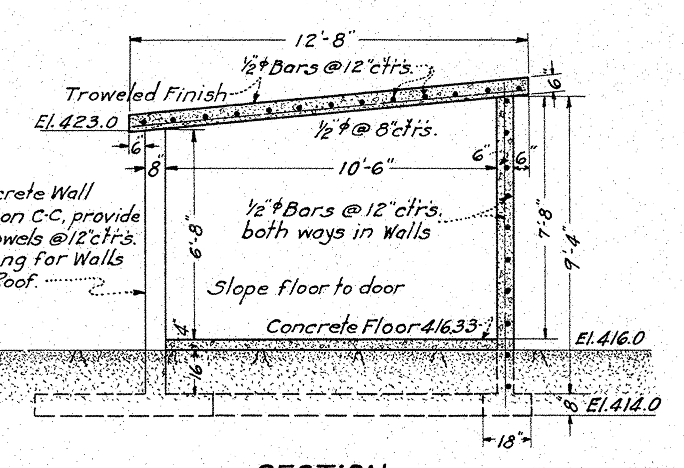
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS. NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN



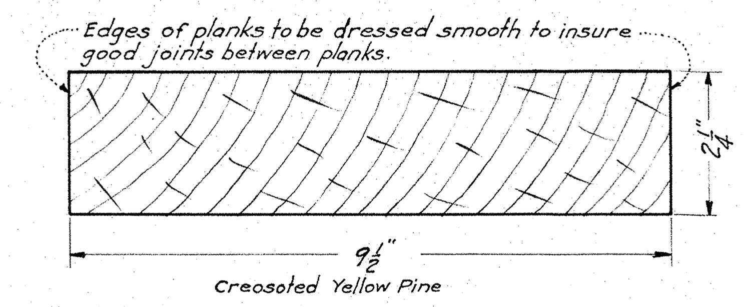
PLAN

FRONT ELEVATION

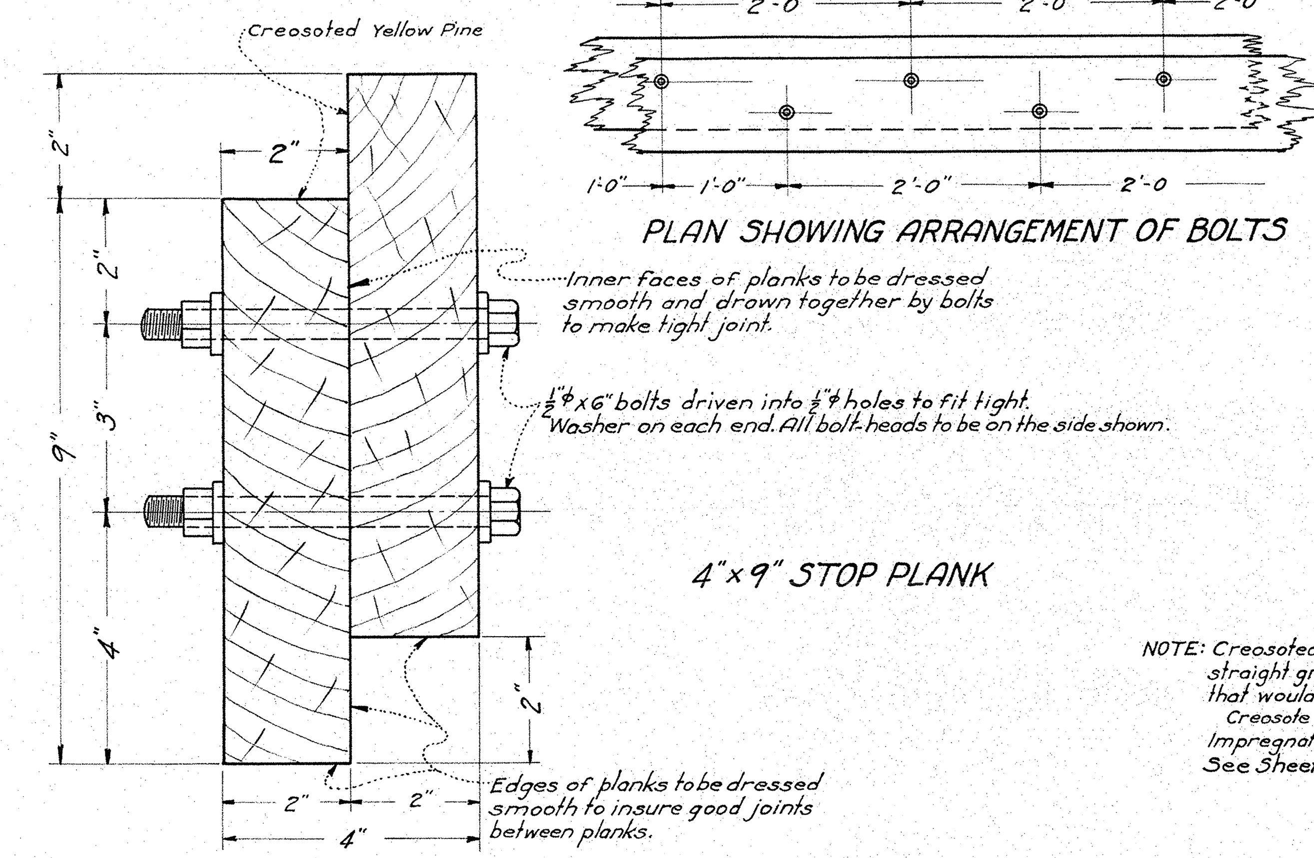


SECTION

PLANK HOUSE
Scale: ¼"=1'-0"



2¼"x 9½" STOP PLANK

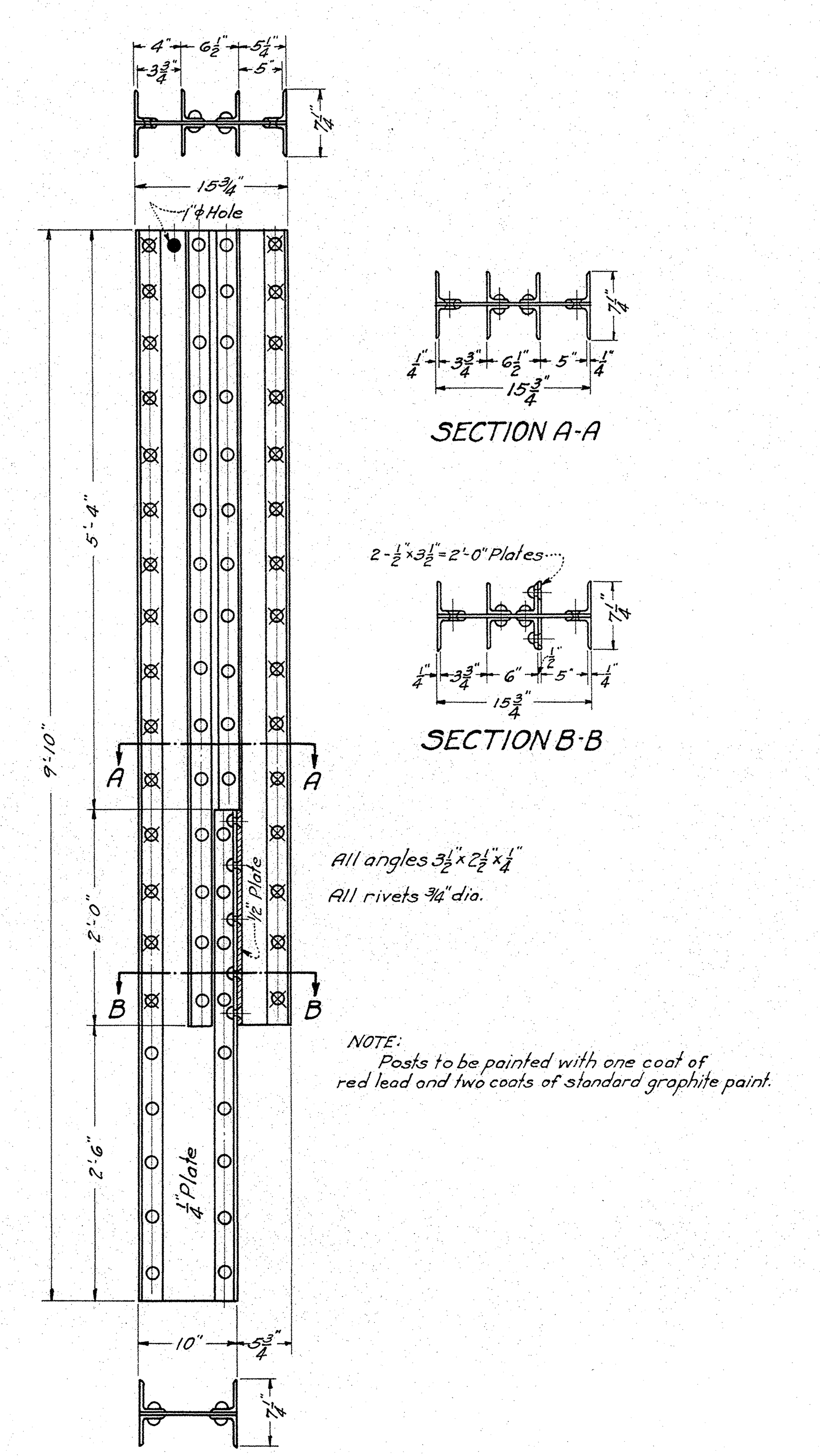


PLAN SHOWING ARRANGEMENT OF BOLTS

4"x 9" STOP PLANK

BILL OF STOP PLANKS			
GATE NUMBER	NUMBER OF PLANKS	SIZE	LENGTH
1	20	4" x 9"	8'-9"
	20	2¼" x 9½"	8'-9"
2	20	4" x 9"	8'-9"
	20	2¼" x 9½"	8'-9"
	20	4" x 9"	6'-10½"
	20	2¼" x 9½"	6'-10½"
3	20	4" x 9"	8'-9"
	20	2¼" x 9½"	8'-9"
	20	4" x 9"	6'-10½"
	20	2¼" x 9½"	6'-10½"
4	20	4" x 9"	8'-9"
	20	2¼" x 9½"	8'-9"

NOTE: Creosoted long leaf yellow pine timber to be thoroughly seasoned, sound, straight grained, free from shakes, large or loose knots or any other defects that would impair its strength or durability.
Creosote shall be a pure coal tar product approved by the Engineer.
Impregnation shall be at least 10 pounds per cubic foot of timber.
See Sheet No's. 7 & 8 for general layout also sheet no. 9 for additional details.



SECTION A-A

SECTION B-B

All angles 3½"x 2½"x ¼"
All rivets ¾" dia.

NOTE:
Posts to be painted with one coat of red lead and two coats of standard graphite paint.

DETAIL OF REMOVABLE POST
8-Required
Scale: 1"=1'-0"

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer
Approved: [signature]
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

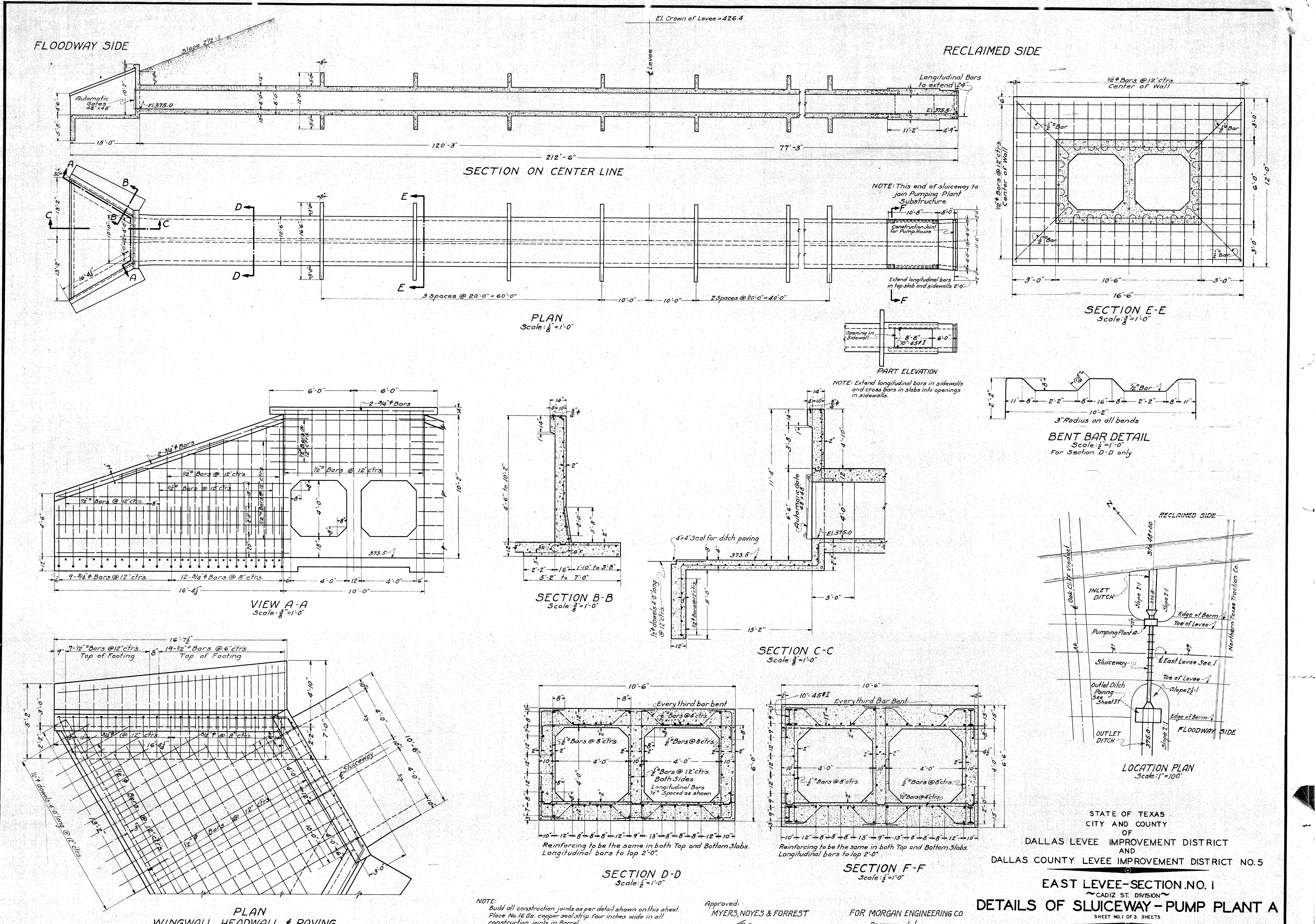
EAST LEVEE–SECTION NO. 1
~CADIZ ST. DIVISION~

CONCRETE LEVEE WALL DETAILS
NEAR SANTA FE R.R.
SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. May, 1929

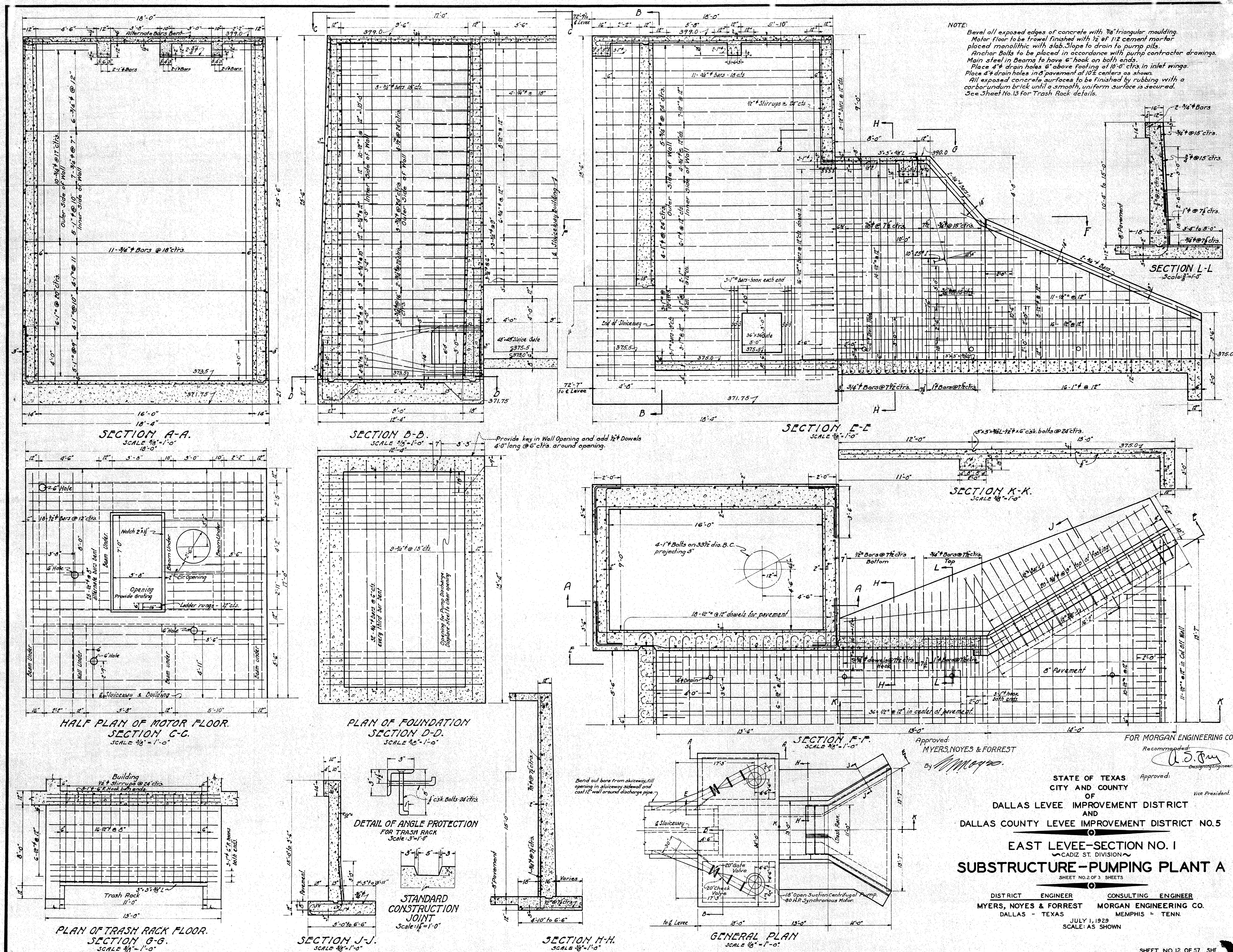


STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

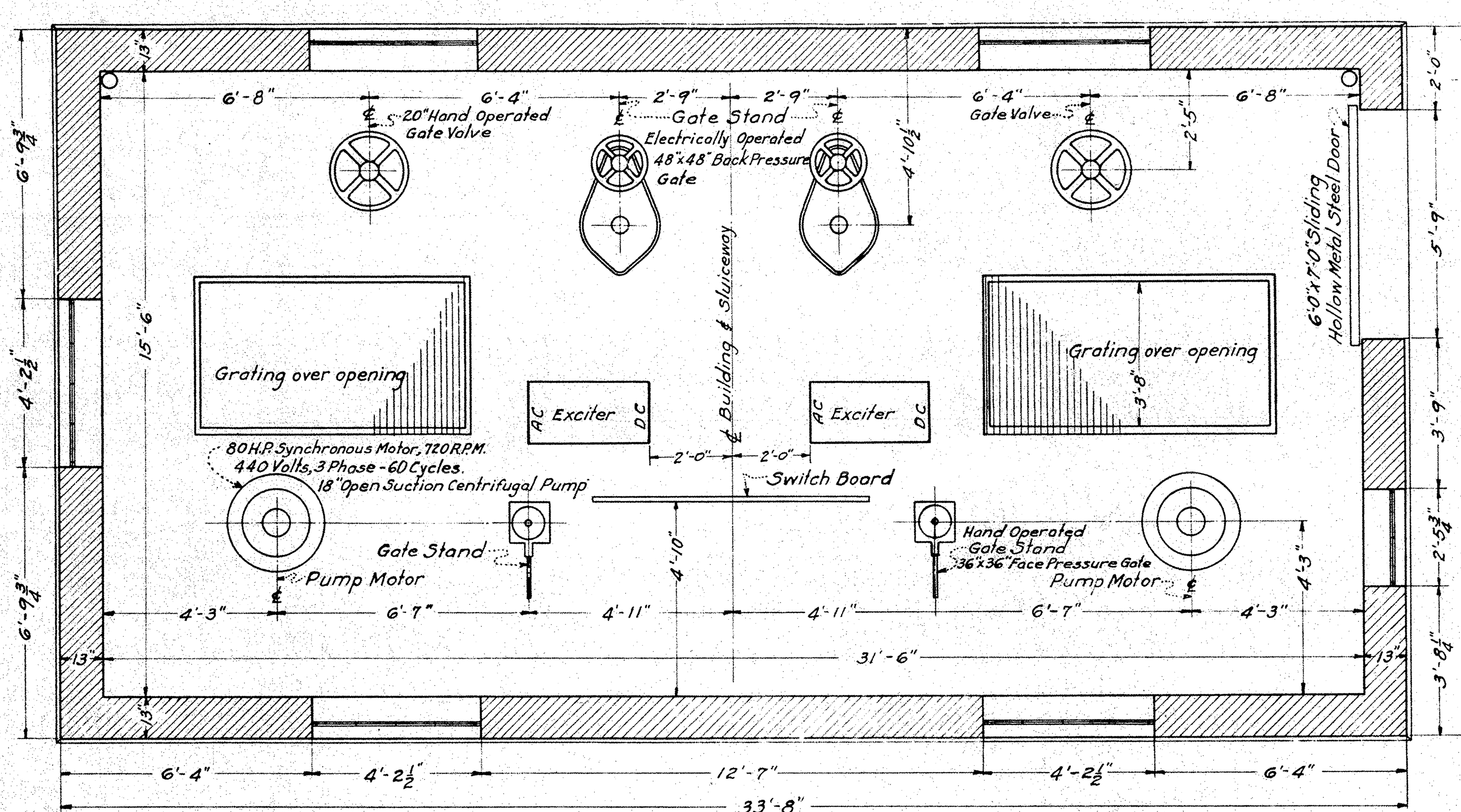
EAST LEVEE-SECTION NO. 1
~CADIZ ST. DIVISION~
DETAILS OF SLUICEWAY - PUMP PLANT A
SHEET NO. 1 OF 3 SHEETS

DISTRICT ENGINEER — MYERS, NOYES & FORREST — DALLAS - TEXAS
CONSULTING ENGINEER — MORGAN ENGINEERING CO. — MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 11 OF 57 SHEETS

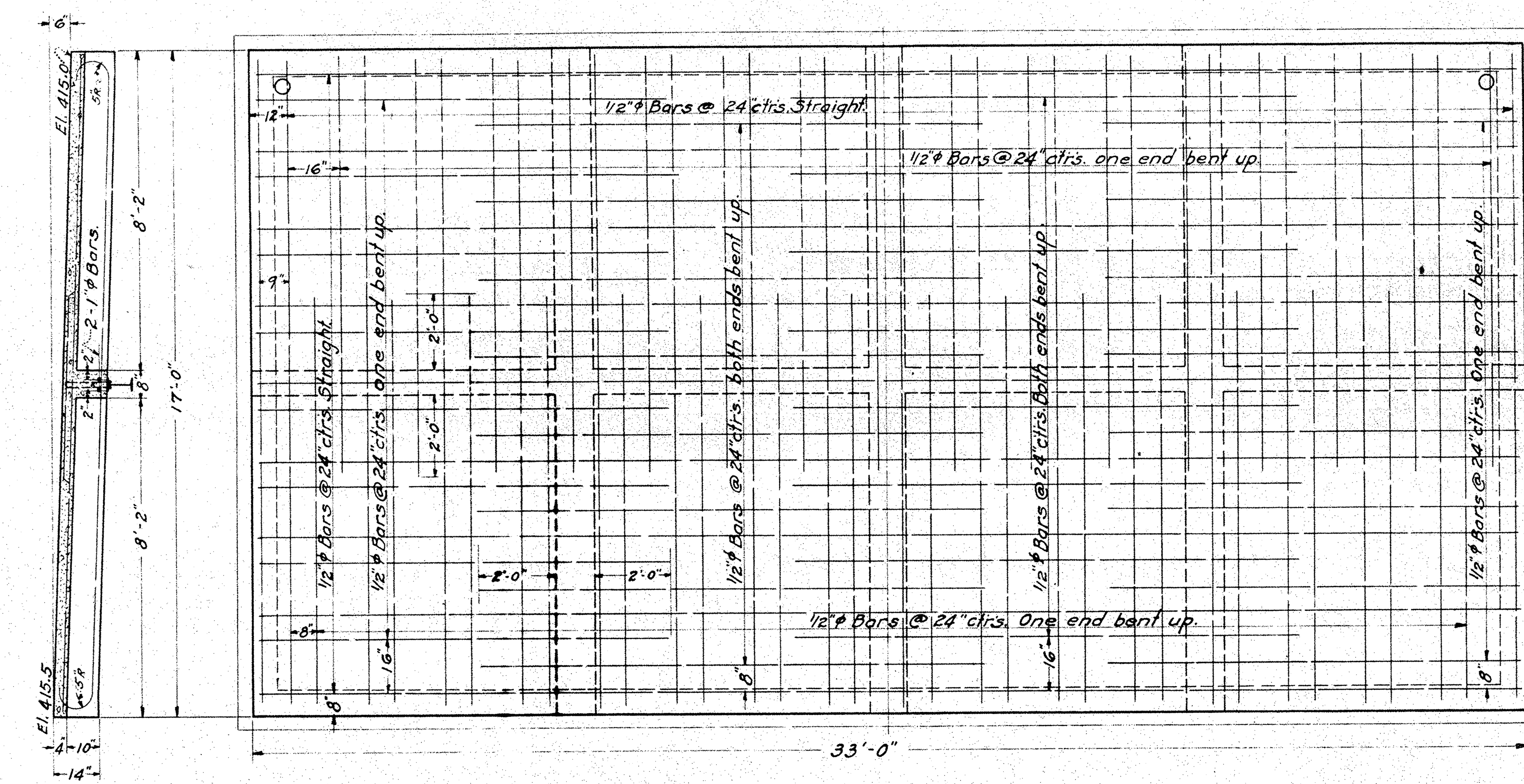


SECTION A-A.
SCALE 3/8"-1'-0"
SECTION B-B.
SCALE 3/8"-1'-0"
SECTION E-E
SCALE 3/8"-1'-0"
SECTION L-L
Scale 3/8"-1'-0"
SECTION K-K.
SCALE 3/8"-1'-0"
HALF PLAN OF MOTOR FLOOR.
SECTION C-C.
SCALE 3/8"-1'-0"
PLAN OF FOUNDATION
SECTION D-D.
SCALE 3/8"-1'-0"
SECTION F-F.
SCALE 3/8"-1'-0"
PLAN OF TRASH RACK FLOOR.
SECTION G-G.
SCALE 3/8"-1'-0"
SECTION J-J.
SCALE 3/8"-1'-0"
DETAIL OF ANGLE PROTECTION
FOR TRASH RACK
Scale: 3"-1'-0"
STANDARD
CONSTRUCTION
JOINT
Scale: 1 1/2"=1'-0"
SECTION H-H.
SCALE 3/8"-1'-0"
GENERAL PLAN
SCALE 1/8"-1'-0"
NOTE:
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Motor floor to be trowel finished with 1/2" of 1:2 cement mortar placed monolithic with slab. Slope to drain to pump pits.
Anchor Bolts to be placed in accordance with pump contractor drawings.
Main steel in Beams to have 6" hook on both ends.
Place 4"ϕ drain holes 6" above footing at 10'-0" ctrs. in inlet wings.
Place 4"ϕ drain holes in 8" pavement at 10'± centers as shown.
All exposed concrete surfaces to be finished by rubbing with a corborundum brick until a smooth, uniform surface is secured.
See Sheet No. 13 for Trash Rack details.
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer.
Approved:
Vice President.
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
EAST LEVEE-SECTION NO. 1
CADIZ ST. DIVISION
SUBSTRUCTURE-PUMPING PLANT A
SHEET NO. 2 OF 3 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN
SHEET NO. 12 OF 57 SHE

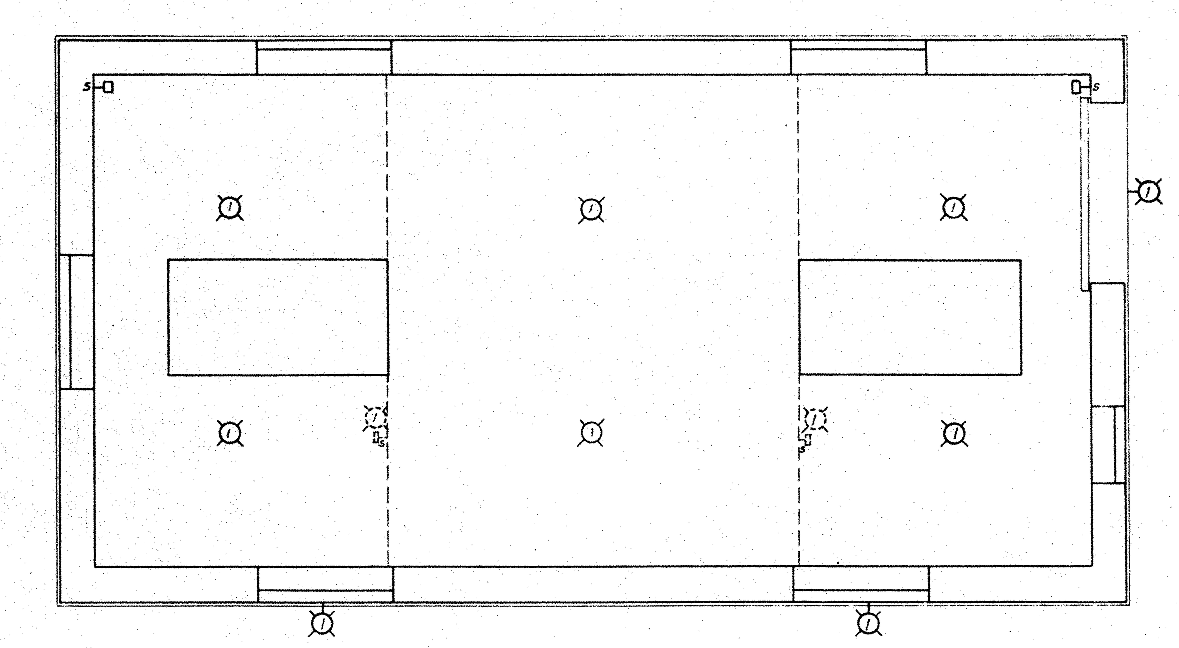


Design Note: This Pumping Plant designed on the consideration that Mill Creek, Dallas Branch, and Pacific Ave. above 1908 H.W. line will be carried by pressure sewers across the District to outlets in the Floodway as provided by the Ulrickson Plan, pressure sewers to be constructed by the City of Dallas.

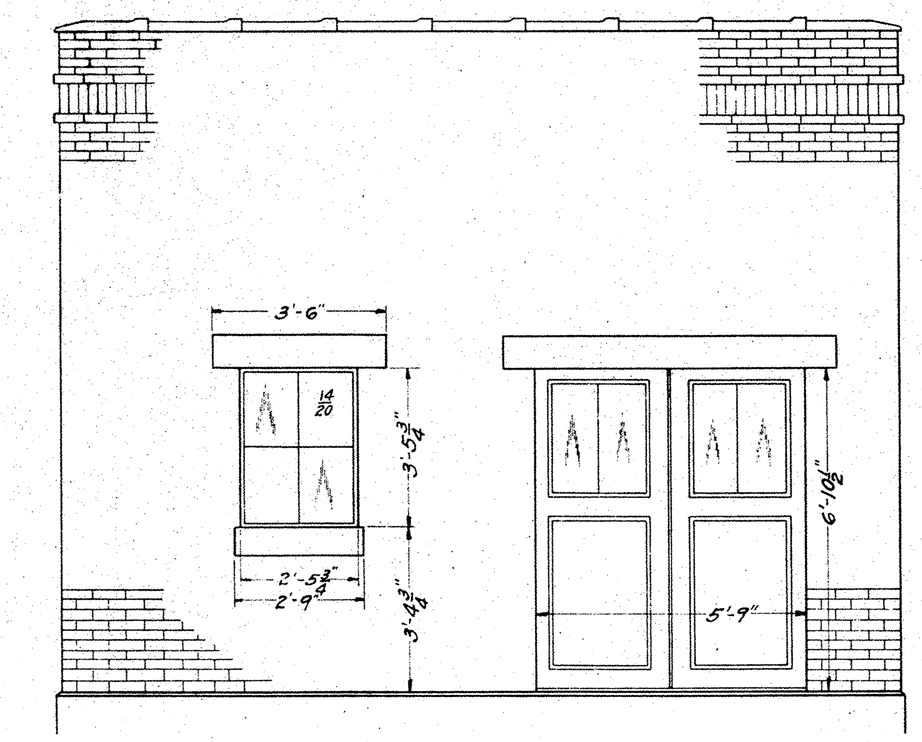
FLOOR PLAN
Scale: 1/8"=1'-0"



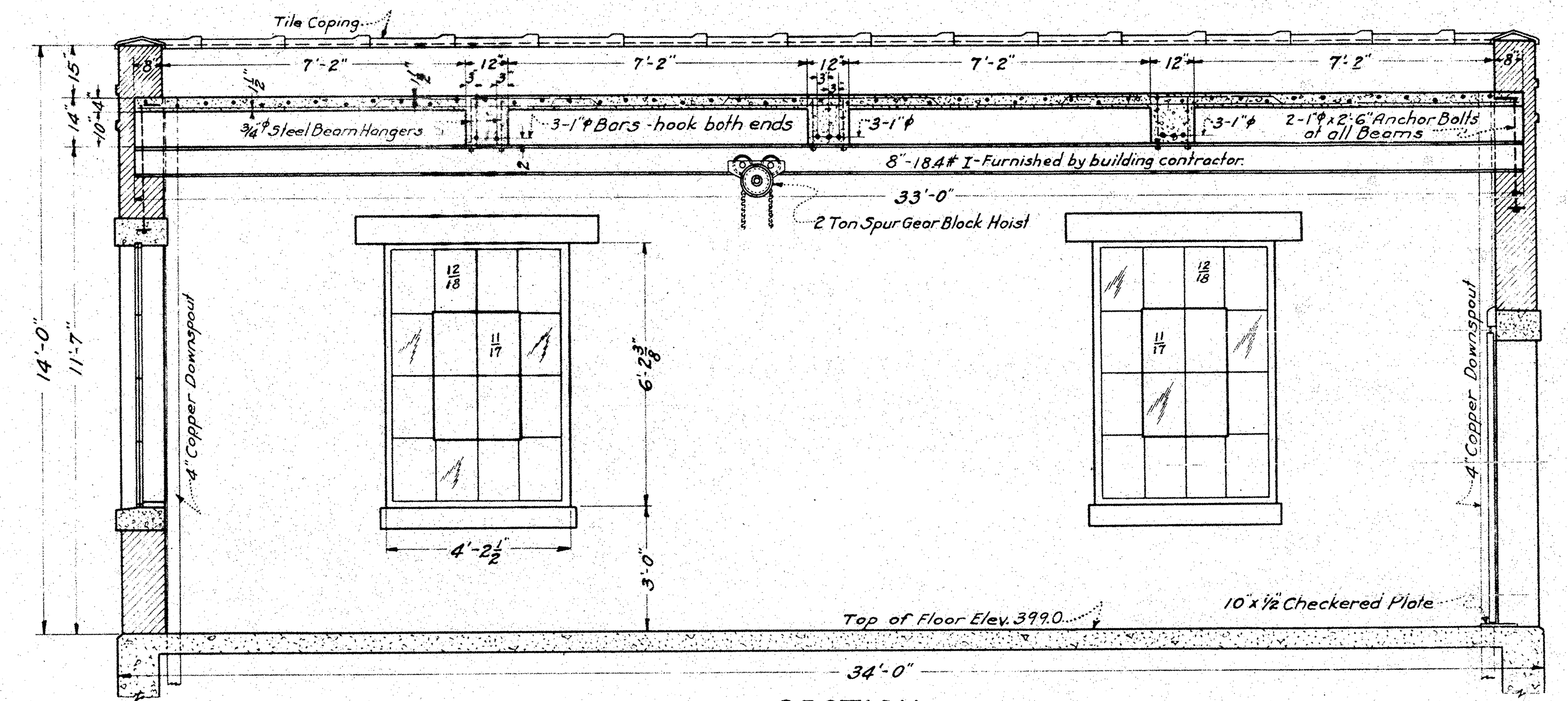
ROOF PLAN
Scale: 1/8"=1'-0"



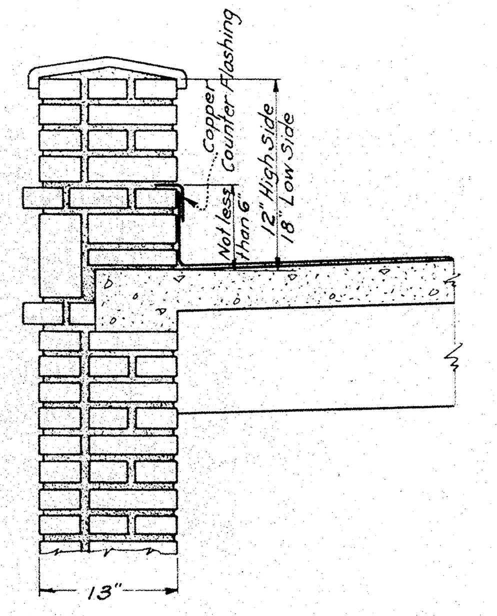
LIGHTING PLAN
Scale: 1/4"=1'-0"



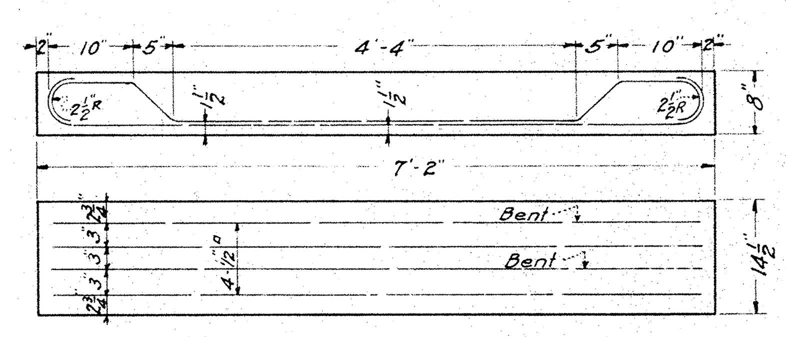
END ELEVATION
Scale: 1/8"=1'-0"



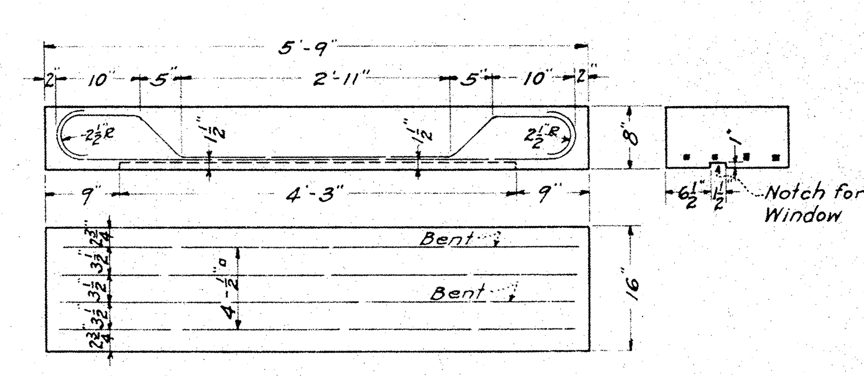
SECTION
Scale: 1/8"=1'-0"



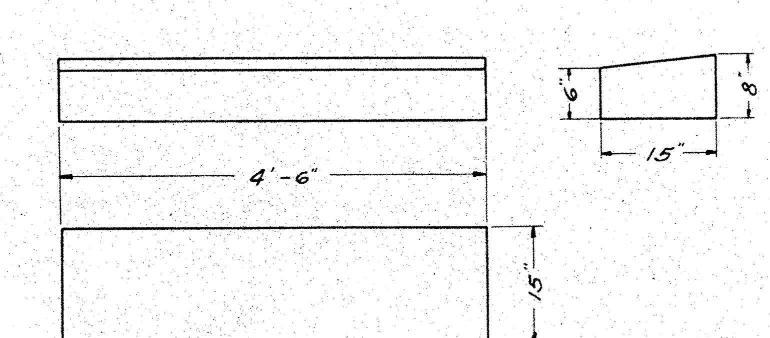
PARAPET DETAIL
Scale: 1"=1'-0"



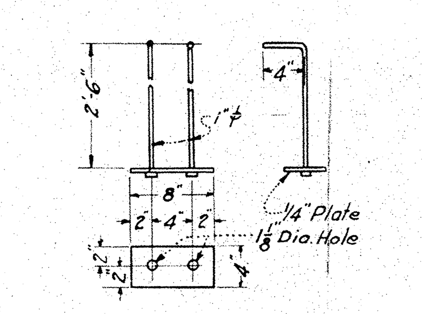
DETAIL DOOR LINTEL
Scale: 3/4"=1'-0"



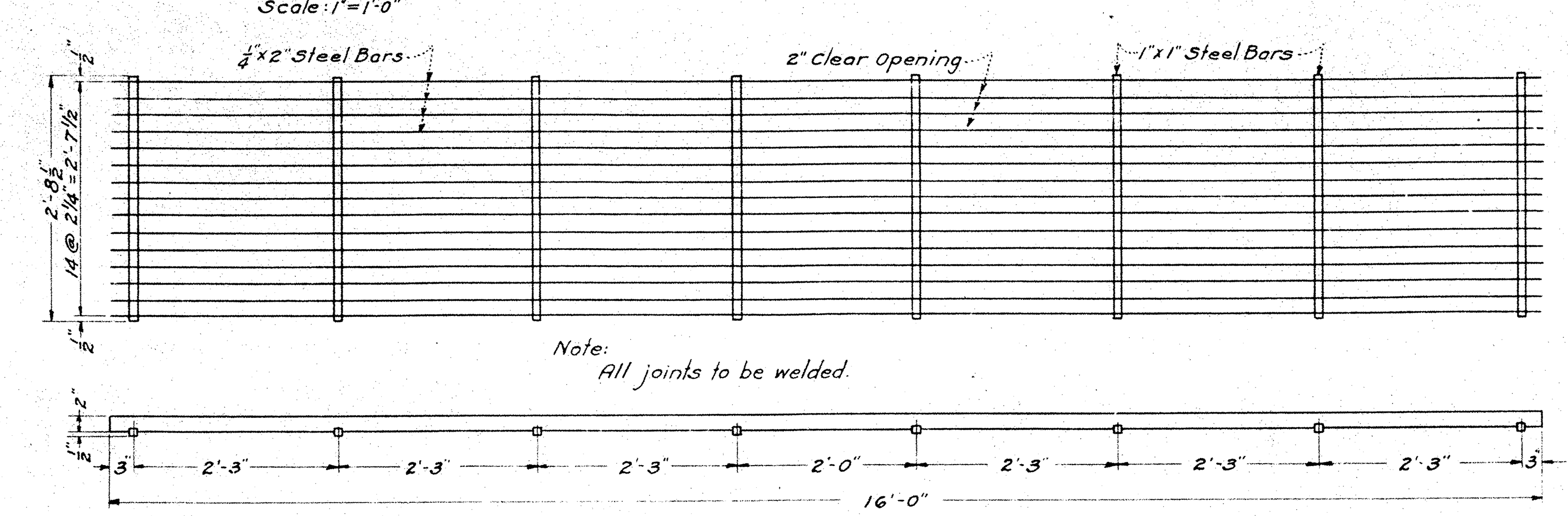
DETAIL WINDOW LINTEL
Scale: 3/4"=1'-0"



CONCRETE WINDOW SILL
Scale: 3/4"=1'-0"

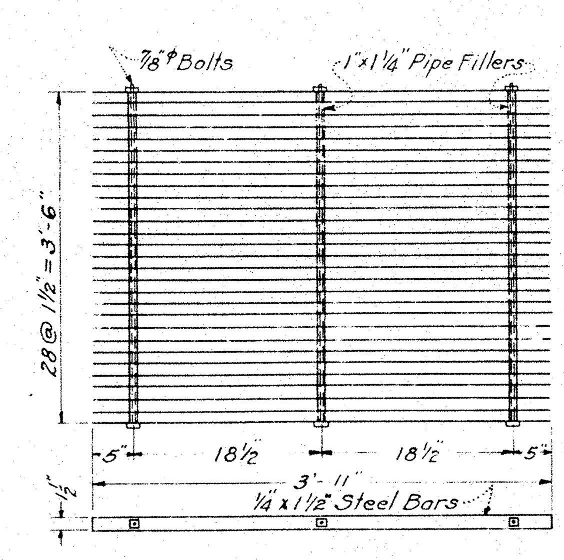


ANCHOR BOLT DETAIL



Note:
All joints to be welded.

DETAIL OF TRASH RACK
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"



DETAIL OF FLOOR GRATING
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"

NOTE:
Roof surface shall consist of four plies of Tarred Felt, laid and thoroughly mopped with pitch, and covered with 400 pounds of 1/4" to 5/8" gravel per hundred square feet embedded in hot pitch.
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Brick facing shall be dark red mat faced Brick laid in black 1:3 Portland Cement mortar, with 1/2" raked joints.
Provide substantial Yale Lock or equal for door.
A commercial steel grating of equal strength may be substituted for steel grating as shown.
Wiring plans and lighting fixtures to be approved by the Engineer.
Backing up brick may be common brick. Approved heavy wall ties shall be used in every course at frequent intervals.
Windows to be Lupton Steel Windows with pivoted ventilators, or equal.
Doors to be Lupton Seamless Steel Tube Doors with wire glass, or equal.
Building contract to include all work above Elevation 399.5 except the 2-Ton Spur Gear Block Hoist and Pumping Equipment.
Structural steel, doors and windows to be painted one shop coat Detroit Graphite Co. No. 400 or equal, one field coat No. 868 or equal and one finishing coat No. 865 or equal.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

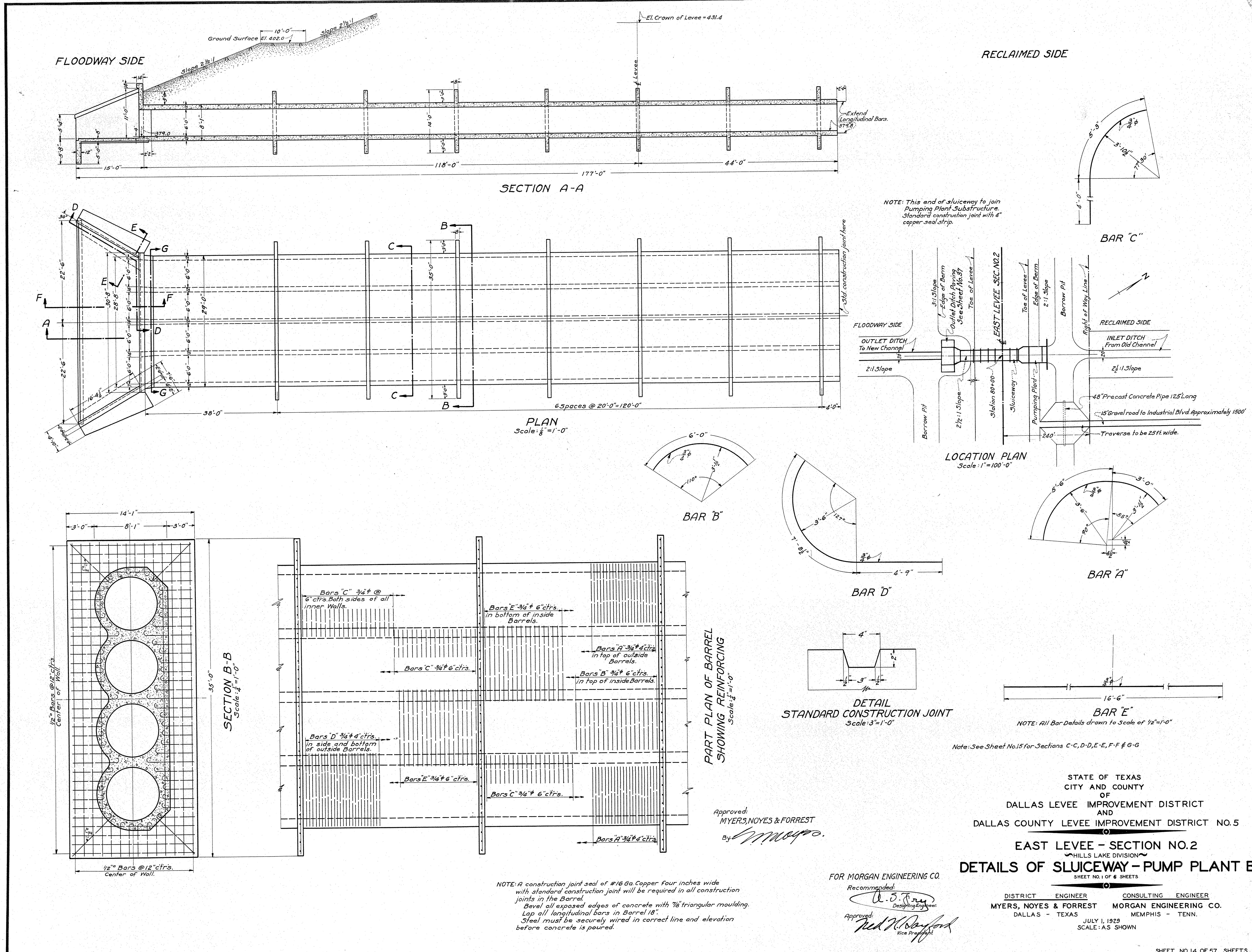
EAST LEVEE SECTION NO. 1
CADIZ ST. DIVISION

SUPERSTRUCTURE–PUMPING PLANT A
SHEET NO. 3 OF 3 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN

JULY 1, 1929
SCALE: AS SHOWN

N.E.G. Apr. 1929



Note: See Sheet No. 15 for Sections C-C, D-D, E-E, F-F & G-G

NOTE: A construction joint seal of #16 Ga. Copper four inches wide with standard construction joint will be required in all construction joints in the Barrel.
Bevel all exposed edges of concrete with ⅞" triangular moulding.
Lap all longitudinal bars in Barrel 18".
Steel must be securely wired in correct line and elevation before concrete is poured.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer.
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

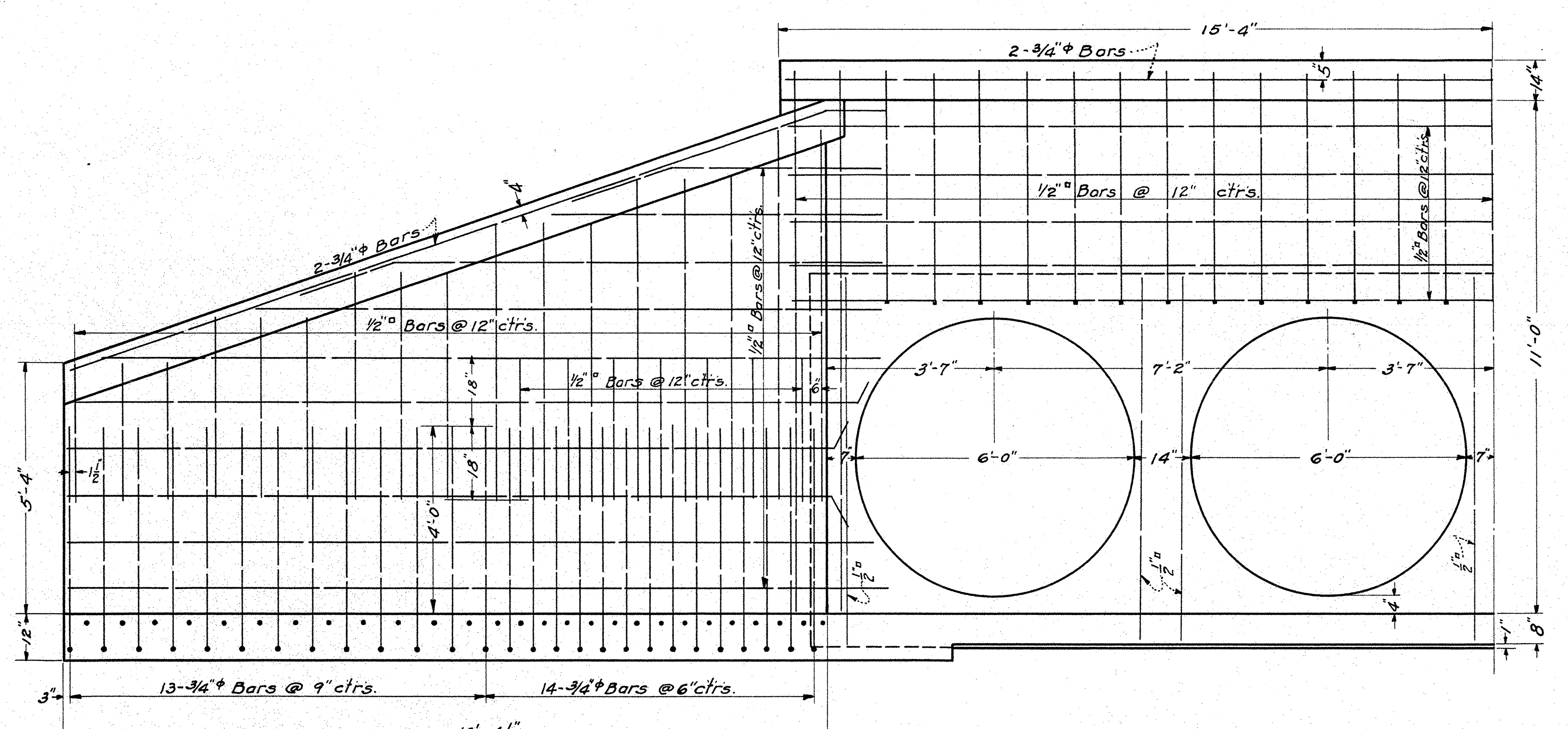
EAST LEVEE – SECTION NO. 2
HILLS LAKE DIVISION

DETAILS OF SLUICEWAY – PUMP PLANT B
SHEET NO. 1 OF 6 SHEETS

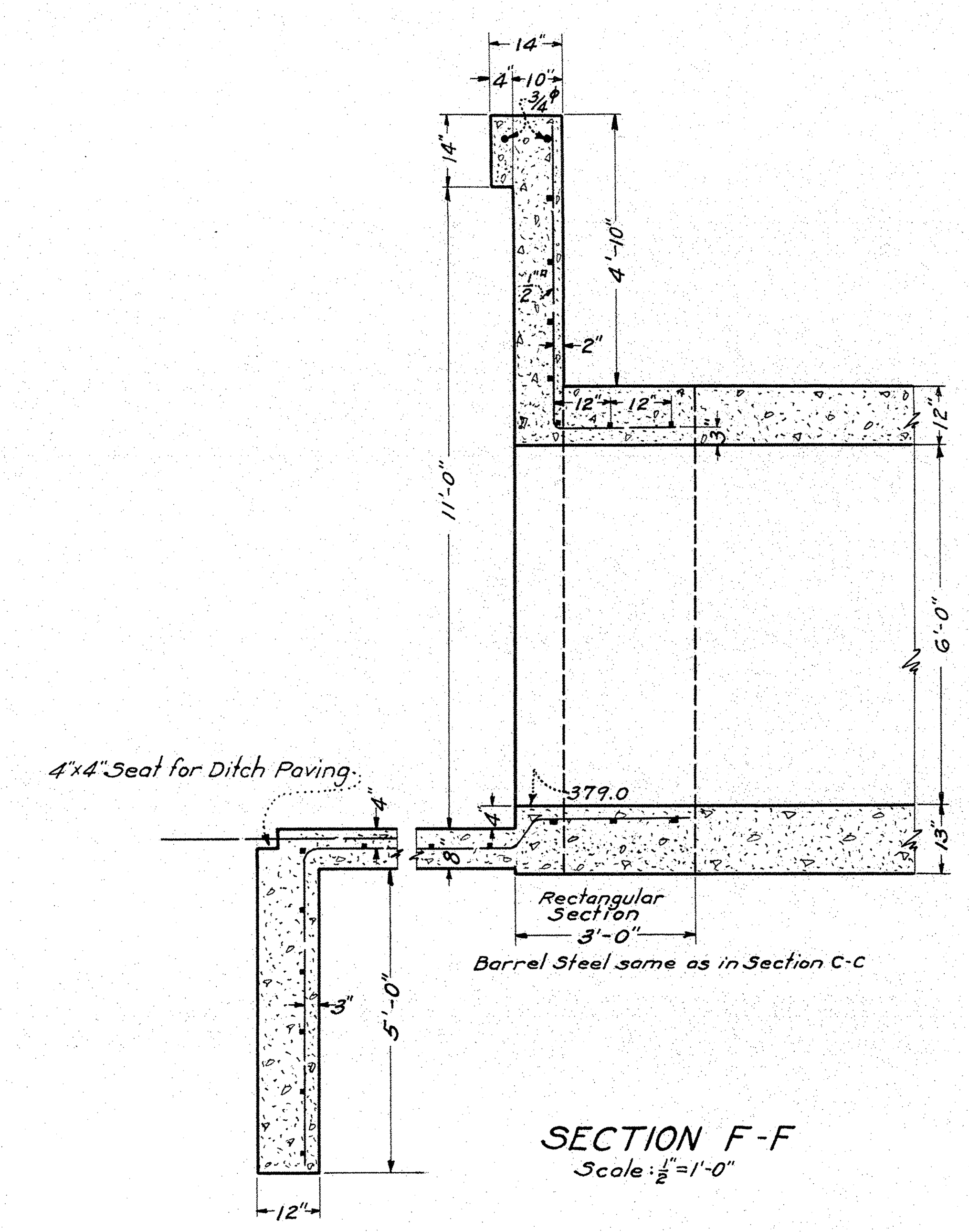
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

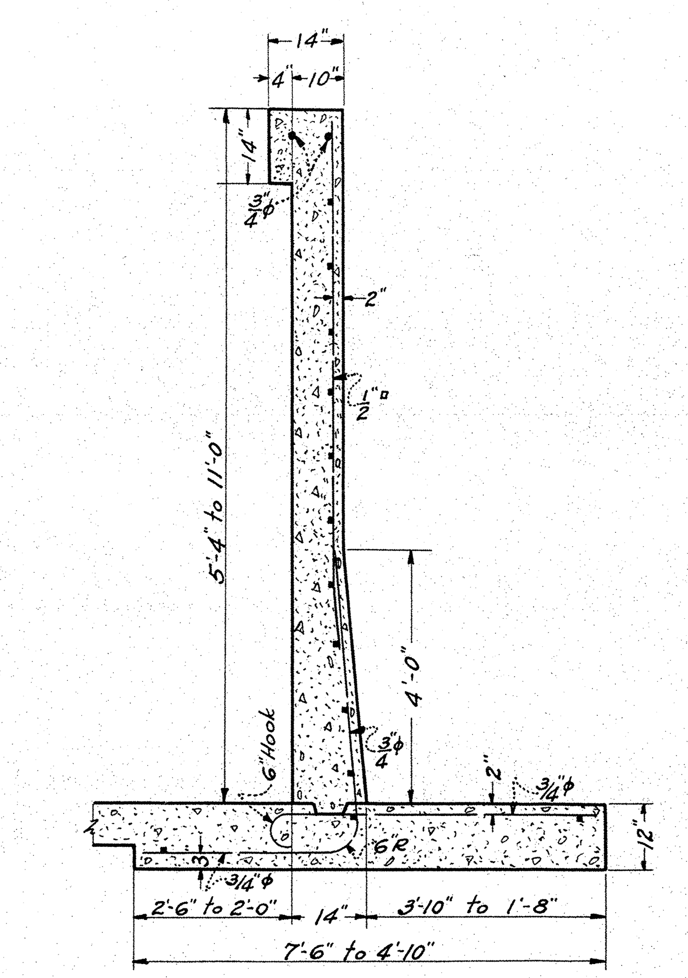
SHEET NO. 14 OF 57 SHEETS



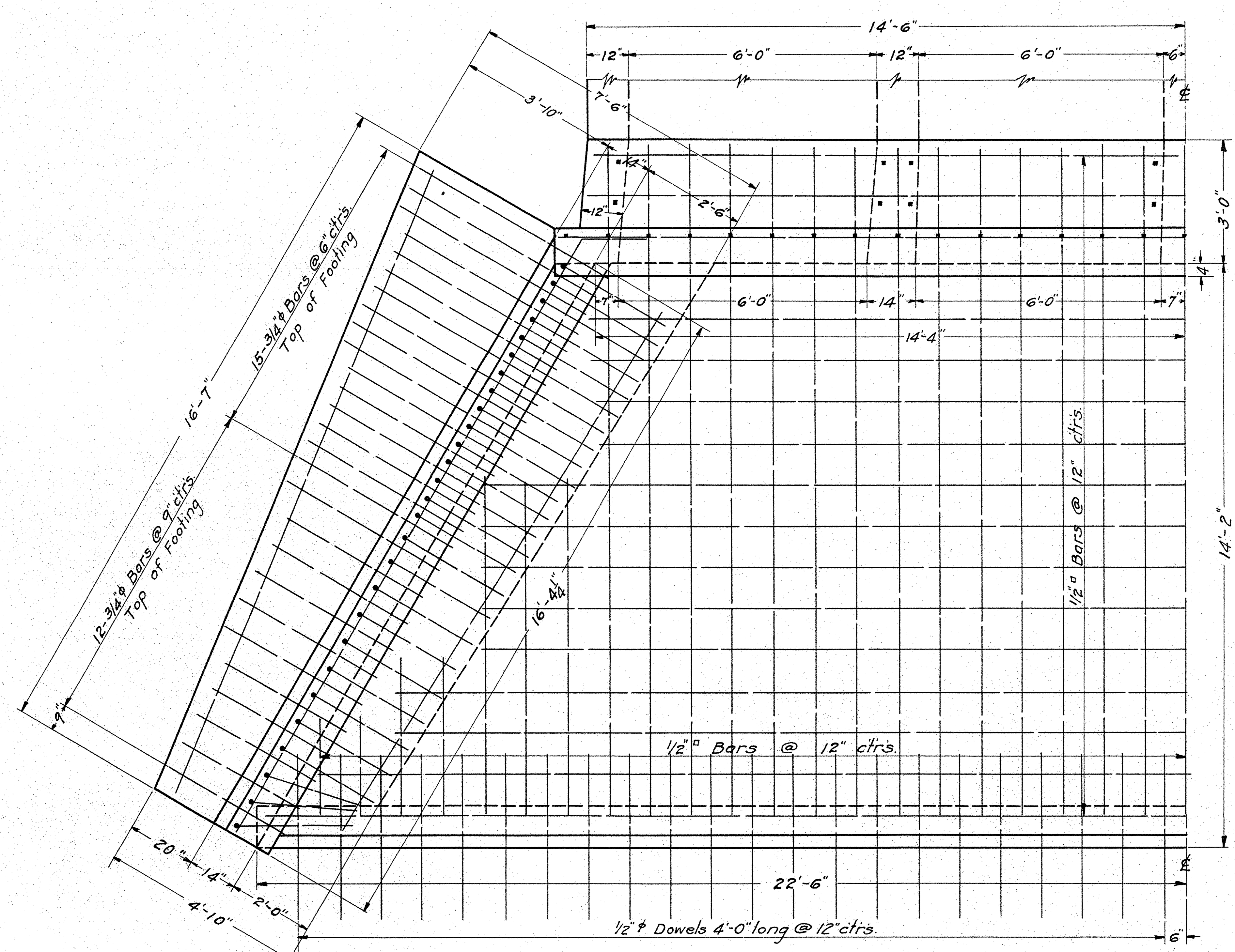
ELEVATION D-D
Scale: ½"=1'-0"



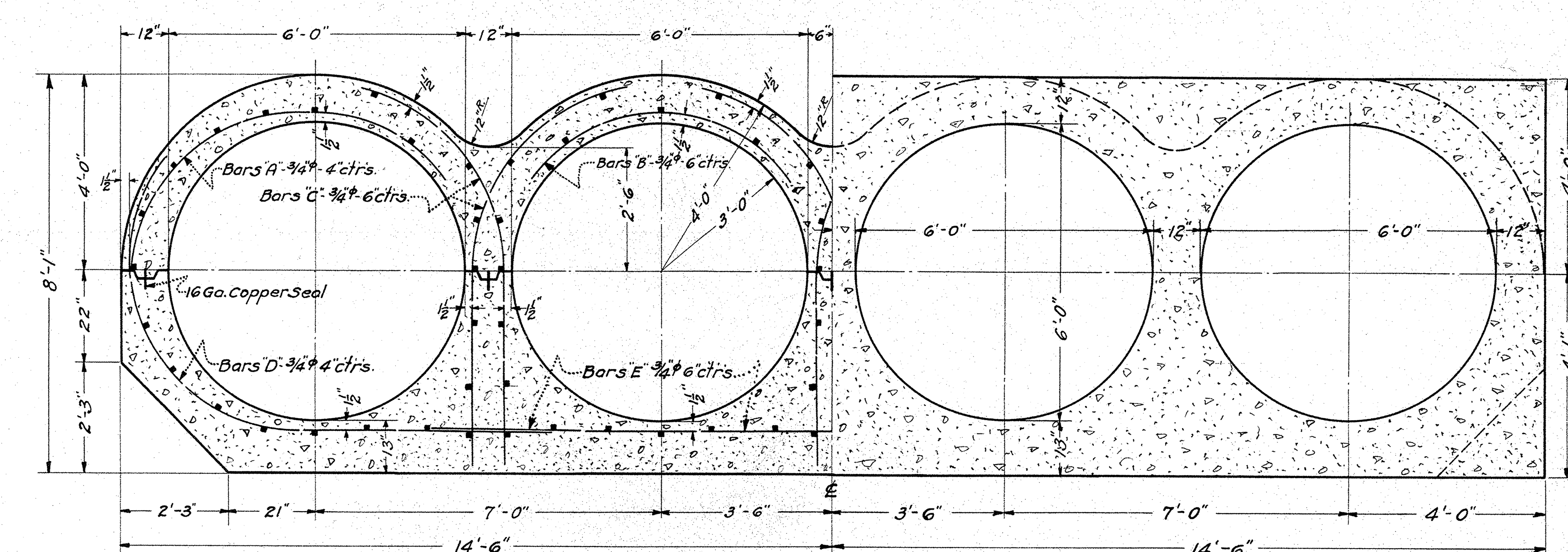
SECTION F-F
Scale: ½"=1'-0"



SECTION E-E
Scale: ½"=1'-0"



PLAN OF FLOODWAY END
Scale: ½"=1'-0"



See part plan of Barrel showing reinforcing, on sheet no.14
21 lines of ½" longitudinal bars in each barrel @ 12" centers as shown.

Reinforcing same as shown in Half Section C-C

HALF SECTION C-C
Scale: ½"=1'-0"

HALF SECTION G-G
Scale: ½"=1'-0"

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
[signature]
Designing Engineer
Approved:
[signature]
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE - SECTION NO. 2
HILLS LAKE DIVISION

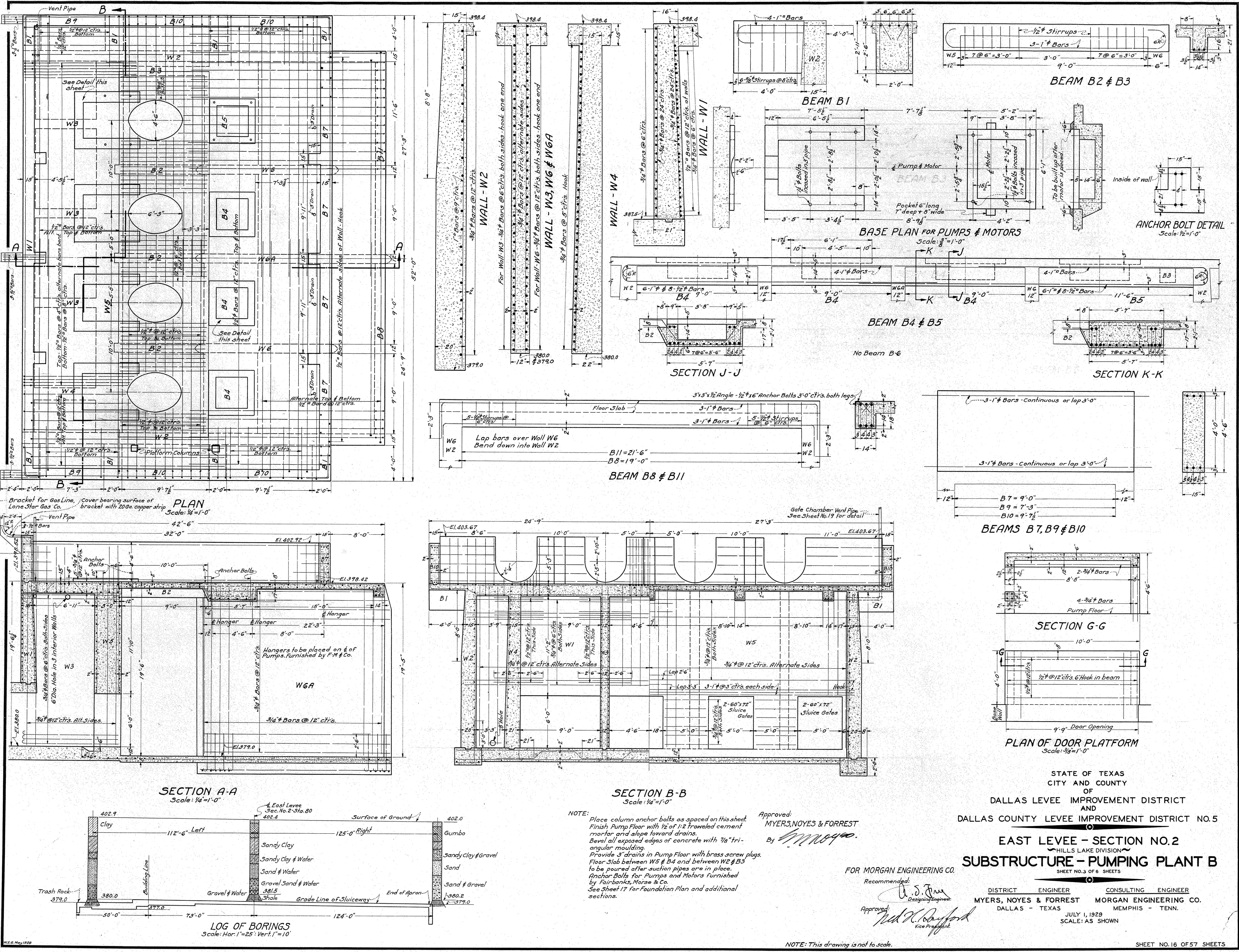
DETAILS OF SLUICEWAY - PUMP PLANT B

SHEET NO 2 OF 6 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Mar. 1929



NOTE:
Place column anchor bolts as spaced on this sheet.
Finish Pump Floor with 1/2" of 1:2 troweled cement mortar and slope toward drains.
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Provide 3" drains in Pump Floor with brass screw plugs.
Floor Slab between W5 & B4 and between W2 & B3 to be poured after suction pipes are in place.
Anchor Bolts for Pumps and Motors furnished by Fairbanks, Morse & Co.
See Sheet 17 for Foundation Plan and additional sections.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer.
Approved: [signature] Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE - SECTION NO. 2
HILLS LAKE DIVISION

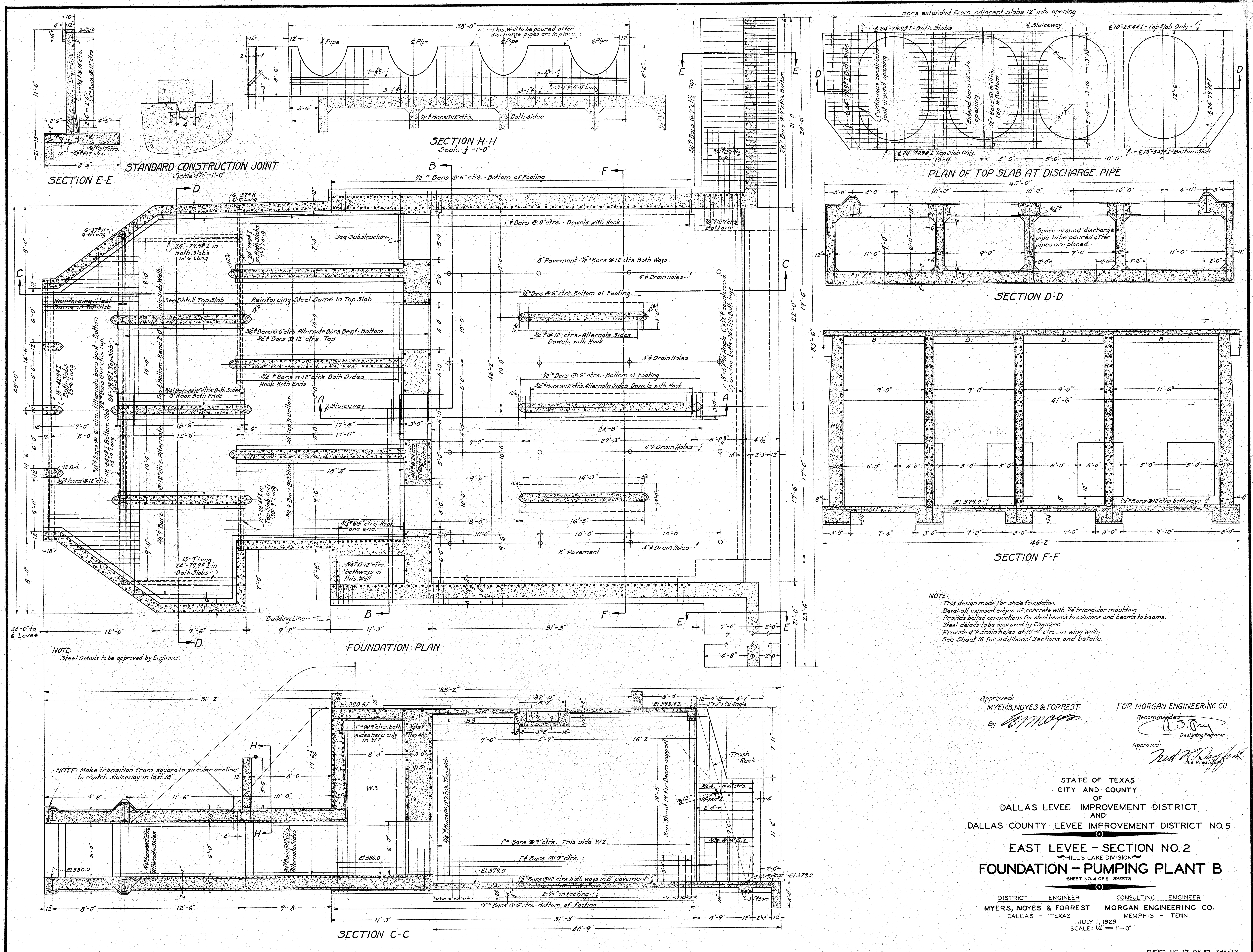
SUBSTRUCTURE - PUMPING PLANT B
SHEET NO. 3 OF 6 SHEETS

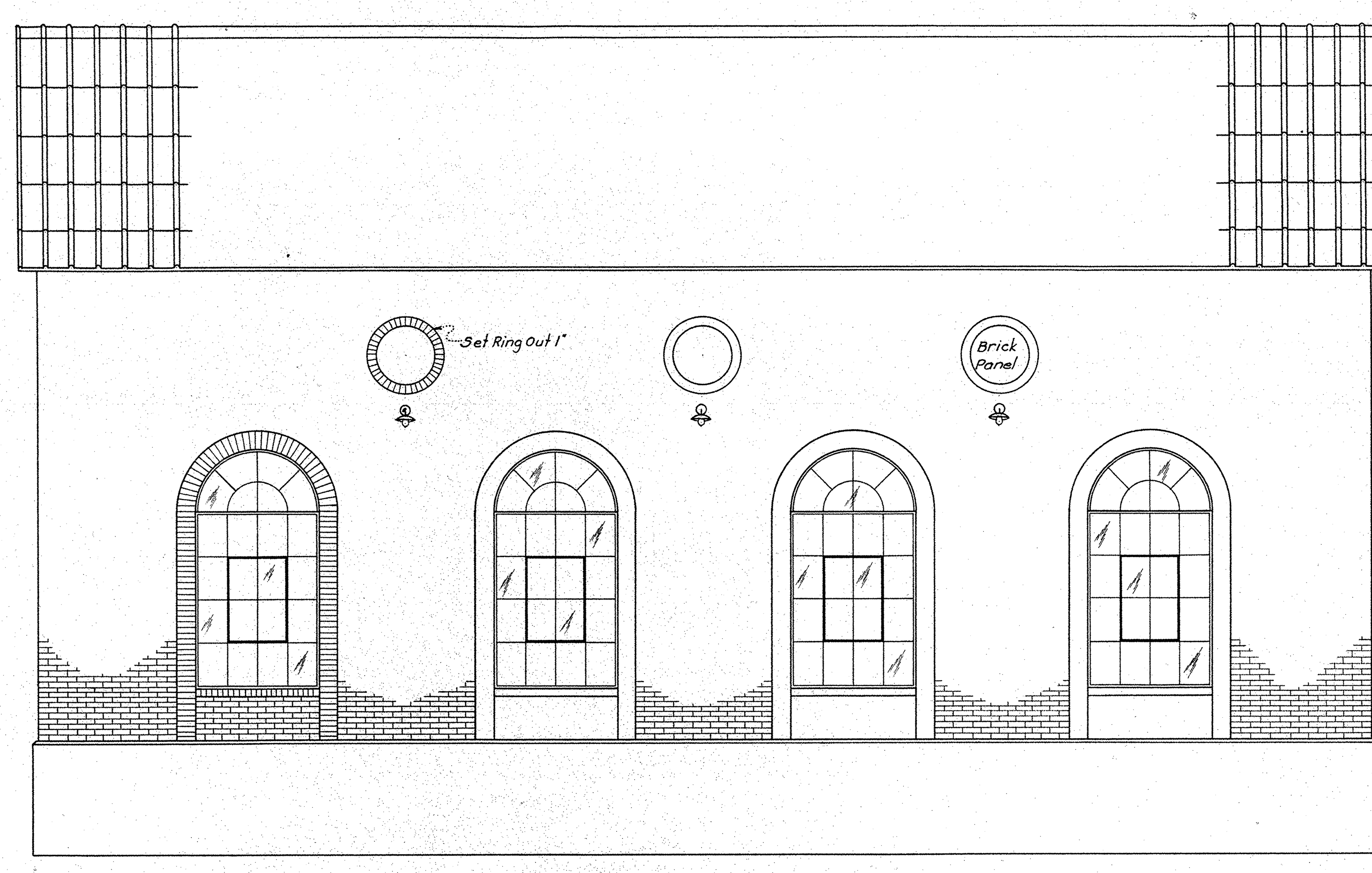
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

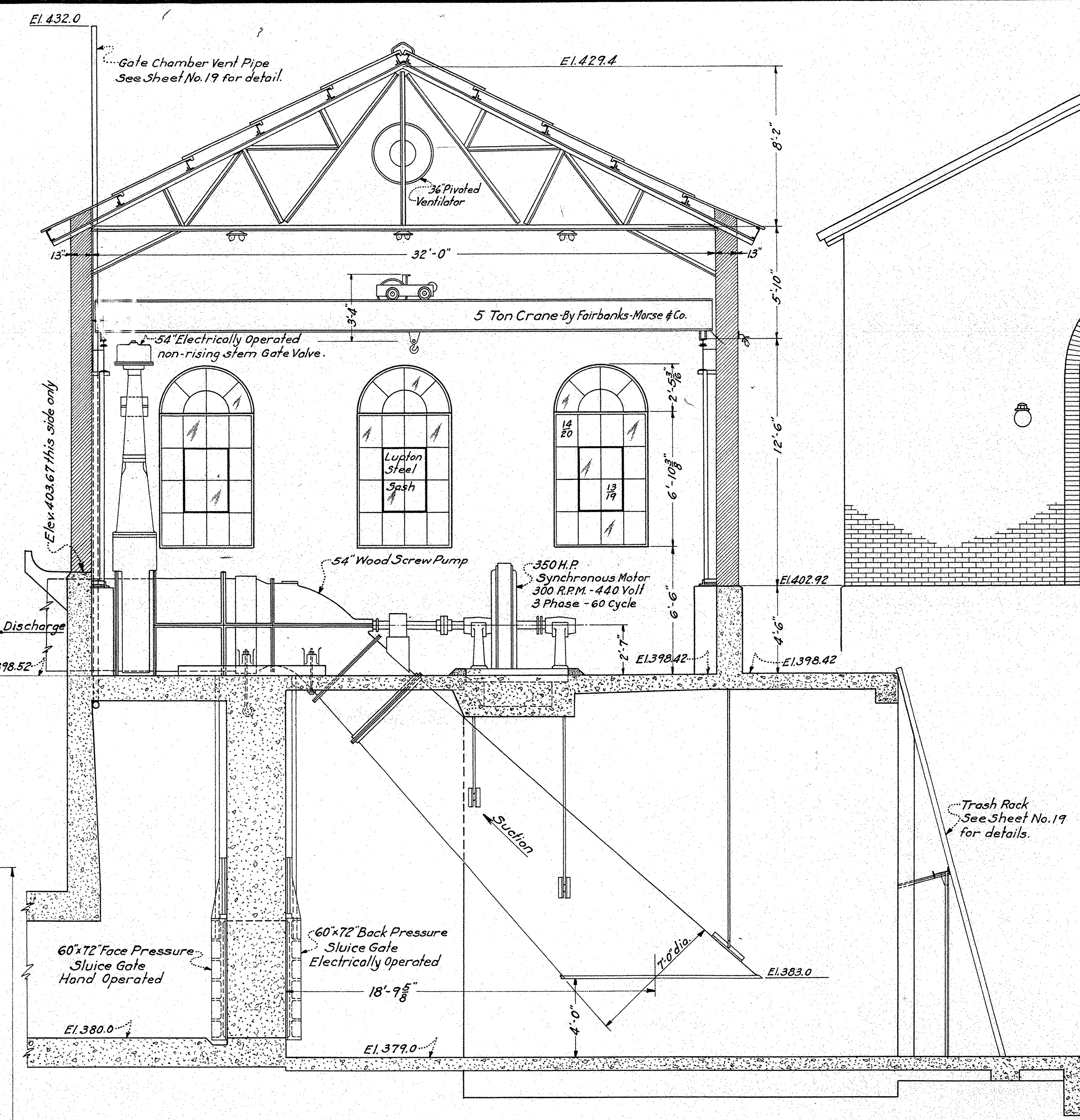
NOTE: This drawing is not to scale.

SHEET NO. 16 OF 57 SHEETS

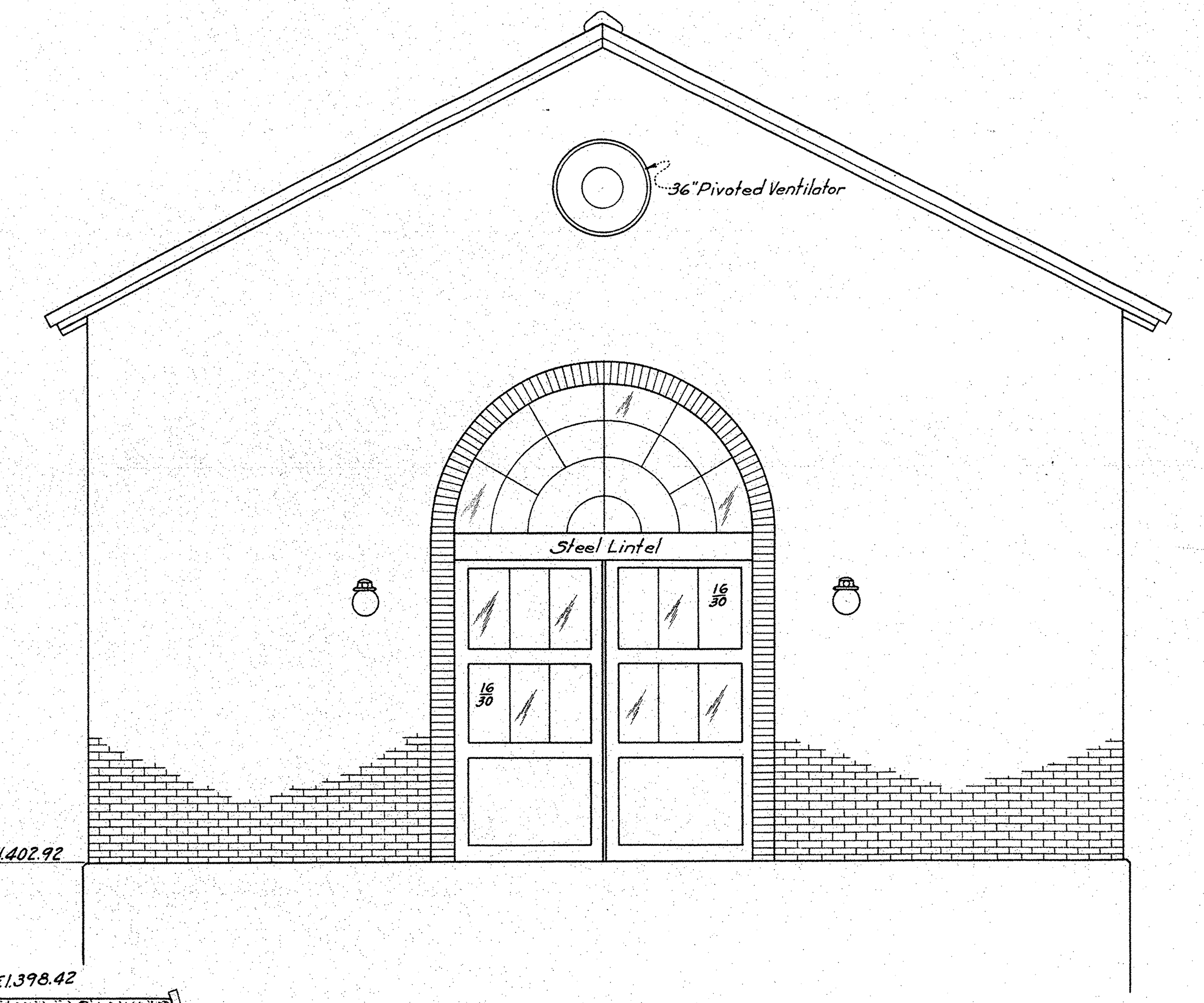

SECTION E-E
STANDARD CONSTRUCTION JOINT
Scale: 1½" = 1'-0"
SECTION H-H
Scale: ¼" = 1'-0"
This Wall to be poured after discharge pipes are in place.
PLAN OF TOP SLAB AT DISCHARGE PIPE
Bars extended from adjacent slabs 12" into opening
SECTION D-D
Space around discharge pipe to be poured after pipes are placed.
SECTION F-F
FOUNDATION PLAN
NOTE:
Steel Details to be approved by Engineer.
NOTE:
This design made for shale foundation.
Bevel all exposed edges of concrete with ¾" triangular moulding.
Provide bolted connections for steel beams to columns and beams to beams.
Steel details to be approved by Engineer.
Provide 4" ϕ drain holes at 10'-0" ctrs., in wing walls.
See Sheet 16 for additional Sections and Details.
NOTE: Make transition from square to circular section to match sluiceway in last 18"
SECTION C-C
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer.
Approved:
Vice President
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
EAST LEVEE - SECTION NO. 2
HILLS LAKE DIVISION
FOUNDATION - PUMPING PLANT B
SHEET NO. 4 OF 6 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: ¼" = 1'-0"
SHEET NO. 17 OF 57 SHEETS
W.E.G. May 1929



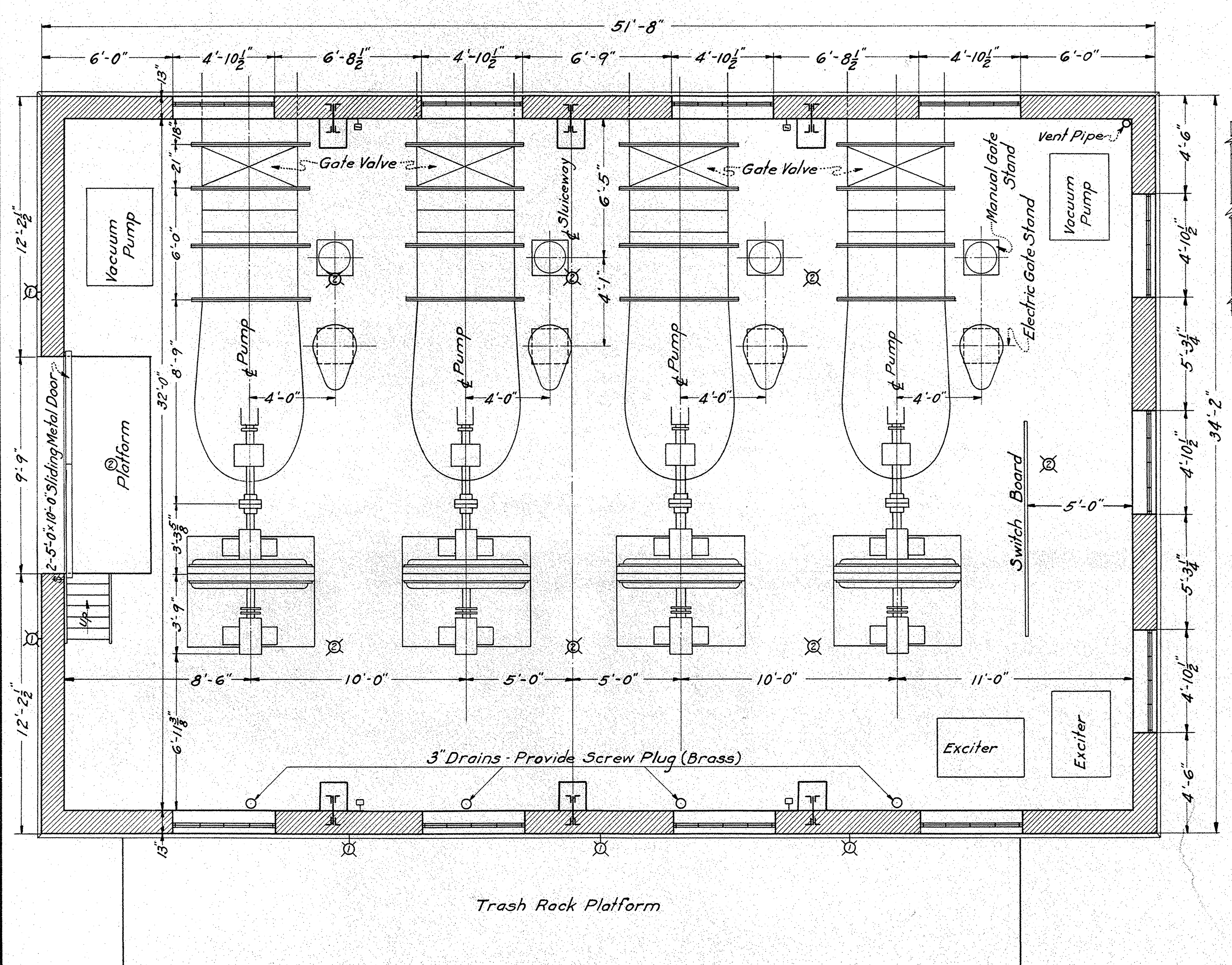
EAST ELEVATION



TYPICAL SECTION



SOUTH ELEVATION



FLOOR PLAN

NOTES:

Roof to be Federal Cement Tile Company's Interlocking Cement Tile or equal.

Details for Structural Steel to be approved by the Engineer.

Brick Facing to be Dark Red Mat Face-Brick, laid in Black 1:3 Portland Cement mortar with 1/2" raked joints. Backing up brick may be common brick. Brick shall be approved by the Engineer. Approved heavy wall ties shall be used in every course at frequent intervals.

Set brick out 2" around windows and door.

Provide substantial Yale lock or equal for door.

Wiring plans and lighting fixtures to be approved by the Engineer.

Windows to be Lupton steel windows with pivoted ventilator, or equal.

Doors to be Lupton seamless steel tube doors with wire glass or equal.

Building contract to include all work above Elevation 402.92, except crane and pumping equipment.

Brick wall on Levee side to be built after discharge pipes are in place.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer.
Approved: [signature]
Vice President.

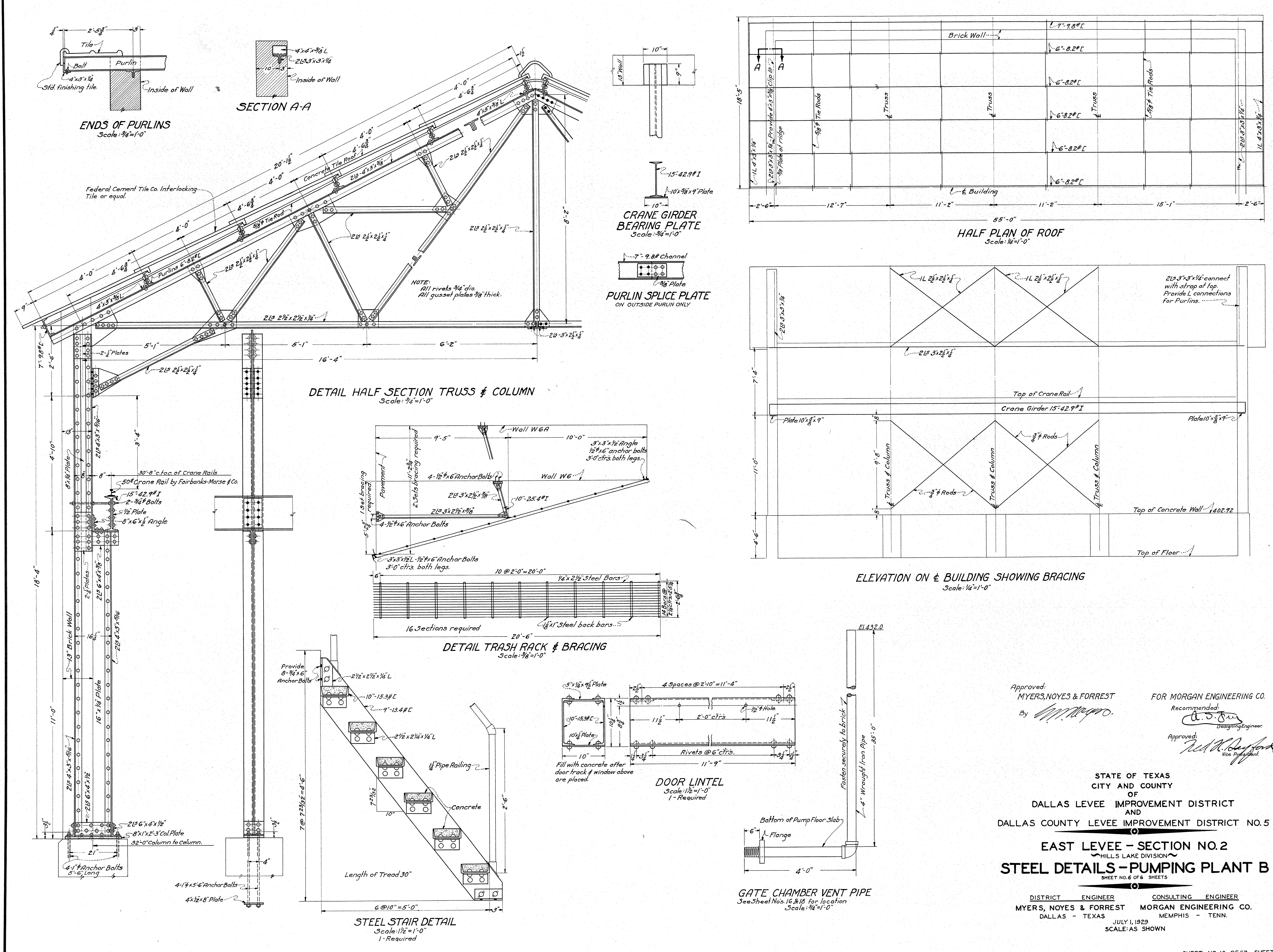
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE - SECTION NO. 2
HILLS LAKE DIVISION

SUPERSTRUCTURE - PUMPING PLANT B
SHEET NO. 5 OF 6 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: 1/4" = 1'-0"



Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer.
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

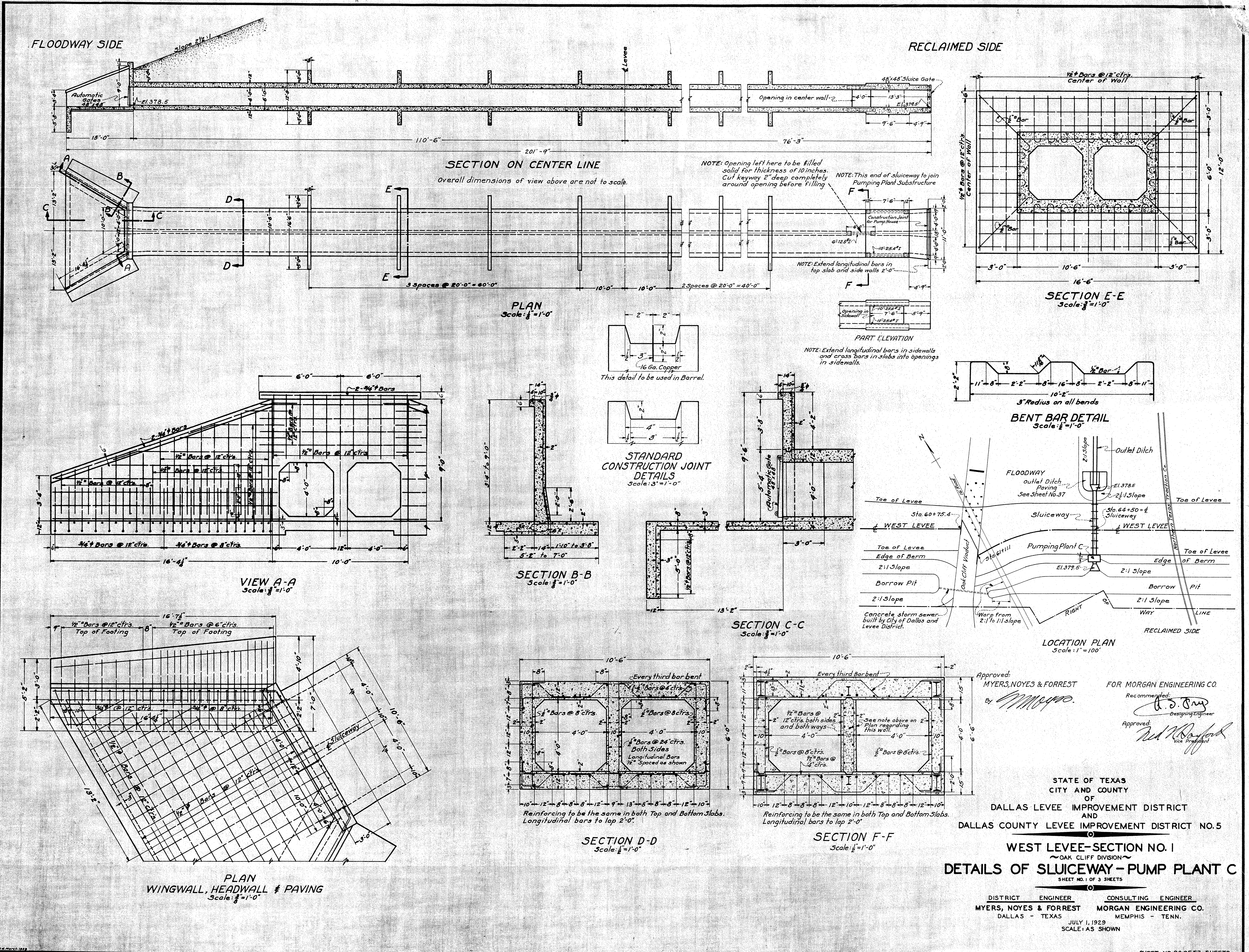
EAST LEVEE – SECTION NO. 2
HILLS LAKE DIVISION

STEEL DETAILS – PUMPING PLANT B
SHEET NO. 6 OF 6 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 19 OF 57 SHEETS



Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer
Approved: [signature] Vice President

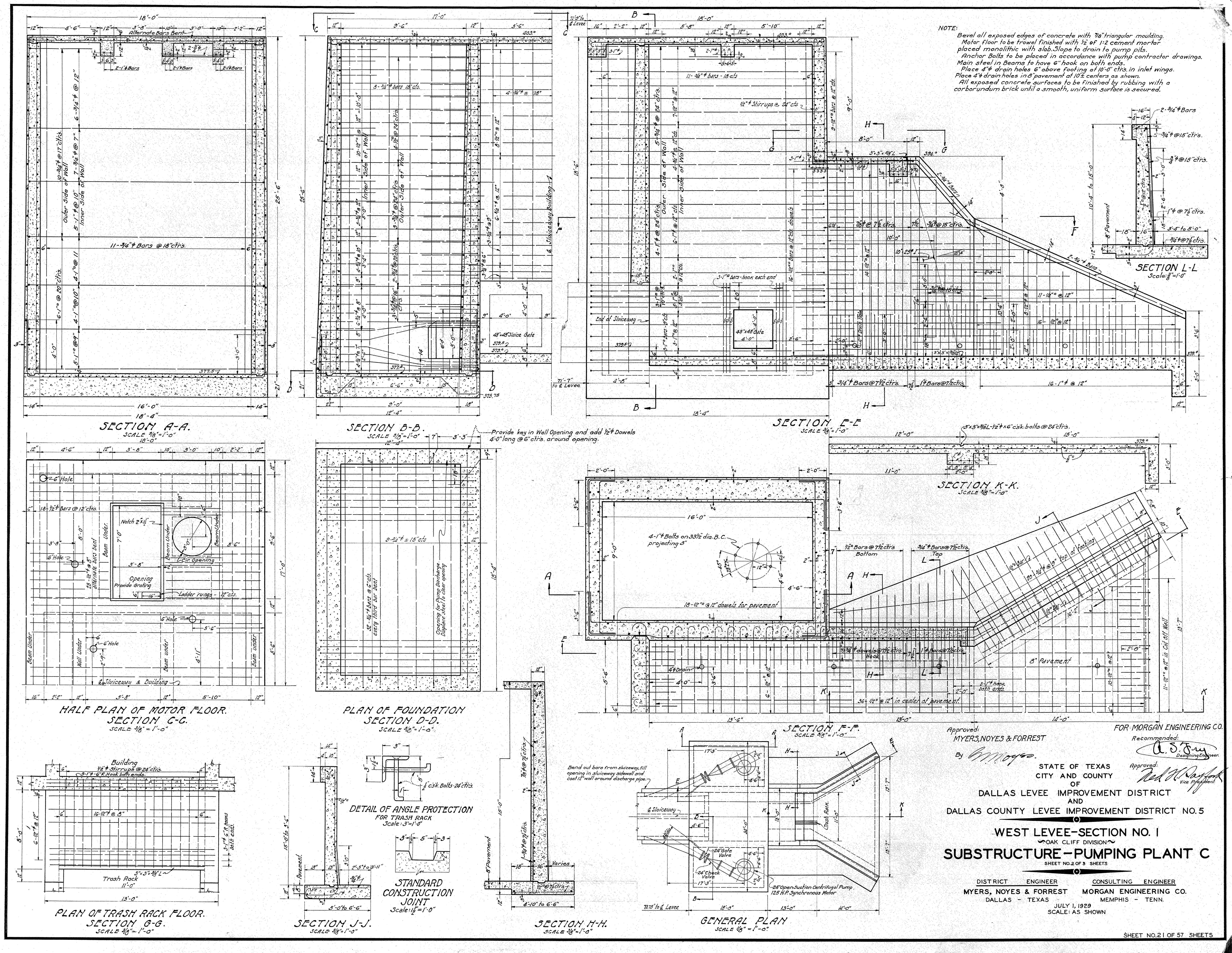
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE-SECTION NO. 1
~OAK CLIFF DIVISION~
DETAILS OF SLUICEWAY - PUMP PLANT C
SHEET NO. 1 OF 3 SHEETS

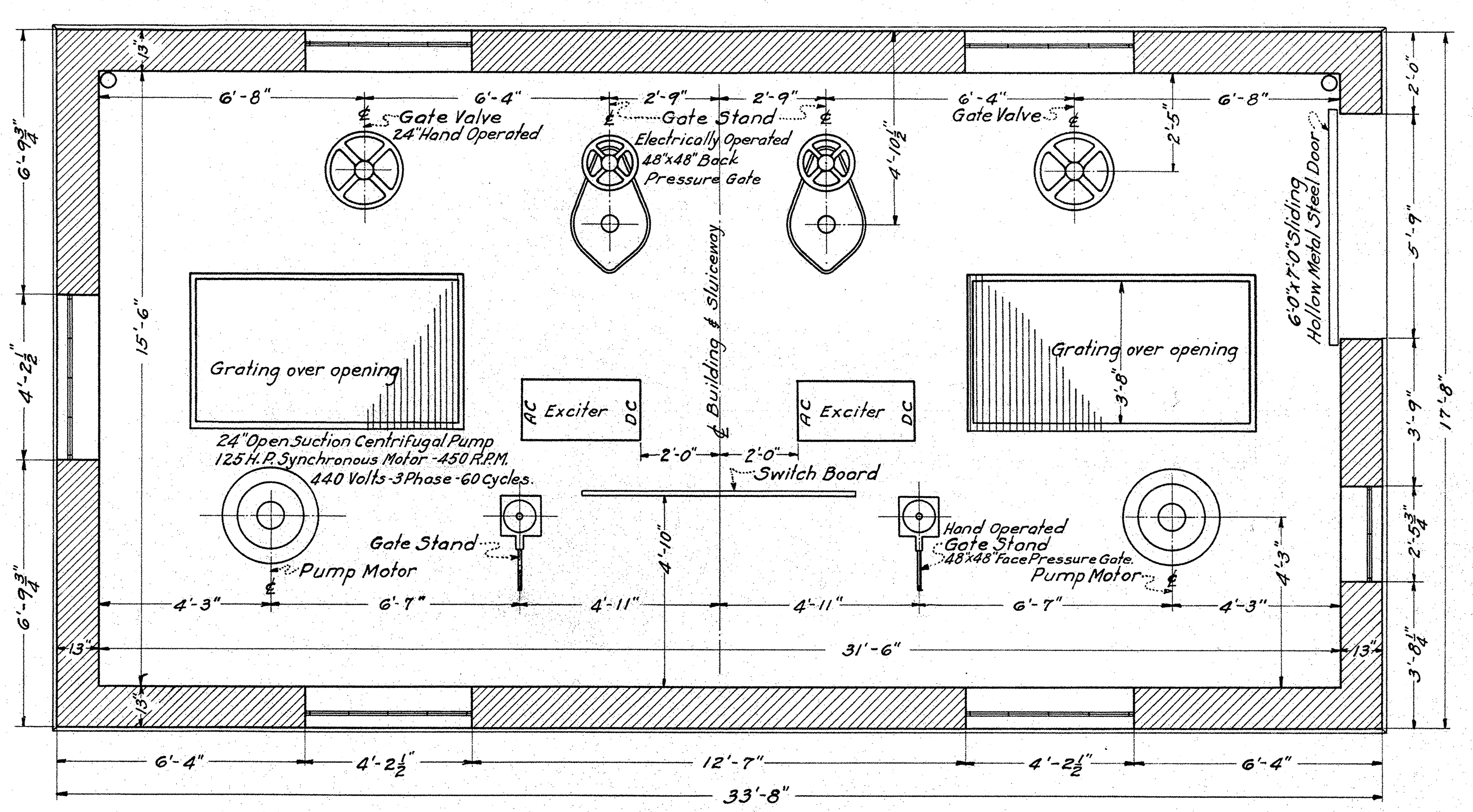
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 20 OF 57 SHEETS

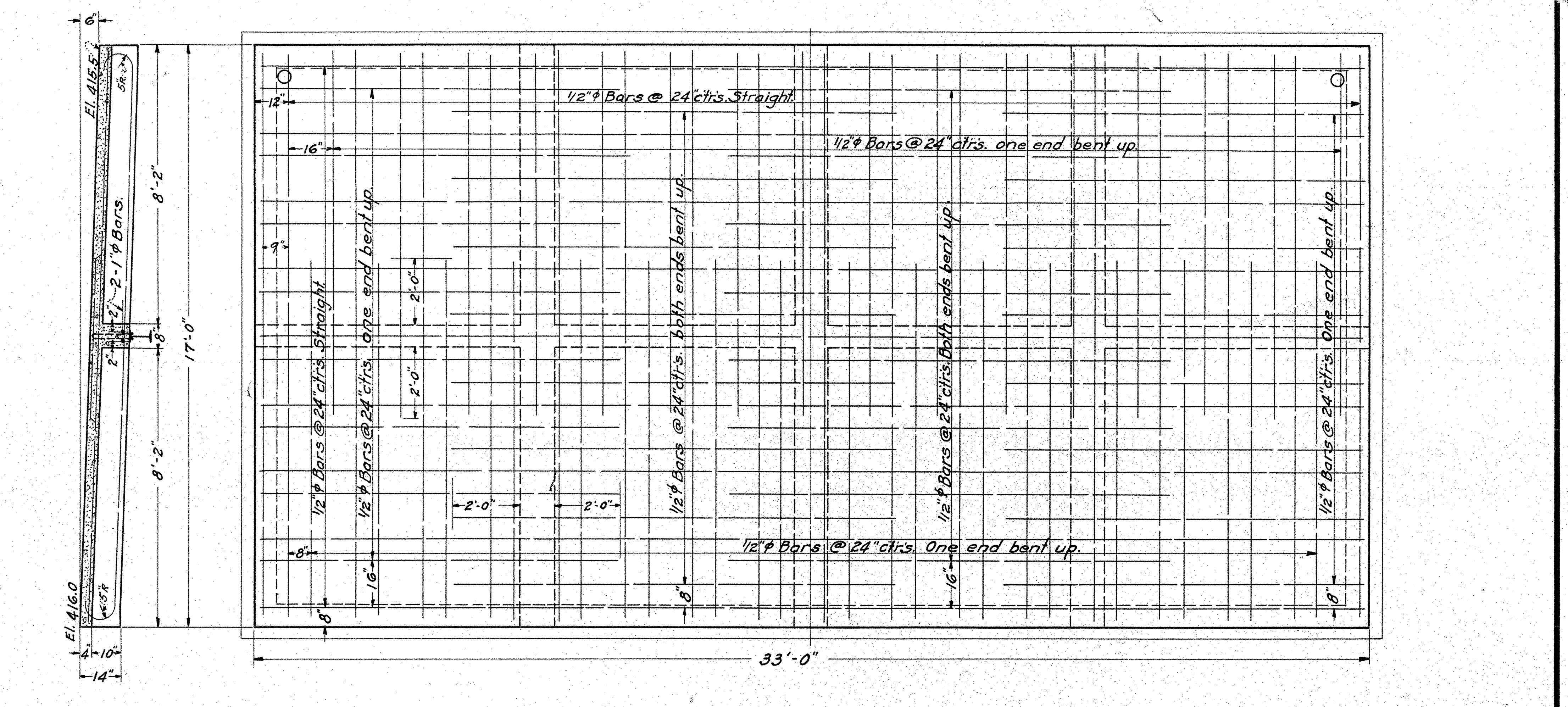


NOTE:
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Motor floor to be trowel finished with 1/2" of 1:2 cement mortar placed monolithic with slab. Slope to drain to pump pits.
Anchor Bolts to be placed in accordance with pump contractor drawings.
Main steel in Beams to have 6" hook on both ends.
Place 4"ϕ drain holes 6" above footing at 10'-0" ctrs. in inlet wings.
Place 4"ϕ drain holes in 8" pavement at 10'± centers as shown.
All exposed concrete surfaces to be finished by rubbing with a corborundum brick until a smooth, uniform surface is secured.
SECTION A-A.
SCALE 3/8"=1'-0"
SECTION B-B.
SCALE 3/8"=1'-0"
Provide key in Wall Opening and add 1/2"ϕ Dowels 4'-0" long @ 6" ctrs. around opening.
SECTION E-E
SCALE 3/8"=1'-0"
SECTION L-L
Scale: 3/8"=1'-0"
HALF PLAN OF MOTOR FLOOR.
SECTION C-C.
SCALE 3/8"=1'-0"
PLAN OF FOUNDATION
SECTION D-D.
SCALE 3/8"=1'-0"
SECTION K-K.
SCALE 3/8"=1'-0"
SECTION F-F.
SCALE 3/8"=1'-0"
PLAN OF TRASH RACK FLOOR.
SECTION G-G.
SCALE 3/8"=1'-0"
SECTION J-J.
SCALE 3/8"=1'-0"
DETAIL OF ANGLE PROTECTION
FOR TRASH RACK
Scale: 3"=1'-0"
STANDARD
CONSTRUCTION
JOINT
Scale: 1 1/2"=1'-0"
SECTION H-H.
SCALE 3/8"=1'-0"
GENERAL PLAN
SCALE 1/8"=1'-0"
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer.
Approved:
Vice President.
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
WEST LEVEE-SECTION NO. 1
OAK CLIFF DIVISION
SUBSTRUCTURE-PUMPING PLANT C
SHEET NO. 2 OF 3 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN
SHEET NO. 21 OF 57 SHEETS

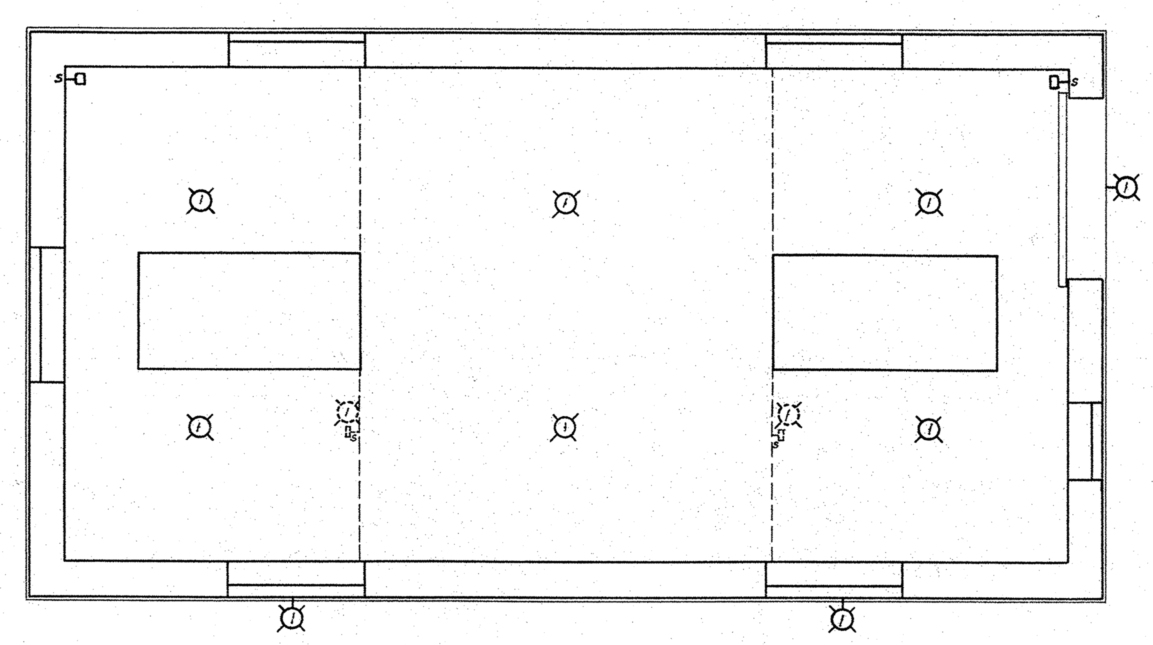


Design Note: This Pumping Plant designed on the consideration that Coombs Creek and Kidd Springs Branch above 1908 H.W. line will be carried by pressure sewers across the District to outlets in the Floodway as provided by the Ulrickson Plan, pressure sewers to be constructed by the City of Dallas.

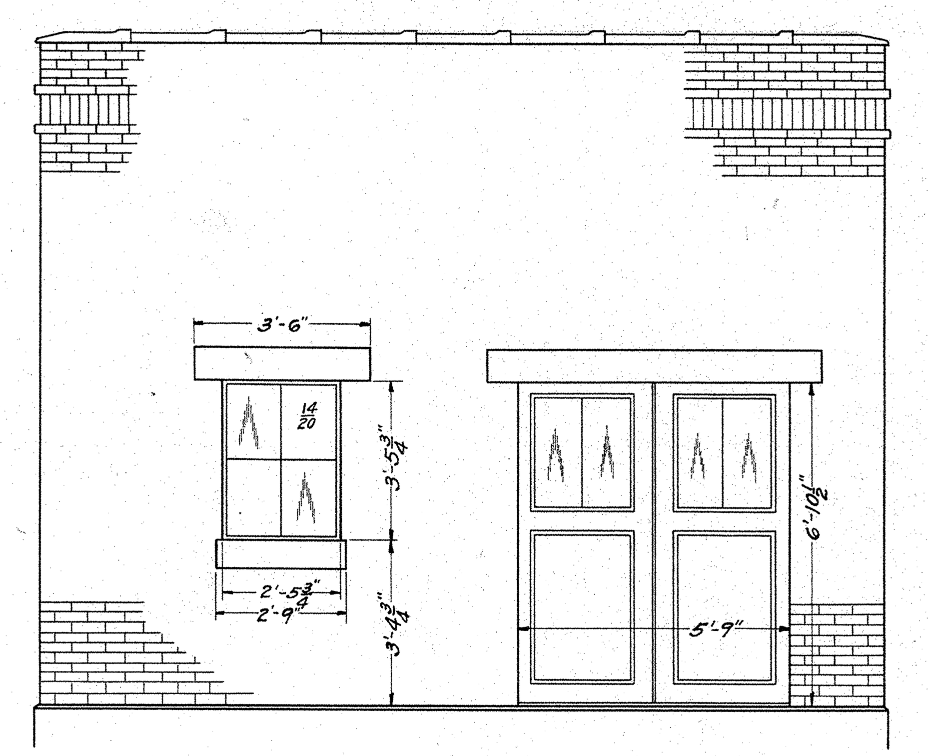
FLOOR PLAN
Scale: 1/8"=1'-0"



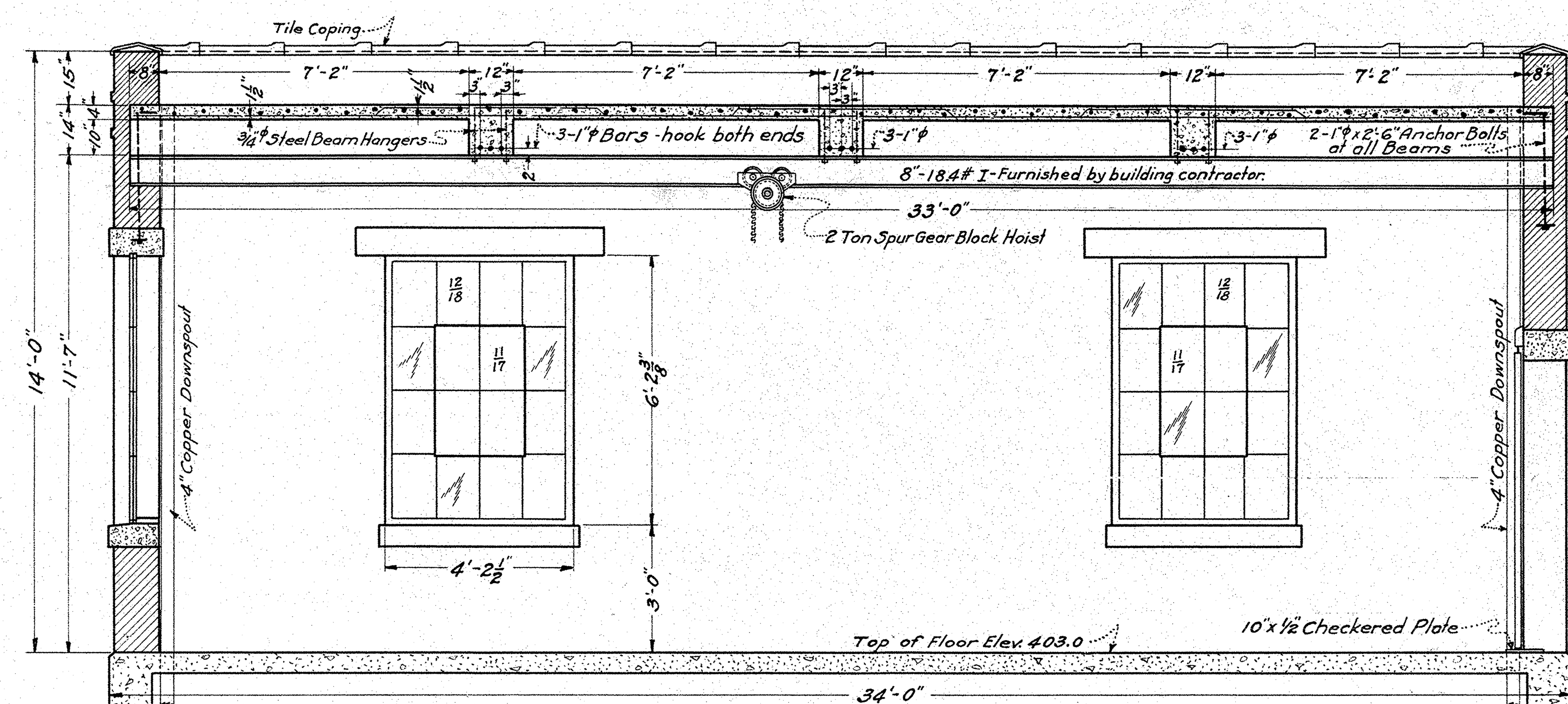
ROOF PLAN
Scale: 1/8"=1'-0"



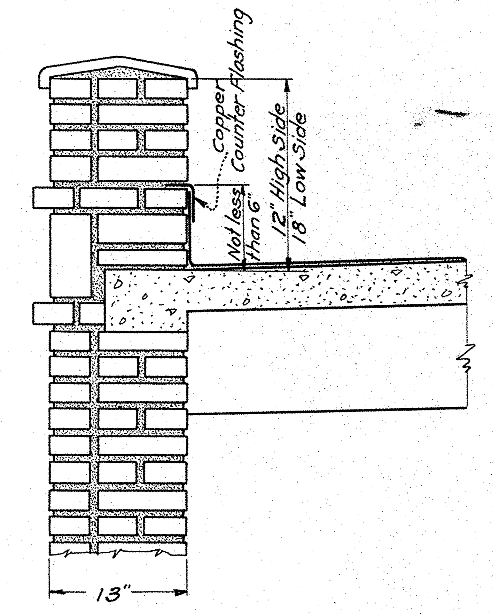
LIGHTING PLAN
Scale: 1/8"=1'-0"



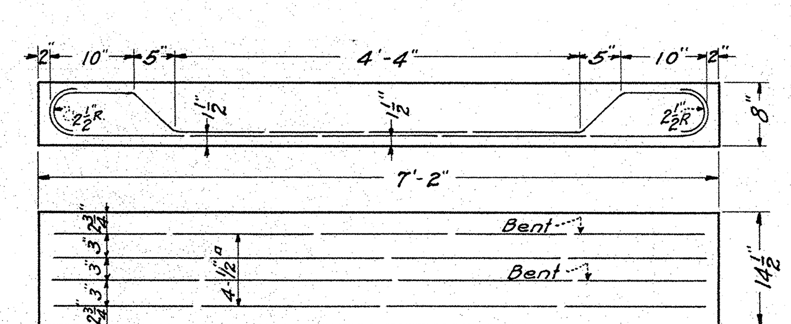
END ELEVATION
Scale: 1/8"=1'-0"



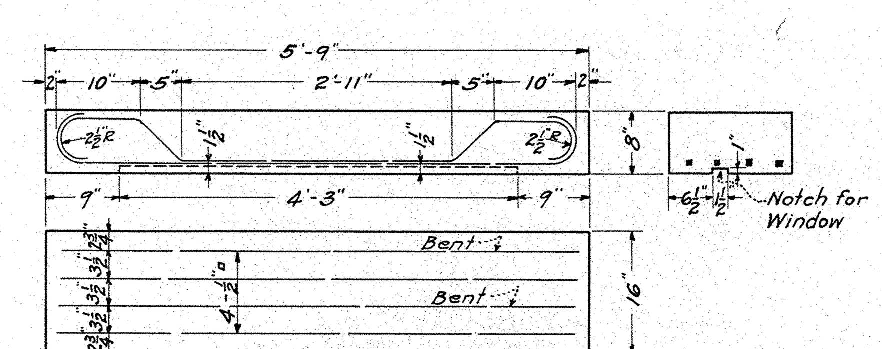
SECTION
Scale: 1/8"=1'-0"



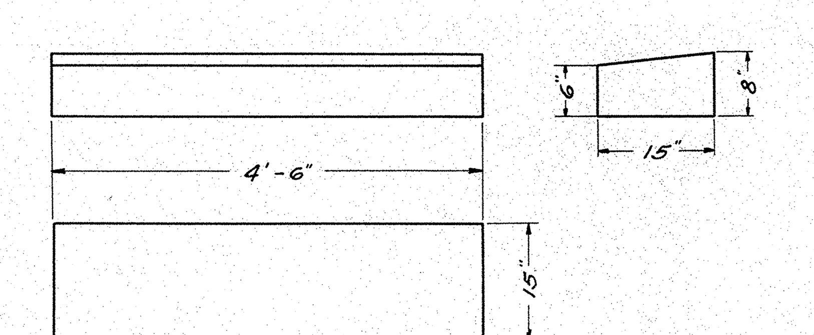
PARAPET DETAIL
Scale: 1"=1'-0"



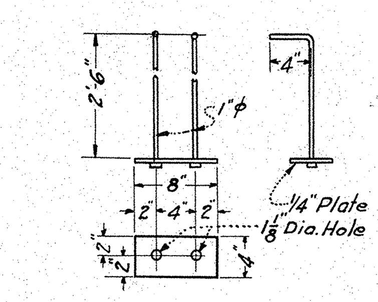
DETAIL DOOR LINTEL
Scale: 3/4"=1'-0"



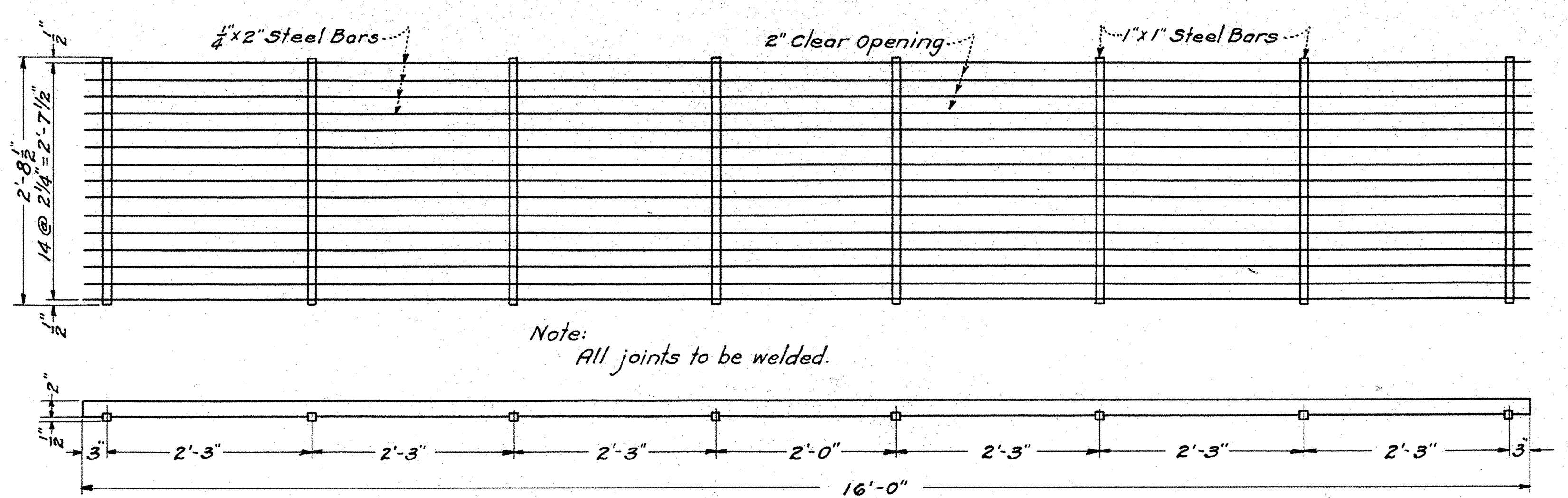
DETAIL WINDOW LINTEL
Scale: 3/4"=1'-0"



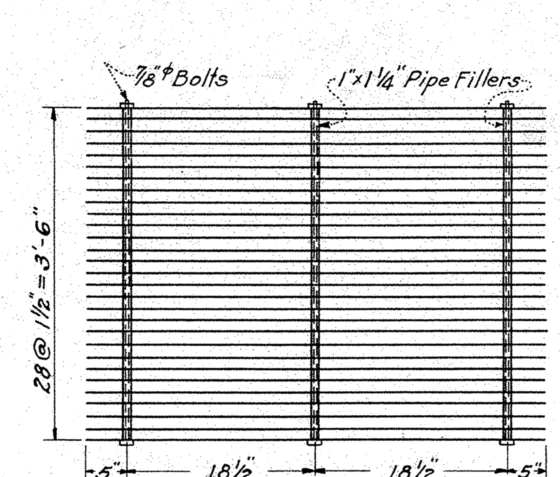
CONCRETE WINDOW SILL
Scale: 3/4"=1'-0"



ANCHOR BOLT DETAIL



DETAIL OF TRASH RACK
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"



DETAIL OF FLOOR GRATING
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"

NOTE:

Roof surface shall consist of four plies of Tarred Felt, laid and thoroughly mopped with pitch, and covered with 400 pounds of 1/4" to 5/8" gravel per hundred square feet embedded in hot pitch.

Bevel all exposed edges of concrete with 7/8" triangular moulding.

Brick facing shall be dark red mat faced Brick laid in black 1:3 Portland Cement mortar, with 1/2" raked joints.

Provide substantial Yale Lock or equal for door.

A commercial steel grating of equal strength may be substituted for steel grating as shown.

Wiring plans and lighting fixtures to be approved by the Engineer.

Backing up brick may be common brick. Approved heavy wall ties shall be used in every course at frequent intervals.

Windows to be Lupton Steel Windows with pivoted ventilators, or equal.

Doors to be Lupton Seamless Steel Tube Doors with wire glass, or equal.

Building contract to include all work above Elevation 403.0 except the 2-Ton Spur Gear Block Hoist and Pumping Equipment.

Structural steel, doors and windows to be painted one shop coat Detroit Graphite Co. No. 400 or equal, one field coat No. 868 or equal and one finishing coat No. 865 or equal.

Approved:
MYERS, NOYES & FORREST
By G. M. Noyes

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer.
Approved:
Ned N. Dayford
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

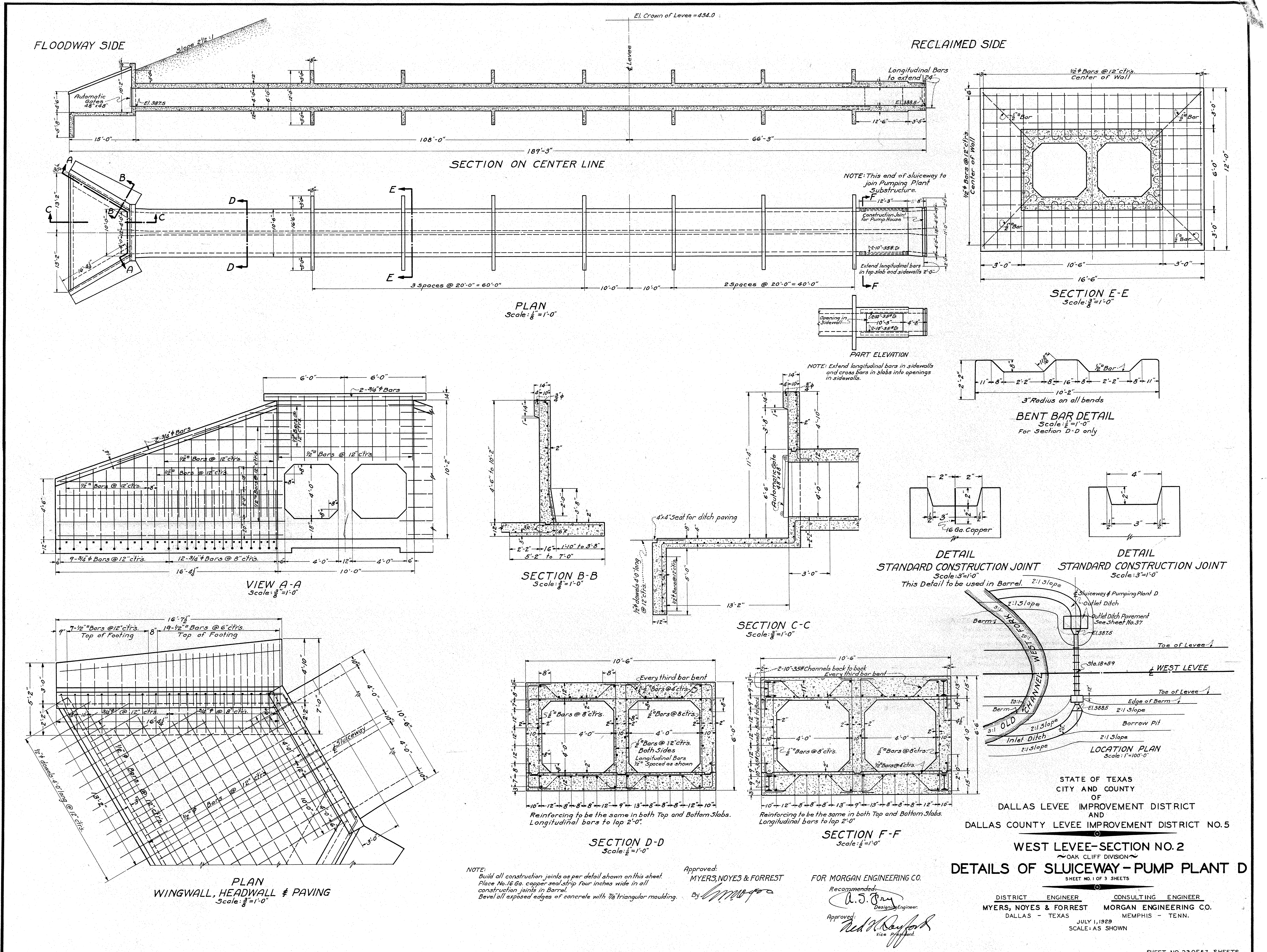
WEST LEVEE-SECTION NO. 1
OAK CLIFF DIVISION

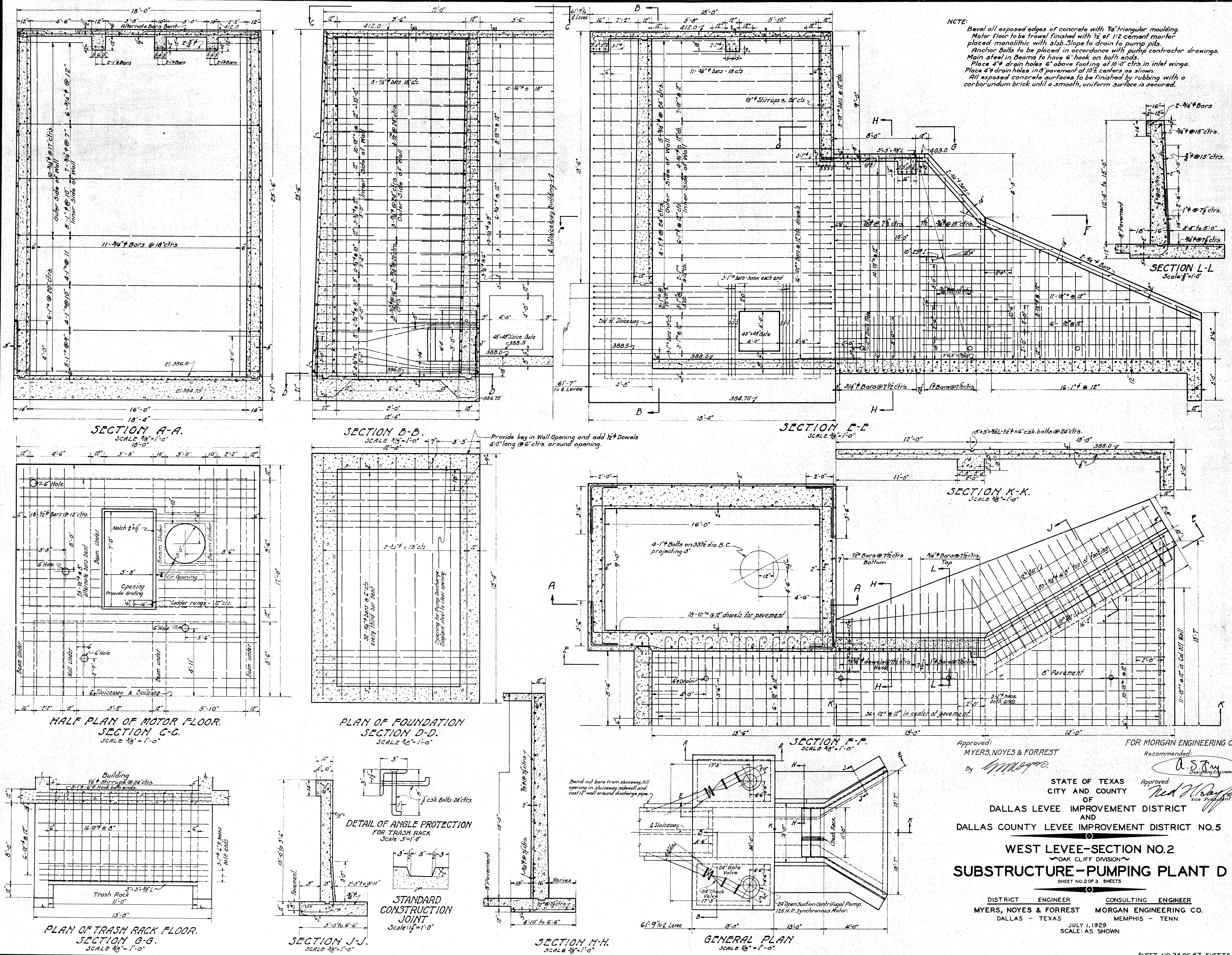
SUPERSTRUCTURE-PUMPING PLANT C
SHEET NO. 3 OF 3 SHEETS

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN

JULY 1, 1929
SCALE: AS SHOWN


FLOODWAY SIDE
RECLAIMED SIDE
El. Crown of Levee = 434.0
Automatic Gates 48"x48"
Longitudinal Bars to extend 24"
189'-3"
SECTION ON CENTER LINE
NOTE: This end of sluiceway to join Pumping Plant Substructure.
Construction Joint for Pump House
Extend longitudinal bars in top slab and sidewalls 2'-0"
3 Spaces @ 20'-0" = 60'-0"
2 Spaces @ 20'-0" = 40'-0"
PLAN
Scale: 1/8"=1'-0"
SECTION E-E
Scale: 3/8"=1'-0"
PART ELEVATION
NOTE: Extend longitudinal bars in sidewalls and cross bars in slabs into openings in sidewalls.
3" Radius on all bends
BENT BAR DETAIL
Scale: 1/2"=1'-0"
For Section D-D only
VIEW A-A
Scale: 3/8"=1'-0"
SECTION B-B
Scale: 3/8"=1'-0"
4"x4" Seat for ditch paving
SECTION C-C
Scale: 3/8"=1'-0"
16 Ga. Copper
DETAIL
STANDARD CONSTRUCTION JOINT
Scale: 3"=1'-0"
This Detail to be used in Barrel.
DETAIL
STANDARD CONSTRUCTION JOINT
Scale: 3"=1'-0"
PLAN
WINGWALL, HEADWALL & PAVING
Scale: 3/8"=1'-0"
Reinforcing to be the same in both Top and Bottom Slabs.
Longitudinal bars to lap 2'-0".
SECTION D-D
Scale: 1/2"=1'-0"
Reinforcing to be the same in both Top and Bottom Slabs.
Longitudinal bars to lap 2'-0".
SECTION F-F
Scale: 1/2"=1'-0"
Toe of Levee
WEST LEVEE
Edge of Berm
Borrow Pit
Inlet Ditch
Outlet Ditch
OLD WEST FORK CHANNEL
LOCATION PLAN
Scale: 1"=100'-0"
NOTE:
Build all construction joints as per detail shown on this sheet.
Place No. 16 Ga. copper seal strip four inches wide in all construction joints in Barrel.
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
A. J. Fry
Designing Engineer
Approved:
Ned H. Dayford
Vice President
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
WEST LEVEE-SECTION NO. 2
~OAK CLIFF DIVISION~
DETAILS OF SLUICEWAY - PUMP PLANT D
SHEET NO. 1 OF 3 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN
SHEET NO. 23 OF 57 SHEETS



NOTE:

Bevel all exposed edges of concrete with 7/8" triangular moulding.

Motor floor to be trowel finished with ½" of 1:2 cement mortar placed monolithic with slab. Slope to drain to pump pits.

Anchor Bolts to be placed in accordance with pump contractor drawings. Main steel in Beams to have 6" hook on both ends.

Place 4"φ drain holes 6" above footing at 10'-0" ctrs. in inlet wings. Place 4"φ drain holes in 8" pavement at 10'± centers as shown.

All exposed concrete surfaces to be finished by rubbing with a corborundum brick until a smooth, uniform surface is secured.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer.
Approved:
Ned H. Dayford
Vice President.

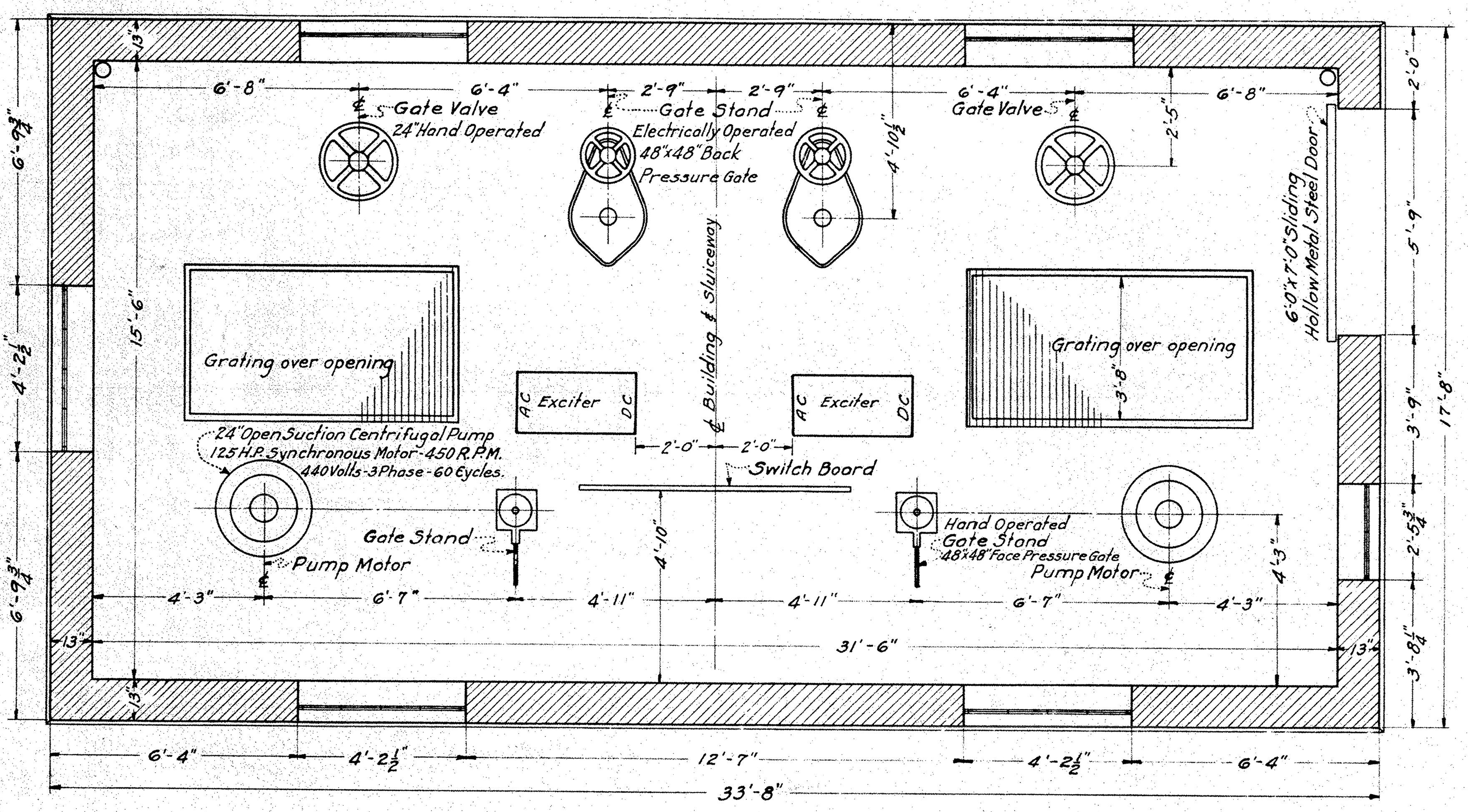
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE-SECTION NO. 2
~OAK CLIFF DIVISION~
SUBSTRUCTURE-PUMPING PLANT D
SHEET NO. 2 OF 3 SHEETS

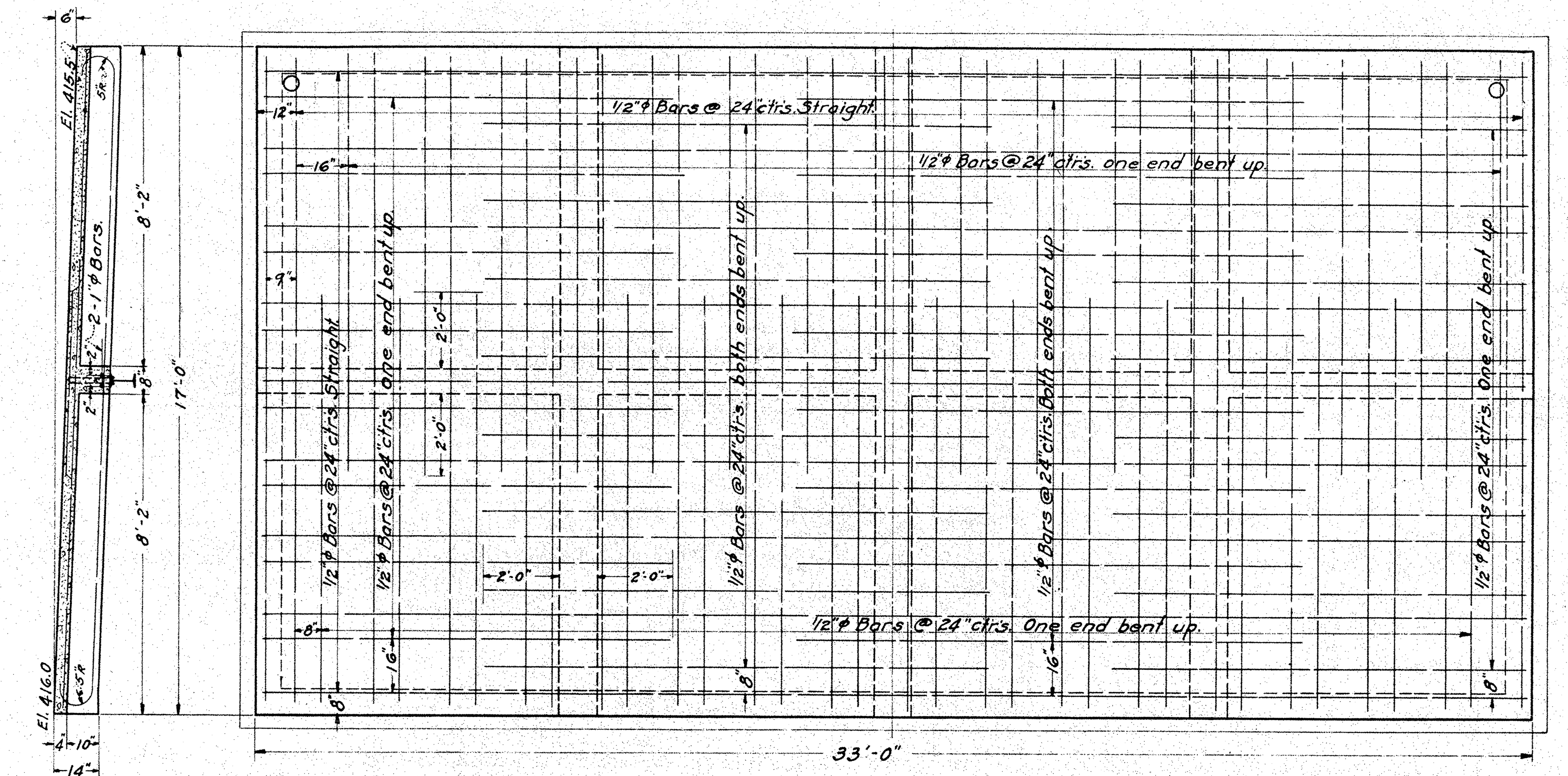
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

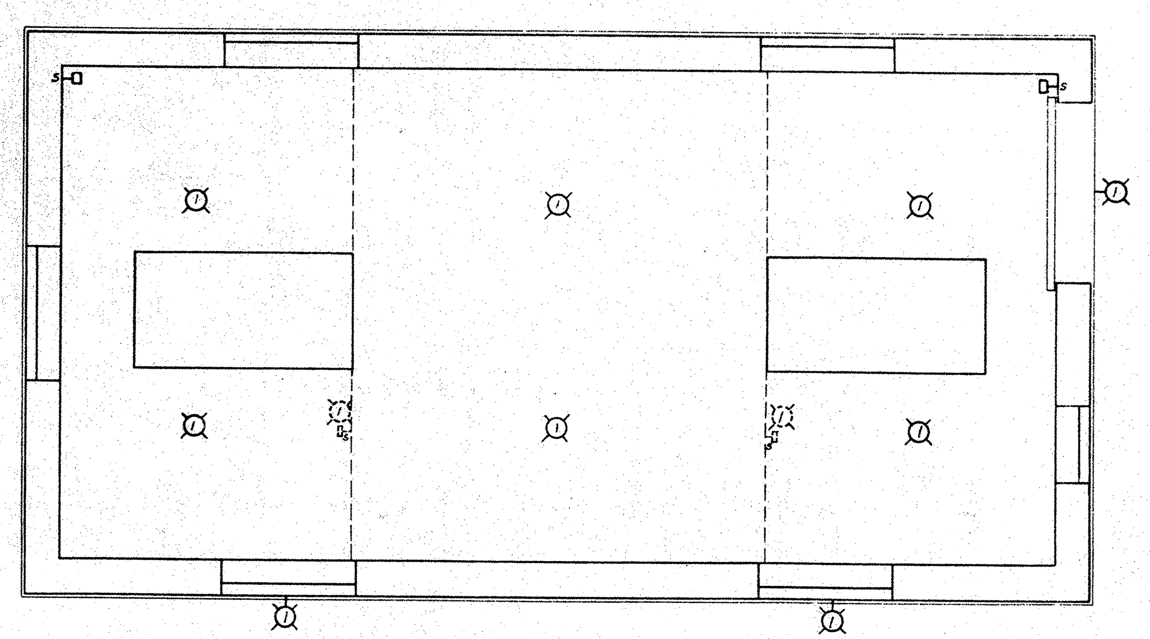
SHEET NO. 24 OF 57 SHEETS



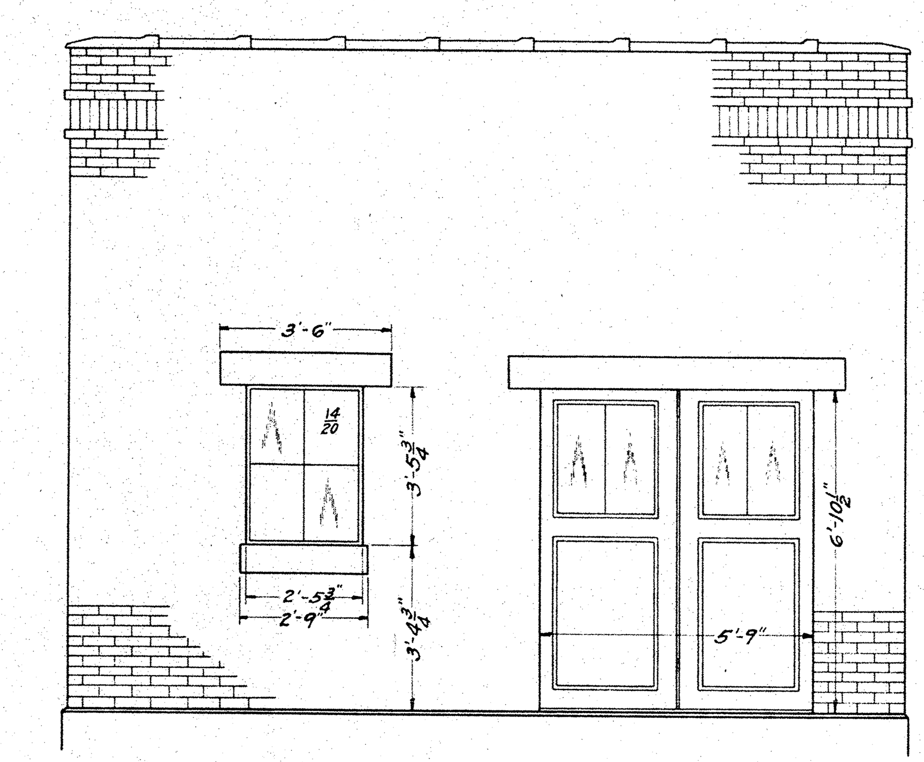
FLOOR PLAN
Scale: 1/8"=1'-0"



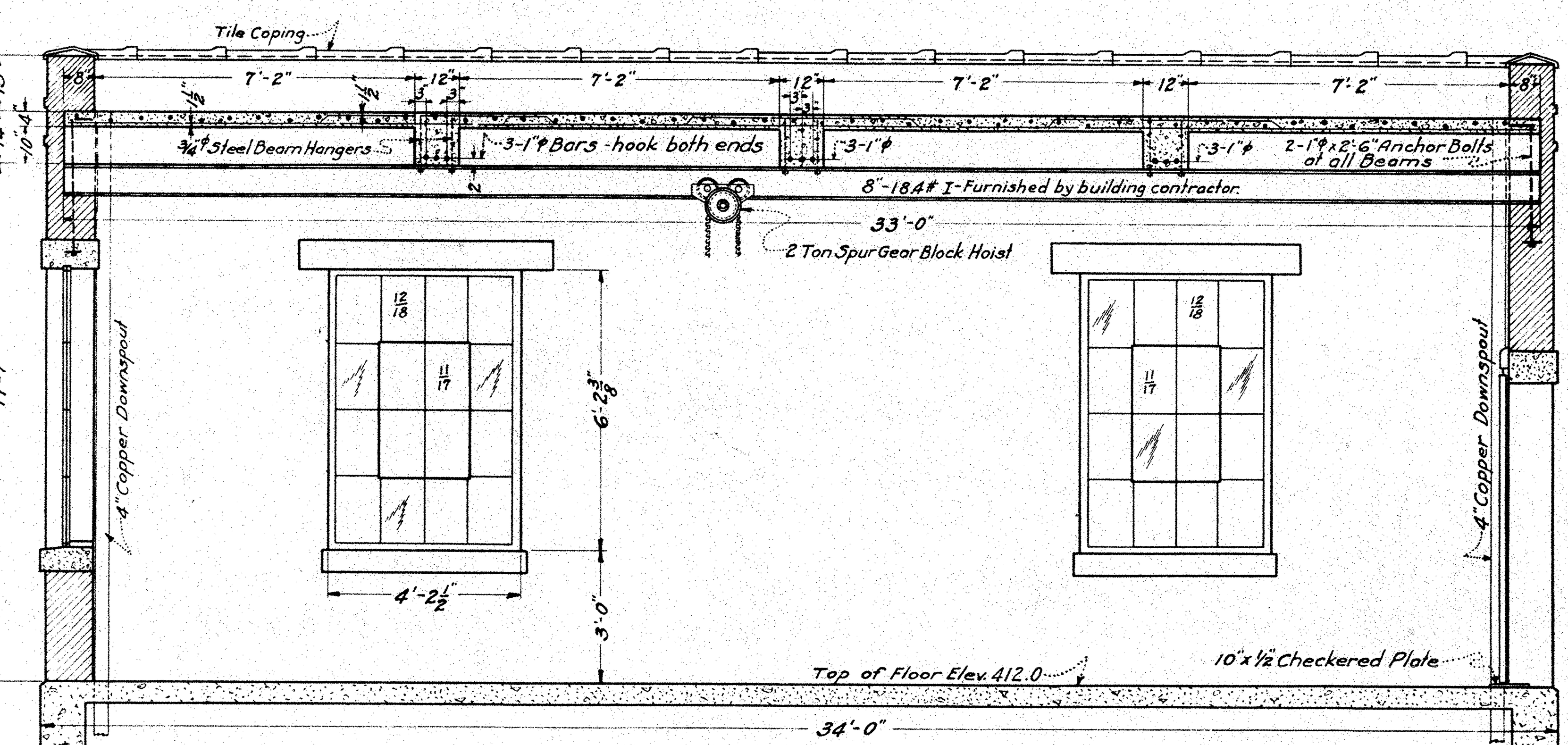
ROOF PLAN
Scale: 1/8"=1'-0"



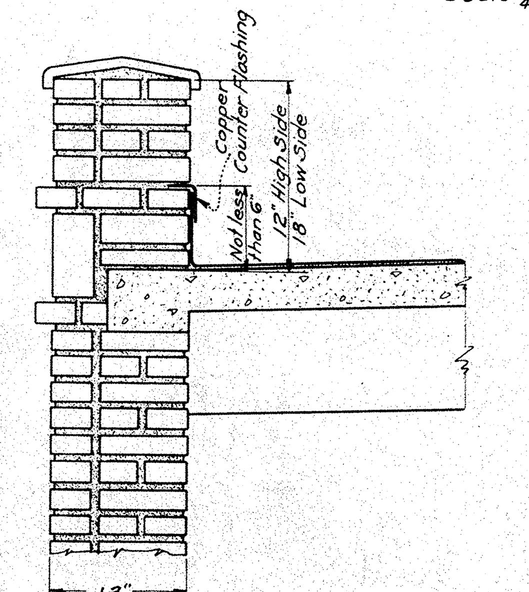
LIGHTING PLAN
Scale: 1/8"=1'-0"



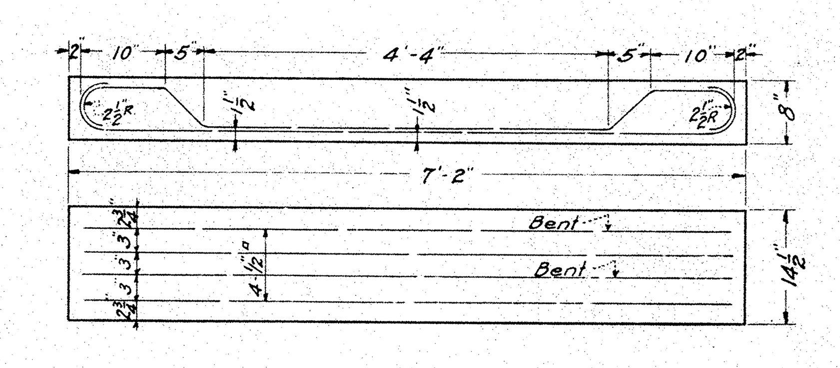
END ELEVATION
Scale: 1/8"=1'-0"



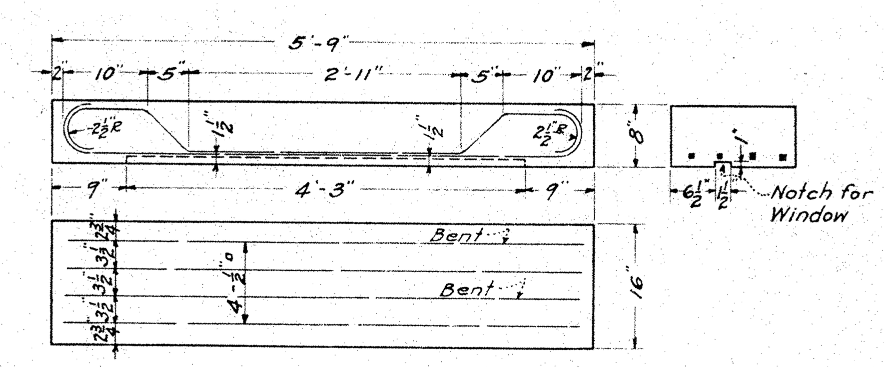
SECTION
Scale: 1/8"=1'-0"



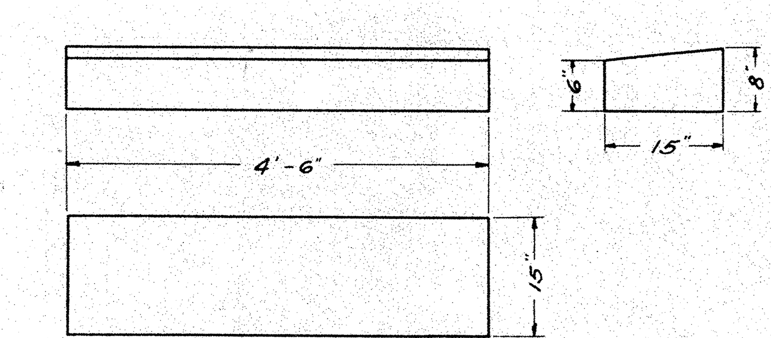
PARAPET DETAIL
Scale: 1"=1'-0"



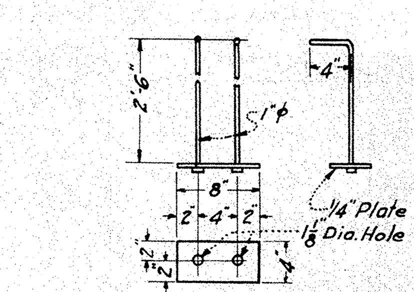
DETAIL DOOR LINTEL
Scale: 3/4"=1'-0"



DETAIL WINDOW LINTEL
Scale: 3/4"=1'-0"



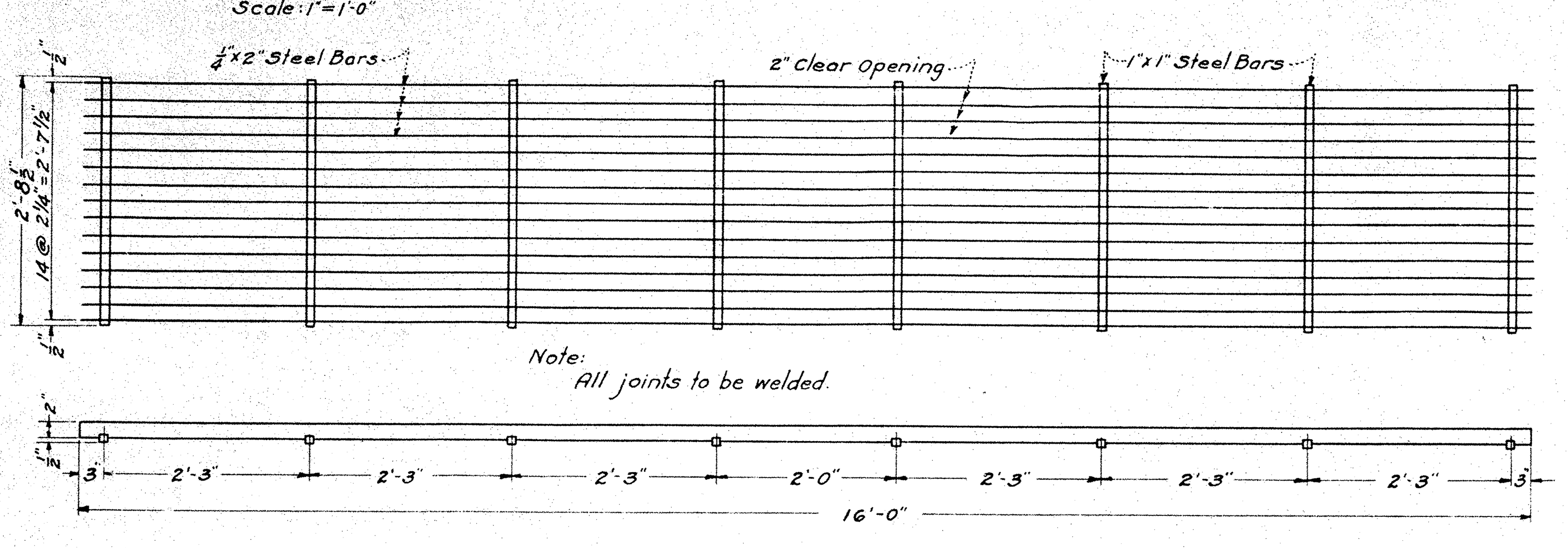
CONCRETE WINDOW SILL
Scale: 3/4"=1'-0"



ANCHOR BOLT DETAIL

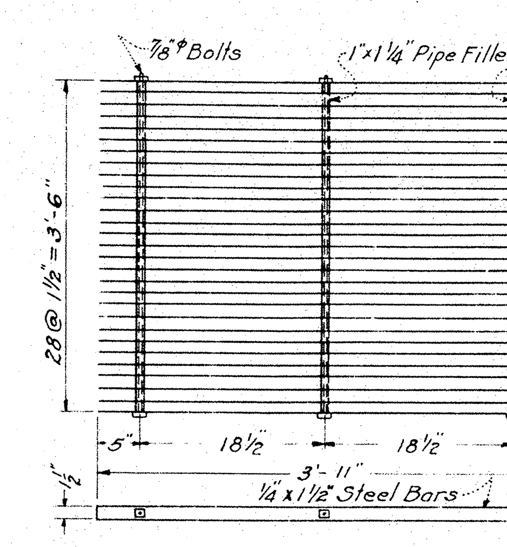
Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer
Approved: [signature] Vice President



Note:
All joints to be welded.

DETAIL OF TRASH RACK
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"



DETAIL OF FLOOR GRATING
4 SECTIONS REQUIRED
Scale: 3/4"=1'-0"

NOTE:

Roof surface shall consist of four plies of Tarred Felt, laid and thoroughly mopped with pitch, and covered with 400 pounds of 1/4" to 5/8" gravel per hundred square feet embedded in hot pitch.

Bevel all exposed edges of concrete with 7/8" triangular moulding.

Brick facing shall be dark red mat faced Brick laid in black 1:3 Portland Cement mortar, with 1/2" raked joints.

Provide substantial Yale Lock or equal for door.

A commercial steel grating of equal strength may be substituted for steel grating as shown.

Wiring plans and lighting fixtures to be approved by the Engineer.

Backing up brick may be common brick. Approved heavy wall ties shall be used in every course at frequent intervals.

Windows to be Lupton Steel Windows with pivoted ventilators, or equal.

Doors to be Lupton Seamless Steel Tube Doors with wire glass, or equal.

Building contract to include all work above Elevation 412.0 except the 2-Ton Spur Gear Block Hoist and Pumping Equipment.

Structural steel, doors and windows to be painted one shop coat Detroit Graphite Co. No. 400 or equal, one field coat No. 868 or equal and one finishing coat No. 865 or equal.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

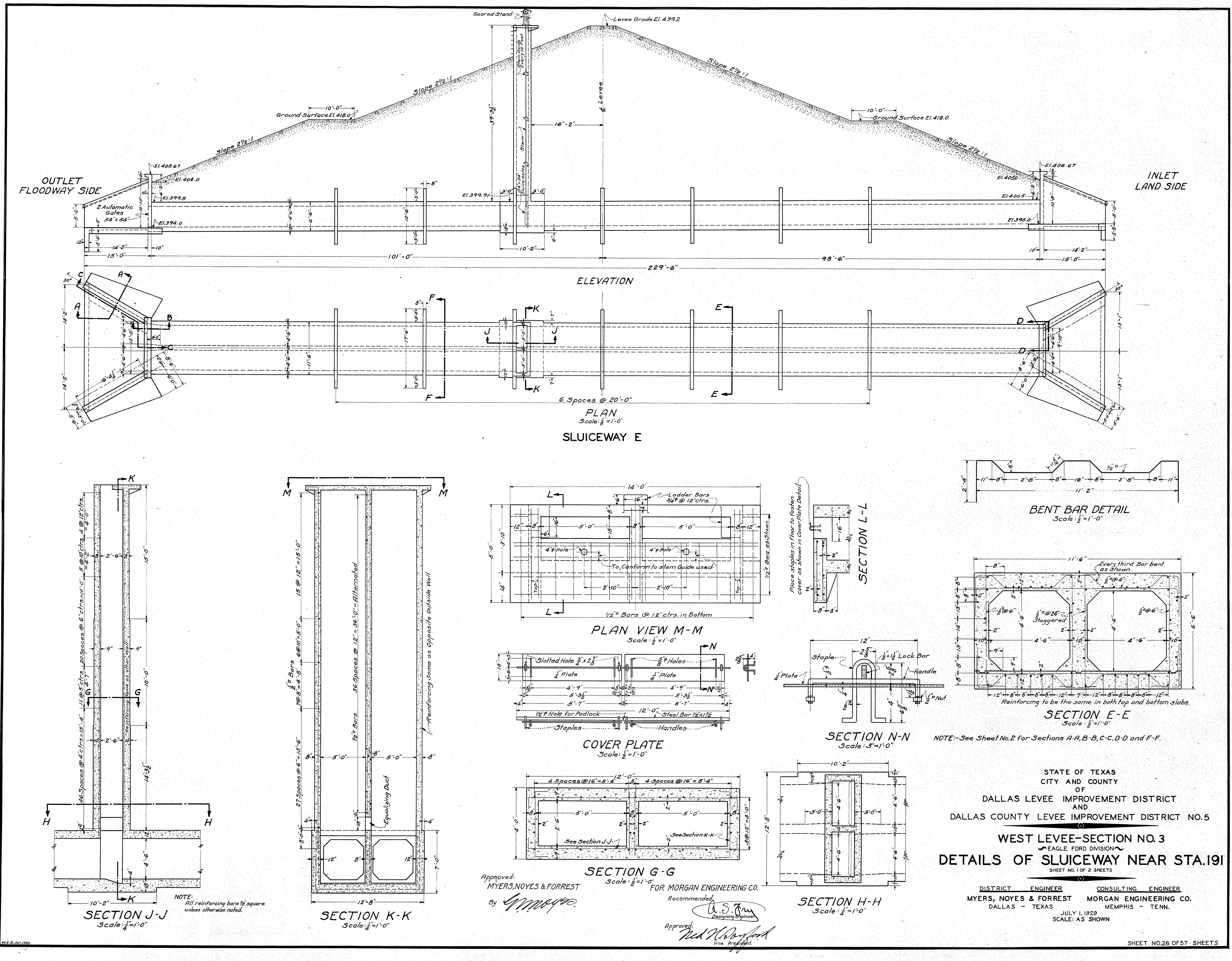
WEST LEVEE-SECTION NO. 2
OAK CLIFF DIVISION

SUPERSTRUCTURE-PUMPING PLANT D
SHEET NO. 3 OF 3 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Apr. 1929



Approved:
MYERS, NOYES & FORREST
By G. M. Noyes
FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry, Designing Engineer
Approved: Ned H. Dayford, Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

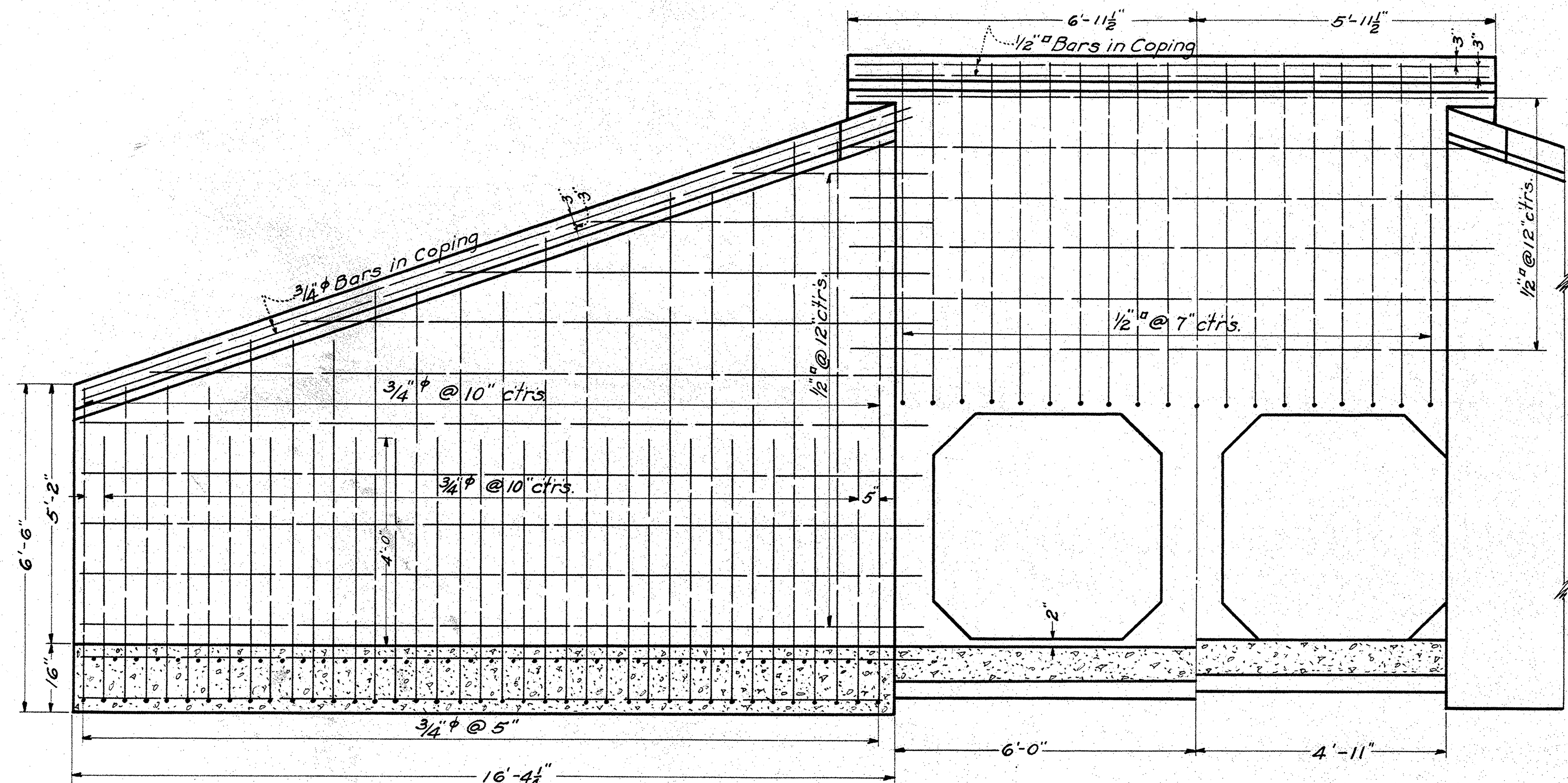
WEST LEVEE-SECTION NO. 3
EAGLE FORD DIVISION

DETAILS OF SLUICEWAY NEAR STA. 191

SHEET NO. 1 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN



OUTLET WING WALL

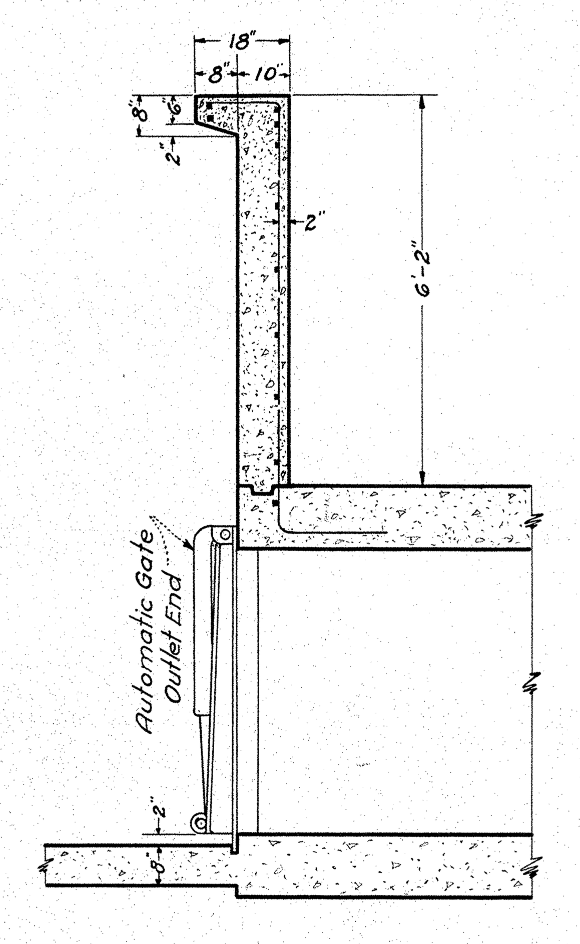
VIEW C-C

OUTLET HEADWALL

SECTION D-D

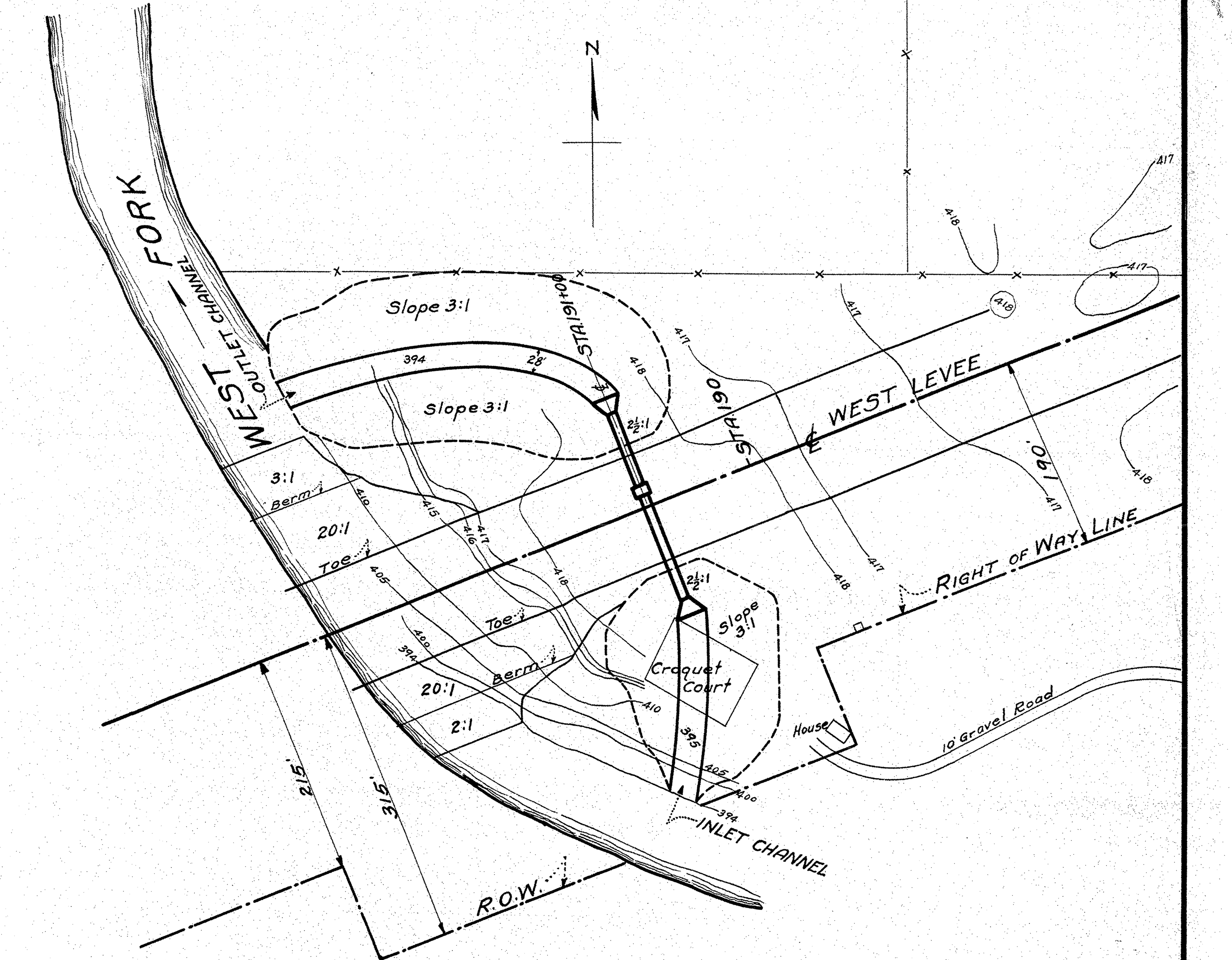
INLET HEADWALL

Scale: ½"=1'-0"



SECTION B-B

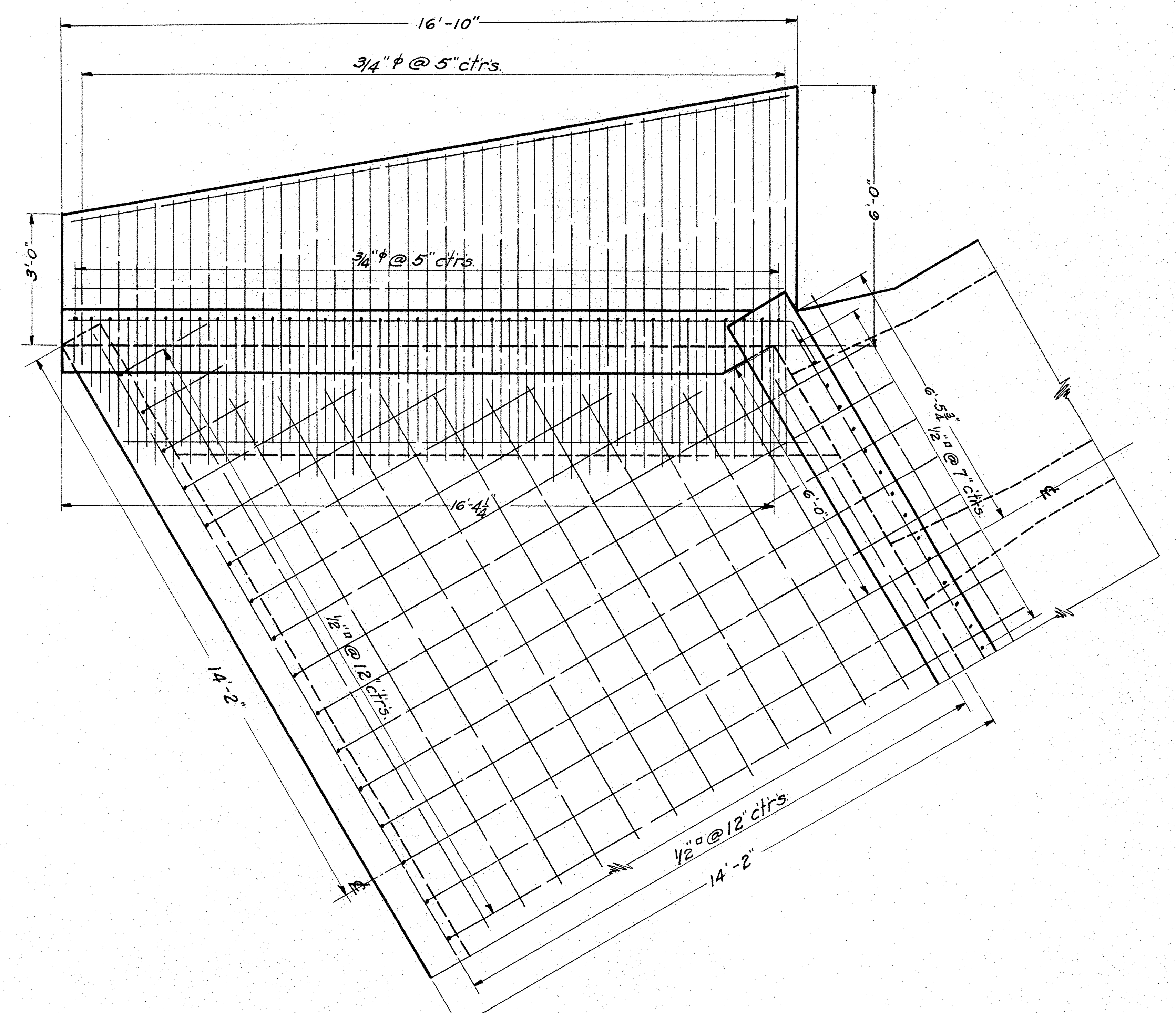
Scale: ½"=1'-0"



LOCATION PLAN

Scale: 1"=100'

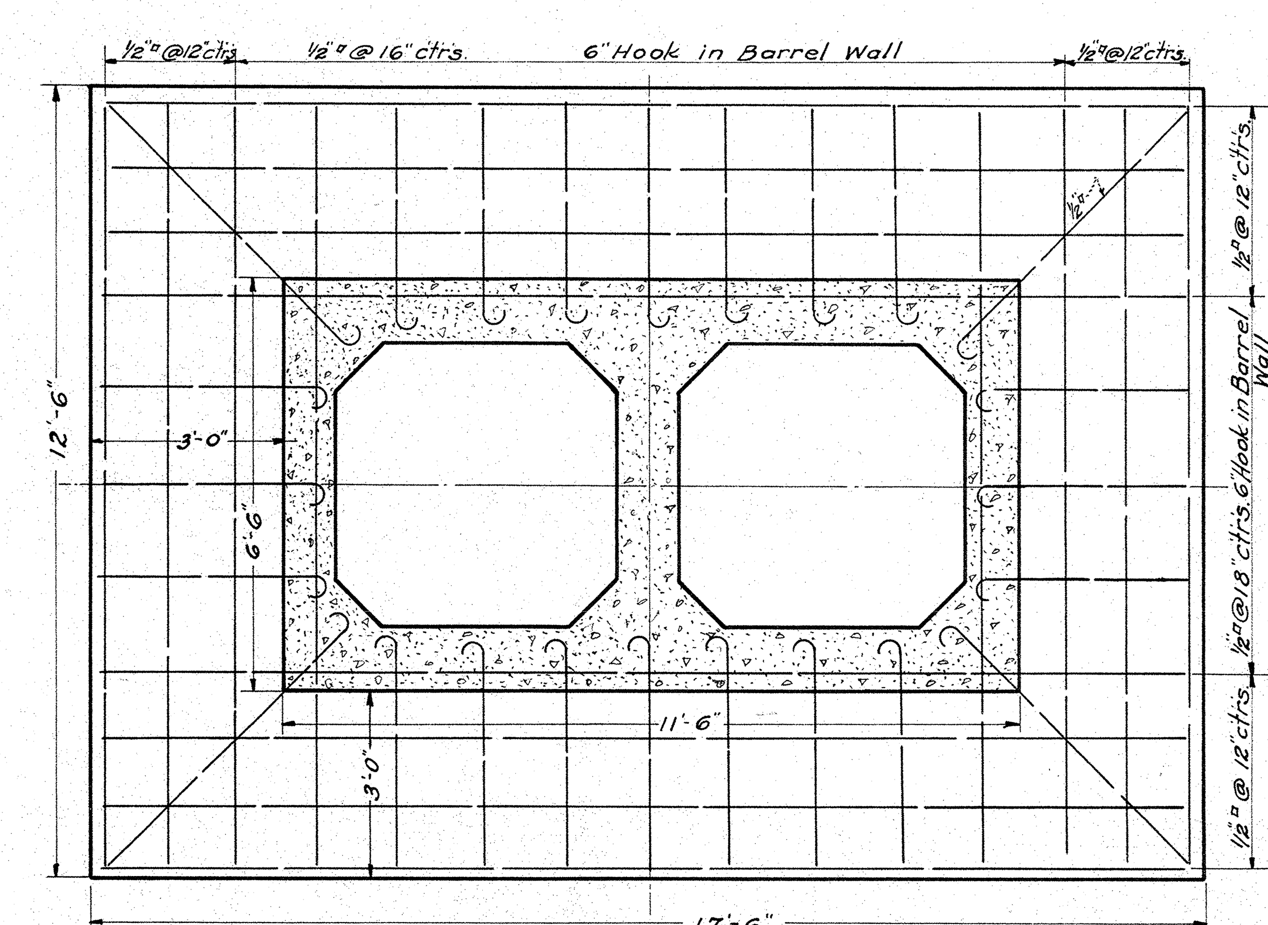
SLUICEWAY E



PLAN

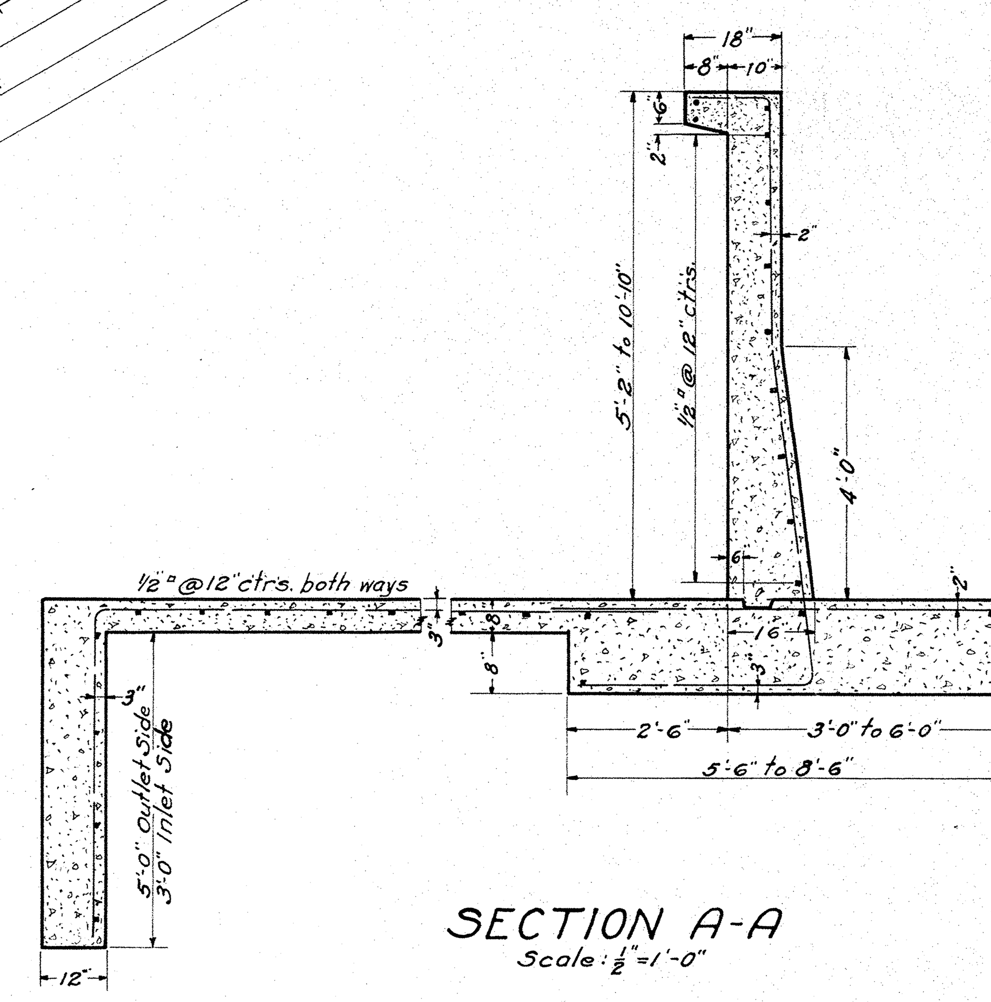
WING WALL, HEADWALL & PAVING

Scale: ½"=1'-0"



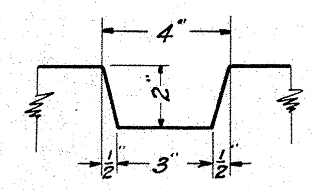
SECTION F-F

Scale: ½"=1'-0"



SECTION A-A

Scale: ½"=1'-0"



STANDARD CONSTRUCTION JOINT DETAIL

Scale: 3"=1'-0"

NOTE:
All construction joints to be as per detail shown on this sheet.
Bevel all exposed edges with ⅞" triangular moulding.

Approved:
MYERS, NOYES & FORREST
By G. Noyes

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry, Designing Engineer
Approved: Ned H. Dayford, Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE—SECTION NO. 3
EAGLE FORD DIVISION

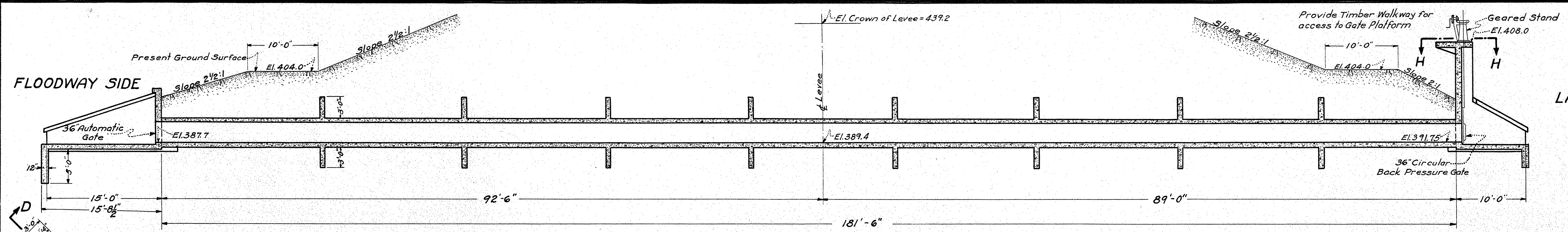
DETAILS OF SLUICEWAY NEAR STA. 191

SHEET NO. 2 OF 2 SHEETS

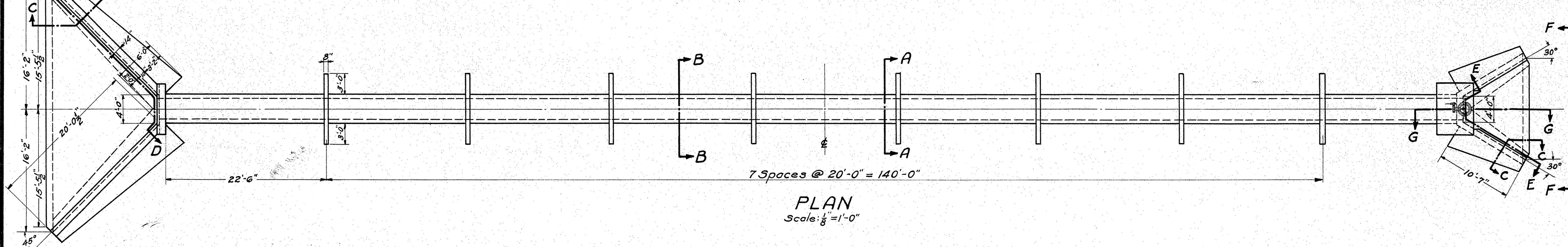
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Jan. 1929

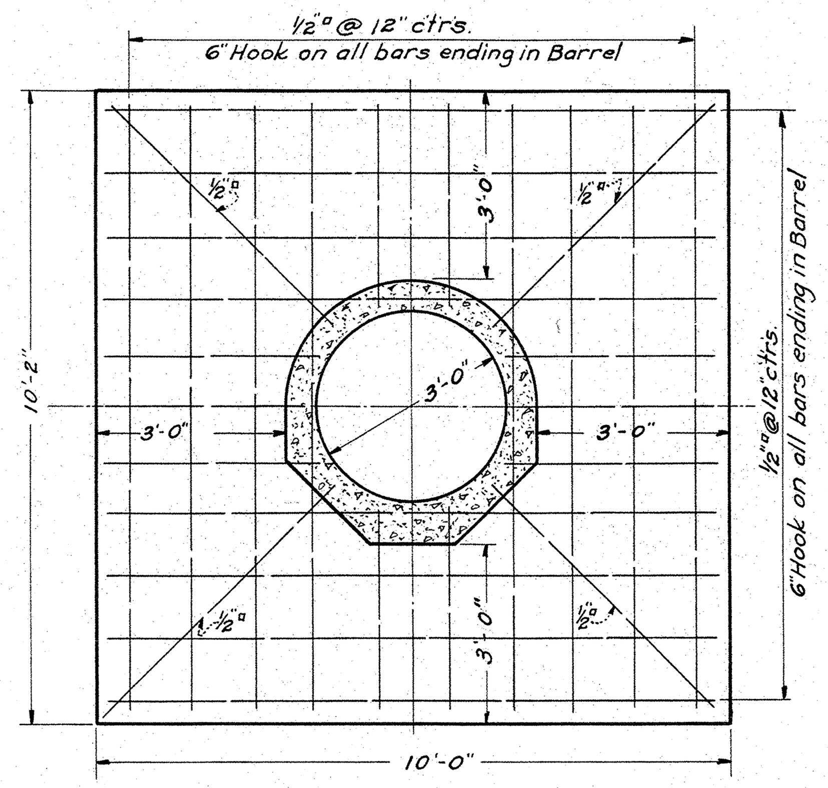


SECTION ON CENTER LINE

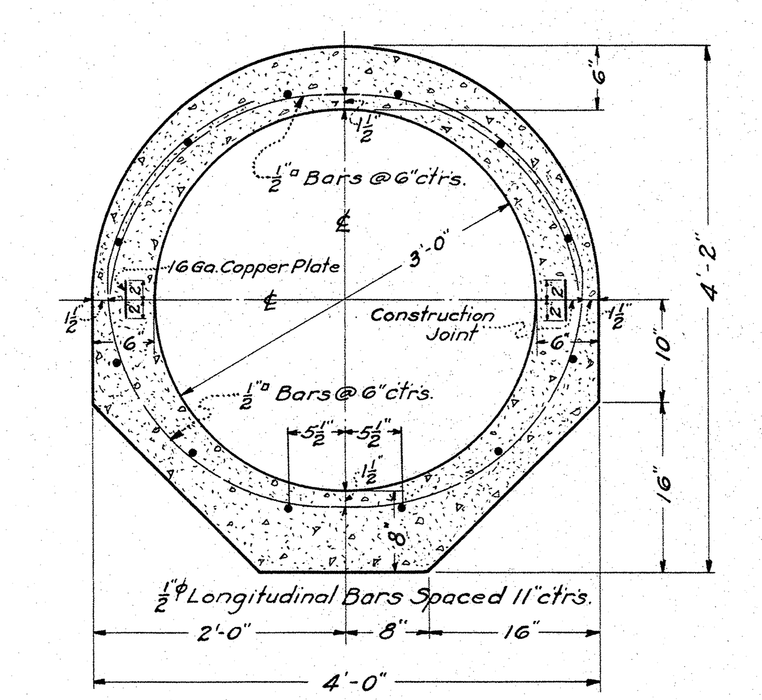


PLAN
Scale: ⅛"=1'-0"

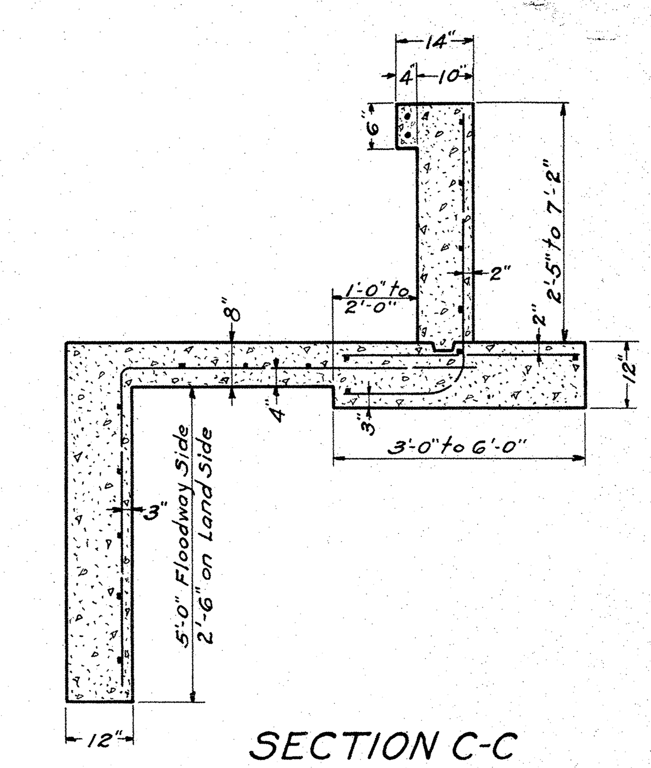
SLUICEWAY F



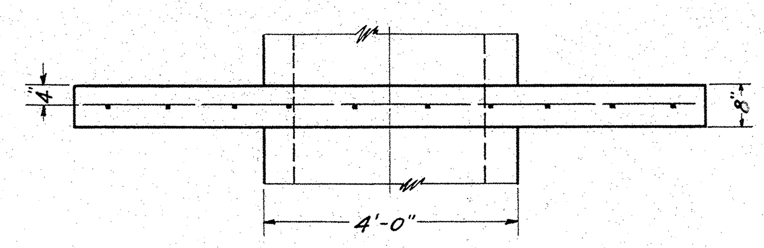
SECTION A-A
Scale: ½"=1'-0"



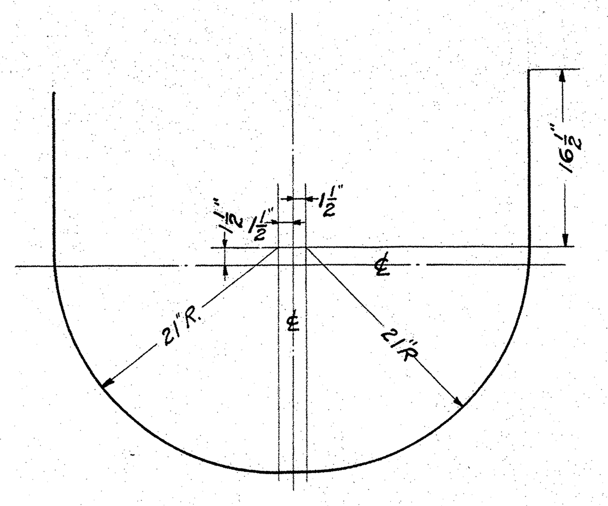
SECTION B-B
Scale: 1"=1'-0"



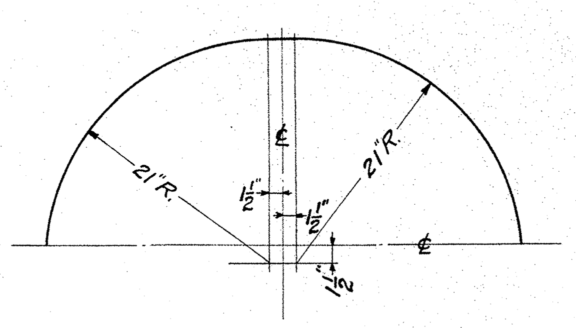
SECTION C-C
WING WALL, PAVEMENT & CUT-OFF WALL
Scale: ½"=1'-0"



PLAN OF COLLAR
Scale: ½"=1'-0"



BENT BAR DETAIL
IN LOWER HALF OF BARREL
Scale: 1"=1'-0"



BENT BAR DETAIL
IN TOP HALF OF BARREL
Scale: 1"=1'-0"

NOTE:
After placing bars in top of Barrel, bend vertical portions of bars in lower section of Barrel and wire as shown in SECTION B-B.
If Barrel is poured in two sections, as indicated in SECTION B-B, a construction joint seal of No. 16 gage copper 4" wide will be required. Joints of seal must lap 6".
Standard construction joint and copper seal will be required in all vertical construction joints.
Standard construction joints will be required in all horizontal construction joints, except in the Barrel.
Bevel all exposed edges with ⁷⁄₁₆" triangular moulding.
Lap longitudinal bars in Barrel 18 inches.
Collars shall be poured with Barrel.

Approved:
MYERS, NOYES & FORREST
By G. M. Noyes

FOR MORGAN ENGINEERING CO.
Recommended: U. S. Fry, Designing Engineer.
Approved: Ned H. Rayford, Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE—SECTION NO. 2
OAK CLIFF DIVISION

DETAILS OF SLUICEWAY NEAR STA. 88

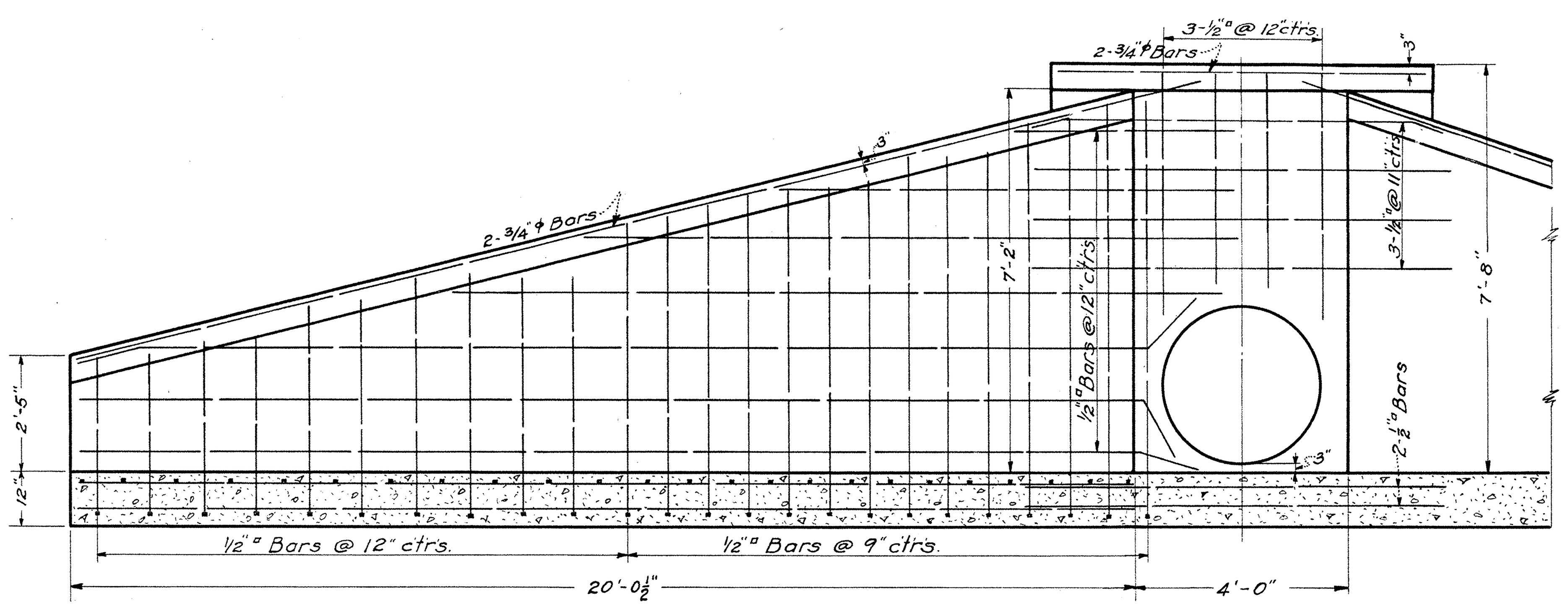
SHEET NO 1 OF 2 SHEETS

DISTRICT ENGINEER: MYERS, NOYES & FORREST, DALLAS - TEXAS
CONSULTING ENGINEER: MORGAN ENGINEERING CO., MEMPHIS - TENN.

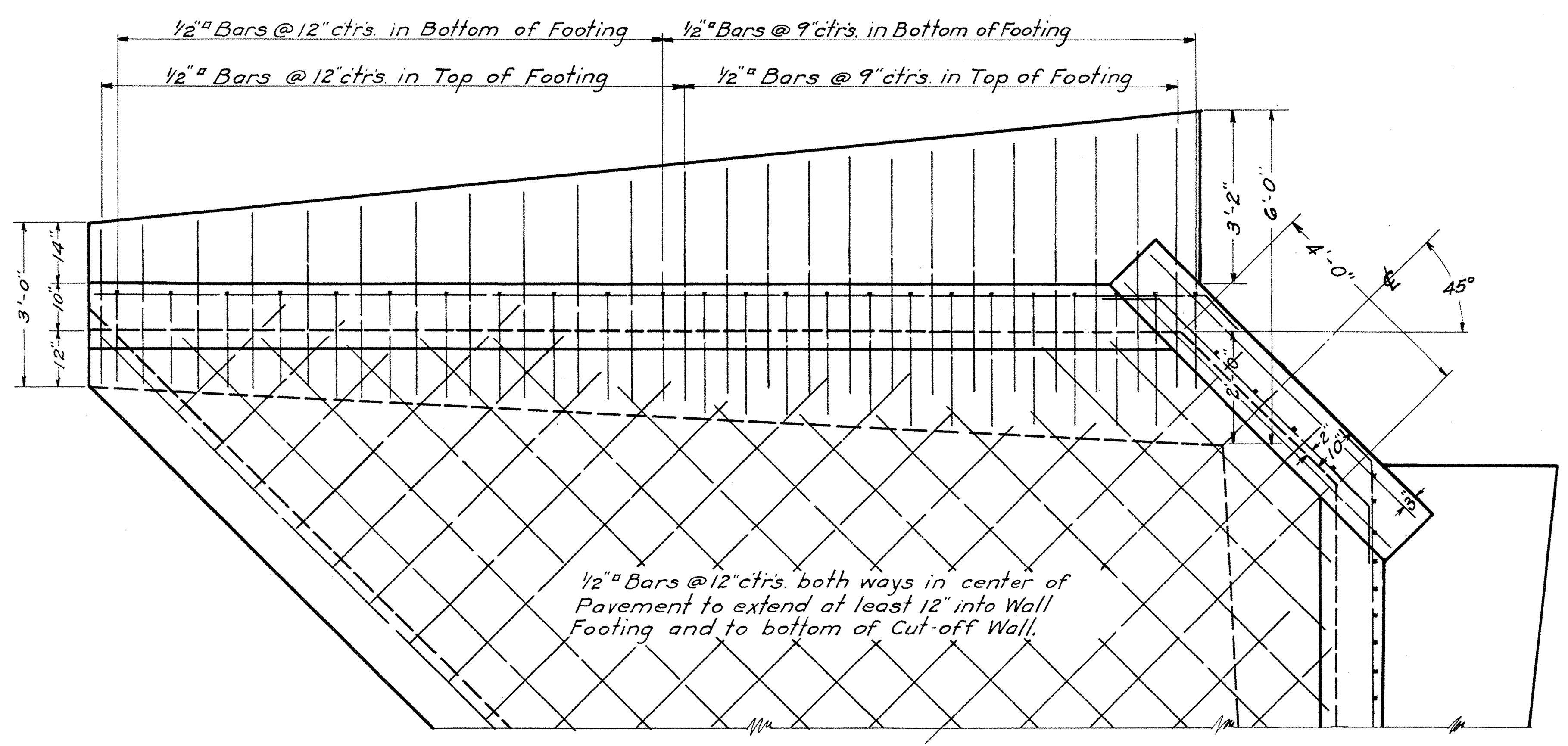
JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Jan. 1929

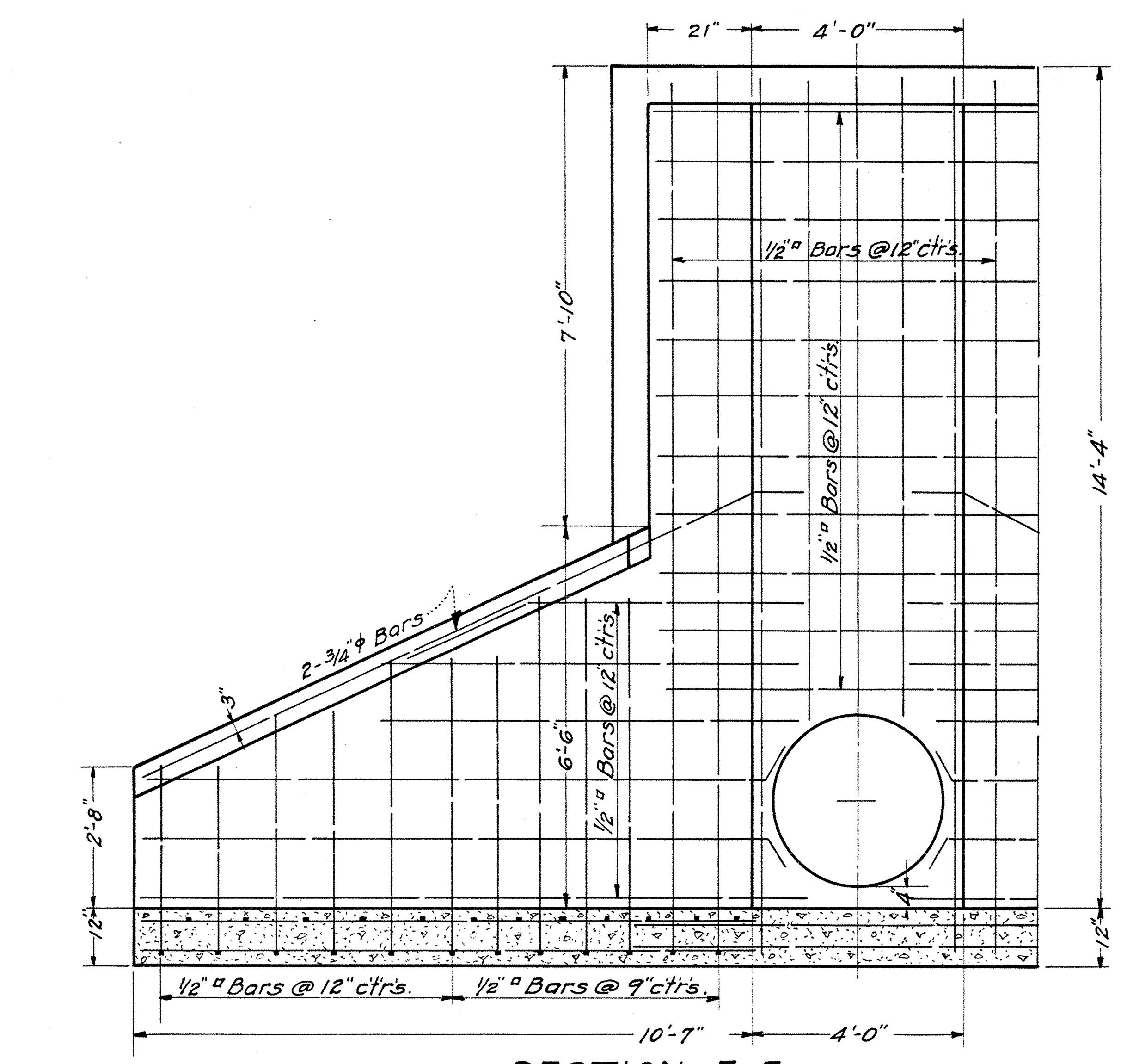
SHEET NO. 28 OF 57 SHEETS



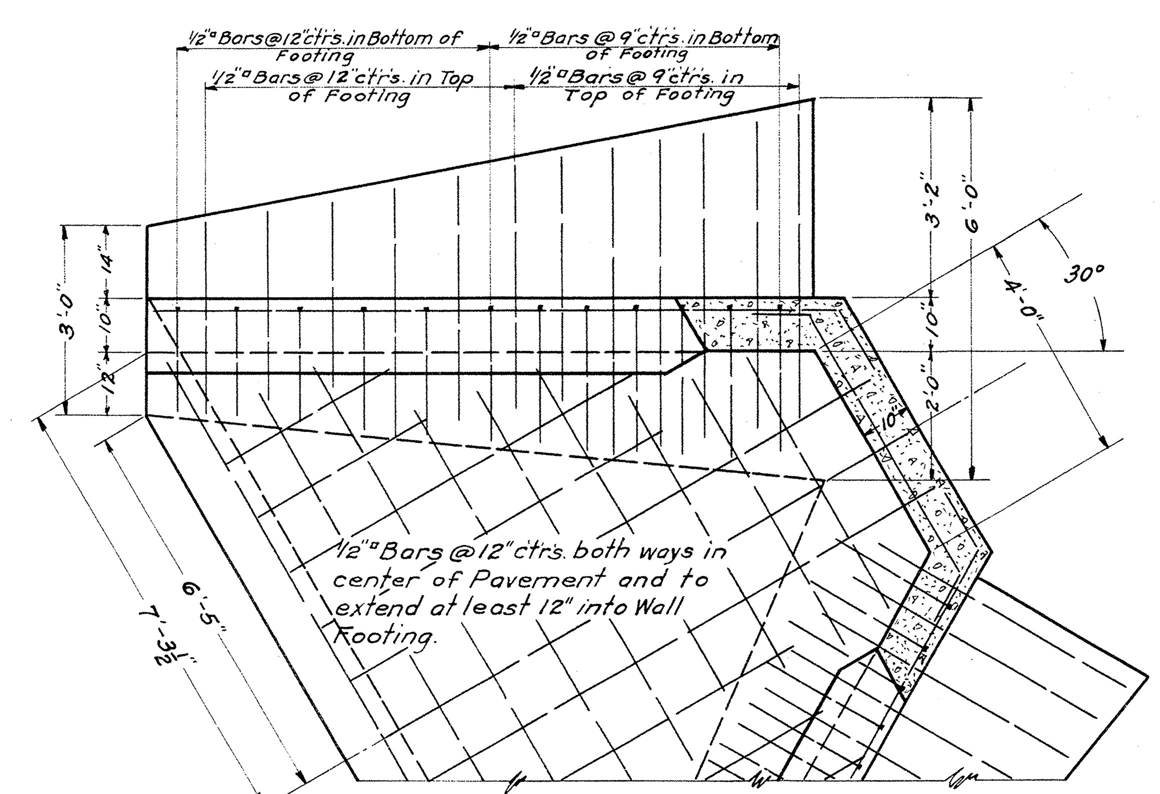
SECTION D-D
FLOODWAY SIDE HEADWALL
Scale: 1/2" = 1'-0"



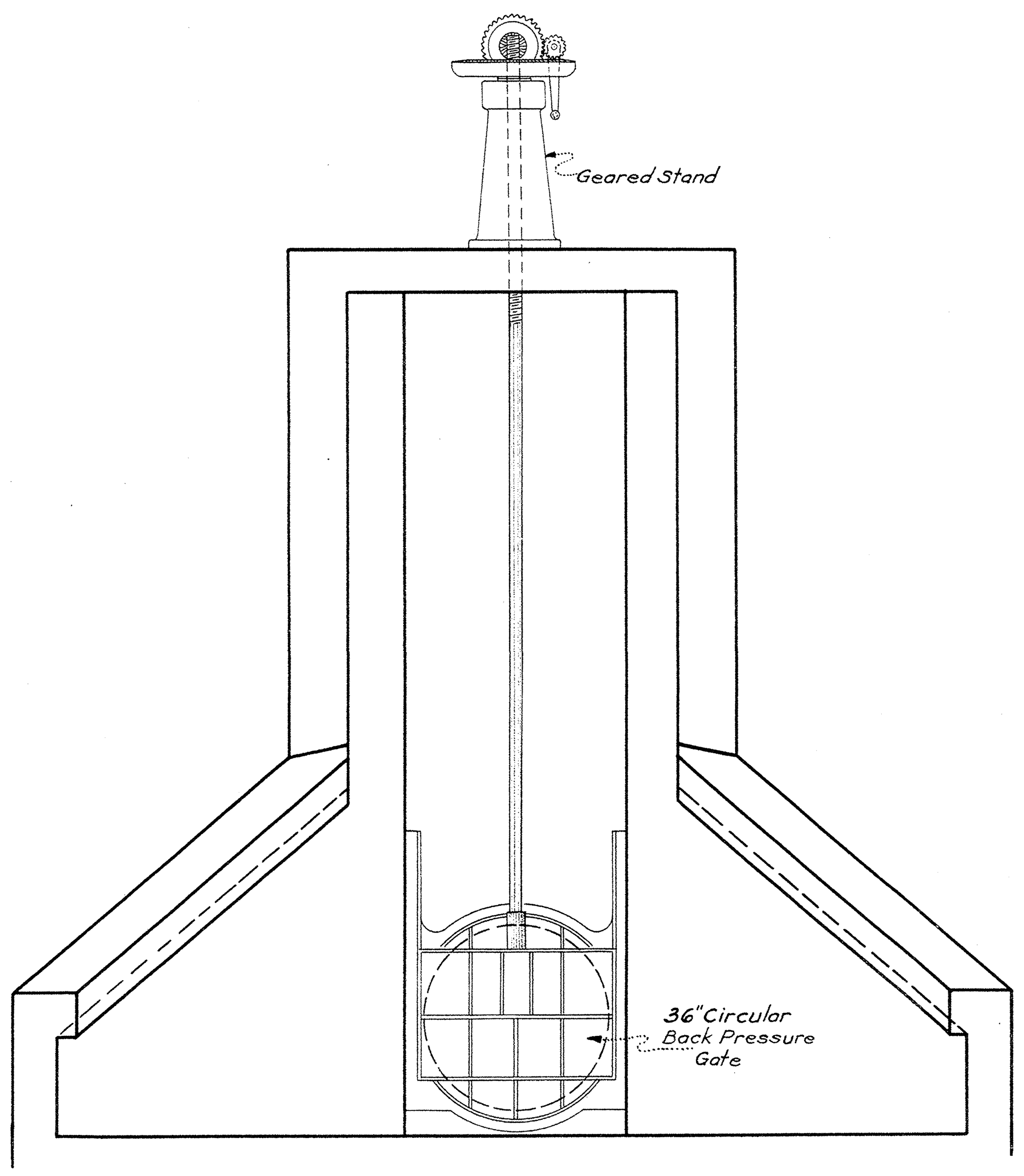
HALF PLAN FLOODWAY SIDE HEADWALL
Scale: 1/2" = 1'-0"



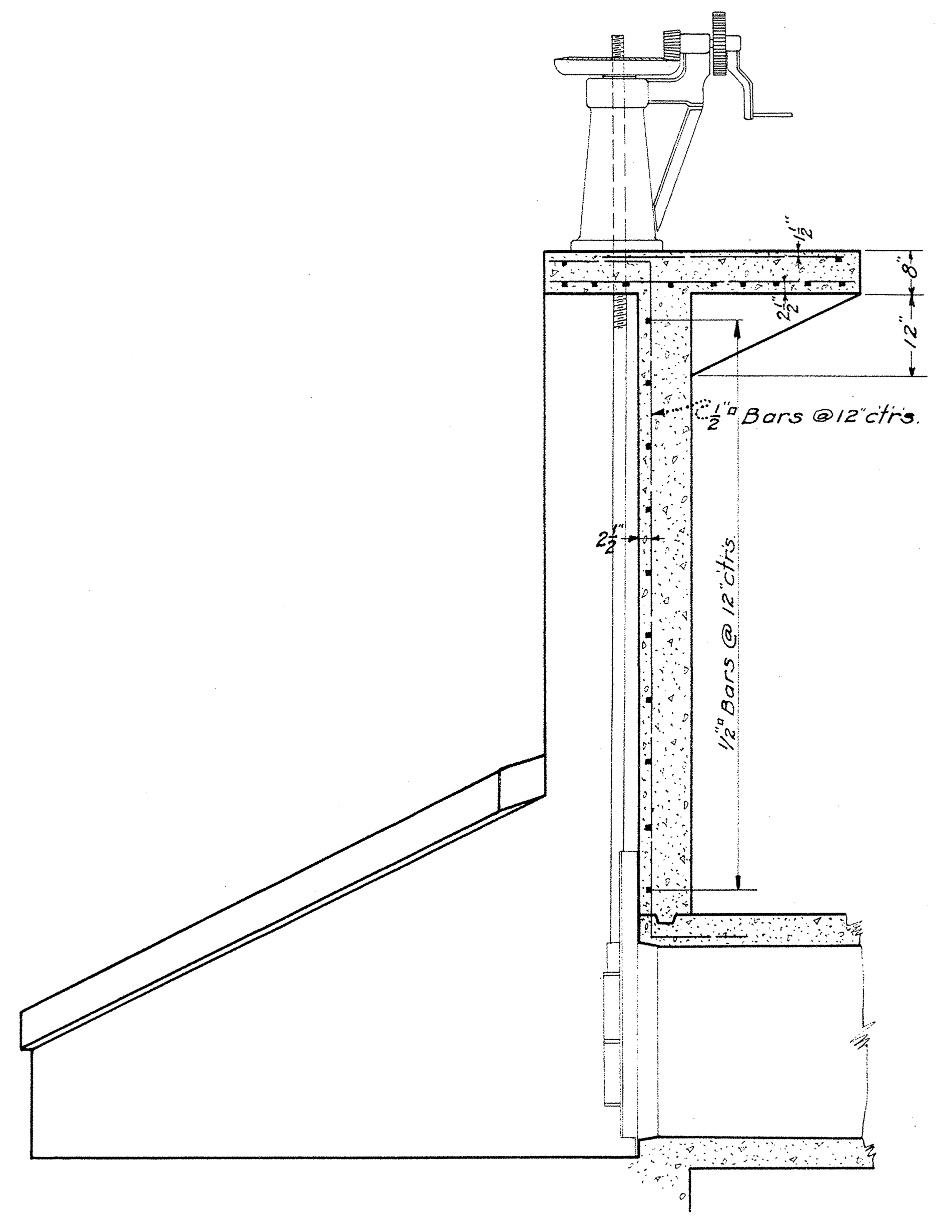
SECTION E-E
LAND SIDE HEADWALL
Scale: 1/2" = 1'-0"



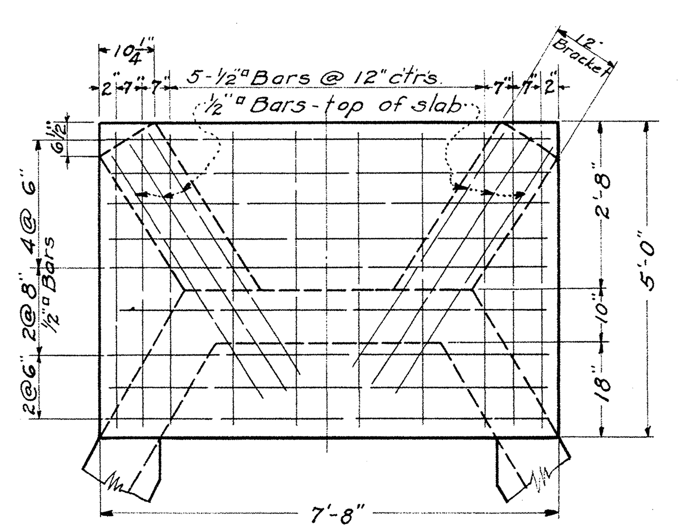
HALF PLAN LAND SIDE HEADWALL
Scale: 1/2" = 1'-0"



VIEW F-F



SECTION G-G



SECTION H-H
Scale: 1/2" = 1'-0"

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE-SECTION NO. 2
OAK CLIFF DIVISION

DETAILS OF SLUICEWAY NEAR STA. 88

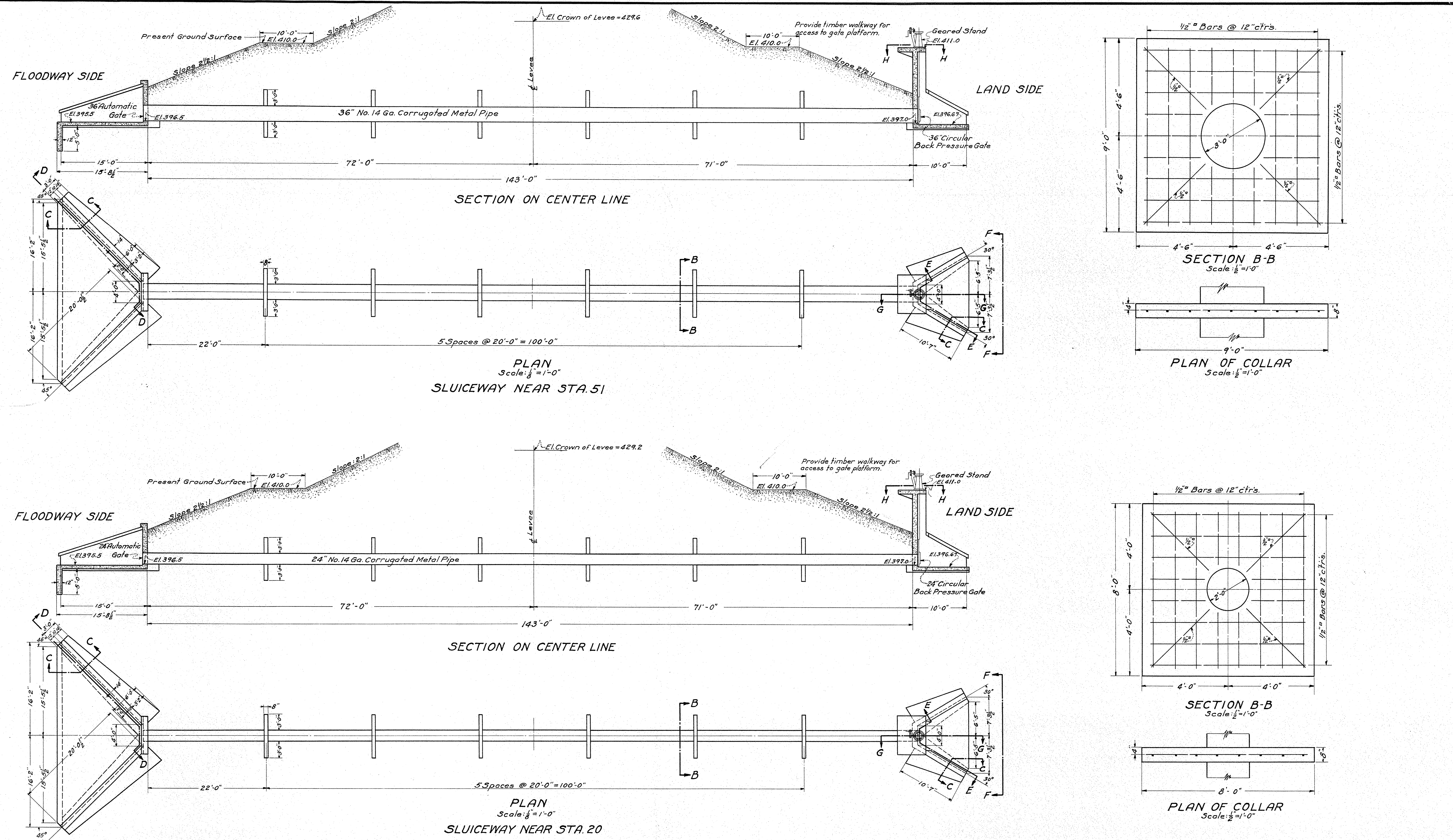
SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER — MYERS, NOYES & FORREST, DALLAS - TEXAS
CONSULTING ENGINEER — MORGAN ENGINEERING CO., MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Jan. 1929

SHEET NO. 29 OF 57 SHEETS



NOTE: Bevel all exposed edges with 7/8" triangular moulding.

Approved:
MYERS, NOYES & FORREST
By

FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

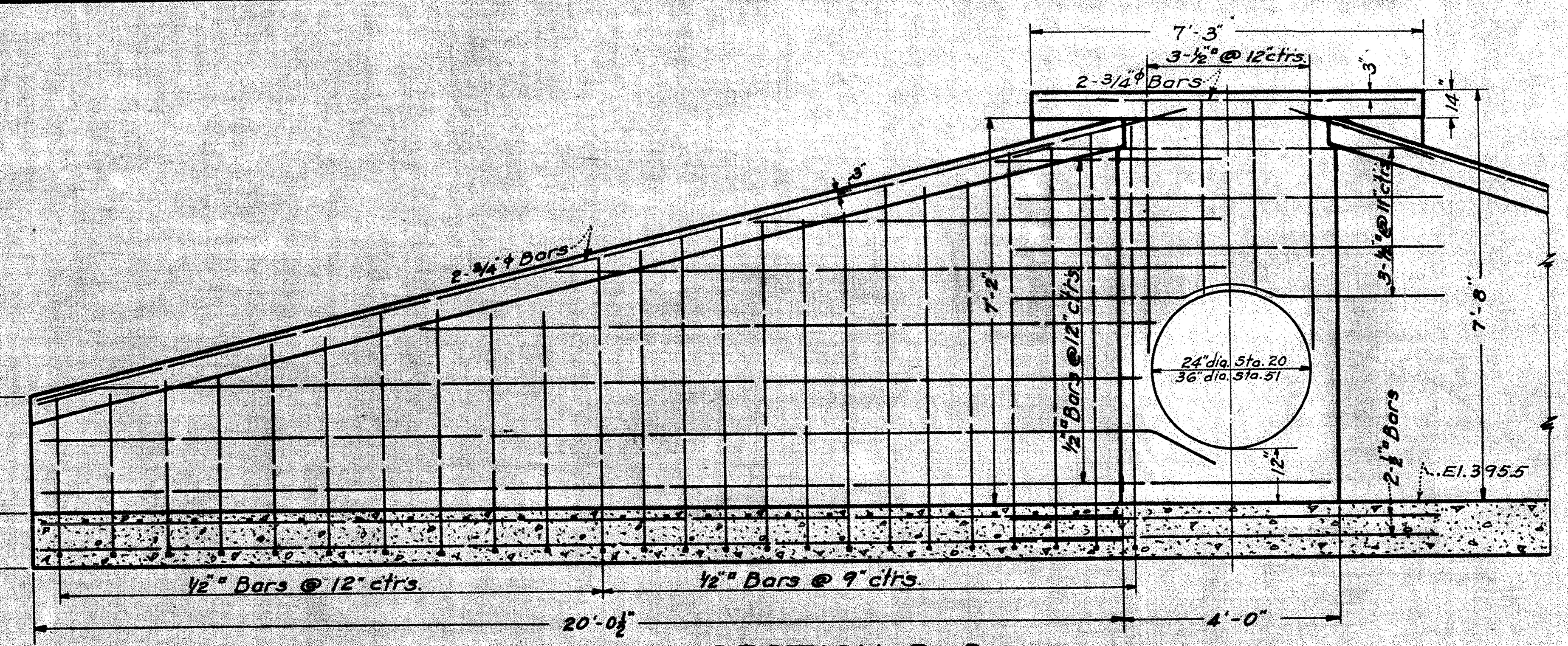
NORTHWEST LEVEE
DETAILS OF SLUICEWAYS
NEAR STA. 20 & STA. 51
SHEET NO. 1 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

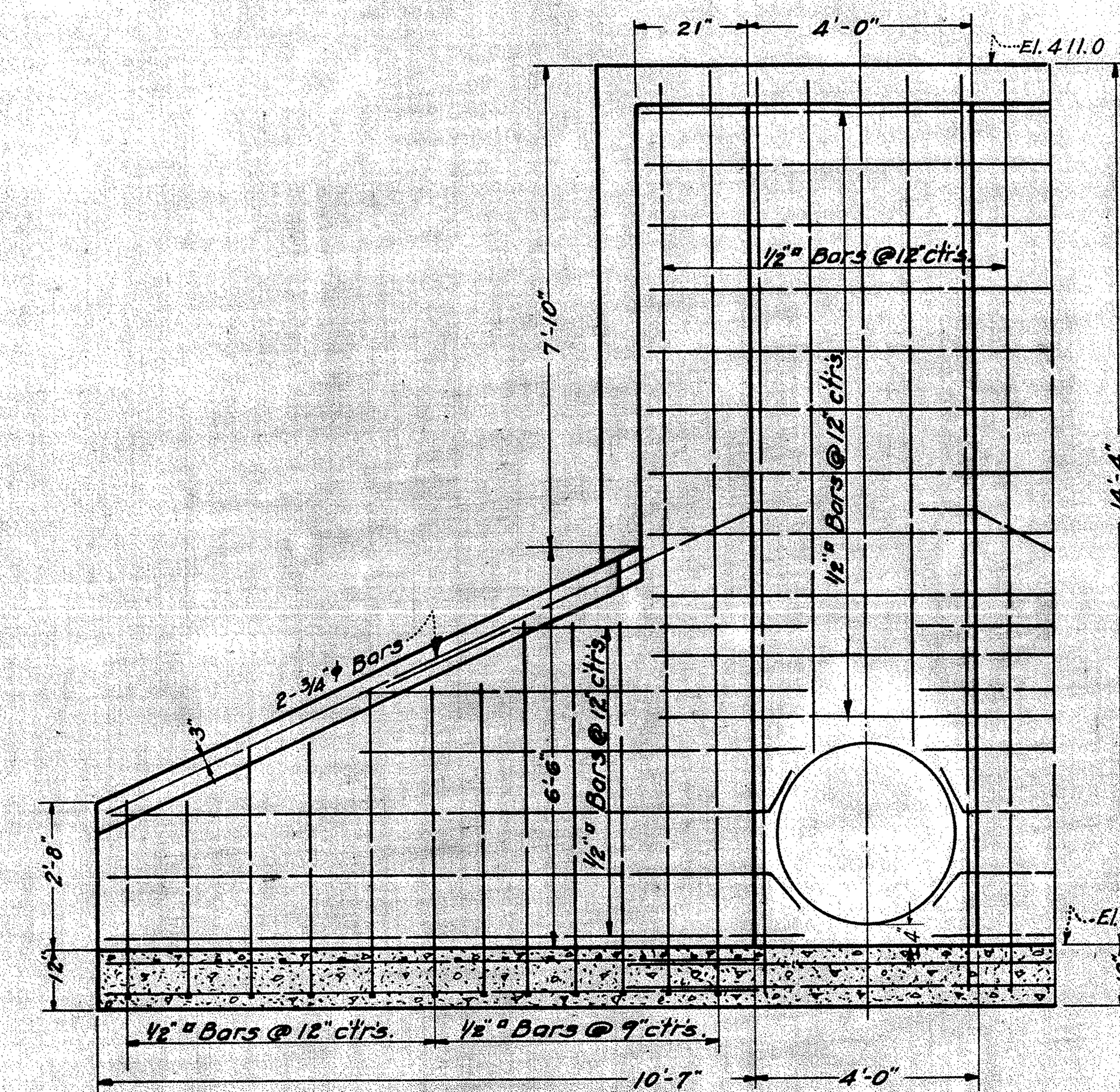
JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Feb. 1929

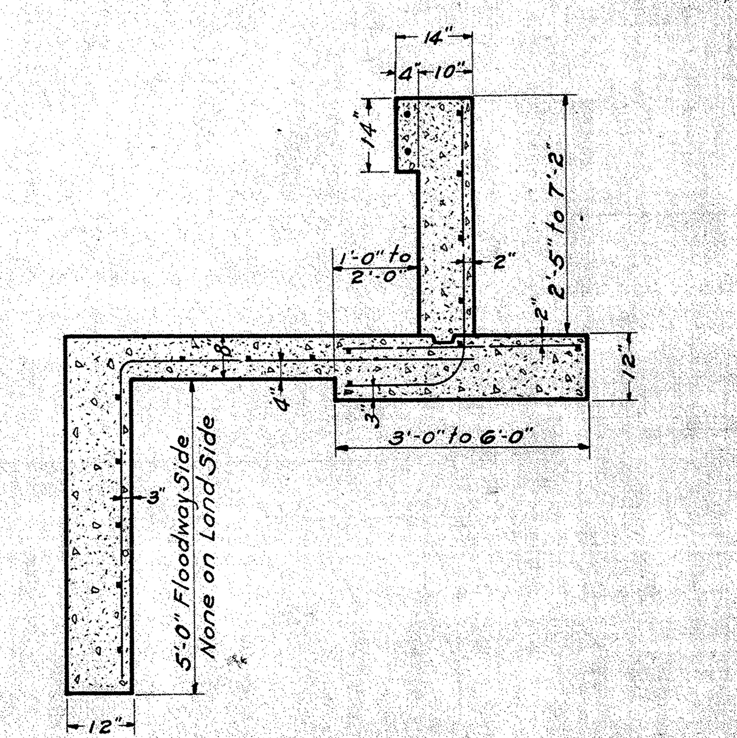
SHEET NO. 30 OF 57 SHEETS



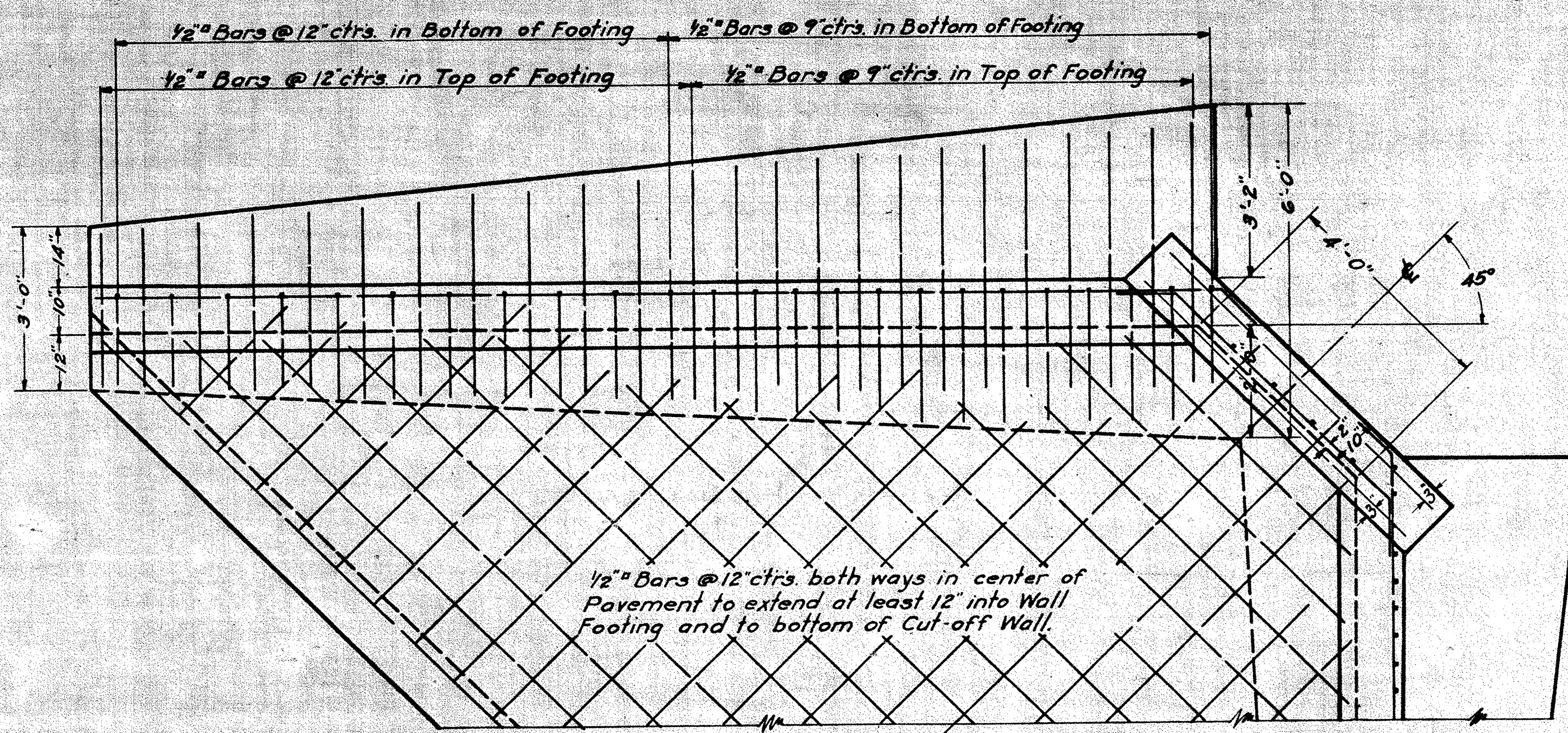
SECTION D-D
FLOODWAY SIDE HEADWALL
Scale: ½"=1'-0"



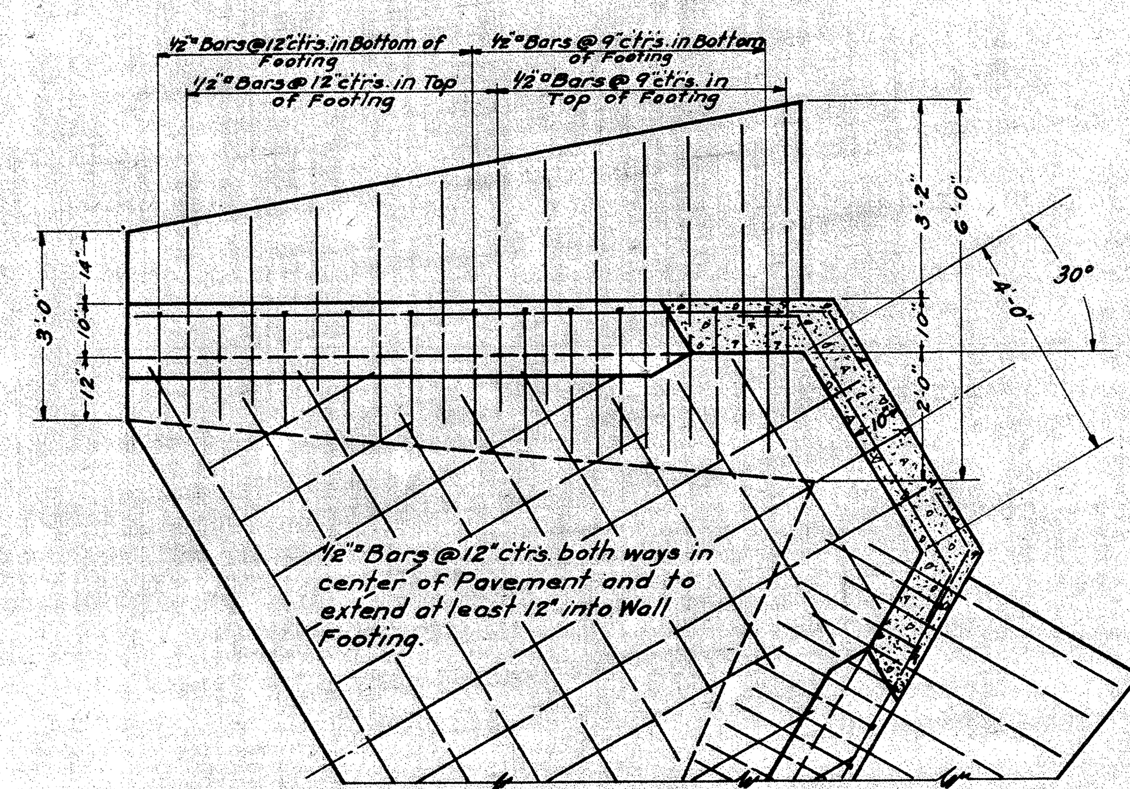
SECTION E-E
LAND SIDE HEADWALL
Scale: ½"=1'-0"



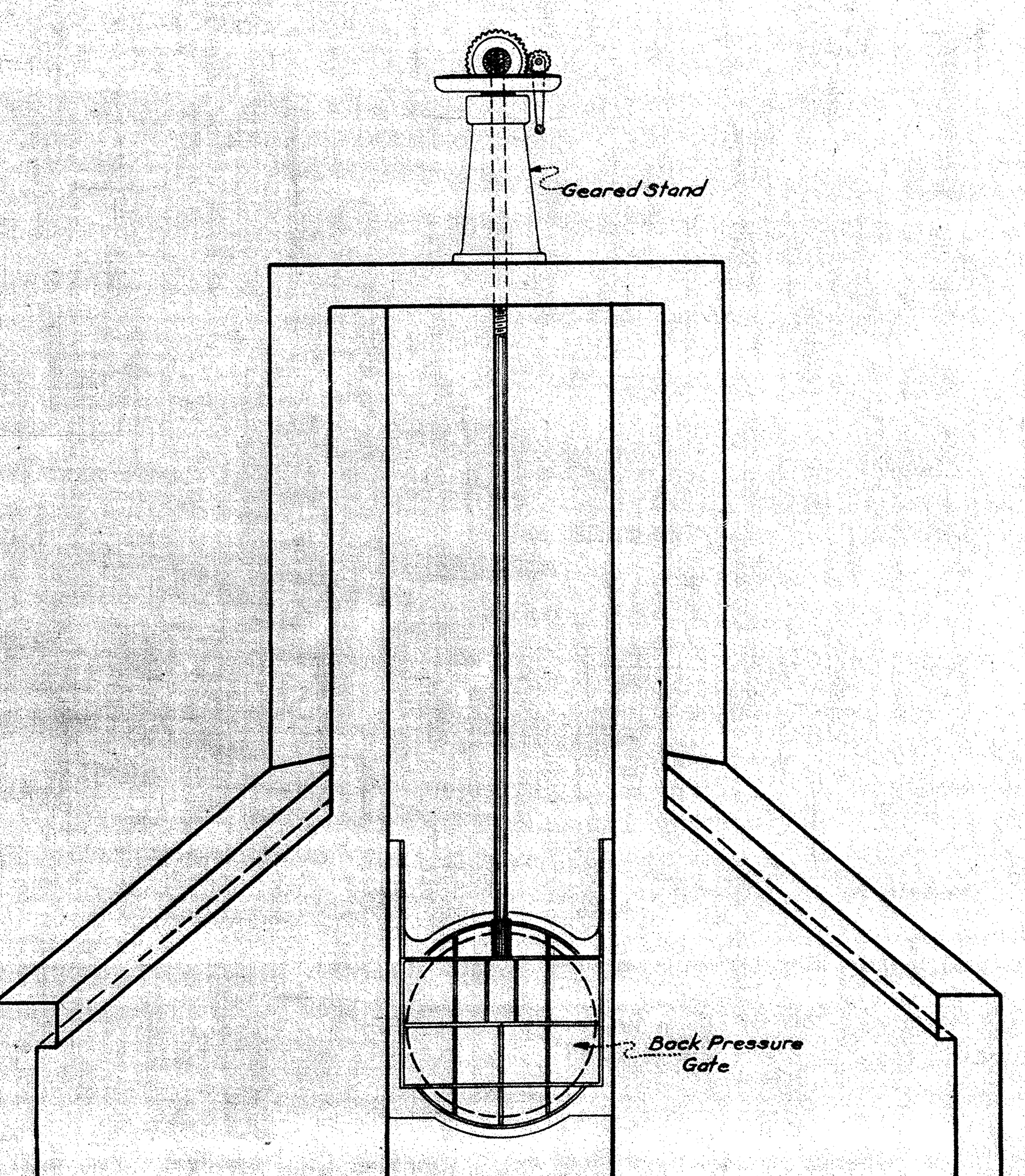
SECTION C-C
WING WALL, PAVEMENT & CUTOFF WALL
Scale: ½"=1'-0"



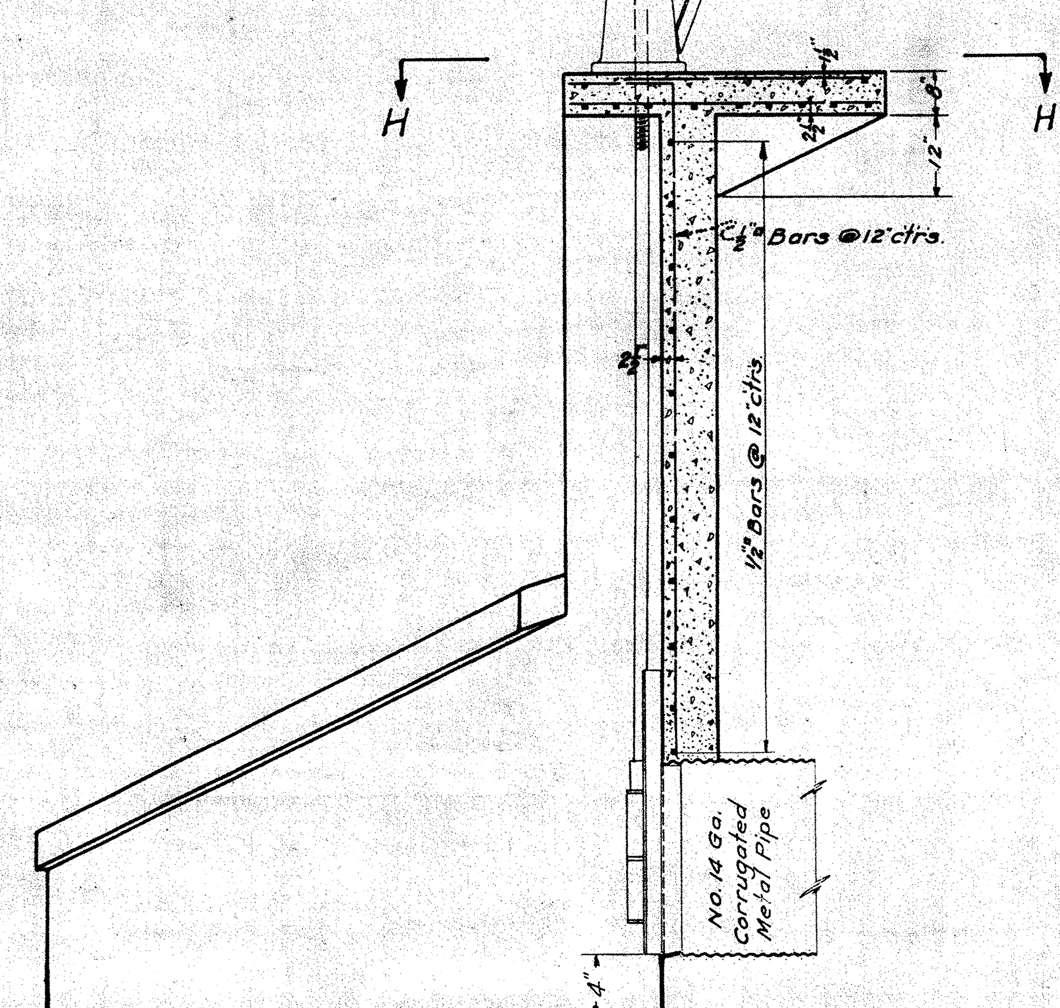
HALF PLAN FLOODWAY SIDE HEADWALL
Scale: ½"=1'-0"



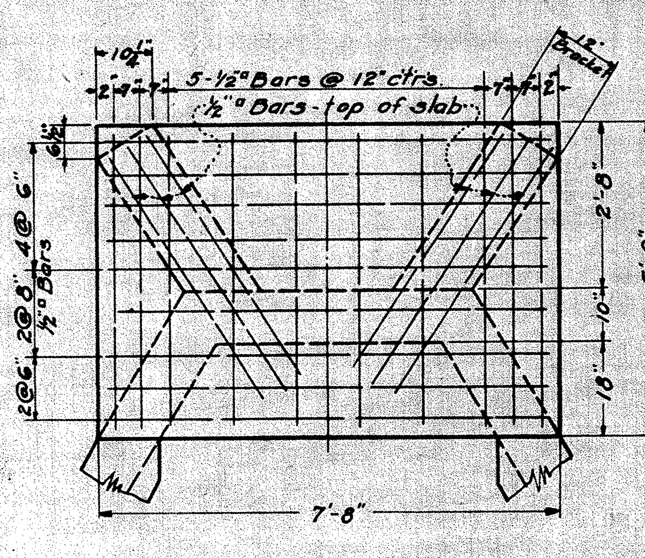
HALF PLAN LAND SIDE HEADWALL
Scale: ½"=1'-0"



VIEW F-F



SECTION G-G



SECTION H-H
Scale: ½"=1'-0"

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended [signature]
Designing Engineer
Approved [signature]
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

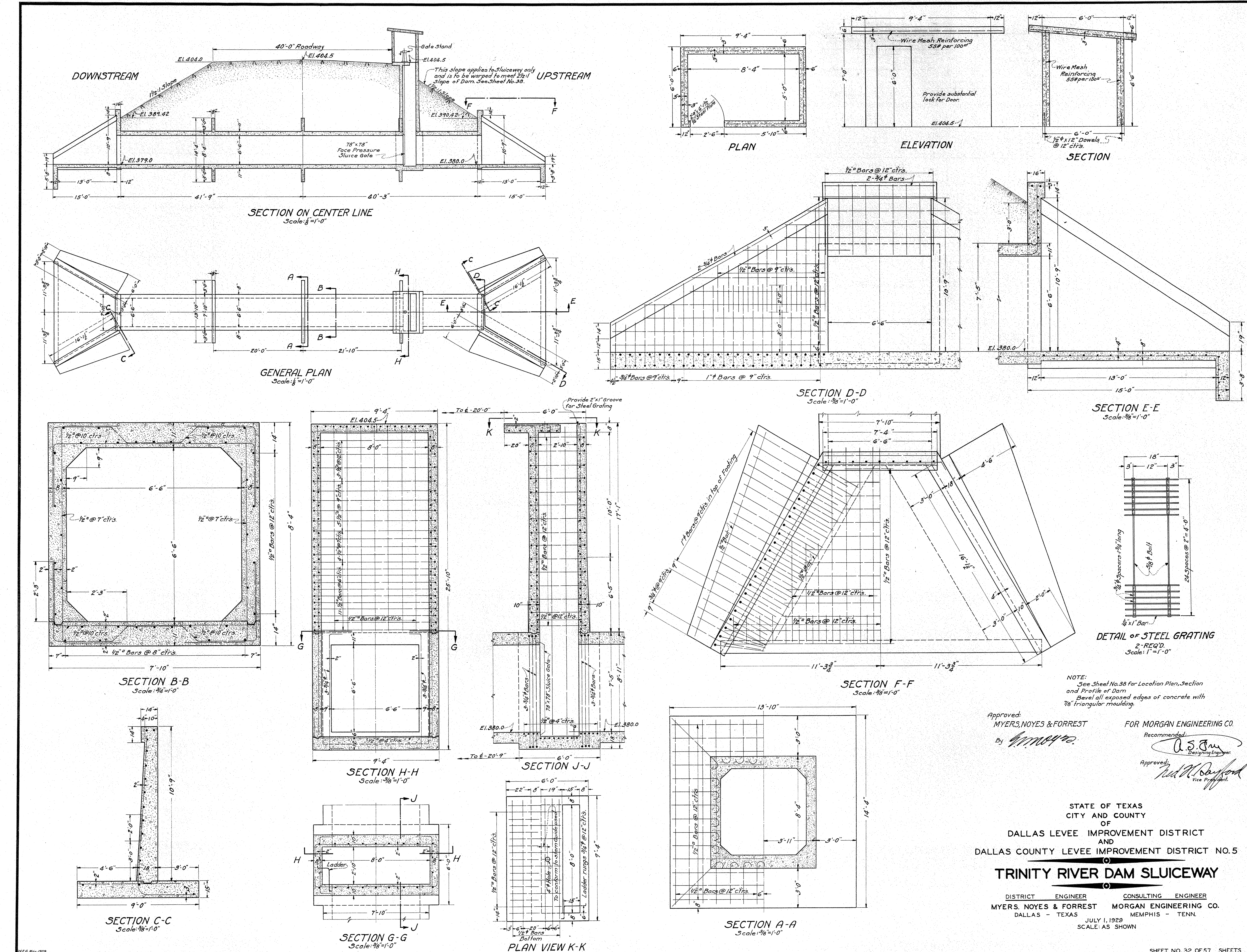
NORTHWEST LEVEE
DETAILS OF SLUICEWAYS
NEAR STA. 20 & STA. 51
SHEET NO. 2 OF 2 SHEETS

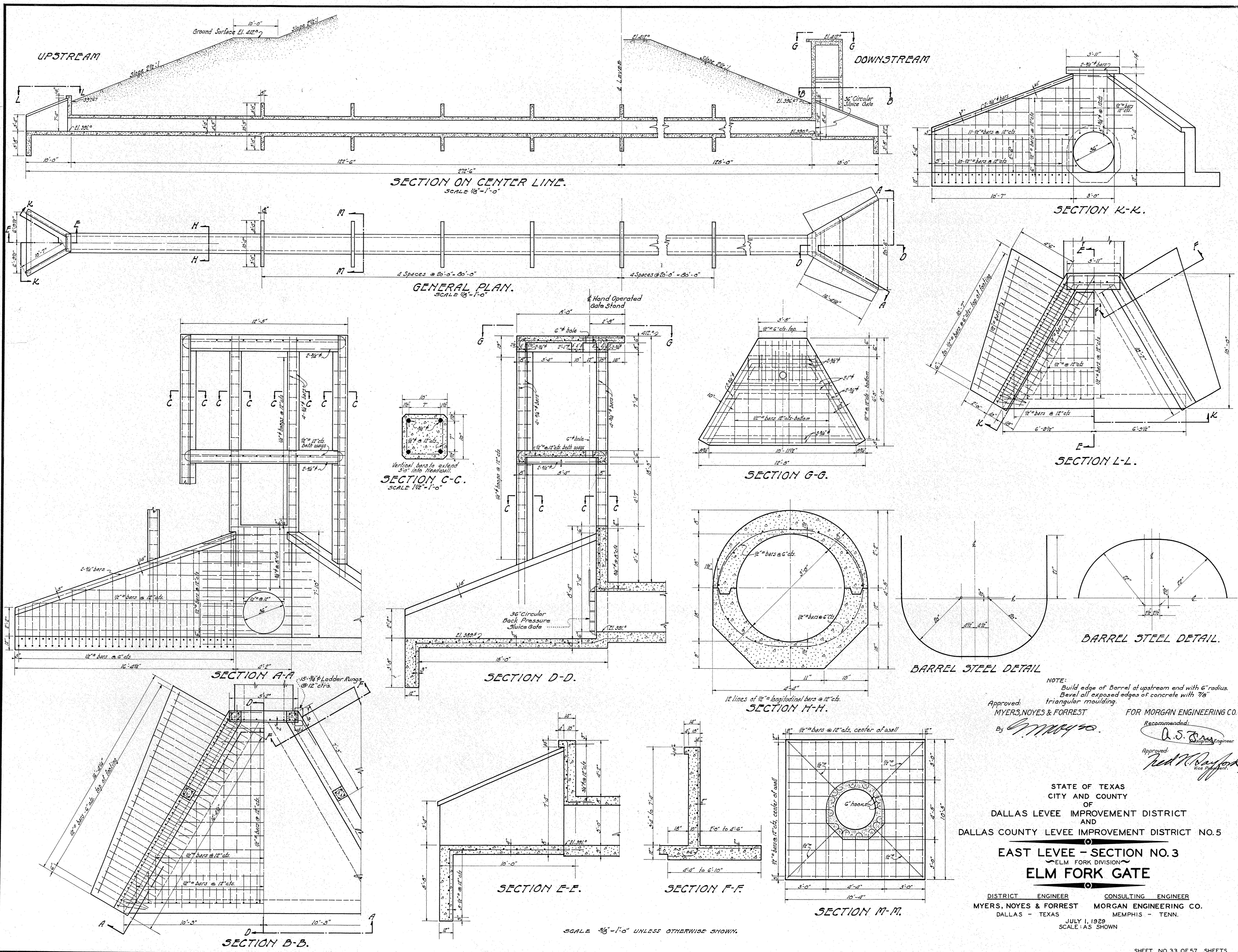
DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

W.E.G. Feb. 1929

SHEET NO. 31 OF 57 SHEETS


DOWNSTREAM
UPSTREAM
40'-0" Roadway
Gate Stand
This slope applies to Sluiceway only and is to be warped to meet 2½:1 Slope of Dam. See Sheet No. 38.
7'8" x 7'8" Face Pressure Sluice Gate
SECTION ON CENTER LINE
Scale: 1/8"=1'-0"
GENERAL PLAN
Scale: 1/8"=1'-0"
PLAN
ELEVATION
SECTION
Wire Mesh Reinforcing 55# per 100□'
Provide substantial lock for Door.
SECTION D-D
Scale: 3/8"=1'-0"
SECTION E-E
Scale: 3/8"=1'-0"
SECTION B-B
Scale: 3/4"=1'-0"
SECTION H-H
Scale: 3/8"=1'-0"
Provide 2"x1" Groove for Steel Grating
SECTION J-J
SECTION F-F
Scale: 3/8"=1'-0"
DETAIL OF STEEL GRATING
2-REQ'D.
Scale: 1"=1'-0"
SECTION C-C
Scale: 3/8"=1'-0"
SECTION G-G
Scale: 3/8"=1'-0"
PLAN VIEW K-K
SECTION A-A
Scale: 3/8"=1'-0"
NOTE:
See Sheet No. 38 for Location Plan, Section and Profile of Dam.
Bevel all exposed edges of concrete with 7/8" triangular moulding.
Approved:
MYERS, NOYES & FORREST
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer.
Approved:
Vice President.
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
TRINITY RIVER DAM SLUICEWAY
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN
SHEET NO. 32 OF 57 SHEETS



NOTE:
Build edge of Barrel at upstream end with 6" radius.
Bevel all exposed edges of concrete with 7/8" triangular moulding.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. [signature]
Designing Engineer

Approved:
Ned N. [signature]
Vice President.

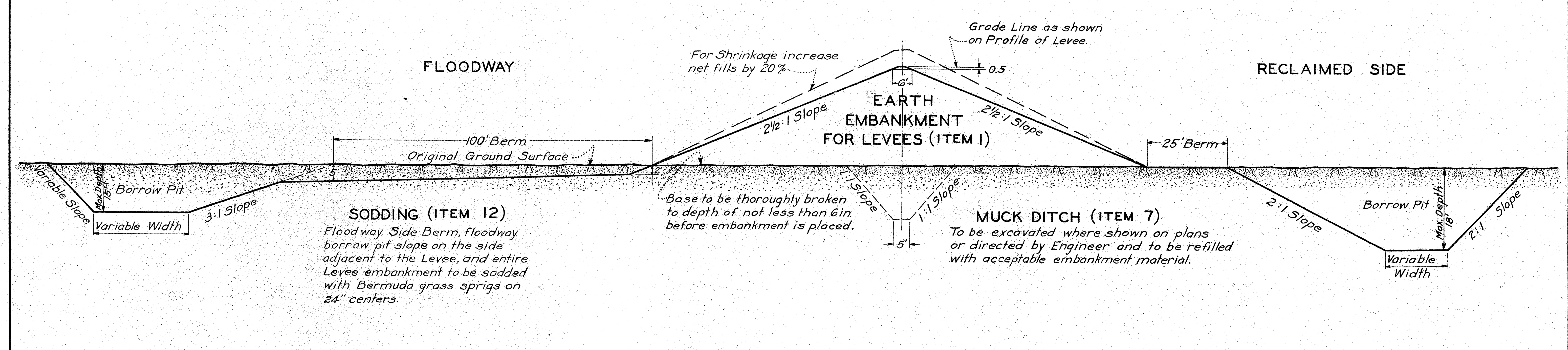
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE - SECTION NO. 3
ELM FORK DIVISION

ELM FORK GATE

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

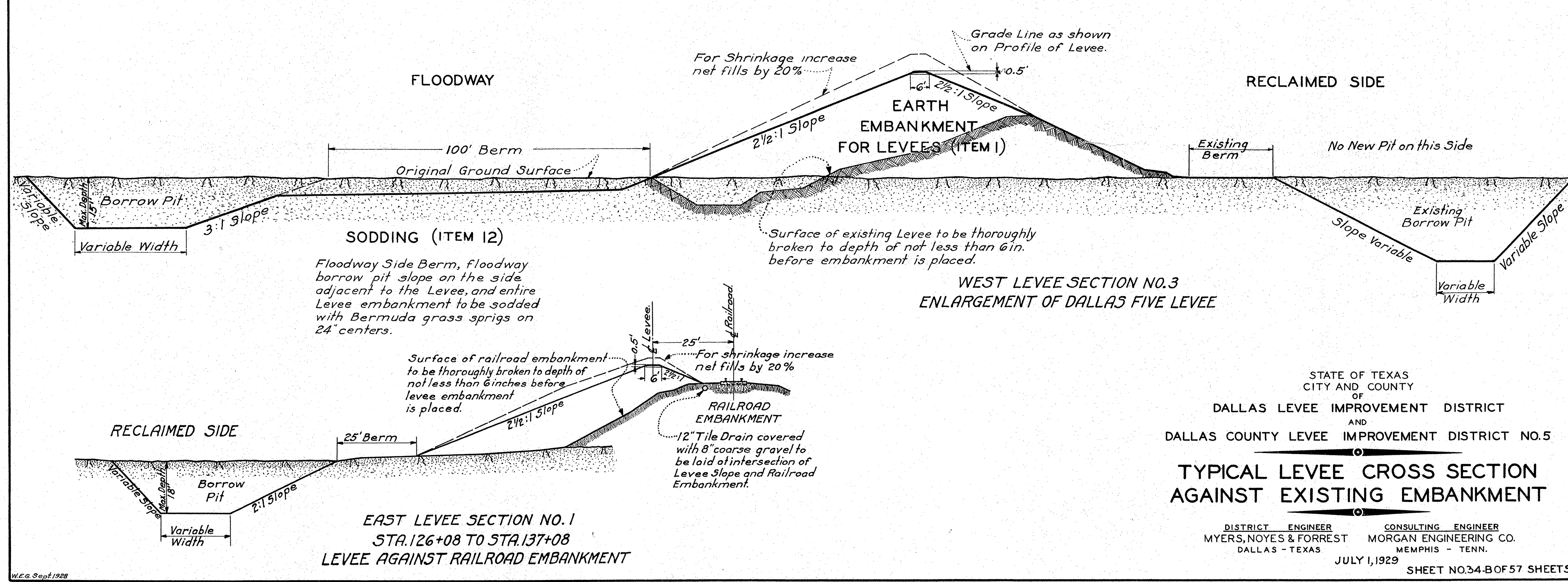
TYPICAL LEVEE CROSS SECTION

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 34-A OF 57 SHEETS



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

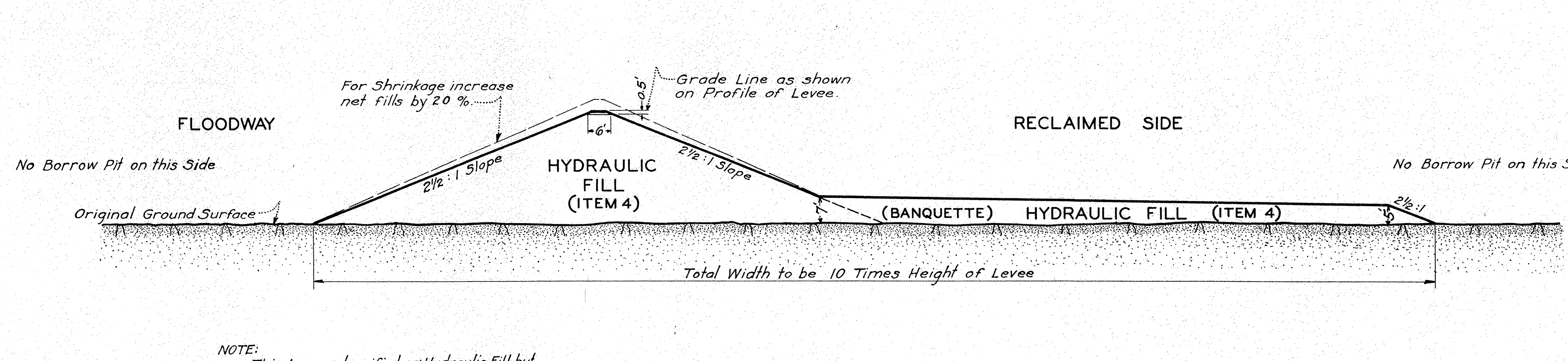
TYPICAL LEVEE CROSS SECTION AGAINST EXISTING EMBANKMENT

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 34-B OF 57 SHEETS



NOTE:
This Levee classified as Hydraulic Fill but constructed with trucks and caterpillars hauling 7-cu. yd. trailer dump wagons.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE SECTION NO. 2
OAK CLIFF DIVISION

TYPICAL LEVEE CROSS SECTION STA. 117 TO STA. 153+42.5

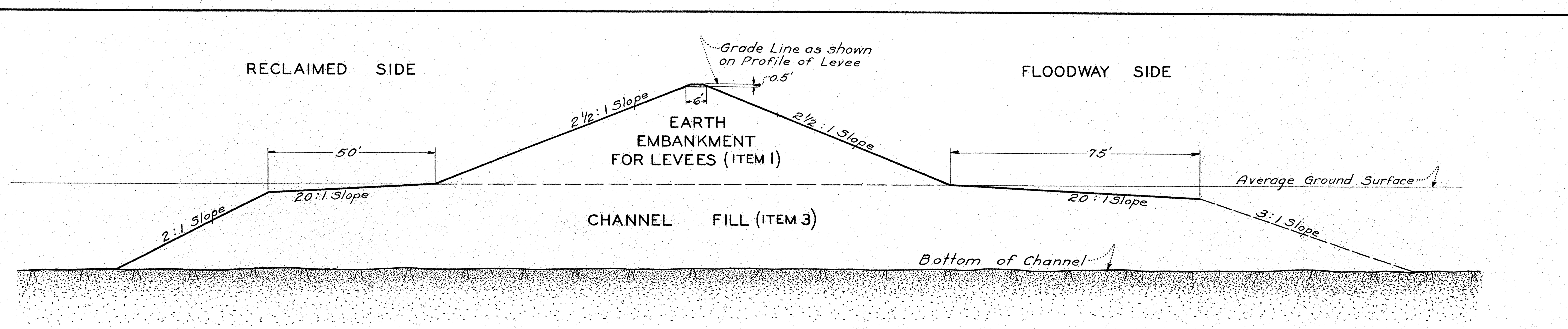
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 34-C OF 57 SHEETS

W.E.G. Sept. 1928



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO.5

TYPICAL CROSS SECTION OF CHANNEL FILL EMBANKMENT

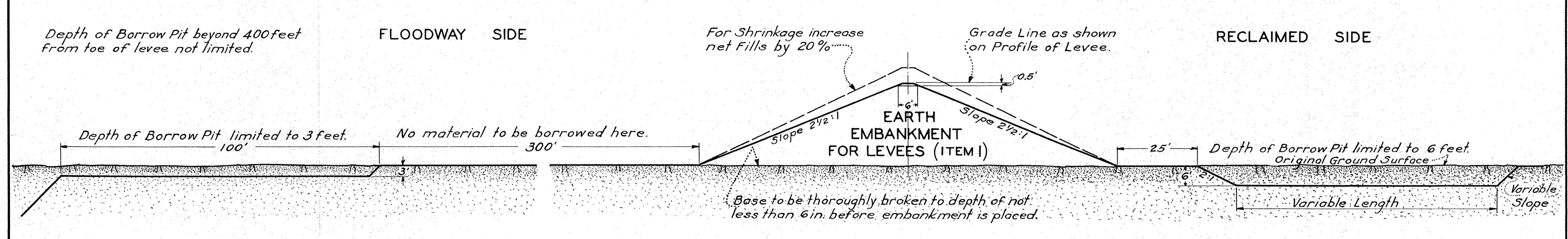
DISTRICT ENGINEER MYERS, NOYES & FORREST DALLAS - TEXAS

CONSULTING ENGINEER MORGAN ENGINEERING CO. MEMPHIS - TENN.

JULY 1, 1929

SHEET NO.35-A OF 57 SHEETS

W.E.G. Oct. 1928



STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO.5

WEST LEVEE SECTION NO. 1
OAKCLIFF DIVISION

TYPICAL LEVEE CROSS SECTION STA. 70 TO STA. 132+18

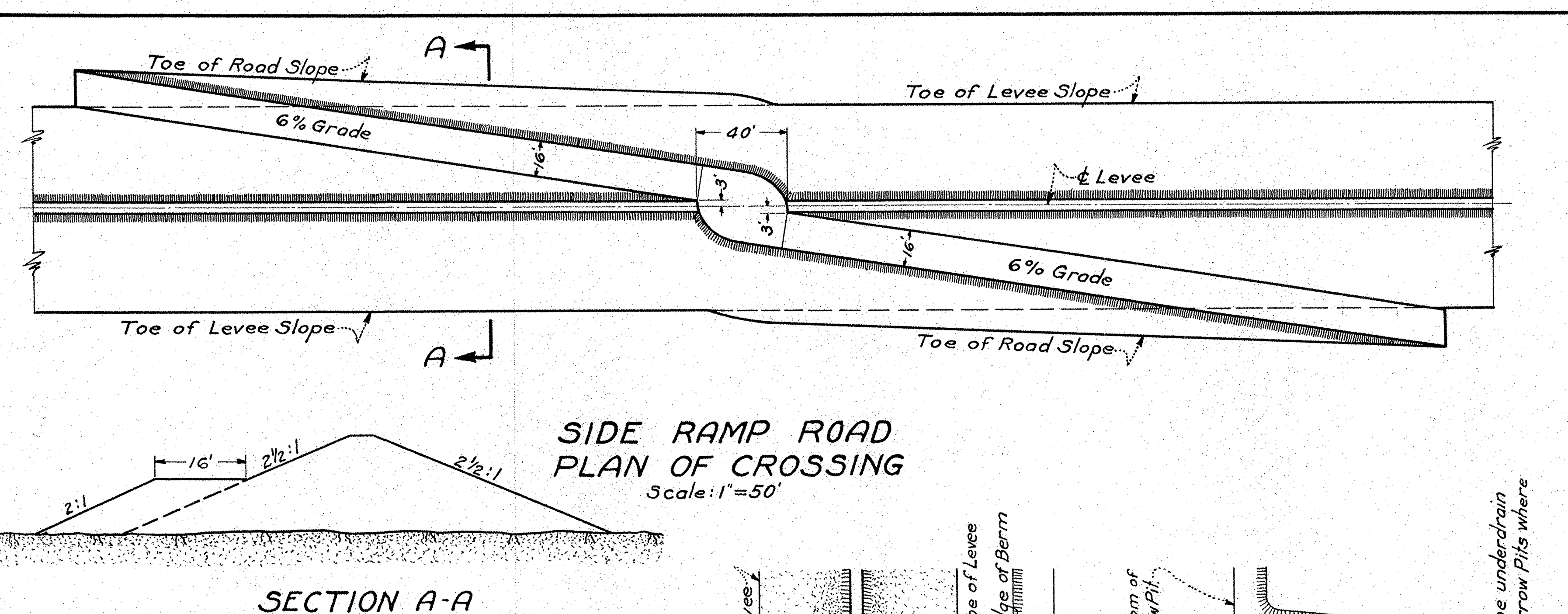
DISTRICT ENGINEER MYERS, NOYES & FORREST DALLAS - TEXAS

CONSULTING ENGINEER MORGAN ENGINEERING CO. MEMPHIS - TENN.

JULY 1, 1929

SHEET NO.35-B OF 57 SHEETS

W.E.G. Oct. 1928



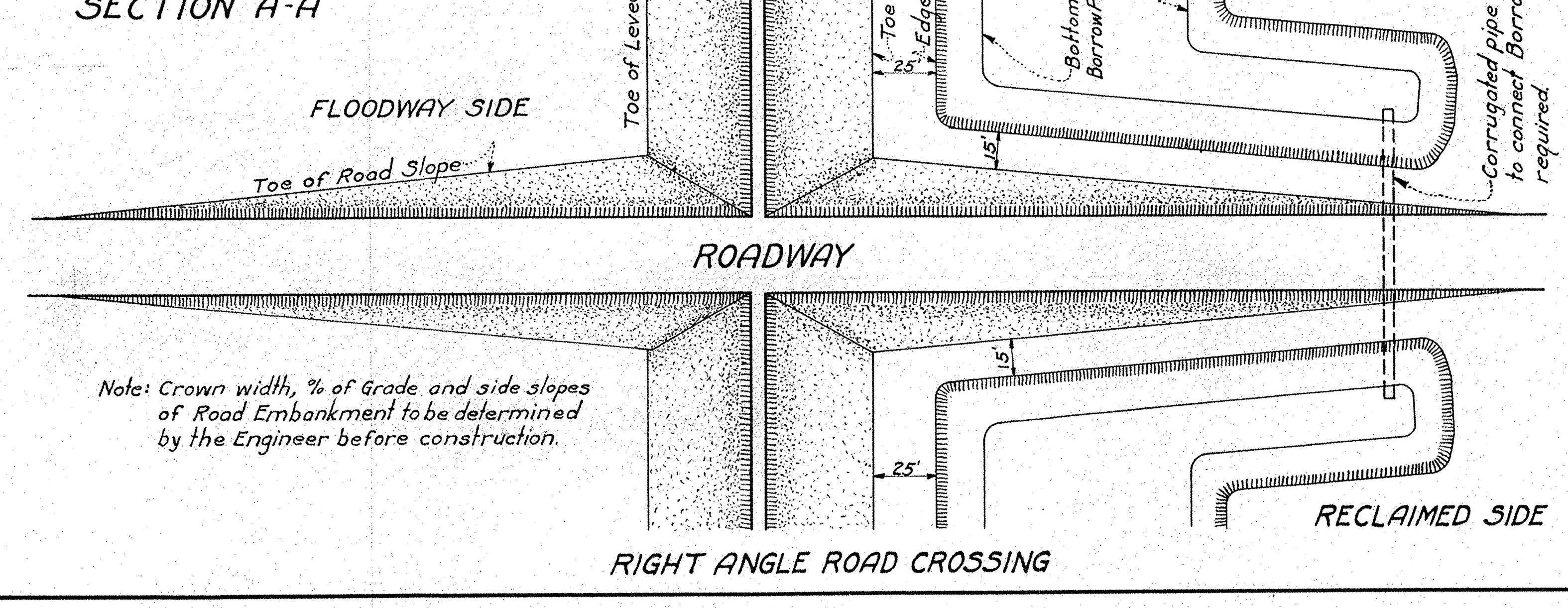


TABLE OF ROAD CROSSINGS OVER LEVEES

LEVEE	SECTION	STATION FROM	STATION TO	TYPE SIDE RAMP	TYPE RIGHT ANGLE	REMARKS
WEST	1	86	92	✓		COLORADO ST.
WEST	2	50	60	✓		VILBIG-BURGESS
WEST	2	32+27		FLOODWAY SIDE	RECLAIMED SIDE	HAMPTON ROAD
WEST	3				✓	EAGLE FORD ROAD
WEST	3	213			✓	SKILES ROAD
WEST	3	285+56			✓	HORTON FARM XING
EAST	1	7		✓		COMMERCE ST
EAST	2	14+32		FLOODWAY SIDE	RECLAIMED SIDE	HAMPTON ROAD
EAST	3	230		✓		GRAUWYLER ROAD

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer.
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO.5

TYPICAL ROAD CROSSINGS OVER LEVEES

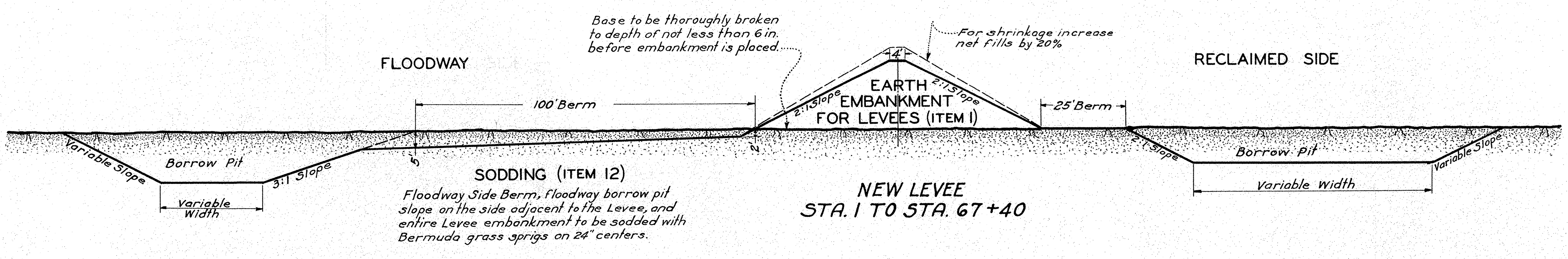
DISTRICT ENGINEER MYERS, NOYES & FORREST DALLAS - TEXAS

CONSULTING ENGINEER MORGAN ENGINEERING CO. MEMPHIS - TENN.

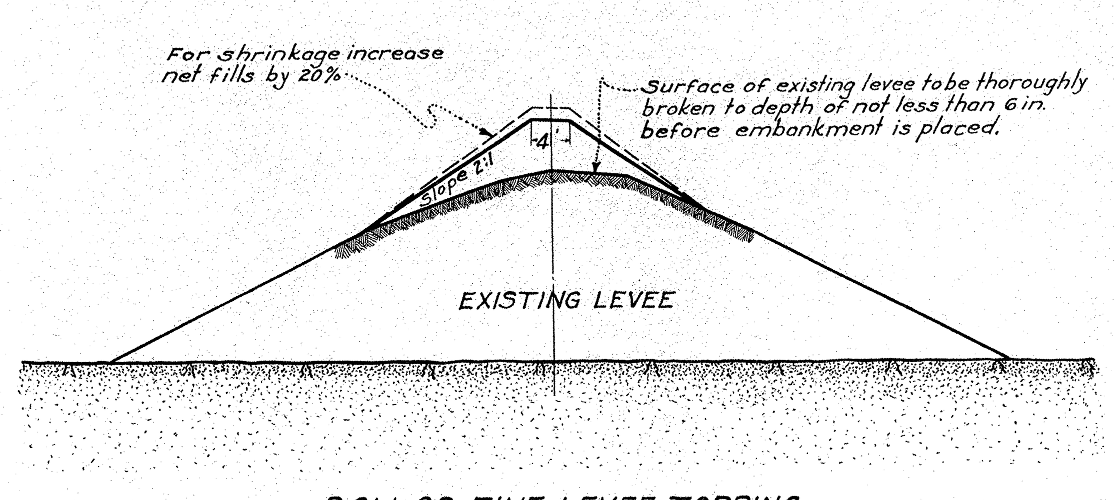
JULY 1, 1929

SHEET NO.35-C OF 57 SHEETS

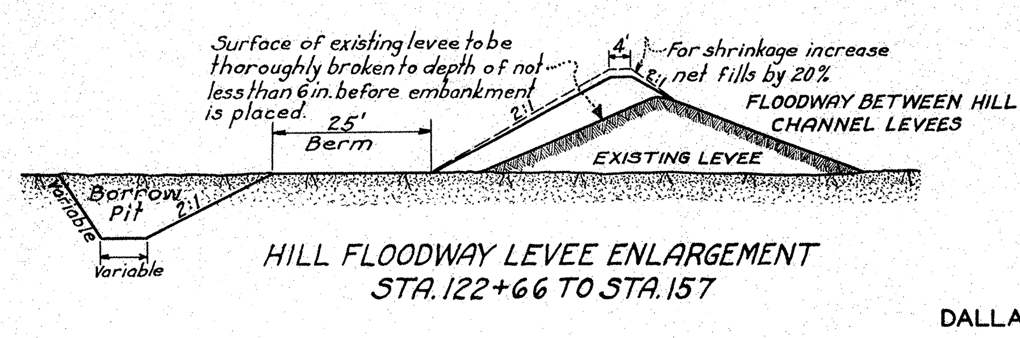
W.E.G. Feb. 1929



NEW LEVEE
STA. 1 TO STA. 67+40



DALLAS FIVE LEVEE TOPPING
STA. 67+40 TO STA. 122+66



HILL FLOODWAY LEVEE ENLARGEMENT
STA. 122+66 TO STA. 157

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

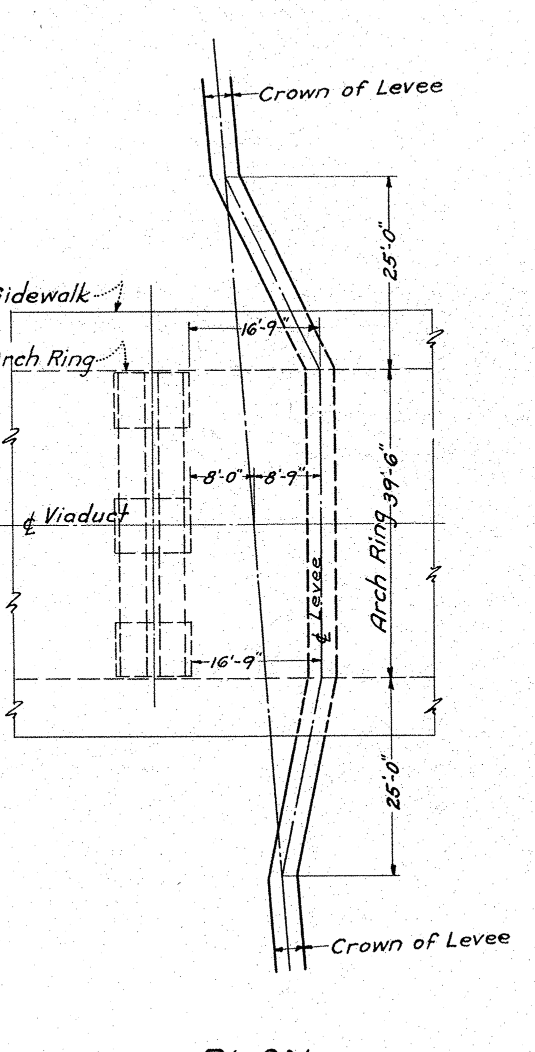
TYPICAL CROSS SECTION OF NORTHWEST LEVEE

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

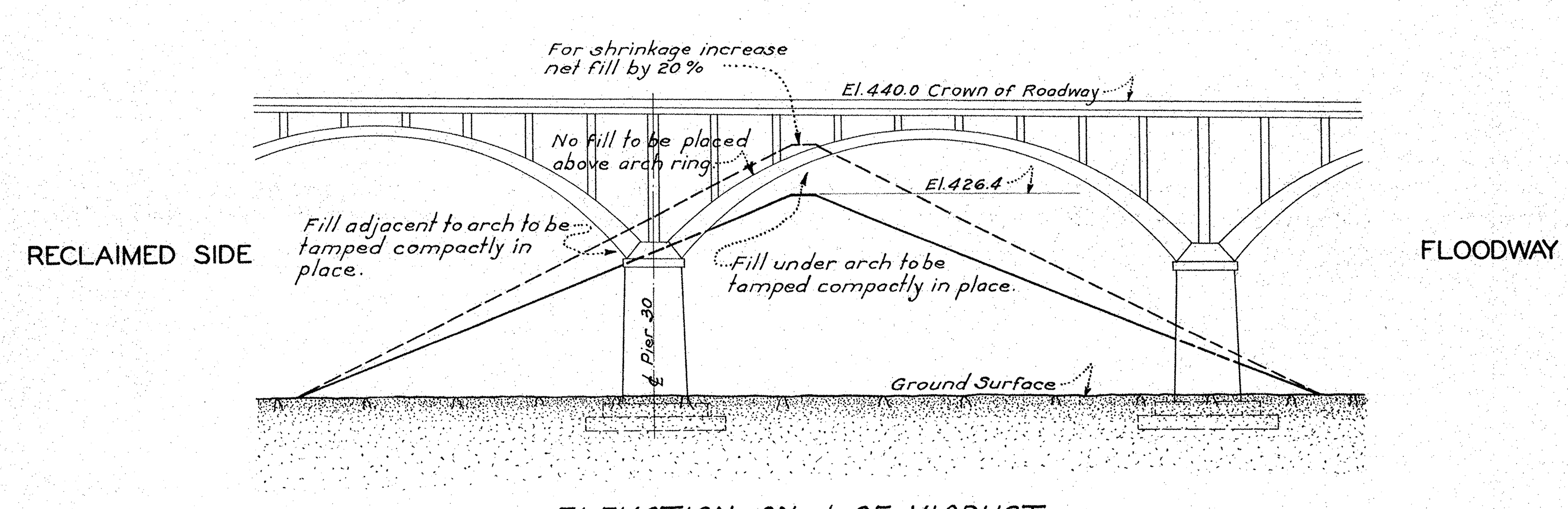
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 36-A OF 57 SHEETS



PLAN
Scale: 1/8" = 1'-0"



ELEVATION ON ℄ OF VIADUCT
Scale: 1/8" = 1'-0"

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

EAST LEVEE SECTION NO. 1
CADIZ ST. DIVISION

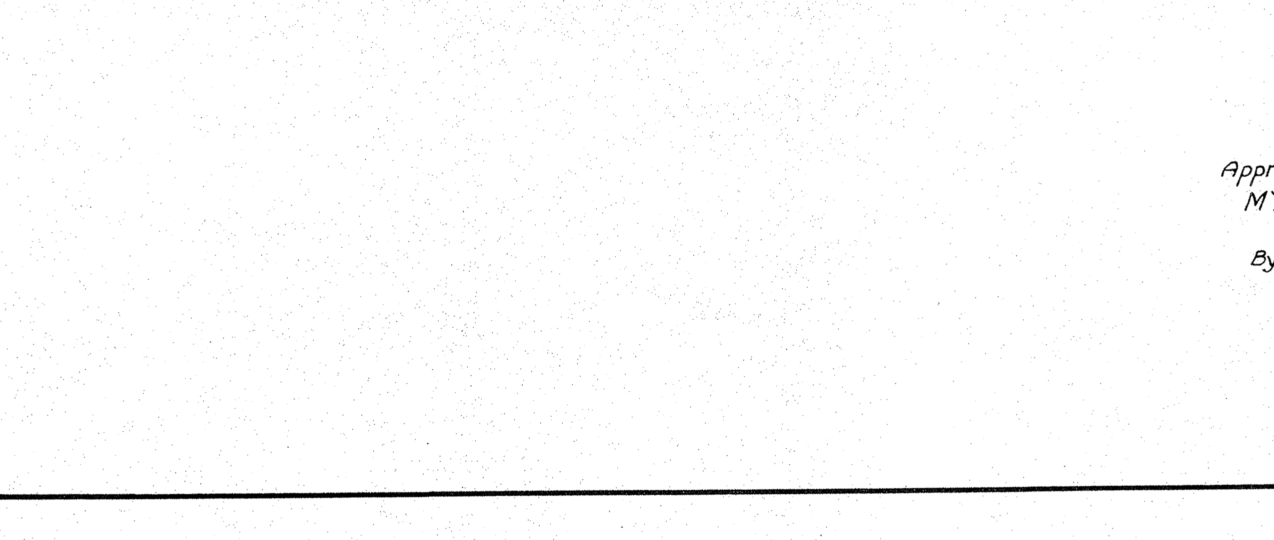
PLAN FOR CONSTRUCTION UNDER OAK CLIFF VIADUCT

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 36-B OF 57 SHEETS



SECTION ON ℄ OF DRAIN

TABLE OF UNDERDRAINS

LEVEE	SECTION	NEAR STATION	ROAD	CORRUGATED PIPE REQUIRED		
				LENGTH IN FEET L	DIAMETER IN INCHES D	GAUGE
WEST	2	60	VILBIG-BURGESS	100	54	12
WEST	2	32-27	HAMPTON (FISH TRAP)	120	54	12
WEST	3	180	EAGLE FORD	225	48	12
WEST	-	-	EAGLE FORD EXTEN.	145	36	12
EAST	3	230	GRAUWYLER	184	36	12

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer.
Approved: [signature]
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

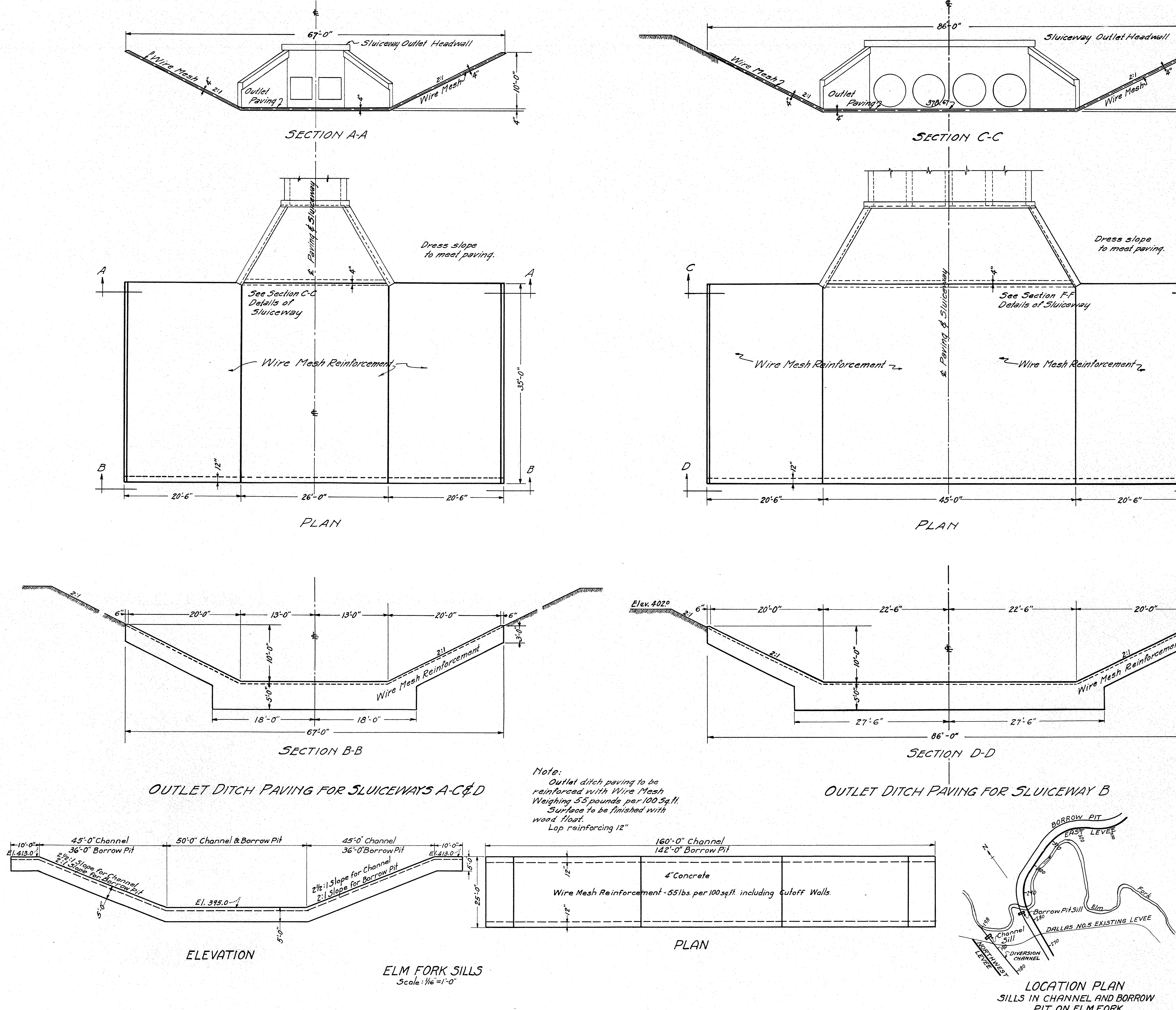
TYPICAL UNDERDRAIN DETAILS

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO
MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 36-C OF 57 SHEETS



Approved:
MYERS, NOYES & FORREST
By [signature]

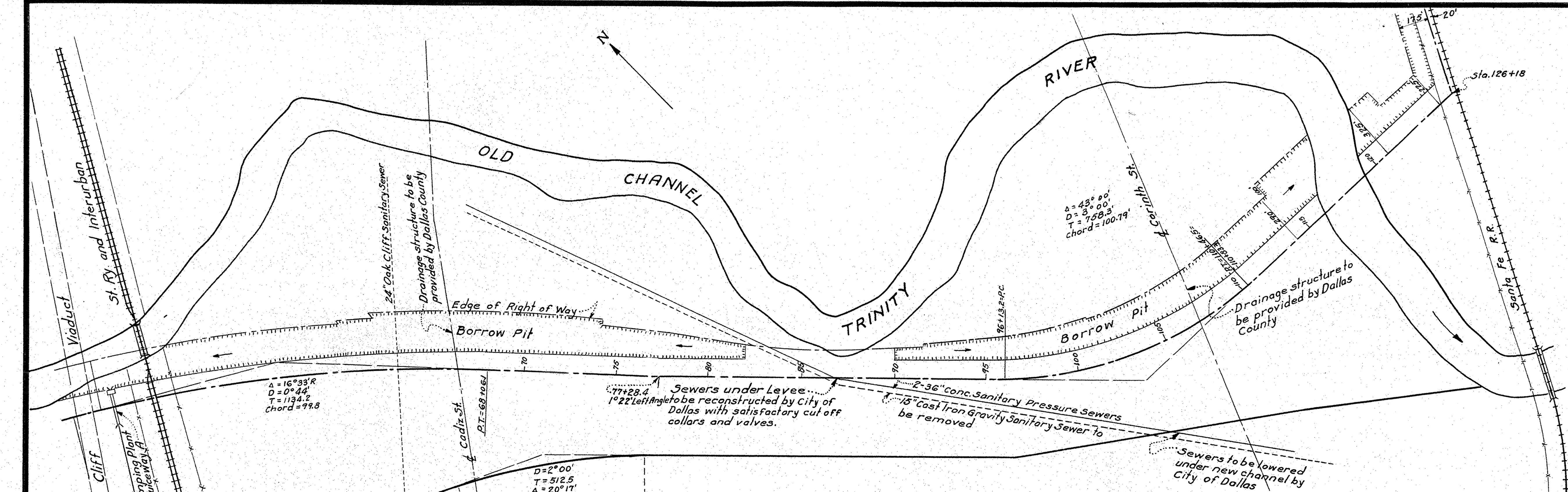
FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

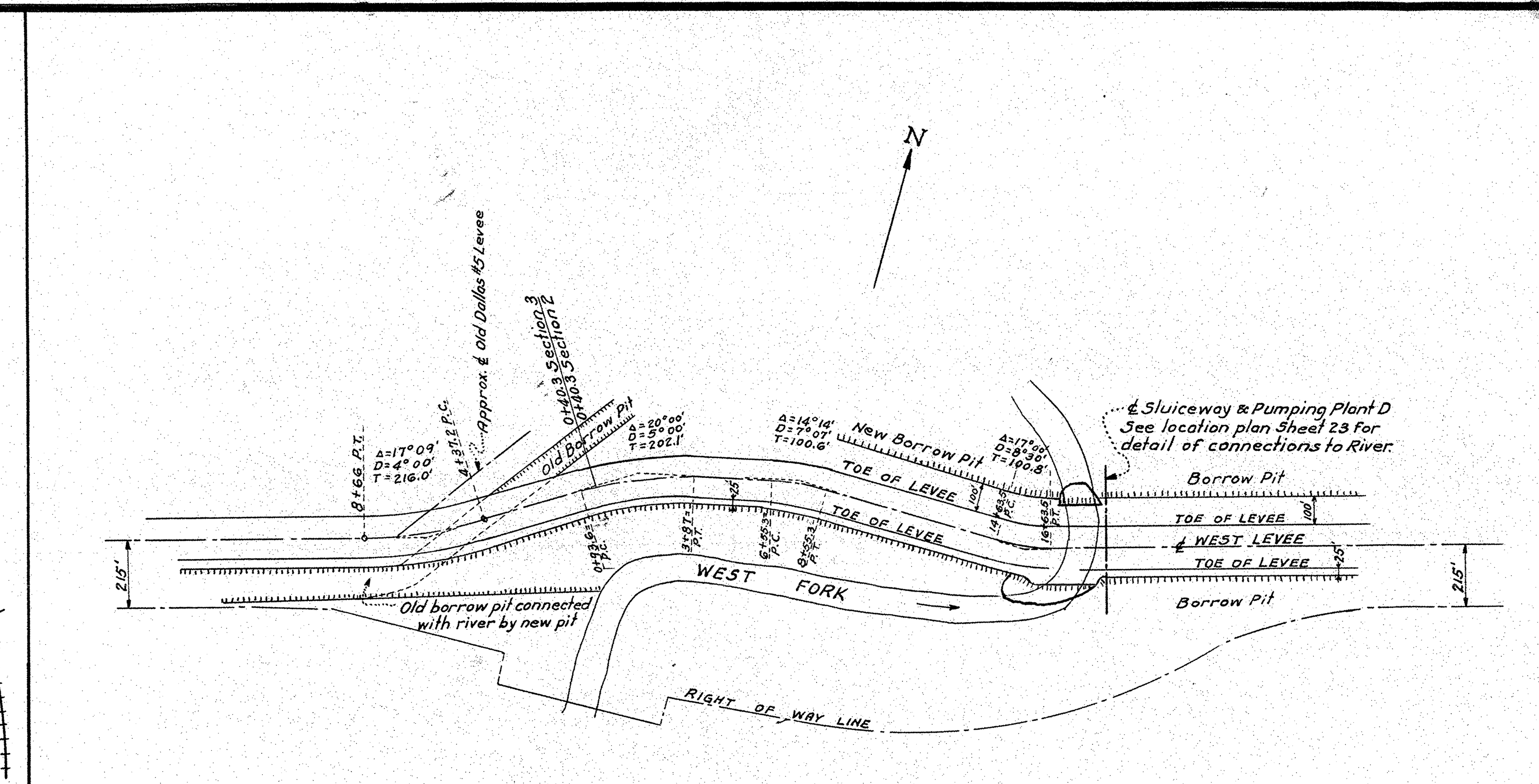
CONCRETE OUTLET DITCH PAVING
AT PUMPING PLANTS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

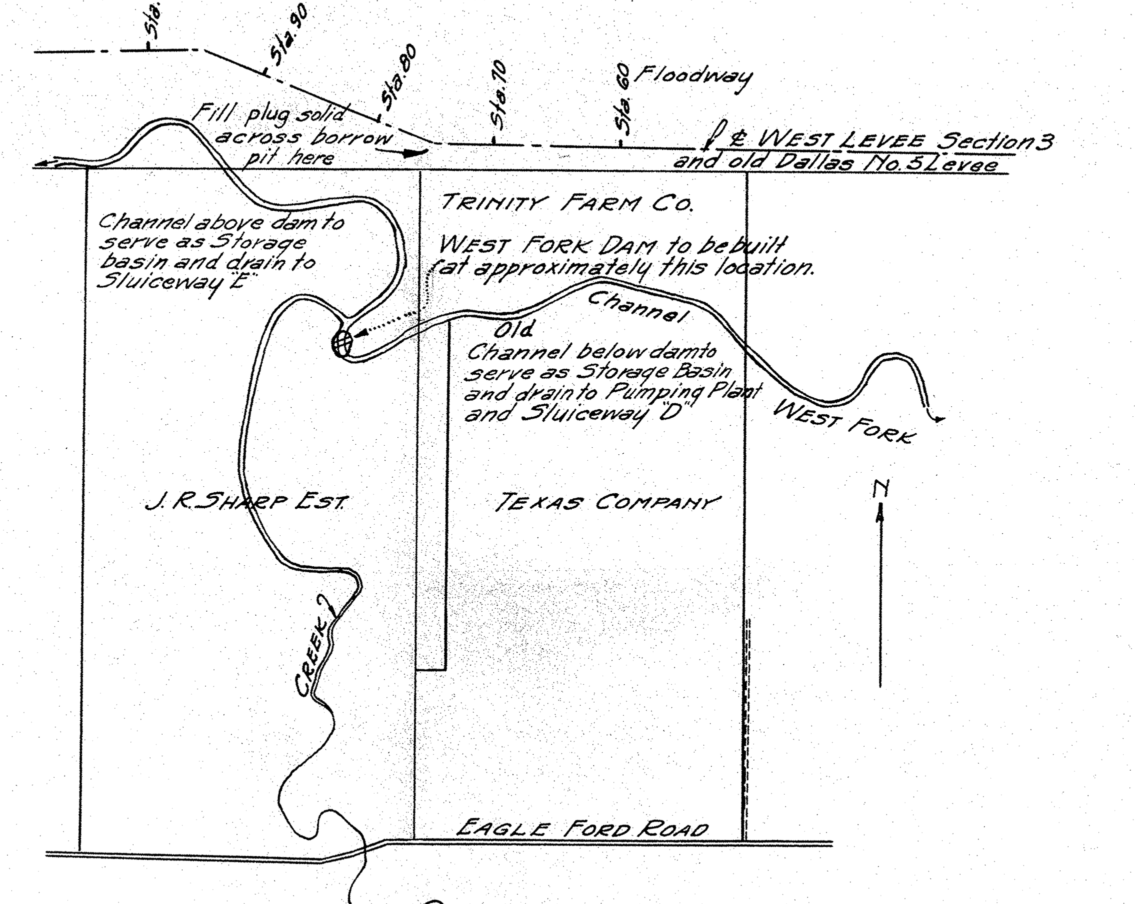
JULY 1, 1929
SCALE: 1/8" = 1'-0"



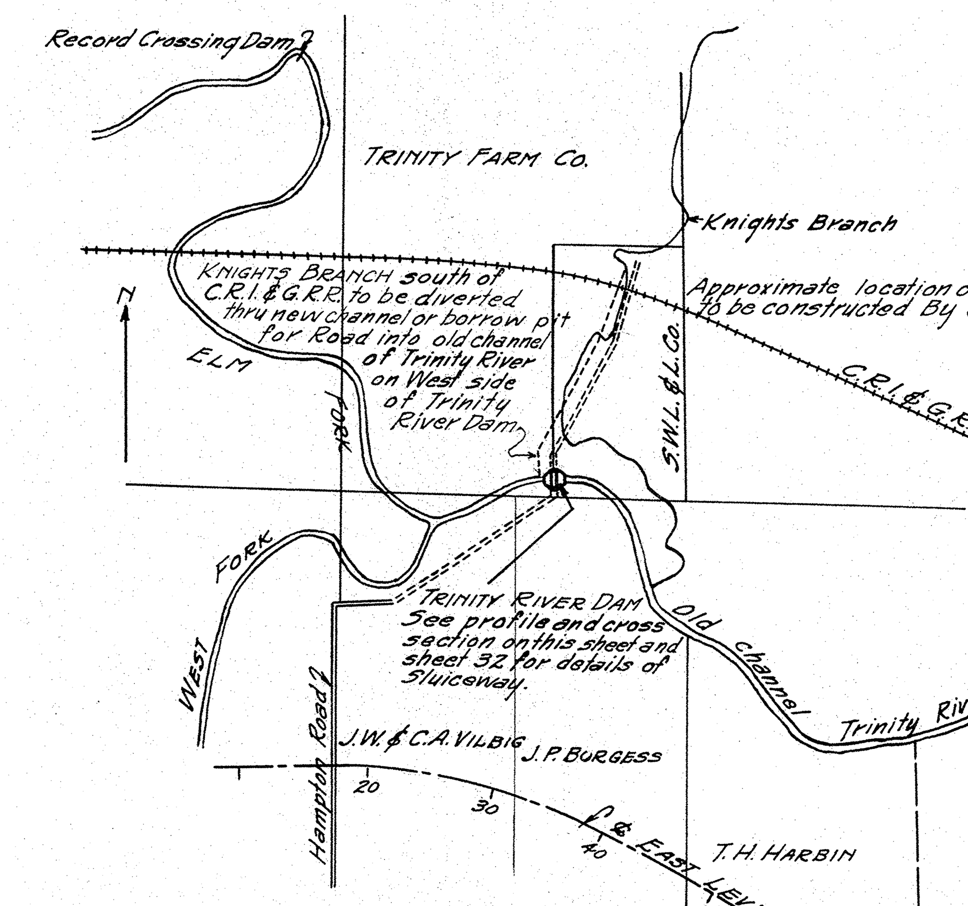
SKETCH DETAIL PLAN
OF
EAST LEVEE & CHANNEL
FROM
OAK CLIFF VIADUCT TO SANTA FE R.R.
Scale: 1" = 400'



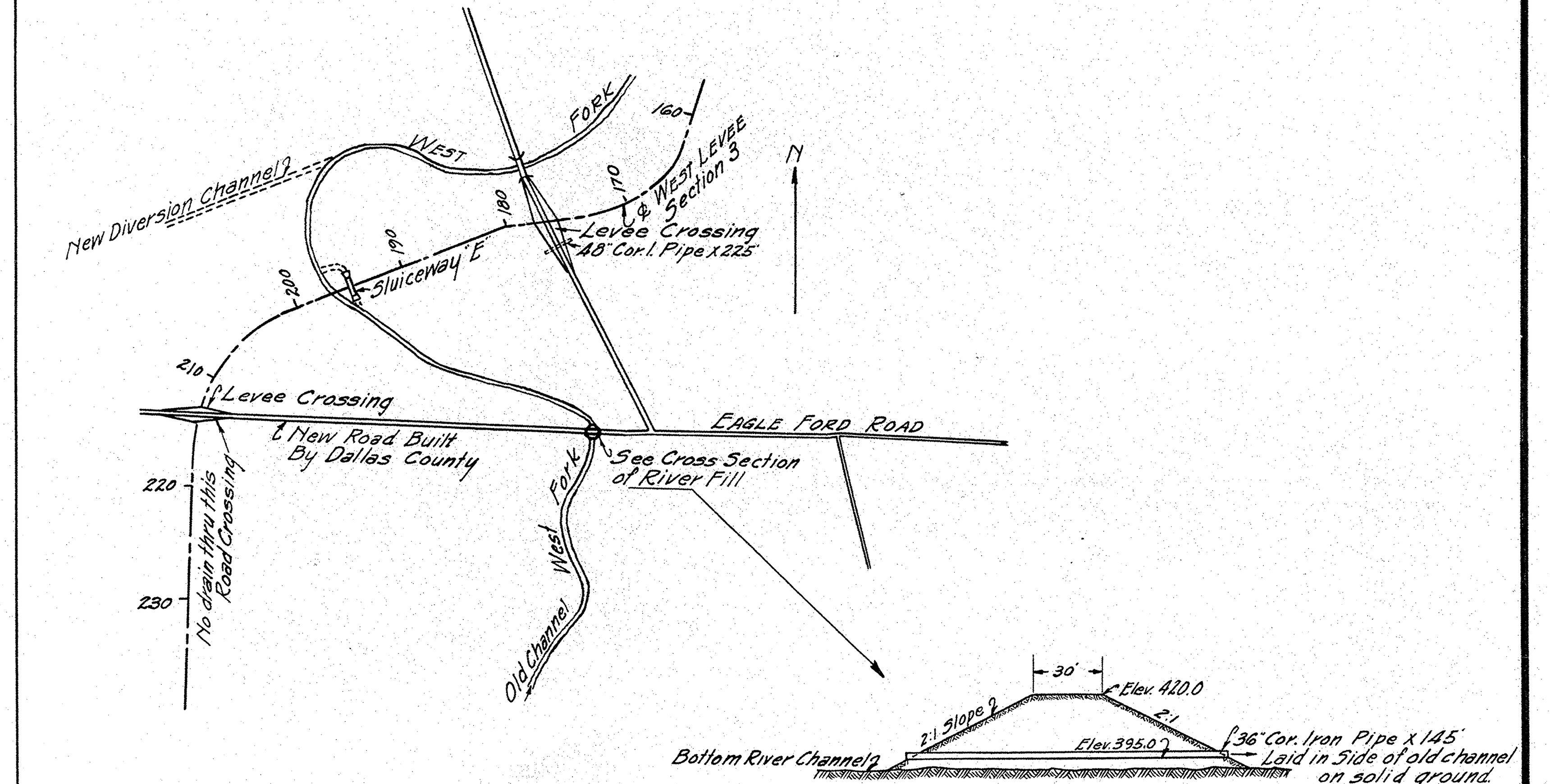
DETAIL PLAN OF WEST LEVEE
NEAR JUNCTION SECTIONS 2 & 3
Scale: 1" = 400'



LOCATION PLAN
OF
WEST FORK DAM
1" = 1000'

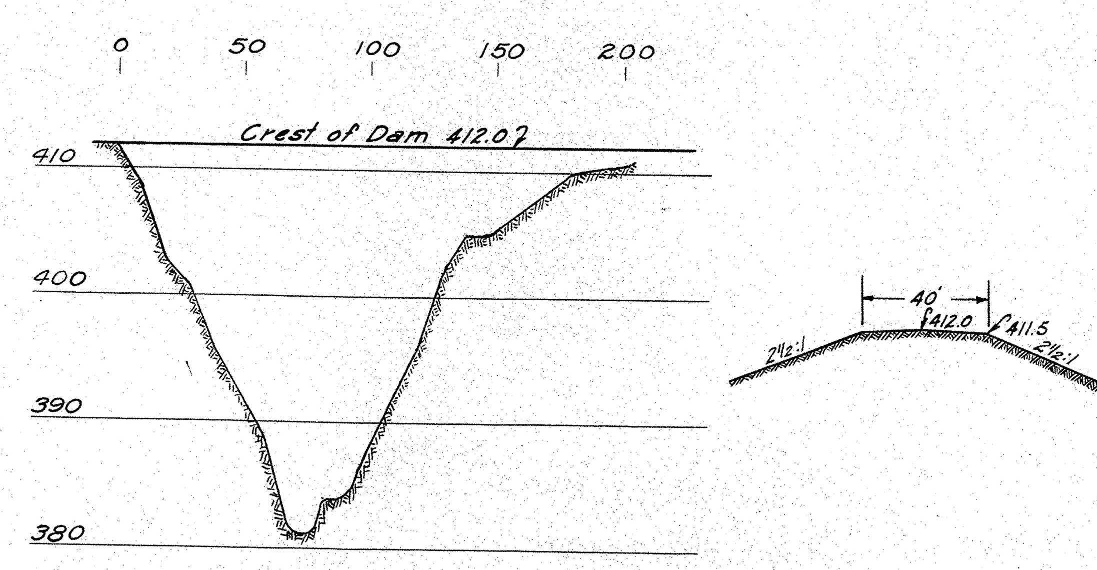


LOCATION PLAN
OF
TRINITY RIVER DAM
& KNIGHTS BRANCH DIVERSION
1" = 1000'

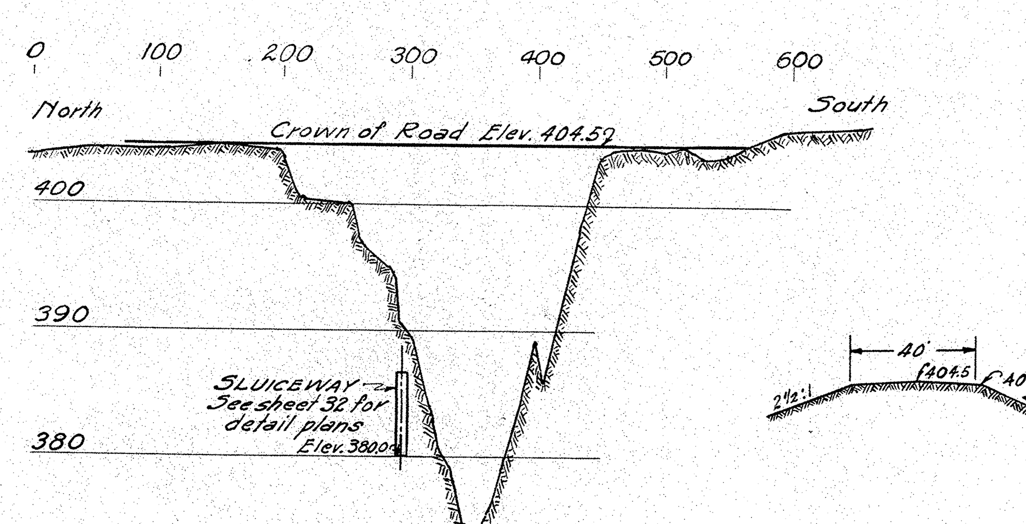


CROSS SECTION OF RIVER FILL
EAGLE FORD ROAD EXTENTION
1" = 50'

SKETCH DETAILS
OF
ROAD CROSSING AND RIVER FILL
NEAR
EAGLE FORD CROSSING OF WEST LEVEE



PROFILE AND CROSS SECTION
WEST FORK DAM
NEAR
STATION 77 SECTION 3 WEST LEVEE
Profile Scale: Hor. 1" = 50'
Vert. 1" = 10'

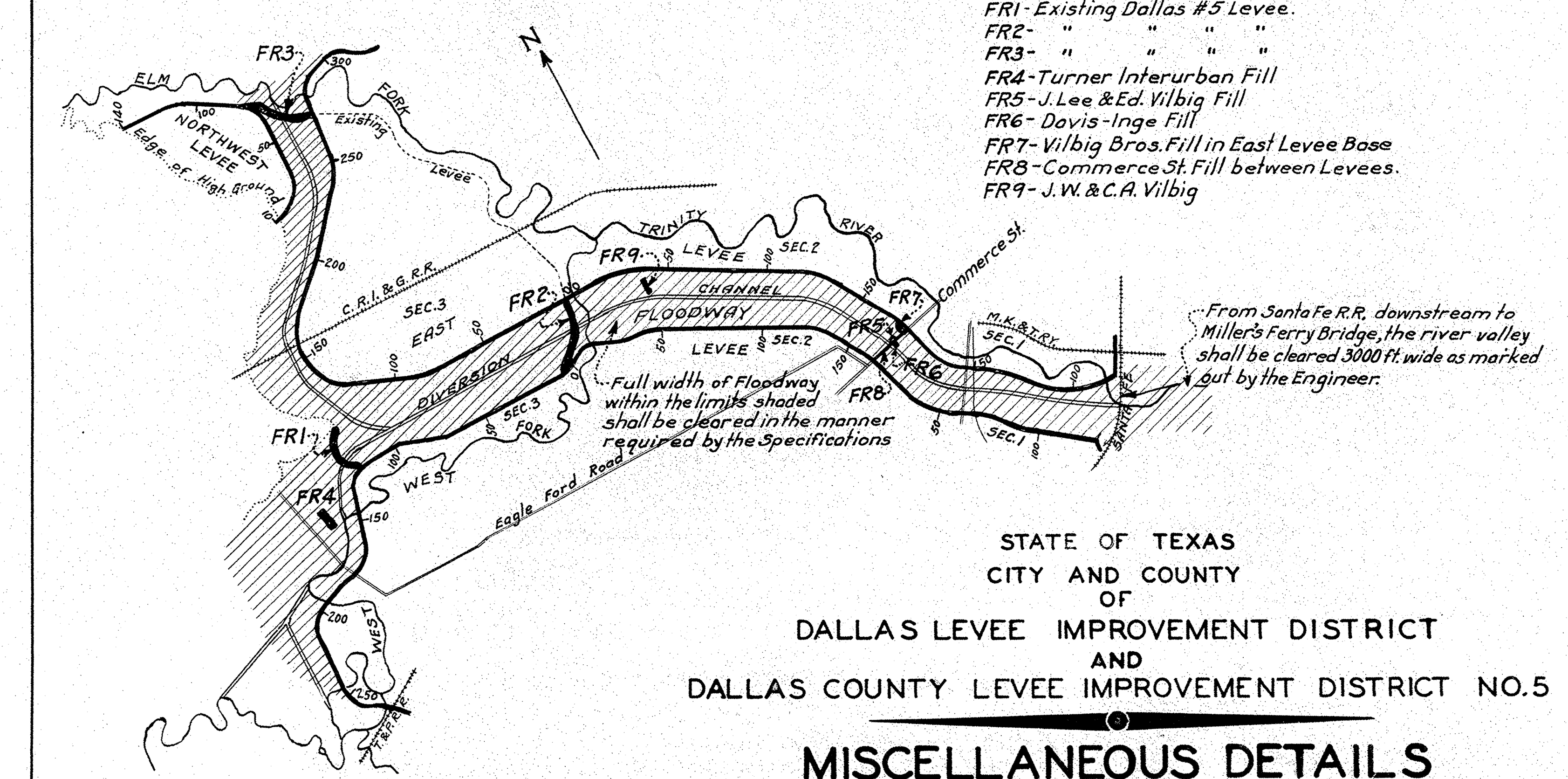


PROFILE AND CROSS SECTION
TRINITY RIVER DAM
Profile Scale: Hor. 1" = 100'
Vert. 1" = 10'

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer.
Approved: [signature] Vice President.

KEY TO FILL REMOVALS
See Item 6 for Specifications
FR1 - Existing Dallas #5 Levee.
FR2 - " " "
FR3 - " " "
FR4 - Turner Interurban Fill
FR5 - J. Lee & Ed. Vilbig Fill
FR6 - Davis-Inge Fill
FR7 - Vilbig Bros. Fill in East Levee Base
FR8 - Commerce St. Fill between Levees.
FR9 - J. W. & C.A. Vilbig



SKETCH PLAN
SHOWING
FLOODWAY CLEARING & FILL REMOVALS

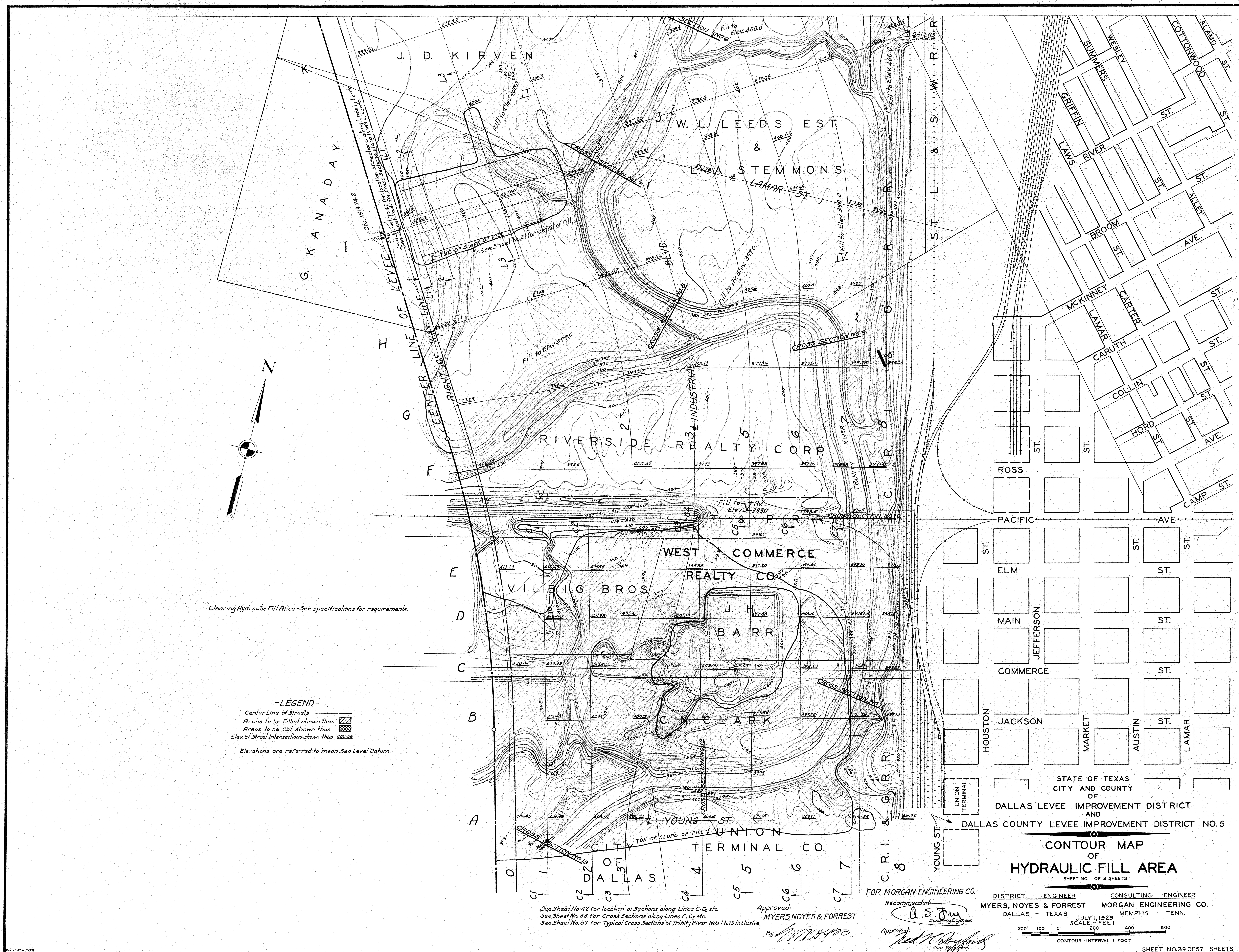
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

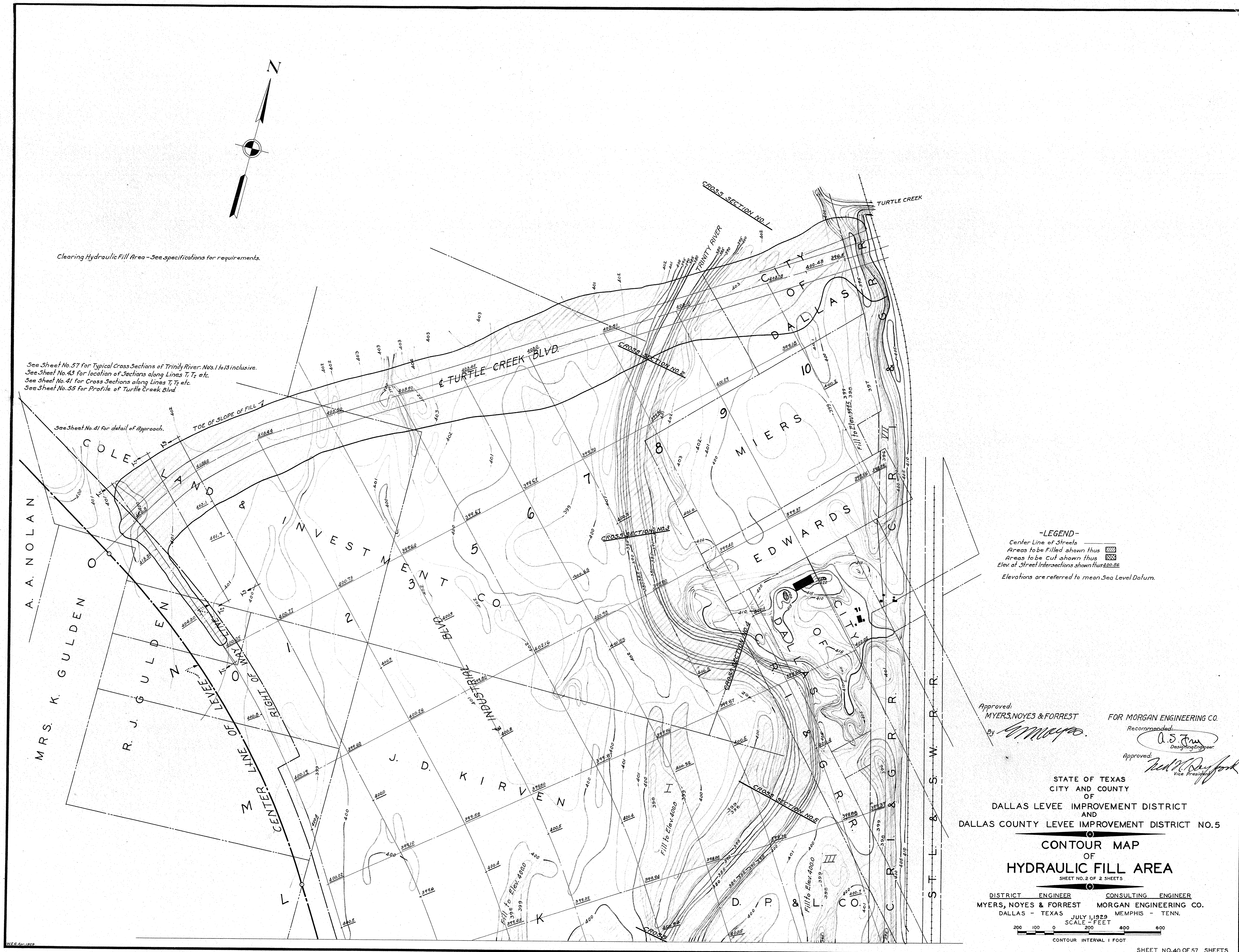
MISCELLANEOUS DETAILS

DISTRICT ENGINEER — CONSULTING ENGINEER
MYERS, NOYES & FORREST — MORGAN ENGINEERING CO.
DALLAS - TEXAS — MEMPHIS - TENN.

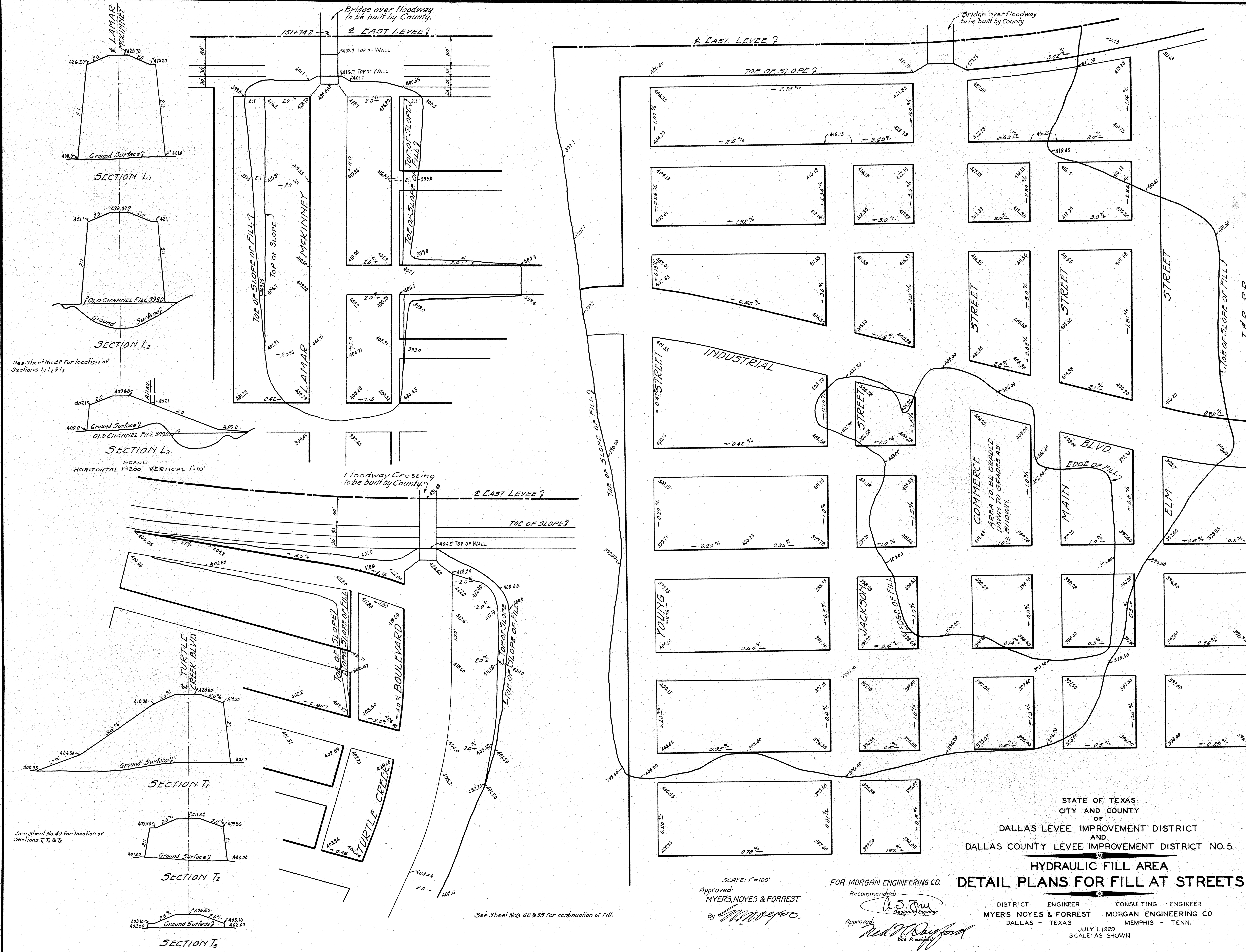
JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 38 OF 57 SHEETS


STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
CONTOUR MAP
OF
HYDRAULIC FILL AREA
SHEET NO. 1 OF 2 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600
CONTOUR INTERVAL 1 FOOT
SHEET NO. 39 OF 57 SHEETS
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President
Approved:
MYERS, NOYES & FORREST
By
See Sheet No. 42 for location of Sections along Lines C1, C2 etc.
See Sheet No. 54 for Cross Sections along Lines C1, C2 etc.
See Sheet No. 57 for Typical Cross Sections of Trinity River No's. 1 to 13 inclusive.
-LEGEND-
Center Line of Streets
Areas to be Filled shown thus
Areas to be Cut shown thus
Elev. of Street Intersections shown thus 400.56
Elevations are referred to mean Sea Level Datum.
Clearing Hydraulic Fill Area - See specifications for requirements.
N
J. D. KIRVEN
J. W. L. LEEDS EST
&
L. A. STEMMONS
G. KANADAY
RIVERSIDE REALTY CORP
WEST COMMERCE REALTY CO
VILBIG BROS
J. H. BARR
C. N. CLARK
UNION TERMINAL CO.
CITY OF DALLAS
CENTER LINE OF LEVEE
RIGHT OF WAY LINE
TOE OF SLOPE OF FILL
See Sheet No. 41 for detail of Fill.
Fill to Elev. 400.0
Fill to Elev. 399.0
Fill to Av. Elev. 399.0
Fill to Av. Elev. 398.0
CROSS SECTION NO. 6
CROSS SECTION NO. 7
CROSS SECTION NO. 8
CROSS SECTION NO. 9
CROSS SECTION NO. 10
CROSS SECTION NO. 11
CROSS SECTION NO. 12
CROSS SECTION NO. 13
LAMAR ST.
INDUSTRIAL BLVD.
TRINITY RIVER
YOUNG ST.
T. & P. R. R.
C. R. I. & G. R. R.
ST. L. & S. W. R. R.
UNION TERMINAL
PACIFIC AVE
ELM ST.
MAIN ST.
COMMERCE ST.
JACKSON ST.
ROSS AVE.
CAMP ST.
HOUSTON ST.
JEFFERSON
MARKET
AUSTIN ST.
LAMAR
MCKINNEY AVE.
BROOM ST.
LAWS ST.
RIVER ST.
GRIFFIN ST.
SUMMERS
WESLEY ST.
COTTONWOOD ST.
ALAMO ST.
ALLEY
CARTER ST.
CARUTH ST.
COLLIN ST.
HORD ST.
DALLAS BRANCH



N
Clearing Hydraulic Fill Area - See specifications for requirements.
See Sheet No. 57 for Typical Cross Sections of Trinity River. No's. 1 to 13 inclusive.
See Sheet No. 43 for location of Sections along Lines T, T1 etc.
See Sheet No. 41 for Cross Sections along Lines T, T1 etc.
See Sheet No. 55 for Profile of Turtle Creek Blvd.
See Sheet No. 41 for detail of Approach.
TOE OF SLOPE OF FILL
℄ TURTLE CREEK BLVD.
TURTLE CREEK
TRINITY RIVER
CROSS SECTION NO. 1
CROSS SECTION NO. 2
CROSS SECTION NO. 3
CROSS SECTION NO. 4
CROSS SECTION NO. 5
CITY OF DALLAS
MIERS
EDWARDS
COLE LAND & INVESTMENT CO.
℄ INDUSTRIAL BLVD.
J. D. KIRVEN
D. P. & L. CO.
A. A. NOLAN
MRS. K. GULDEN
R. J. GULDEN
M. L. NOLAN
CENTER LINE OF LEVEE
RIGHT OF WAY LINE
C. R. I. & G. R. R.
ST. L. & S. W. R. R.
CITY OF DALLAS
Fill to Elev. 400.0
Fill to Elev. 399.0
-LEGEND-
Center Line of Streets
Areas to be Filled shown thus
Areas to be Cut shown thus
Elev. of Street Intersections shown thus 400.56
Elevations are referred to mean Sea Level Datum.
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
CONTOUR MAP
OF
HYDRAULIC FILL AREA
SHEET NO. 2 OF 2 SHEETS
DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS - TEXAS
CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS - TENN.
JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600
CONTOUR INTERVAL 1 FOOT
SHEET NO. 40 OF 57 SHEETS



Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry, Designing Engineer
Approved: [signature] Vice President

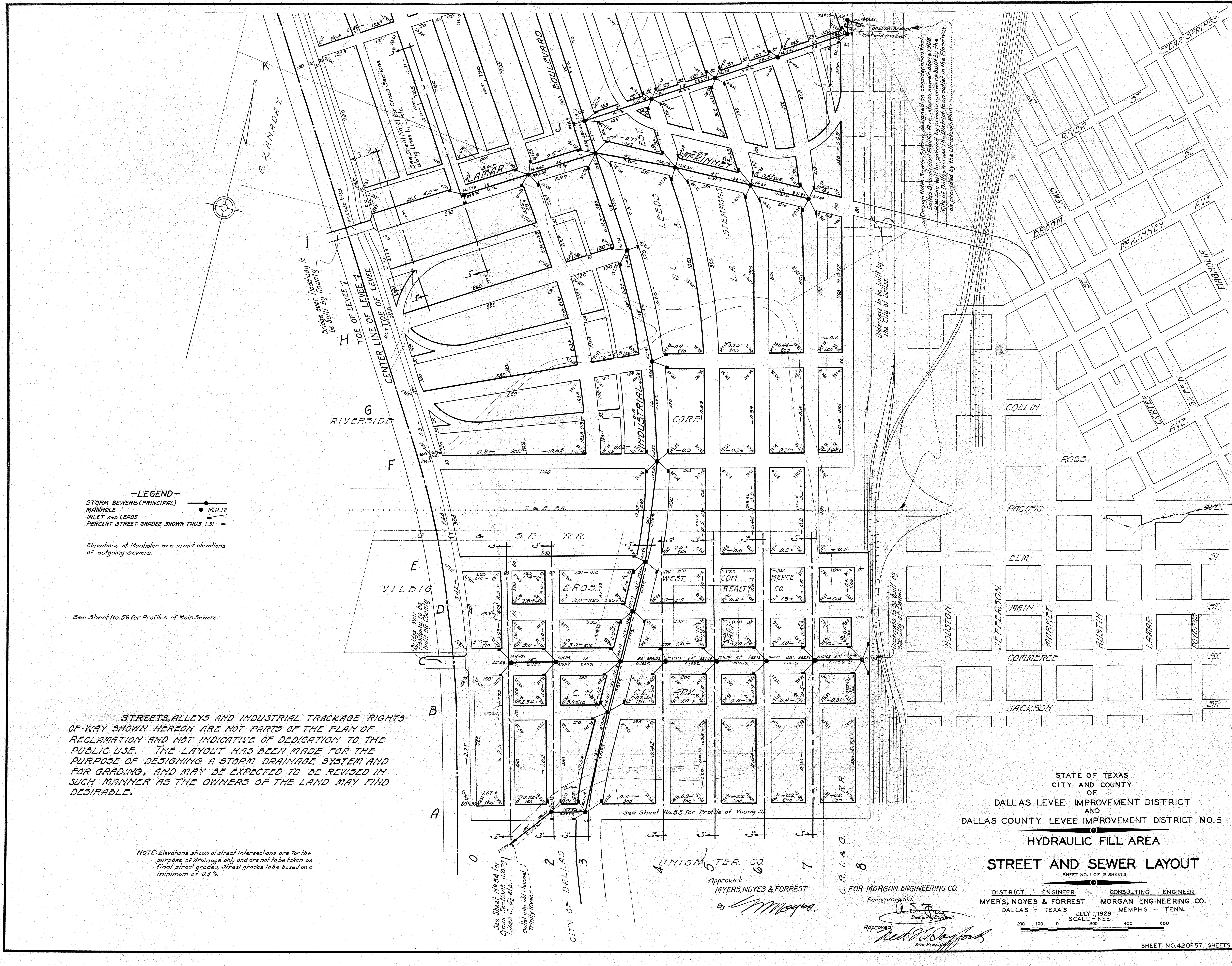
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

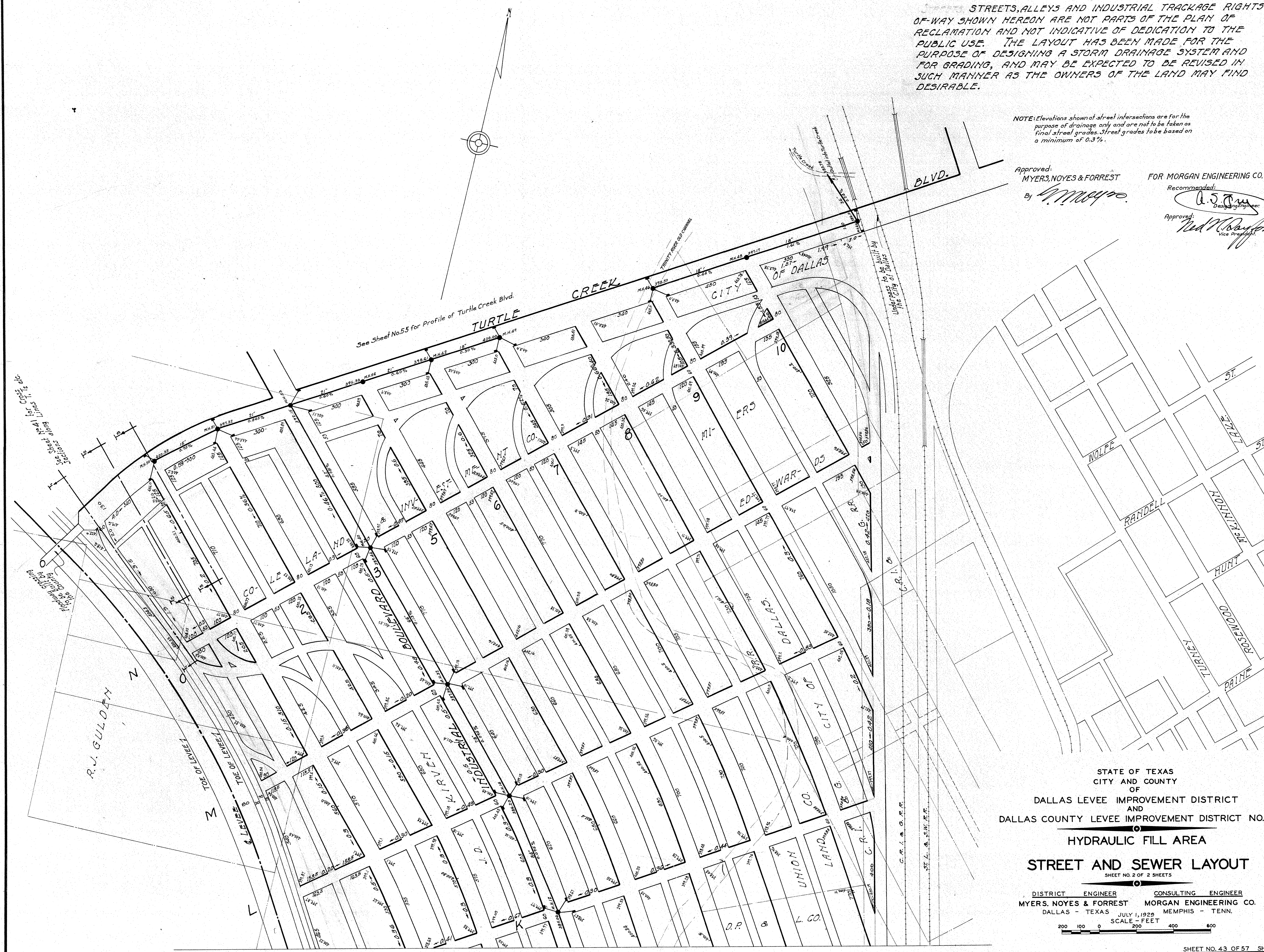
HYDRAULIC FILL AREA
DETAIL PLANS FOR FILL AT STREETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 41 OF 57 SHEETS


-LEGEND-
STORM SEWERS (PRINCIPAL)
MANHOLE
M.H. 12
INLET AND LEADS
PERCENT STREET GRADES SHOWN THUS 1.31→
Elevations of Manholes are invert elevations of outgoing sewers.
See Sheet No. 56 for Profiles of Main Sewers.
STREETS, ALLEYS AND INDUSTRIAL TRACKAGE RIGHTS-OF-WAY SHOWN HEREON ARE NOT PARTS OF THE PLAN OF RECLAMATION AND NOT INDICATIVE OF DEDICATION TO THE PUBLIC USE. THE LAYOUT HAS BEEN MADE FOR THE PURPOSE OF DESIGNING A STORM DRAINAGE SYSTEM AND FOR GRADING, AND MAY BE EXPECTED TO BE REVISED IN SUCH MANNER AS THE OWNERS OF THE LAND MAY FIND DESIRABLE.
NOTE: Elevations shown at street intersections are for the purpose of drainage only and are not to be taken as final street grades. Street grades to be based on a minimum of 0.3%.
Design Note: Sewer System designed on consideration that Dallas Branch and Pacific Ave. storm sewer above 1908 H.W. line will be carried by pressure sewers built by the City of Dallas across the District to an outlet in the Floodway as provided by the Ulrickson Plan.
DALLAS BRANCH Inlet and Headwall
Bridge over Floodway to be built by County
Underpass to be built by the City of Dallas.
See Sheet No. 41 for Cross Sections along Lines L, J etc.
See Sheet No. 54 for Cross Sections along Lines C, G etc.
Outlet into old channel Trinity River
See Sheet No. 55 for Profile of Young St.
G. KANADAY
CENTER LINE TOE OF LEVEE
TOE OF LEVEE
RIVERSIDE
VILDIG
LAMAR
BOULEVARD
McKINNEY
LEEDS
STEMMONS
W. L.
L. A.
INDUSTRIAL
CORP.
WEST
COM REALTY
MERCE CO.
BROS.
C. M.
CL
ARK
T. & P. R.R.
G. C. & S. F. R.R.
UNION TER. CO.
C. R. I. & G.
CITY OF DALLAS
CEDAR SPRINGS
RIVER ST.
LAMAR ST.
BROOM ST.
LAWS
McKINNEY AVE
MAGNOLIA
COLLIN
ROSS
CARTER
GRIFFIN
AVE.
PACIFIC AVE.
ELM ST.
MAIN ST.
COMMERCE ST.
JACKSON ST.
HOUSTON
JEFFERSON
MARKET
AUSTIN
LAMAR
POYDRAS
STATE OF TEXAS
CITY AND COUNTY OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5
HYDRAULIC FILL AREA
STREET AND SEWER LAYOUT
SHEET NO. 1 OF 2 SHEETS
DISTRICT ENGINEER
CONSULTING ENGINEER
MYERS, NOYES & FORREST
MORGAN ENGINEERING CO.
DALLAS - TEXAS
MEMPHIS - TENN.
JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600
Approved:
MYERS, NOYES & FORREST
By
FOR MORGAN ENGINEERING CO.
Recommended:
Designing Engineer
Approved:
Vice President
SHEET NO. 42 OF 57 SHEETS



STREETS, ALLEYS AND INDUSTRIAL TRACKAGE RIGHTS-OF-WAY SHOWN HEREON ARE NOT PARTS OF THE PLAN OF RECLAMATION AND NOT INDICATIVE OF DEDICATION TO THE PUBLIC USE. THE LAYOUT HAS BEEN MADE FOR THE PURPOSE OF DESIGNING A STORM DRAINAGE SYSTEM AND FOR GRADING, AND MAY BE EXPECTED TO BE REVISED IN SUCH MANNER AS THE OWNERS OF THE LAND MAY FIND DESIRABLE.

NOTE: Elevations shown at street intersections are for the purpose of drainage only and are not to be taken as final street grades. Street grades to be based on a minimum of 0.3%.

Approved:
MYERS, NOYES & FORREST
By G. Noyes

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer.
Approved: Ned N. Rayford
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA

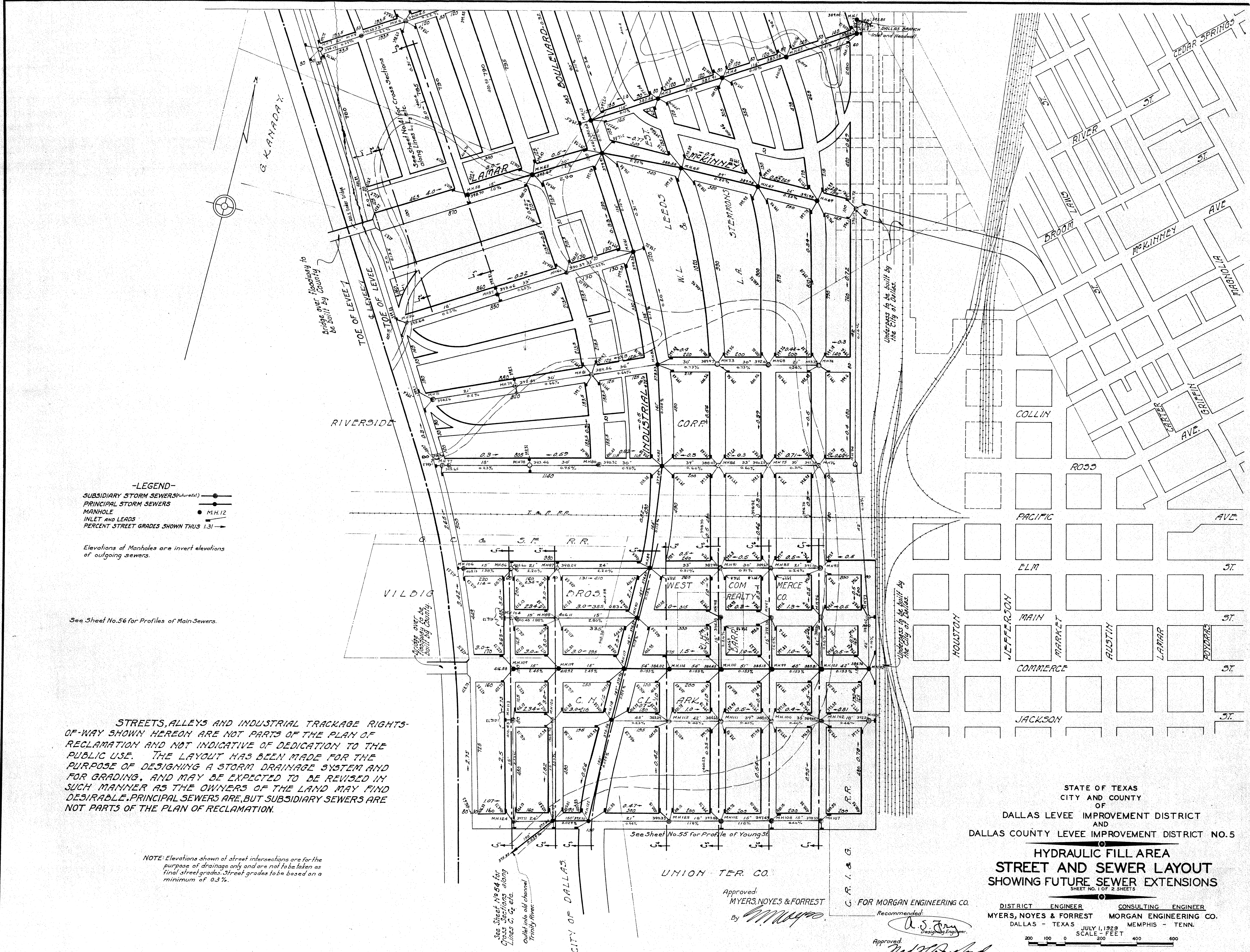
STREET AND SEWER LAYOUT

SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS. NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600

SHEET NO. 43 OF 57 SHEETS



-LEGEND-

SUBSIDIARY STORM SEWERS (Future)
PRINCIPAL STORM SEWERS
MANHOLE ● M.H.12
INLET AND LEADS
PERCENT STREET GRADES SHOWN THUS 1.31 →

Elevations of Manholes are invert elevations of outgoing sewers.

See Sheet No. 56 for Profiles of Main Sewers.

STREETS, ALLEYS AND INDUSTRIAL TRACKAGE RIGHTS-OF-WAY SHOWN HEREON ARE NOT PARTS OF THE PLAN OF RECLAMATION AND NOT INDICATIVE OF DEDICATION TO THE PUBLIC USE. THE LAYOUT HAS BEEN MADE FOR THE PURPOSE OF DESIGNING A STORM DRAINAGE SYSTEM AND FOR GRADING, AND MAY BE EXPECTED TO BE REVISED IN SUCH MANNER AS THE OWNERS OF THE LAND MAY FIND DESIRABLE. PRINCIPAL SEWERS ARE, BUT SUBSIDIARY SEWERS ARE NOT PARTS OF THE PLAN OF RECLAMATION.

NOTE: Elevations shown at street intersections are for the purpose of drainage only and are not to be taken as final street grades. Street grades to be based on a minimum of 0.3%.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
[signature]
Designing Engineer.

Approved:
Ned M. Dayford
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
STREET AND SEWER LAYOUT
SHOWING FUTURE SEWER EXTENSIONS

SHEET NO. 1 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600

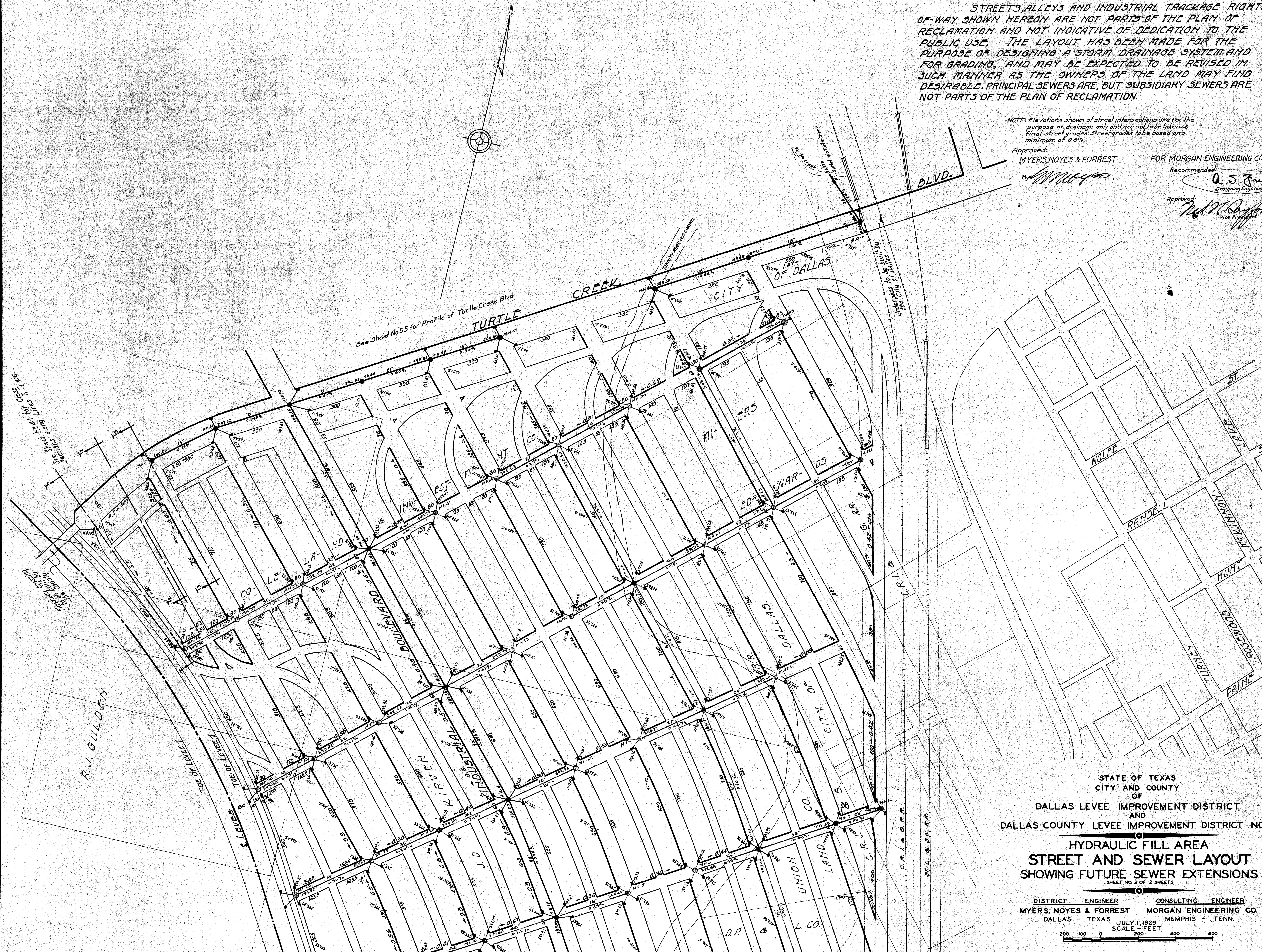
SHEET NO. 44 OF 57 SHEETS

STREETS, ALLEYS AND INDUSTRIAL TRACKAGE RIGHTS-OF-WAY SHOWN HEREON ARE NOT PARTS OF THE PLAN OF RECLAMATION AND NOT INDICATIVE OF DEDICATION TO THE PUBLIC USE. THE LAYOUT HAS BEEN MADE FOR THE PURPOSE OF DESIGNING A STORM DRAINAGE SYSTEM AND FOR GRADING, AND MAY BE EXPECTED TO BE REVISED IN SUCH MANNER AS THE OWNERS OF THE LAND MAY FIND DESIRABLE. PRINCIPAL SEWERS ARE, BUT SUBSIDIARY SEWERS ARE NOT PARTS OF THE PLAN OF RECLAMATION.

NOTE: Elevations shown at street intersections are for the purpose of drainage only and are not to be taken as final street grades. Street grades to be based on a minimum of 0.3%.

Approved:
MYERS, NOYES & FORREST.
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer.
Approved: [signature]
Vice President.



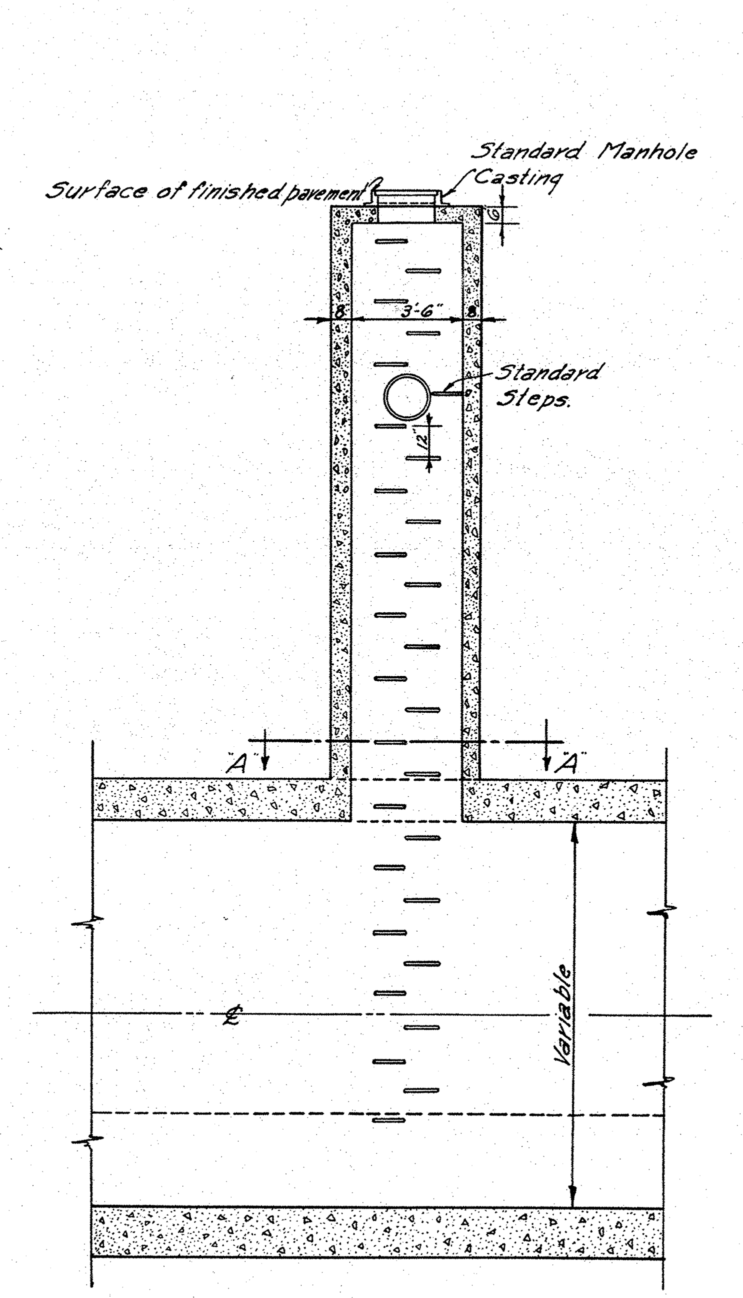
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
STREET AND SEWER LAYOUT
SHOWING FUTURE SEWER EXTENSIONS

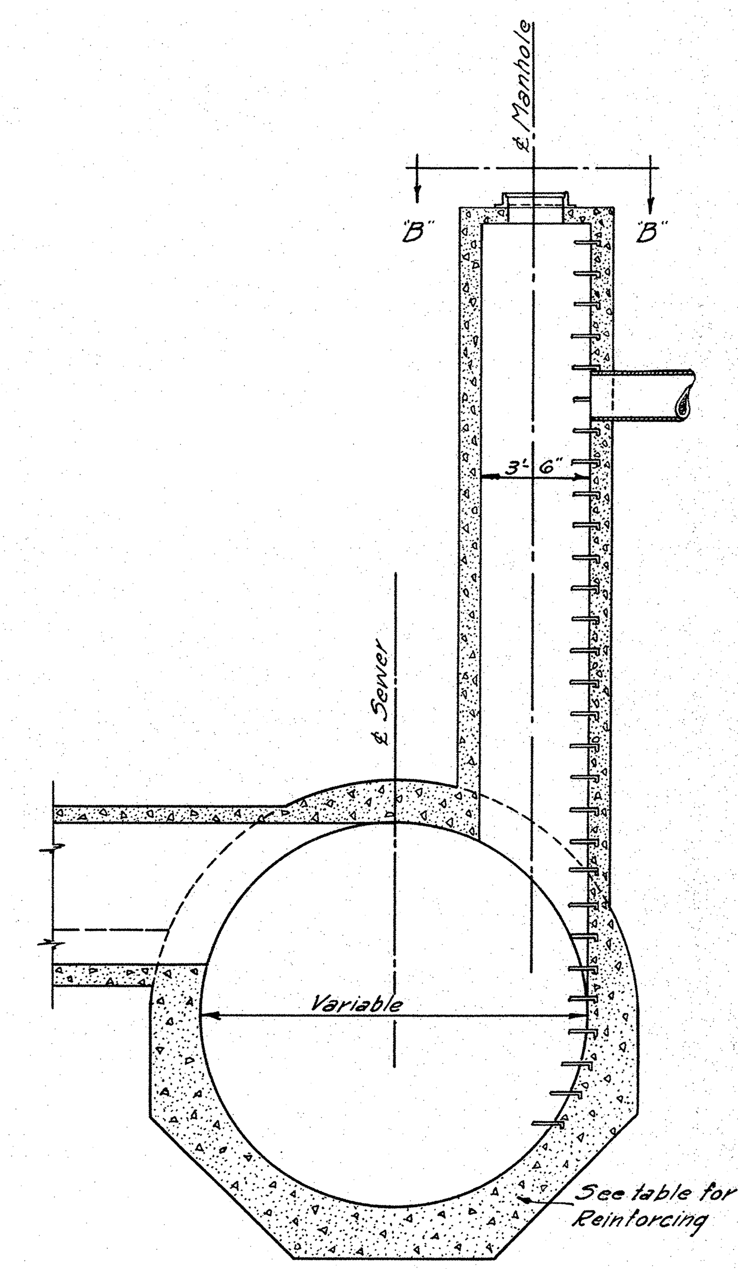
SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS. NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALE - FEET
200 100 0 200 400 600



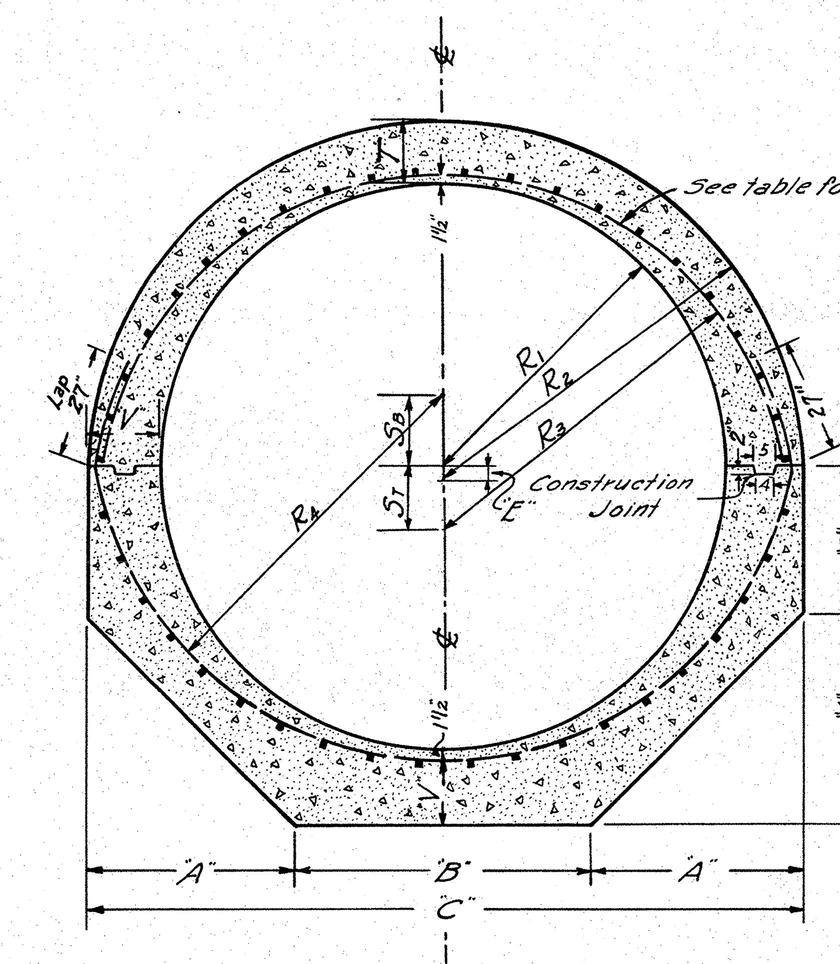
SECTION PARALLEL TO MAIN SEWER



SECTION AT RIGHT ANGLES TO MAIN SEWER

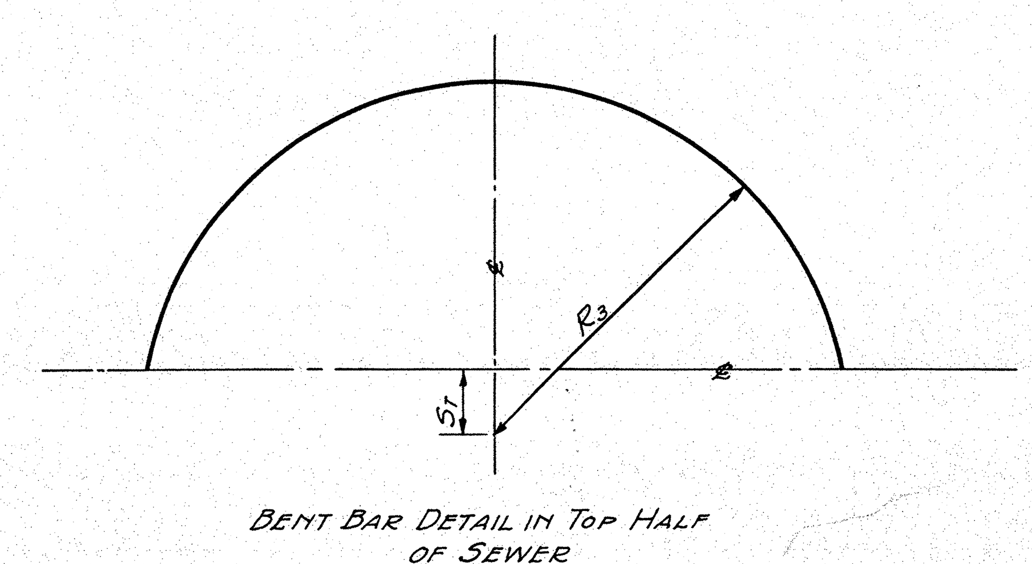
Scale ¼"=1'-0"

MANHOLE FOR LARGE SEWERS

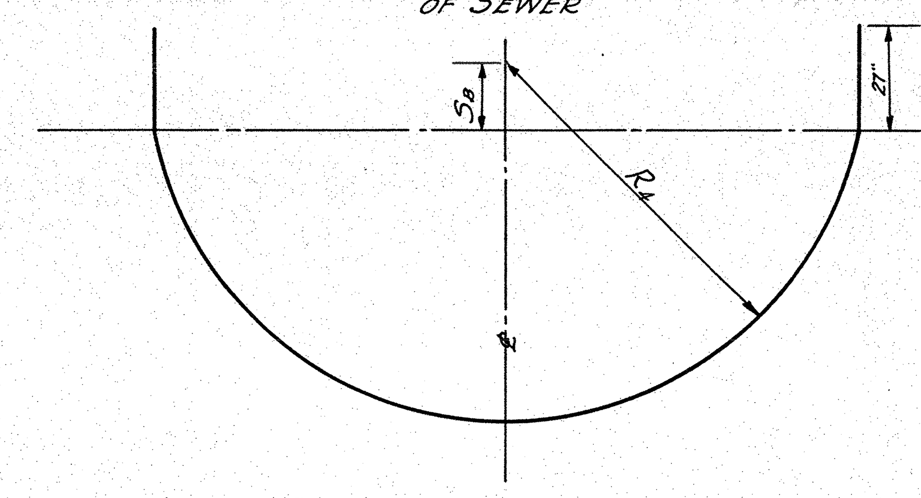


TYPICAL SECTION
MONOLITHIC SEWER

Note:
After placing bars in top of Sewer, bend vertical portions of bars in lower section of Sewer and wire as shown in Typical Section.
Concrete to be proportioned as required by Specifications.

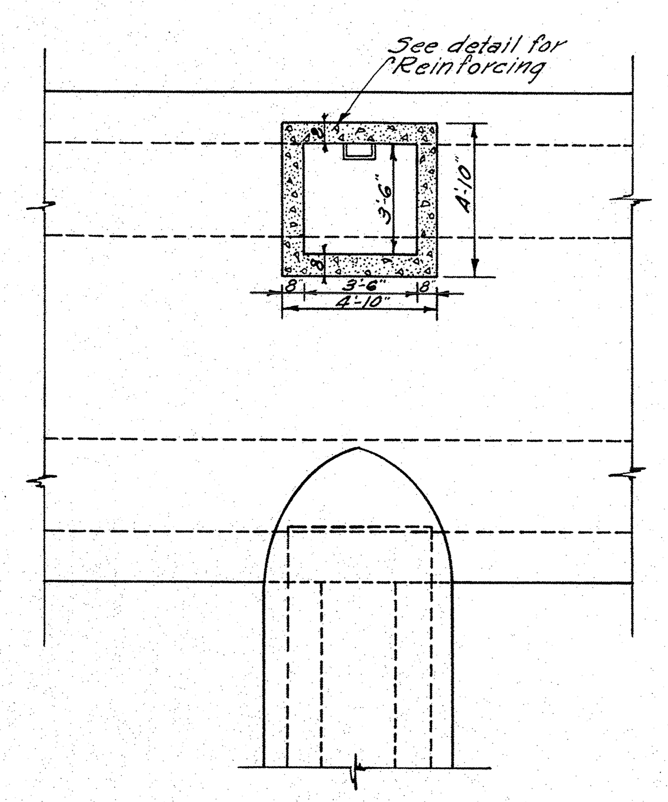


BENT BAR DETAIL IN TOP HALF OF SEWER

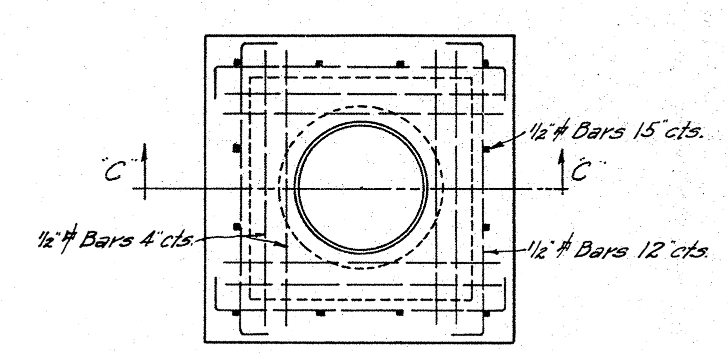


BENT BAR DETAIL IN LOWER HALF OF SEWER

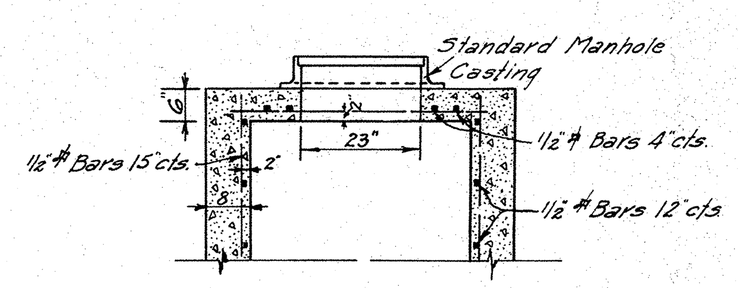
TABLE OF SEWER DESIGN																							
SIZE	A	B	C	E	V	I	J	R1	R2	R3	R4	T	ST	SB	HOOP STEEL						LONGITUDINAL STEEL		REMARKS
															TOP			BOTTOM					
															Size	Spacing	Length	Size	Spacing	Length	Size	Spacing	
30" To 48"																							Precast Concrete Pipe
51"	19¾	27½	67"	1½"	8"	13¾	33½	25½	33½			6½											Plain Monolithic Pipe
54"	21"	29	71"	2"	8½	14½	35½	27"	35½			6½											Plain Monolithic Pipe
57"	21¾	30½	74"	1½"	8½"	15¼	37"	28½	37"			7"											Plain Monolithic Pipe
60"	22¼	31½	76"	2"	8"	15¾	38"	30"	38"	36½	38"	6"	5"	6½	½" □	9"	18'-3"	½" □	9"	23'-3"	½" ϕ	12" cts.	
66"	24¼	34½	83"	2"	8½	17¼	41½	33"	41½	40"	41½	6½	5½	7"	½" □	8"	20'-0"	½" □	8"	25'-0"	½" ϕ	12" cts.	
69"	25¾	36½	88"	2½	9½	18¼	44"	34½	44"	42½	44"	7"	6½	8"	½" □	8"	21'-3"	½" □	8"	26'-3"	½" ϕ	12" cts.	
78"	28½	40"	97"	2½	9½	20"	48½	39"	48½	47"	48½	7"	6½	8"	½" □	7"	23'-6"	½" □	7"	28'-6"	½" ϕ	12" cts.	
81"	29½	42"	101"	2½	10"	21"	50½	40½	50½	49"	50½	7½	7"	8½	½" □	7"	24'-6"	½" □	7"	29'-6"	½" ϕ	12" cts.	
84"	30½	43"	104"	2½	10"	21½	52"	42"	52"	50½	52"	7½	7"	8½	½" □	7"	25'-3"	½" □	7"	30'-3"	½" ϕ	12" cts.	
87"	31¾	44½	108"	2½	10½	22¼	54"	43½	54"	52½	54"	8"	7½	9"	½" □	7"	26'-3"	½" □	7"	31'-3"	½" ϕ	12" cts.	
90"	32½	46"	111"	2½	10½	23"	55½	45"	55½	54"	55½	8"	7½	9"	½" □	6"	27'-0"	½" □	6"	32'-0"	½" ϕ	12" cts.	
96"	34½	49"	118"	2½	11"	24½	59"	48"	59"	57½	59"	8½	8"	9½	½" □	6"	28'-9"	½" □	6"	33'-9"	½" ϕ	12" cts.	
114"	40½	57"	138"	2½	12"	28½	69"	57"	69"	67½	69"	9½	9"	10½	½" □	6"	33'-9"	½" □	6"	38'-9"	½" ϕ	12" cts.	
132"	46¾	66½	160"	3"	14"	33¼	80"	66"	80"	78½	80"	11"	11"	12½	¾" ϕ	7"	39'-3"	¾" ϕ	7"	44'-3"	½" ϕ	12" cts.	
138"	48½	69"	166"	3"	14"	34½	83"	69"	83"	81½	83"	11"	11"	12½	¾" ϕ	7"	40'-9"	¾" ϕ	7"	45'-9"	½" ϕ	12" cts.	
141"	49¾	70½	170"	3"	14½	35¼	85"	70½	85"	83½	85"	11½	11½	13"	¾" ϕ	7"	41'-9"	¾" ϕ	7"	46'-9"	½" ϕ	12" cts.	
144"	50¾	71½	173"	3"	14½	35¾	86½	72"	86½	85"	86½	11½	11½	13"	¾" ϕ	5"	42'-6"	¾" ϕ	5"	47'-6"	½" ϕ	12" cts.	
144"	53¼	75½	182"	3"	19	37¾	91"	72"	91"	89½	91"	16"	16"	17½	¾" ϕ	5"	44'-3"	¾" ϕ	5"	49'-3"	½" ϕ	12" cts.	Special Section under T.P.R.R.
147"	54½	77"	186"	3"	19½	38½	93"	73½	93"	91½	93"	16½	16½	18"	¾" ϕ	5"	45'-3"	¾" ϕ	5"	50'-3"	½" ϕ	12" cts.	
150"	54"	76"	184"	3"	17	38"	92"	75"	92"	90½	92"	14"	14"	15½	¾" ϕ	5"	45'-0"	¾" ϕ	5"	50'-0"	½" ϕ	12" cts.	



PLAN SECTION A-A

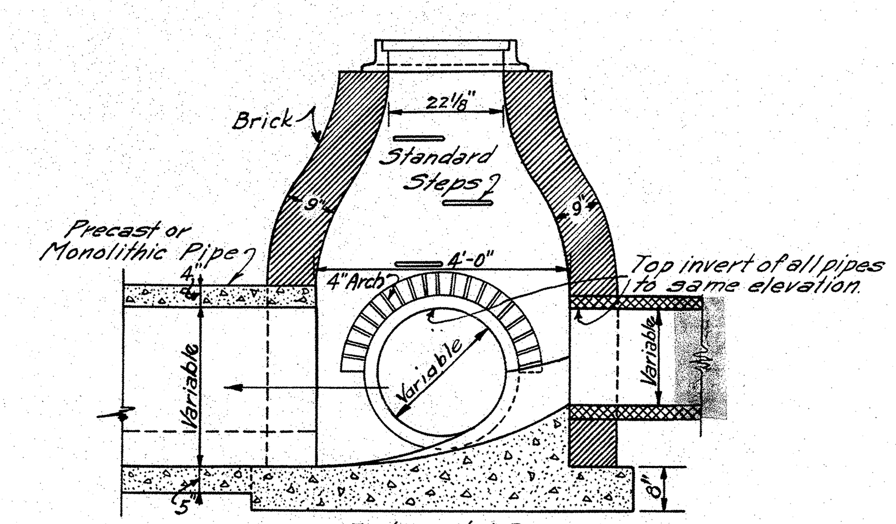


VIEW B-B



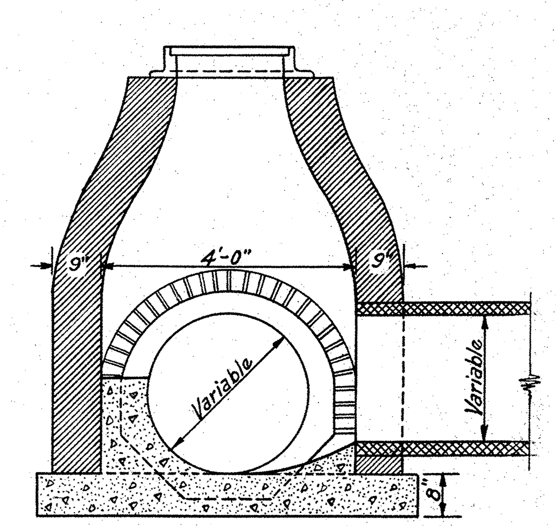
SECTION CC

Scale ½"=1'-0"



Footing 6'-0" Dia.

SECTION PARALLEL TO MAIN SEWER

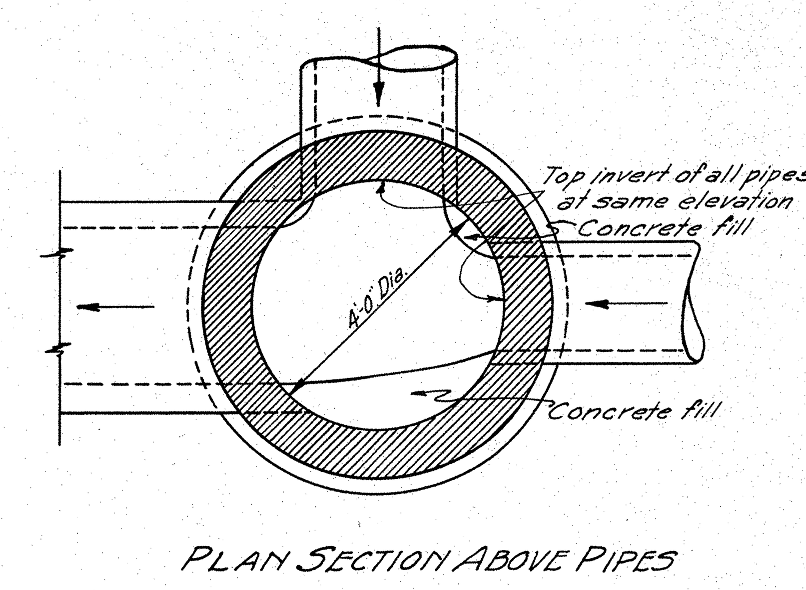


Footing 6'-0" Dia.

SECTION AT RIGHT ANGLES TO MAIN SEWER

Scale ½"=1'-0"

MANHOLE FOR SMALL SEWERS



PLAN SECTION ABOVE PIPES

Approved:
MYERS, NOYES & FORREST
By [signature]

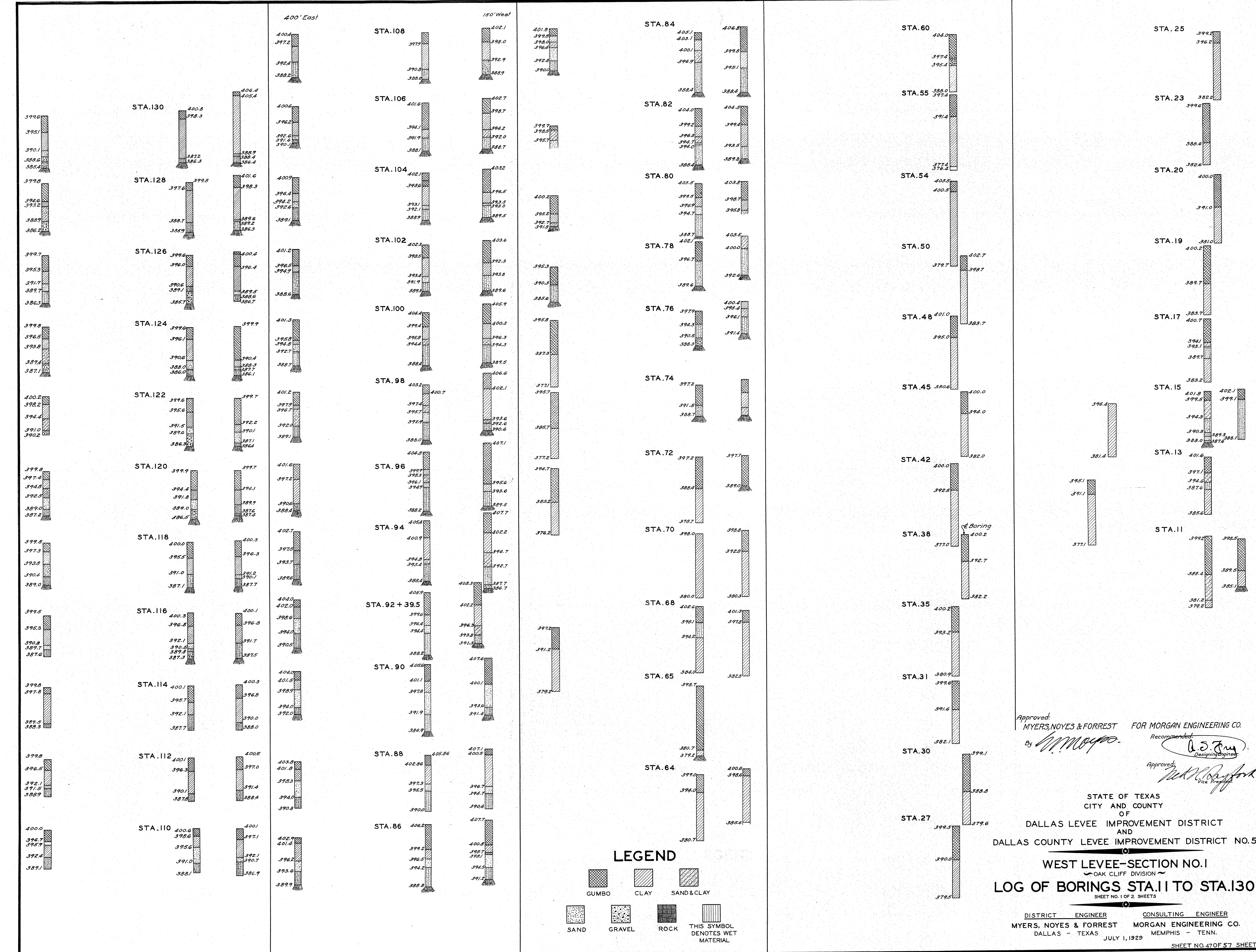
FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer.
Approved: [signature]
Vice President.

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
SEWER DETAILS

DISTRICT ENGINEER — MYERS NOYES & FORREST — DALLAS - TEXAS
CONSULTING ENGINEER — MORGAN ENGINEERING CO — MEMPHIS - TENN.
JULY 1, 1929
SCALE: AS SHOWN

SHEET NO. 46 OF 57 SHEETS



LEGEND

GUMBO CLAY SAND & CLAY

SAND GRAVEL ROCK THIS SYMBOL DENOTES WET MATERIAL

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature] Designing Engineer
Approved: [signature] Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE–SECTION NO. I
~OAK CLIFF DIVISION~

LOG OF BORINGS STA. 11 TO STA. 130

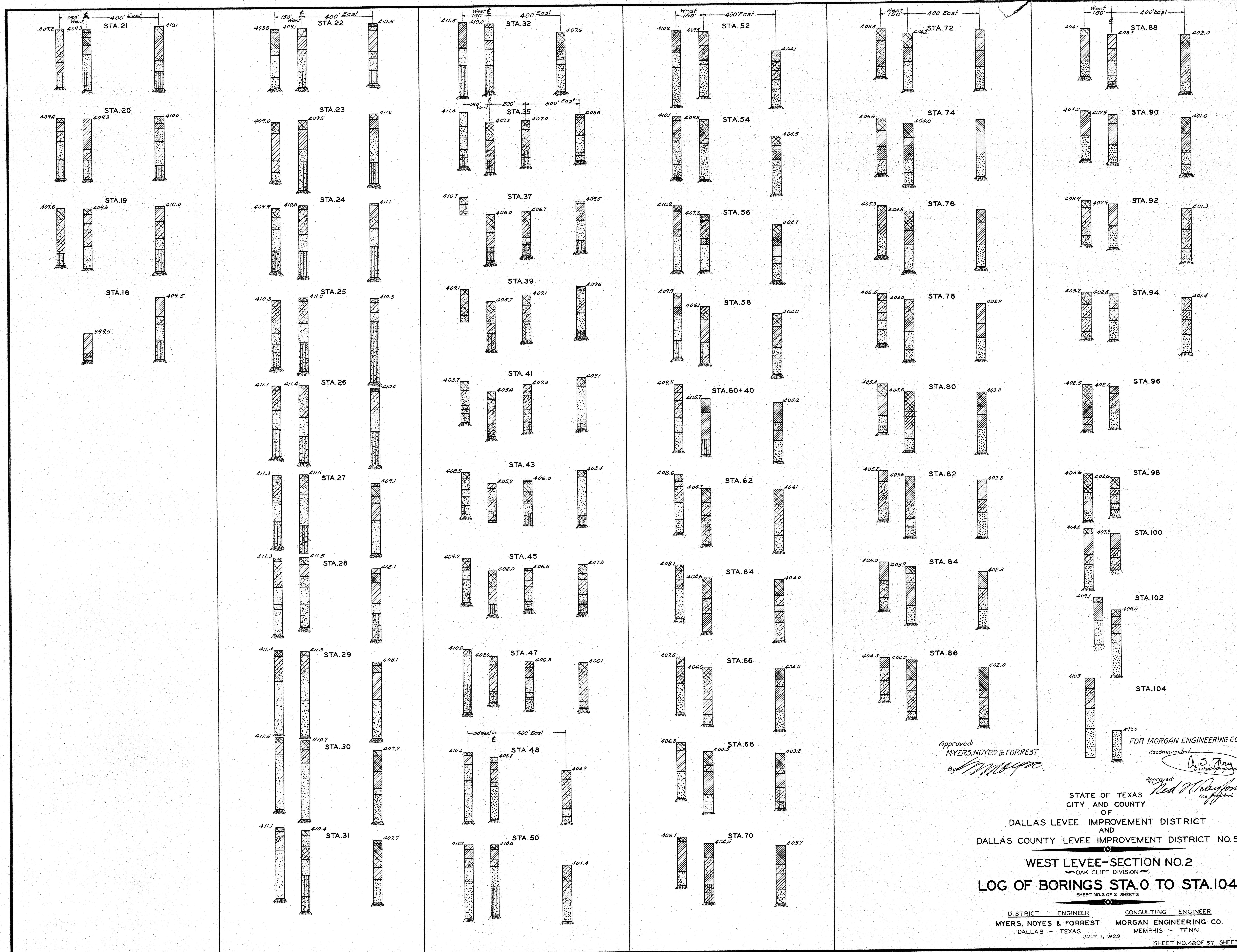
SHEET NO. 1 OF 2 SHEETS

DISTRICT ENGINEER
MYERS, NOYES & FORREST
DALLAS – TEXAS

CONSULTING ENGINEER
MORGAN ENGINEERING CO.
MEMPHIS – TENN.

JULY 1, 1929

SHEET NO. 47 OF 57 SHEETS



Approved:
MYERS, NOYES & FORREST
By

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer
Approved:
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

WEST LEVEE-SECTION NO. 2

OAK CLIFF DIVISION

LOG OF BORINGS STA.0 TO STA.104

SHEET NO. 2 OF 2 SHEETS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929

SHEET NO. 48 OF 57 SHEETS

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

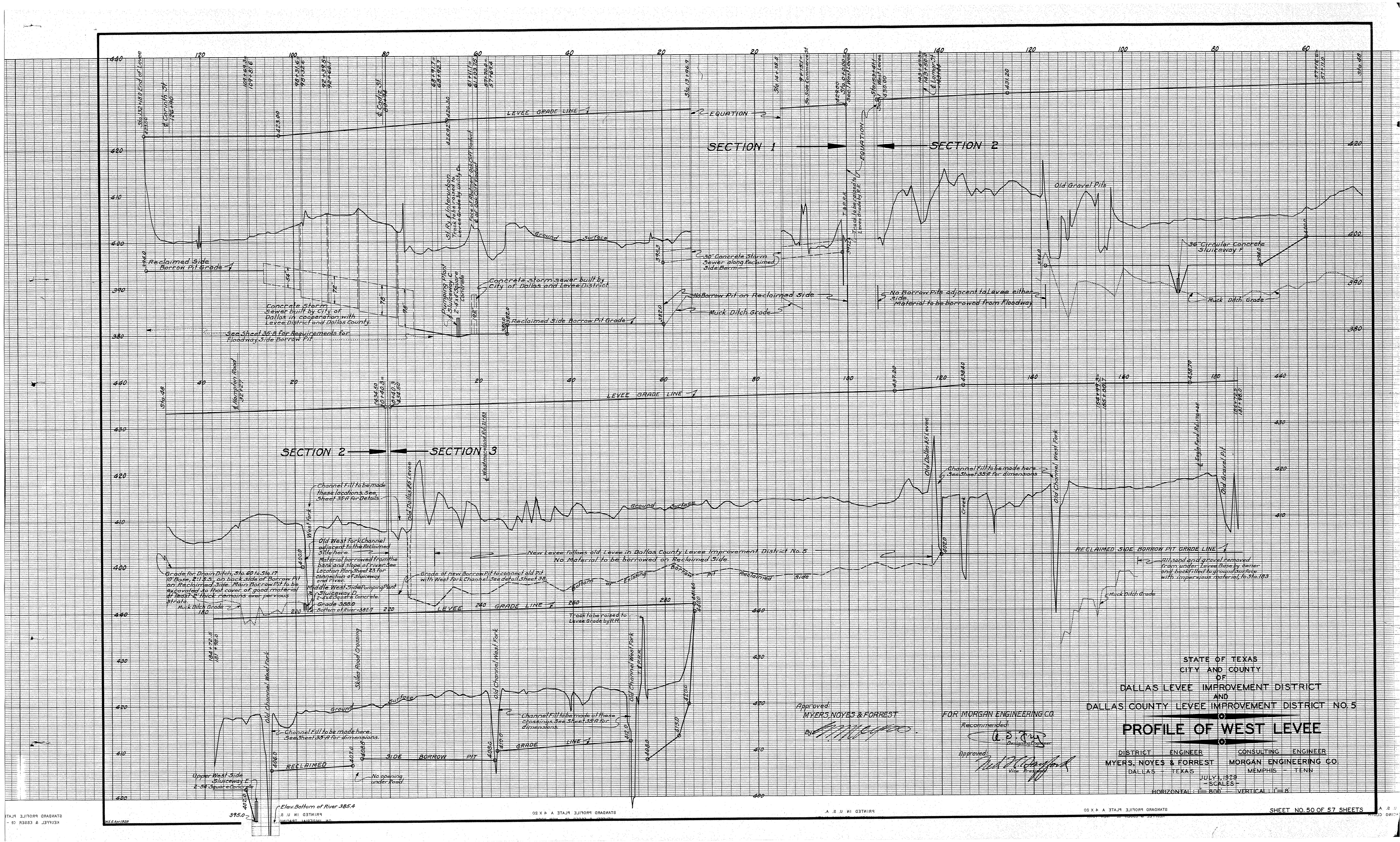
PROFILE OF EAST LEVEE

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
\- SCALES -
HORIZONTAL: 1" = 800' — VERTICAL: 1" = 8'



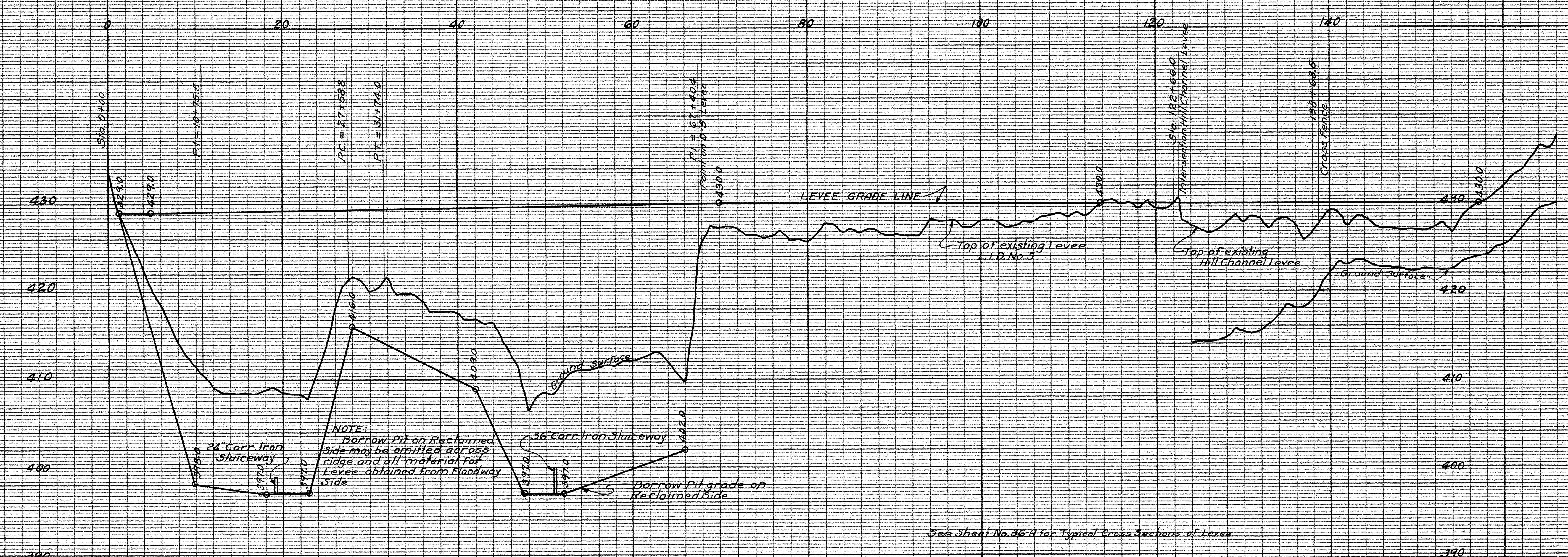
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

PROFILE OF WEST LEVEE

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN

JULY 1, 1929
- SCALES -
HORIZONTAL: 1" = 800' — VERTICAL: 1" = 8'

SHEET NO. 50 OF 57 SHEETS



Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

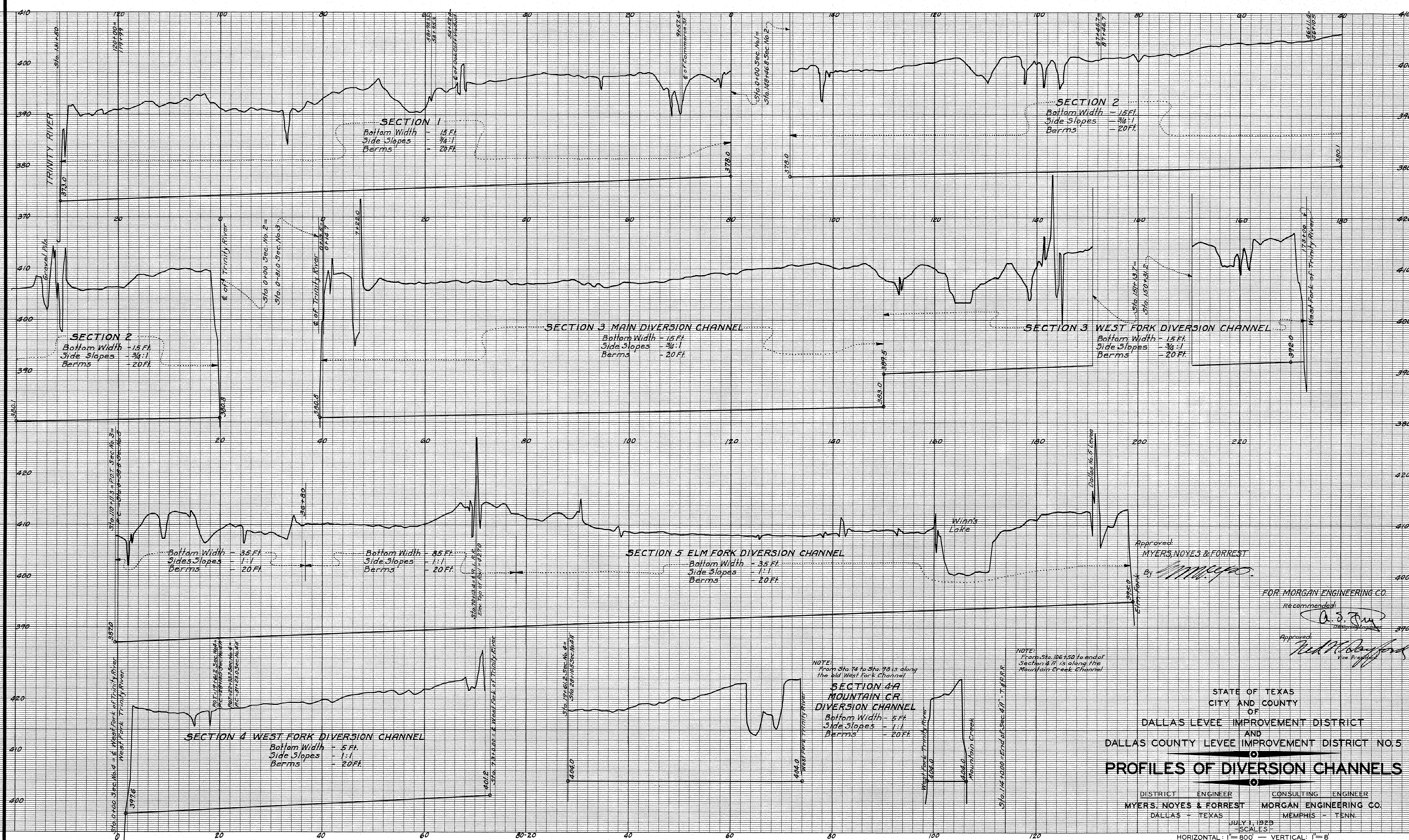
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

PROFILE OF NORTHWEST LEVEE

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
-SCALES-
HORIZONTAL: 1" = 800' — VERTICAL: 1" = 8'

SHEET NO. 51 OF 57 SHEETS



Approved
MYERS, NOYES & FORREST
By [signature]

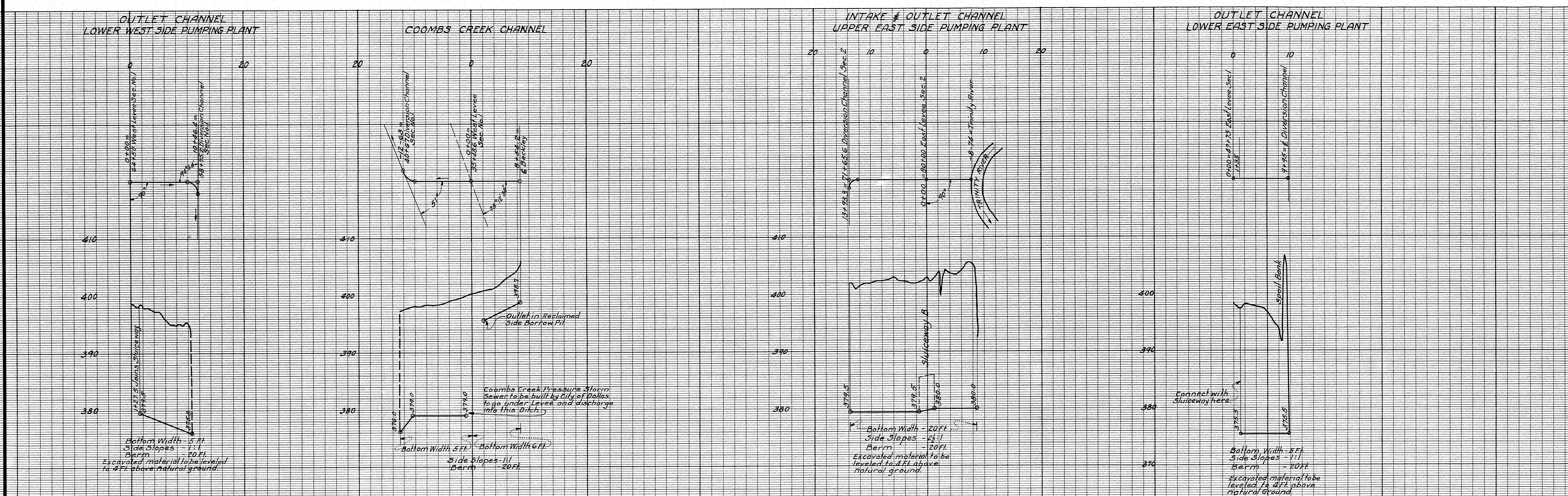
FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

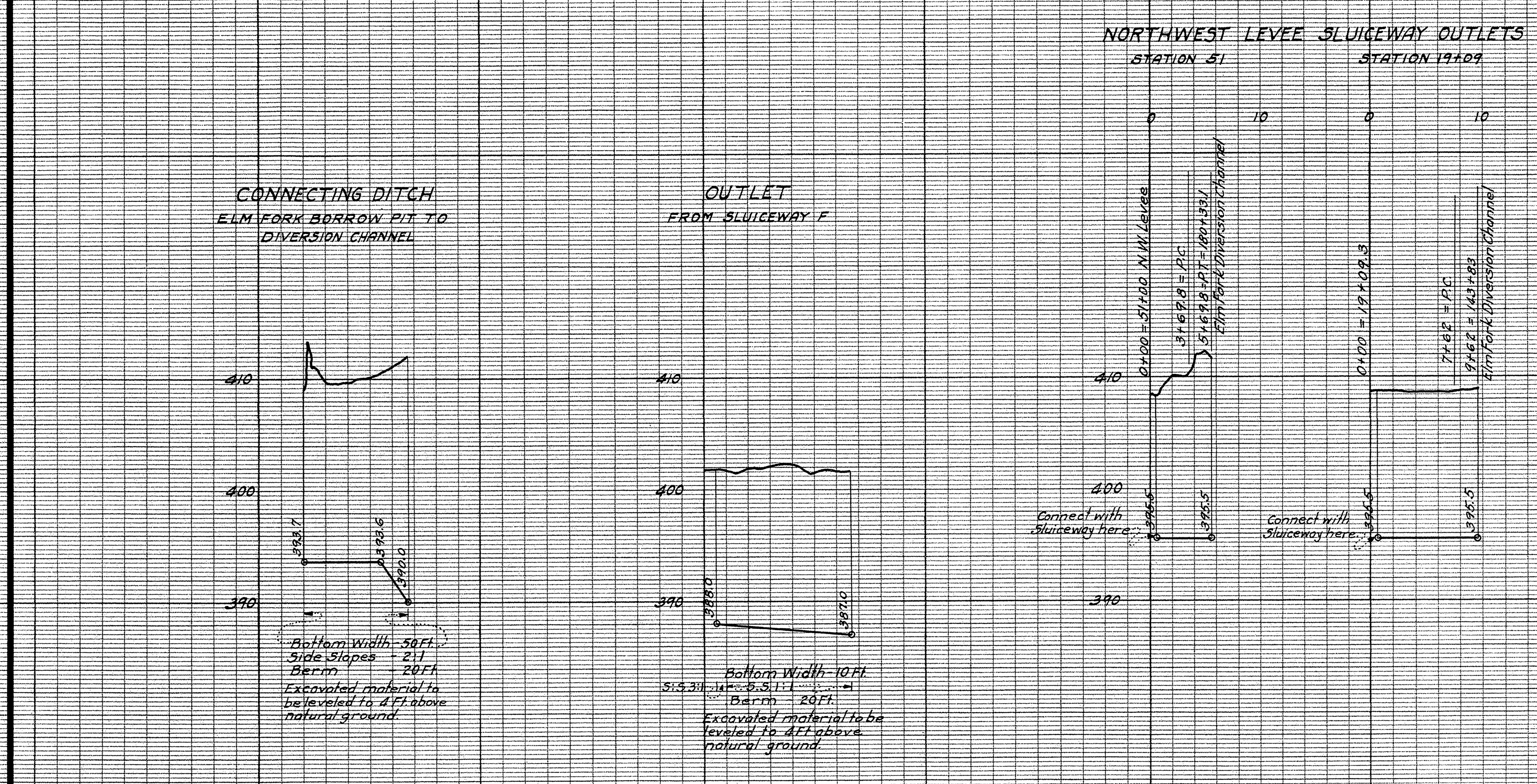
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

PROFILES OF DIVERSION CHANNELS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALES
HORIZONTAL: 1" = 800' — VERTICAL: 1" = 8'





Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: [signature]
Designing Engineer
Approved: [signature]
Vice President

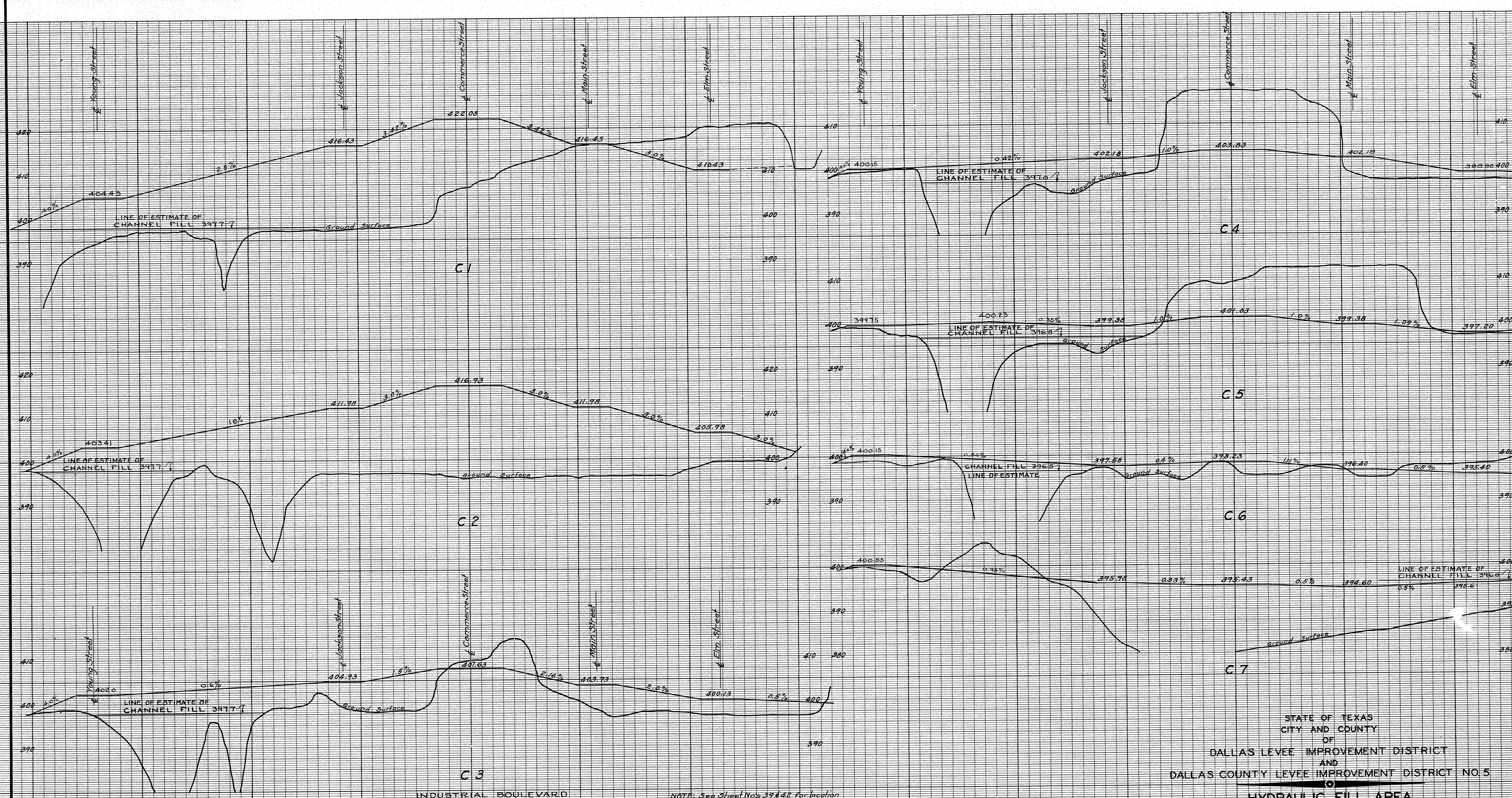
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

MISCELLANEOUS DITCH PROFILES

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALES
HORIZONTAL: 1"=800' — VERTICAL: 1"=8'

SHEET NO. 53 OF 57 SHEETS



NOTE: See Sheet No's 39 & 42 for location of Cross Sections C_1 C_2 etc.

Approved
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer
Approved:
[signature]
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
STREET CROSS SECTIONS
COMMERCE STREET FILL

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
-SCALES-
HORIZONTAL: 1"=100' — VERTICAL: 1"=10'

SHEET NO. 54 OF 57 SHEETS

NOTE: See Sheet No's 39 & 42 for location of Cross Sections C_1, C_2 etc.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer

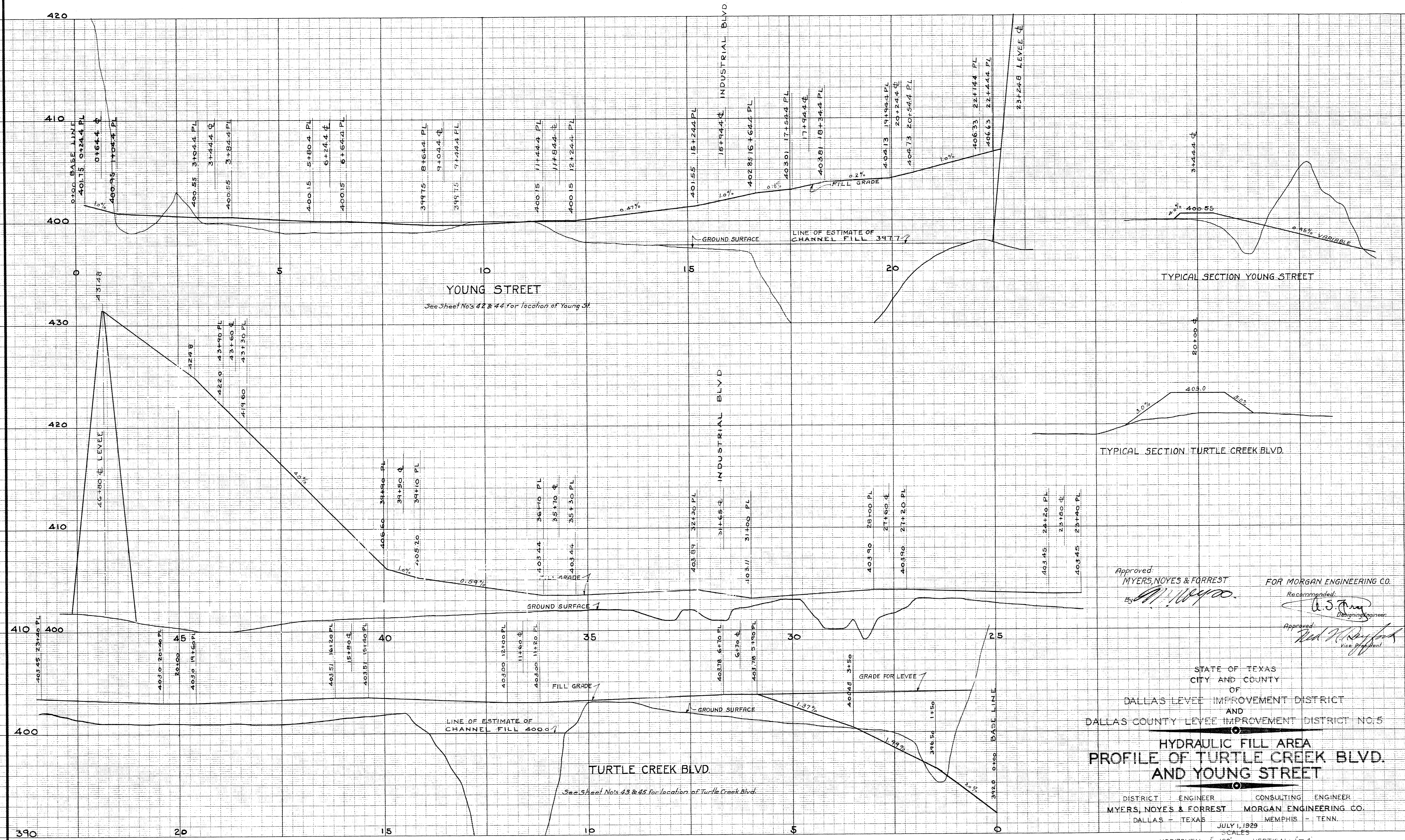
Approved:
Ned H. Dayford
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
STREET CROSS SECTIONS
COMMERCE STREET FILL

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
-SCALES-
HORIZONTAL: 1"=100' — VERTICAL: 1"=10'



Approved:
MYERS, NOYES & FORREST
By M. Noyes

FOR MORGAN ENGINEERING CO.
Recommended:
A. S. Fry
Designing Engineer.
Approved:
Vice President

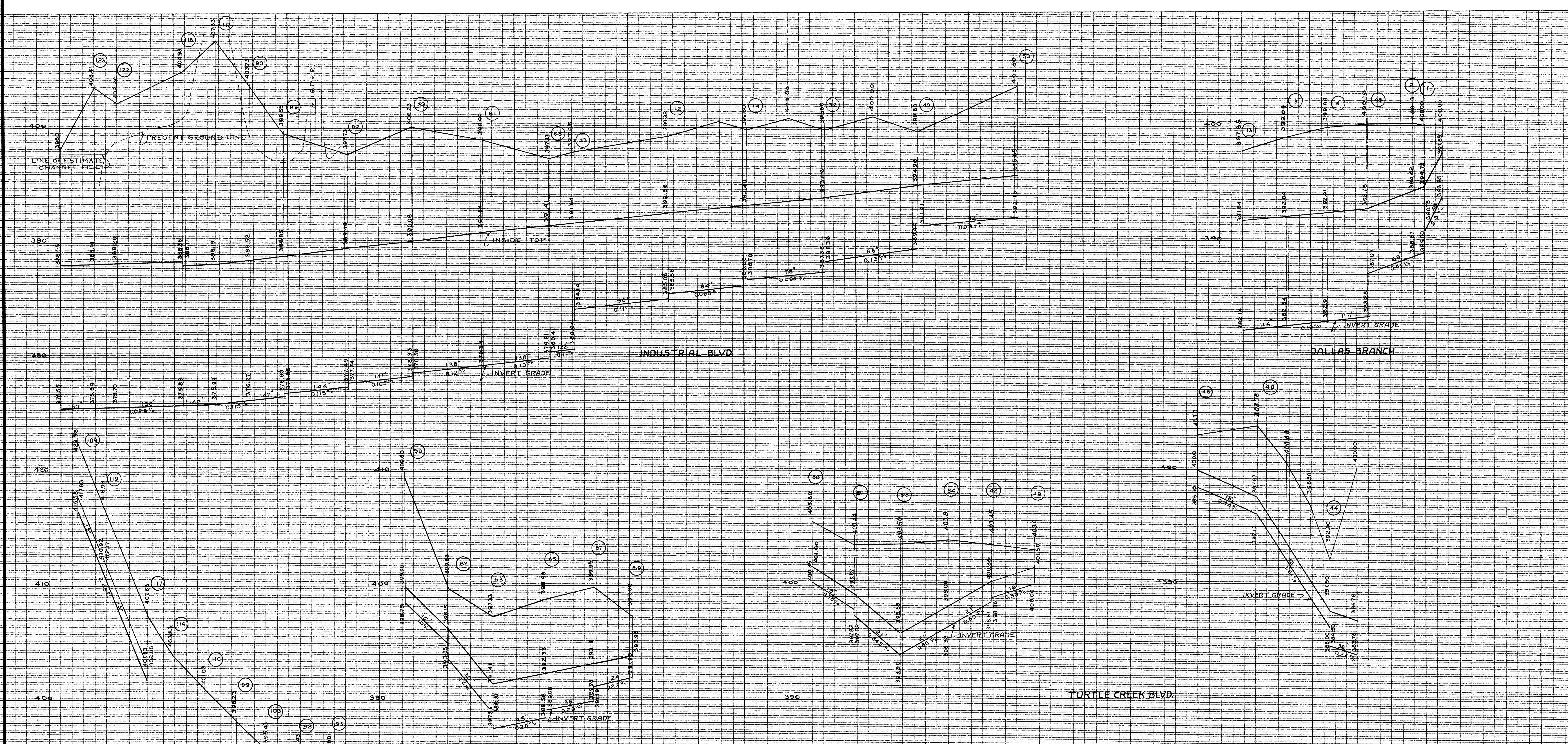
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
PROFILE OF TURTLE CREEK BLVD. AND YOUNG STREET

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALES
HORIZONTAL: 1"=100' — VERTICAL: 1"=4

SHEET NO. 55 OF 57 SHEETS



Manhole No's shown thus (51)

See Sheet No's 42, 43, 44, & 45 for location of Main Sewers.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer.
Approved: Ned H. [signature]
Vice President

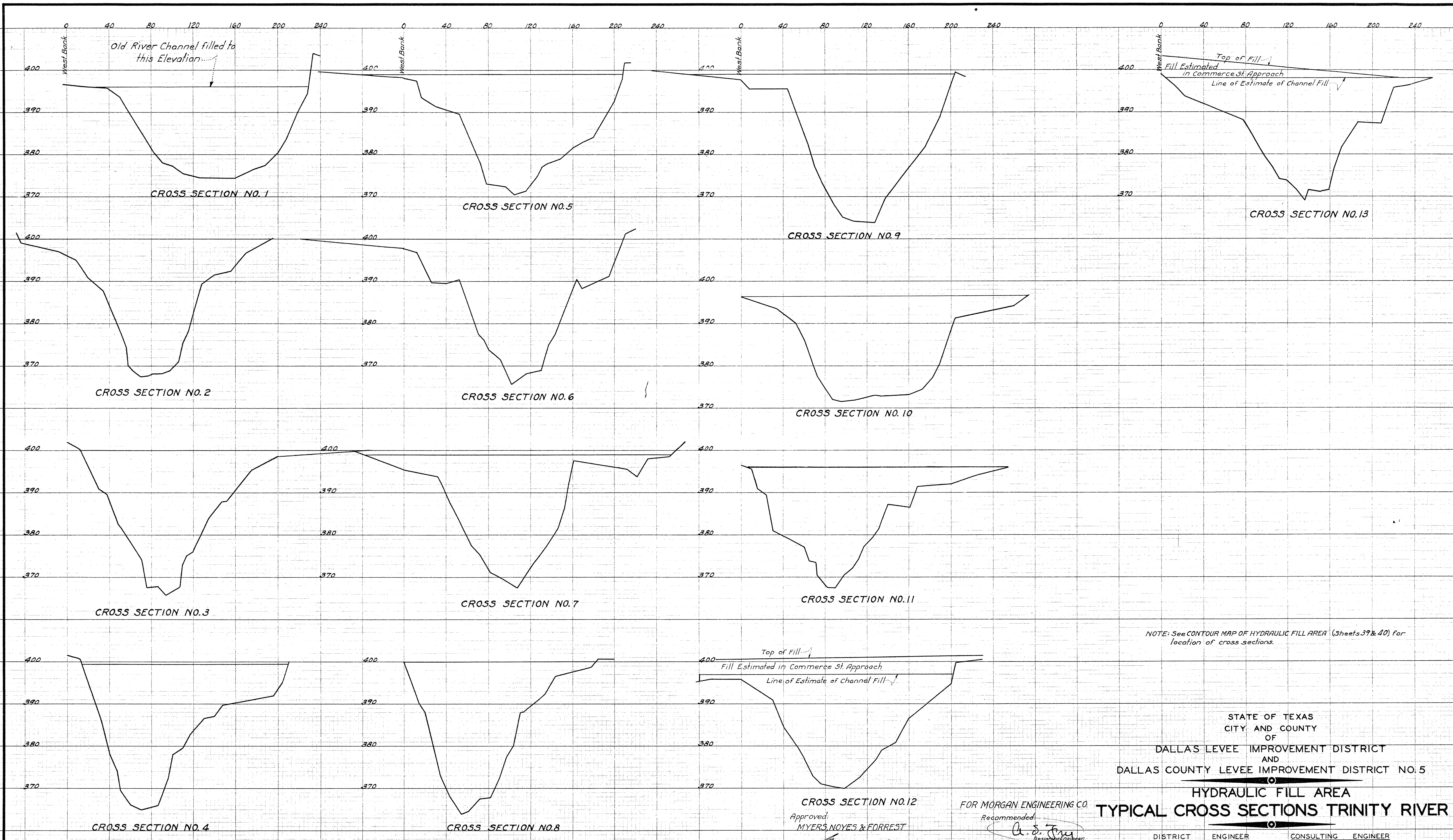
STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMEMT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
PROFILE MAIN SEWERS

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO
DALLAS - TEXAS	MEMPHIS - TENN.

JULY 1, 1929
SCALES-
HORIZONTAL: 1"=400 — VERTICAL: 1"=4'

SHEET NO. 56 OF 57 SHEETS
№ 5491-W



NOTE: See CONTOUR MAP OF HYDRAULIC FILL AREA (Sheets 39 & 40) for location of cross sections.

Approved:
MYERS, NOYES & FORREST
By [signature]

FOR MORGAN ENGINEERING CO.
Recommended: A. S. Fry
Designing Engineer.
Approved: Ned H. Bayford
Vice President

STATE OF TEXAS
CITY AND COUNTY
OF
DALLAS LEVEE IMPROVEMENT DISTRICT
AND
DALLAS COUNTY LEVEE IMPROVEMENT DISTRICT NO. 5

HYDRAULIC FILL AREA
TYPICAL CROSS SECTIONS TRINITY RIVER

DISTRICT ENGINEER	CONSULTING ENGINEER
MYERS, NOYES & FORREST	MORGAN ENGINEERING CO.
DALLAS - TEXAS	MEMPHIS - TENN

JULY 1, 1929

-SCALES-

HORIZONTAL: 1"=40' — VERTICAL: 1"=10'

View from West Levee toward downtown Dallas

Appendix E

National Historic Civil Engineering Landmark Nomination Form

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NATIONAL HISTORIC CIVIL ENGINEERING LANDMARK NOMINATION FORM

TO: Committee on the History and Heritage of American Civil Engineering, (CHHACE)
American Society of Civil Engineers
345 East 47th Street
New York, NY 10017-2398

FROM: Dallas Branch,
Texas Section ASCE

This is to nominate the following for designation as a National Historic Civil Engineering Landmark:

THE ORIGINAL DALLAS FLOODWAY

LOCATED AT: Dallas COUNTY: Dallas STATE: Texas
LATITUDE: N 32 46' 00" W 96 48' 45"

THE PROJECT IS OWNED BY: The City of Dallas, Texas

In support of the nomination, the following information is provided:

1. DATES OF CONCEPTION AND CONSTRUCTION:

The plan for reclamation of the Trinity River Valley originated within the plan of development for the City of Dallas (known as the Kessler Plan) as a result of committee action by the Dallas Chamber of Commerce in January of 1910. This development plan reconized the need for flood control of the Trinity River, especially after the May, 1908 flood which is the worst of all recorded Dallas floods. The main stream of the Trinity River forms at the junction of the Elm Fork and the West Fork in Dallas. The river's length is 550 miles, and it drains an area of 17,969 square miles. After Dallas was settled in 1841, the first great flood occurred in 1844 when the water rose to a gauge mark of nearly 51 feet. In 1866 another great flood produced an official 49 foot flood gauge reading and an unofficial reading of 56.5 feet. In 1871, the flood level reached 47 feet. The 1908 flood had a ten inch rainfall in the upper Trinity River Basin and the Trinity River soared out of its banks, expanding until it was two miles wide and 52.6 feet deep. The flood killed eleven people and 4,000 others fled their homes to seek higher ground. Much of the downtown area and all of west Dallas was flooded with damage estimated at more than five million dollars. The committee subsequently formed the City Plan and Improvement League to promote the Kessler Plan and its implementation. The major factor of this plan was the leveeing of the Trinity River for flood control purposes.

The levee project was dormant from 1910 to 1919, with planning and planning revisions being the only form of activity. World War I had intervened and the problem of potential flooding with its retarding influence to the logical growth of Dallas remained.

The Kessler Plan was revised in 1919 to require levees to be 30 feet in height with a floodway width between the levees of 2000 feet instead of the originally planned 1200 feet width. This plan would result in the protection of about 4500 acres of land adjacent to the confluence of the Elm Fork and West Fork of the Trinity River. To accomplish the proposed levee system, the Dallas County Levee Improvement District No. 5 was formed in 1919.

In 1920, Myers and Noyes (later to become Myers, Noyes and Forrest) Engineers of Dallas developed a modified plan of levees that would amend the plan of levees for the Levee Improvement District No. 5 and add levees outside of the limits of Levee Improvement District No. 5. The City and County of Dallas Levee Improvement District was created in 1926 for construction of the levees outside of Levee Improvement District No. 5 and the entire levee system was known as the Joint Plan of Reclamation. This joint plan provided for the reclamation of 7217 acres of land in the City and County of Dallas Levee Improvement District and 3336 acres of land out of the original Dallas County Levee Improvement District No. 5. A total of 10,553 acres (approximately 17 square miles) was included in the Joint Plan of Reclamation with geographical boundaries of the Districts coinciding for the most part with the flood limitation line of the 1908 flood.

The project was completed in 1931 but even though the levees were in place with four pump stations on line, there were no funds available during and immediately following the depression for the maintenance of the floodway or operation of the equipment and facilities used as an integral part of floodway management.

2. NAMES OF KEY PROFESSIONALS ASSOCIATED WITH THE PROJECT:

Mr. Clifford V. Keheley, Director of Public Works, City of Dallas

Mr. M. Lee Halford, Sr., Industrial Properties Corporation

3. CIVIL ENGINEERING SIGNIFICANCE OF THIS PROJECT:

The Dallas Floodway (also known as the Trinity Floodway) is significant in the respect of the design providing regional flood control and storm water management that was instrumental to the development of Dallas and surrounding communities. The levee system with pump stations was the major part of a comprehensive plan for public works improvements that was to be financed by property owners within the area to be reclaimed (ie-bonds issued by the flood control districts), City of Dallas, County of Dallas, Railroads, and Utilities. The levees and pump stations as completed in 1931 are being nominated for reconition as a National Civil Engineering Landmark. The original Dallas Floodway was designed for a flow of 300,000 cfs with no freeboard (the 1908 flood produced an approximate flow of 184,000 cfs). The original Dallas Floodway constisted of approximately 23.5 miles of levees with four pump stations.

The original floodway has undergone some revisions since it's completion in 1931. In 1945, the Texas Legislature created the Dallas County Flood Control District that essentially replaced the previously created flood control districts because of their default on the bonds issued for the construction of the original floodway. This new flood control district was the response to the major floods of 1941 and 1942. The new flood control district acted to repair and maintain the levees and operate the pump stations.

The U.S. Army Corps of Engineers made major improvements to the levees and drainage facilities in the early 1950's. These improvements included enlargement of the levees (with subsequent reduction of floodway area), construction of larger pump stations and expansion of existing storm sewer systems.

4. COMPARABLE OR SIMILAR PROJECTS:

Examples of similar or larger levee projects are typified with the improvements along or in conjunction with the Mississippi River, the levee improvements in the Atchlafalaya basin, LA., or the levee improvements creating the New Madrid floodway, MO.

5. UNIQUE FACTORS OR CHARACTERISTICS WHICH SET THIS PROPOSED PROJECT APART FROM OTHER CIVIL ENGINEERING PROJECTS, INCLUDING THOSE IN '4' ABOVE.

The original Dallas Floodway did not incorporate any truly innovative civil engineering design; however, it does reflect the practical application of civil engineering practice with respect to providing a solution for a regional flooding problem that aided future economic development of the Southwest region.

6. CONTRIBUTION THIS PROJECT MADE TOWARD THE DEVELOPMENT OF A LARGE REGION:

The growth of Dallas and flood protection of such facilities as viaducts, highways and underpasses which form a component part of State and Federal Highways Nos. 14,16,18,114,183,67,75,77,80 and 175, and also including buildings such as the Dallas County Courthouse, Dallas County Criminal Courts and Jail, Dallas County Hall of Records and the Railway Terminal Annex of the U.S. Post Office was one immediate benefit of the original Dallas Floodway. The City of Dallas was the first city in the nation to begin a completely new highway (I-35E) under the Federal Aid Highway Act of 1956. Stemmons Freeway is a part of Interstate 35E and is located entirely in the area reclaimed as a result of the levee system. This freeway also provided a north-south corridor from downtown Dallas to North Dallas. Other facilities that were constructed within the reclaimed areas are as follows: Reunion Arena (home of the Dallas Mavericks) and Hyatt Regency Hotel, Apparel Mart, Market Hall, Trade Mart, Furniture Mart, Info Mart, Anatole Hotel, Texas Stadium (home of the Dallas Cowboys), Dallas Convention Center (site of the 1984 Republican convention), University of Texas Medical Center and School, Parkland Hospital, Major business and industrial parks, and West Dallas residential areas.

7. IN FURTHER SUPPORT OF THIS NOMINATION, THE FOLLOWING DOCUMENTATION IS SUBMITTED:

   Excerpts from 'Dallas County Flood Control District, "Yesterday and Today" ', prepared by URS/ Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas.

8. THE FOLLOWING IS THE RECOMMENDED CITATION FOR BOARD CONSIDERATION:

   THE ORIGINAL DALLAS FLOODWAY, Dallas, Texas - Constructed in 1931, the original Dallas Floodway was the integral part of a regional flood control plan and public improvements and was instrumental in the growth and development of Dallas. The original floodway consisted of 23.5 miles of levees and four pump stations.

9. THE FOLLOWING IS A SUMMARY OF THE OWNER'S ATTITUDE CONCERNING OUR NOMINATION:

   A copy of letter from the City of Dallas that supports the nomination of this facility is included as proof of owners permission for the nomination.

If this nomination is approved for designation as a National Civil Engineering Landmark by the Board of Direction of ASCE, we understand that the Section will have the major responsibility for the public presentation ceremony of the plaque.

____

Chairman, Section History & Heritage Committee

____

Section Secretary

____

Section President

CITY OF DALLAS

July 12, 1988

Mr. Thomas W. Wilhite, P.E.
Chairman - History and Heritage Committee
Huitt-Zollars, Inc.
3131 McKinney Avenue, Suite 600
Dallas, Texas 75204

Dear Mr. Wilhite:

In response to your letter of June 17, 1988, please be assured of my enthusiastic support and approval of your efforts to obtain historical recognition by the ASCE for the Houston Street Viaduct and the Trinity Floodway.

I understand that you have obtained the historical data necessary for your recommendation, but if more information is needed I will make the resources of my department available to you. National recognition by the ASCE for these engineering achievements will enhance our coveted reputation as a can-do City.

If we can be of further assistance, you may call Stan Blystone, Project Manager, 948-4260.

Sincerely,

Clifford Kehely

Clifford V. Keheley
Director of Public Works

ec88/2-19

RECEIVED
JUL 18 1988
HUITT-ZOLLARS, INC.

DEPARTMENT OF PUBLIC WORKS OAK CLIFF MUNICIPAL CENTER 320 E. JEFFERSON BOULEVARD DALLAS, TEXAS 75203 TELEPHONE 214/948-4200

ORIGINAL DALLAS FLOODWAY

The plan for reclamation of the Trinity River Valley within the limits of Dallas by utilizing levees originated in 1910 as a result of the record 1908 flood. The original plan for the levee system was revised in 1919 and the Dallas County Levee Improvement District No. 5 was formed. This plan protected about 4500 acres of land adjacent to the confluence of the Elm Fork and the West Fork of the Trinity River. The reclamation plan was again revised in 1920 by Myers and Noyes (later Myers, Noyes and Forrest) Engineers. This plan included the creation of the City and County of Dallas Levee Improvement Districts which supplemented the original levee district and resulted in a joint plan of reclamation of 10,553 acres (almost 17 square miles). The construction of the Dallas Floodway, consisting of approximately 23.5 miles of levees and four pump stations, was completed in 1931. Present day facilities that lie within the land reclaimed by these levees include State and Federal Highways Nos. 114, 183, 67, 75, 77, 80, 175, 289, 342, and 356. Present day Interstate Highways 30, 35E, and 45 now cross this area. Within the protected area are located such buildings as Reunion Arena, Apparel Mart, Market Hall, Trade Mart, Furniture Mart, Anatole Hotel, Dallas County Courthouse, Union Station, Industrial Parks, and West Dallas residential areas. The current value of the development within the protected area has been estimated at over $13 billion.

The original Dallas Floodway is significant because the design provided regional flood control and storm water management that was instrumental to the development of Dallas and the surrounding communities. These public works improvements were financed by property owners within the protected area.

TEXAS SECTION

of the

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

HISTORIC CIVIL ENGINEERING

LANDMARK DESIGNATION

FOR

HOUSTON STREET VIADUCT

AND THE

ORIGINAL DALLAS FLOODWAY

DALLAS, TEXAS
MARCH 16, 1989

PROGRAM

5 P.M., MARCH 16, 1989

REUNION TOWER, OBSERVATION DECK

WELCOME AND INTRODUCTIONS	WILLIAM CORREA President, Dallas Branch
HISTORICAL DESIGNATIONS	MALCOLM STEINBERG Past President, Texas Section
PRESENTATION OF PLAQUES	DR. JERRY ROGERS President, Texas Section
ACCEPTANCE OF PLAQUES	THE HON. JOHN EVANS Mayor Pro-Tem, Dallas
READING OF PROCLAMATION	THE HON. JOHN EVANS
CLOSING REMARKS	WILLIAM CORREA

HOUSTON STREET VIADUCT

On May 25, 1908, the worst flood in Dallas history swept down the Trinity River causing over five million dollars of damage to homes and businesses. This flood washed away most of the bridges which resulted in the Oak Cliff community and Dallas being effectively cut off from each other for a week. In 1909 the residents of Dallas County approved a bond issue of $600,000 to construct a new bridge and in November, County Engineer, J.F. Witt advertised for the design and construction of the Houston Street Viaduct. Extending across the Trinity River and connecting the Dallas Central Business District with the early suburb of Oak Cliff, the Houston Street Viaduct is one of the longest viaducts, 6,562 feet, with reinforced concrete arches ever built. The viaduct, completed in late 1911, has had few alterations and is noteworthy for several engineering design and construction features. Two of these features were for the future: the special provisions to accommodate vessels on the Trinity River Canal and the strength to carry two 100,000 pound electric transit cars. Another provision, which is being used, was to provide spaces longitudinally throughout the viaduct for utility conduits. The viaduct is built on wooden piles and contains fifty-one 79'-6" reinforced concrete arches. The "navigation" span is a steel girder design, 100 feet in length and with a 90 foot clearance. The roadway deck is 44 feet wide with two 4.5 foot sidewalks. The low construction bid permitted widening the roadway by 4 feet over the original proposal.

The design that was accepted from the 15 bids submitted, was done by Ira G. Hedrick, Civil Engineer of Kansas City, Missouri, with M. R. Ash as Associate Engineer. The construction was performed by Corrigan, Lee and Halpin of Kansas City, Missouri. The field work was supervised by Hedrick and Cocrane, Consulting Engineers, also of Kansas City.

View of Overbank from Westmoreland Road toward downtown Dallas

Appendix F

NEPA Historic and Cultural Resources Inventory

(This page intentionally left blank)

NEPA Historic and Cultural Resource Inventory Form

A. Name of Historic and Cultural Resource

Dallas Trinity River Floodway

B. Associated Historic Contexts

(Name each associated historic context, identifying theme, geographical area, and chronoligical period for each.)

Civil Engineering and Flood Control, Dallas, Texas, 1908–1959

Community Planning and Development, Dallas, Texas, 1908–1959

C. Form Prepared by

name/title TEC Inc. for U.S. Army Corps of Engineers, Fort Worth District

organization U.S. Army Corps of Engineers, Fort Worth District date August 13, 2010

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E. Statement of Historic Contexts
(if more than one historic context is documented, present them in sequential order.)

(Provide description, significance, and registration requirments.)

(Discuss the methods used in developing the multiple property listing.)

(List major written works and primary location of additional documentation: State Historic Preservation Office, other State agency, Federal agency, local government, university, or other, specifying repository.)

The following developmental historic context discusses the Dallas Floodway primarily within the historical themes of civil works and community planning and development.

The Trinity River bisects the city of Dallas geographically, separating the downtown to the east from Oak Cliff and West Dallas to the west. Flooding and potential flooding have guided urban development and affected Dallas geographically, politically, economically, and socially throughout its history, resulting in repeated efforts to tame the Trinity River. At the epicenter is the debate over the relationship of public works with private development which, through study of the Dallas Trinity River Reclamation Project, forms a textbook example of twentieth century American city planning.

BACKGROUND – THE TRINITY RIVER AND THE EARLY DEVELOPMENT OF DALLAS

The area that would become the center of Dallas was first settled in November 1841 by John Neely Bryan, an Arkansas land speculator, who built a cabin to serve as a trading post on the east bank of a promising ford across the Trinity River. A permanent community soon developed. The easy crossing of the Trinity River in Dallas increased traffic and trade to the area, and the town quickly became a commercial and transportation center. Manufacturing concerns, eagerly sought, played a subordinate role (Texas Department of Transportation [TxDOT] 2004, 2–3, 6–7; Wilson 1989, 254).

The Trinity River was initially thought to be a great benefit to the city of Dallas as a steamboat link to the Gulf of Mexico. However, several attempts to make the river navigable failed. It proved to be unsuitable for navigation because of its shallow depth, narrow banks, and frequent floods (TxDOT 2004, 9).

Although the idea of creating a navigable waterway between Dallas and the Gulf of Mexico was one which resonated with Dallas residents, the reality of the situation was not lost on the city. During the 1850s, the city of Dallas was separated from nearby settlements by the Trinity River because of the inability to safely and easily cross the waterway. As such, in 1855 Alexander Cockrell and the Dallas Bridge and Causeway Company built the first permanent, wood bridge across the Trinity River near the current-day Commerce Street Viaduct. This bridge provided Dallasites access to the western bank of the river. The bridge, however, survived only a few years before it was washed away in one of the Trinity River's frequent floods. It was replaced in 1872 by a toll bridge, which the city of Dallas purchased in 1882, making it the first free bridge across the Trinity River (FHWA et al. 2008). The city later built two new bridges, one near present-day Cadiz Street, and a second on Zang Boulevard near the present-day Houston Street Viaduct. These three early bridges were designed in a manner that made them susceptible to flooding, even during moderate flooding events, which submerged the bridges and their approaches.

In the years following the Civil War, the railroads reconfigured the landscape of Dallas and put the city on the map as one of the region's largest shipping ports. The Houston & Texas Central Railroad (H&TC, formerly the Galveston and Red River Railroad) reached Dallas in 1872, and the next year, the Texas & Pacific Railway arrived in Dallas. These important rail lines provided Dallas access to southern and eastern Texas and allowed the city to acquire the benefits of an urban area including modern utility and communication systems (Cliff et al. 1999).

Dallas residents had a number of significant problems to confront, however, in expanding the city. The Trinity River was the most menacing problem in Dallas as it separated the city from neighborhoods on the south and west and inhibited growth within its 10,000-acre floodplain. Due to flooding of large areas near the downtown area, farming was the predominant use of the land to the west of the city along the Trinity River bottoms rather than commercial and industrial development (Wilson 1989, 254).

The first major flood in newly established Dallas occurred in 1844 when the river rose to a gauge height at Commerce Street of 50.7 feet. The highest flood of the Trinity River in the history of Dallas occurred in 1866. Although the official flood gauge reading was 49.2 feet, the waters rose in some areas to 56.5 feet, cutting Dallas off from all communication and causing the city to become an island. During a flood five years later, the flood level reached 47.4 feet. Another flood in 1890 submerged 200 homes as it spread the width of two miles (Furlong et al. 2003, 1; TxDOT 2004, 9). On Easter Sunday, April 19, 1908, another major flood measured 39.4 feet and overran the river banks flooding all the way down to the Commerce Street Bridge (TxDOT 2004, 9).

PLANNING THE FLOODWAY AND RECLAMATION, 1908–1931

The 1908 Flood and the Push for Civic Improvement

The modern city of Dallas was born from the great flood of 1908 (*Dallas Morning News* [*DMN*] 2008). A storm during the weekend of May 23, 1908, dumped 10- to 15-inches of rainfall in the Dallas-Fort Worth area over a three-day period. The run-off of the rains north and west of Dallas caused the Elm Fork and the West Fork to swell so much that when they merged just north of Dallas; the water began to spread beyond the banks of the Trinity River (Figure E-1). In 1908, the Trinity River meandered much closer to the western edge of the downtown area, near the present location of the Triple Underpass. The Trinity River swelled to two miles wide near downtown, flooding parts of it and inundating Oak Cliff and West Dallas. The floods caused the city to lose water, electricity, streetcar service, and rail service, and cut Oak Cliff off from Dallas and city services for more than a week. By May 29, the waters of the Trinity River had started to recede from 52.6 feet, the second highest level in its recorded history. The flood killed between five and eleven, displaced more than 4,000 people from their homes, and caused more than $2.5 million in property damage (Furlong et al. 2003, 2; TxDOT 2004, 10).

Figure E-1. 1908 Flood

Restoring transportation connections to Dallas was the first major rebuilding effort after the flood. First, the Santa Fe, Southern Pacific, and Missouri-Kansas-Texas railway bridges were replaced. The next immediate need was to reestablish a permanent connection between Dallas and Oak Cliff. The well-known publisher of the *Dallas Morning News*, George B. Dealey, gathered a group of businessmen and sought the community's help in passing a bond issue to construct a viaduct at Houston Street. Although Dealey's proposal was met with resistance from members of the community who objected to the bridge's $609,797 estimated cost, the bond passed. Construction of the Dallas-Oak Cliff Viaduct began in October 1910 and was completed in late 1911 (Figure E-2). The reinforced concrete, high-level bridge was billed as the longest concrete structure in the world when it was opened (Jackson 1996; Payne 1994). Today it is known as the Houston Street Viaduct. With bridge construction under way, the city government turned its attention to long-term issues (Eisenhour 2009, 30).

Figure E-2. Dallas-Oak Cliff Viaduct, 1912

Dallas also had several other problems to address besides the Trinity River in order for the city to prosper. The city had five different railroad stations and their tracks crossed congested, unorganized downtown streets. It also lacked large-scale arterial roadways (Eisenhour 2009, 32). Furthermore, Dallas was not a visually attractive place to live. There were no impressive vistas, boulevard system, park system, or large nearby recreational areas. The city was choking on its own growth. At the turn of the twentieth century, the president of the Dallas Civic Improvement League stated, "there is scarcely a more slovenly community in the United States" (Wilson 1989, 257).

Prior to the flood, city planning in Dallas was a piecemeal affair with no comprehensive plan. George Dealey was intent to change that, and emerged as a leader in the struggle for a better city. George Bannerman Dealey (1859–1946) is perhaps best known as the publisher of the *Dallas Morning News*. He started as an office boy at the *Galveston News*, became business manager of the *Dallas Morning News* when the newspaper was founded in 1885, and worked his way up to president in 1919. Dealey used his position, influence, and at times, his newspaper, to advocate city planning for Dallas. His role in helping to secure financing for the Dallas-Oak Cliff Viaduct is an example of his civic activism for Dallas. Dealey was also responsible for donating most of the right-of-way for the Triple Underpass (Perez 2009; Hunt 1991). Another of his important contributions to city planning in Dallas was his crusade for improvements to the Trinity River corridor.

According to Dealey, during the winter of 1902, he walked onto the Commerce Street Bridge. With nothing particular on his mind, he smoked a cigar while gazing at the Trinity River bottomland before him. Suddenly the realization came to him that the worthless land adjacent to the downtown business district could become highly prized if the Trinity River was moved. He secretly began to buy land in the area as it became available (Payne 1994, 29).

After reading a pamphlet on the City Beautiful Movement, Dealey became immersed in this urban planning movement. As a committed citizen activist, he would later become a man some called "the father of planning in the southwest" (Fairbanks 1996, 190; Wilson 1989, 258).The City Beautiful Movement was a nationwide, turn-of-the-twentieth-century (1890–1920s) trend in urban planning to rectify the decay and demoralization of communities through the beautification of the city. Urban areas across the nation were growing exponentially, and leaders increasingly realized the critical importance of community planning, not only in sustaining urban growth but also for the continued health and safety of residents and visitors. Proponents of the City Beautiful Movement believed that by beautifying an urban area with wide, elegant avenues, carefully planned landscape designs, and opulent, usually Beaux Arts style buildings, the pride of the city would be restored, and inner cities would maintain their central position within the expanding community (Wilson 1989).

Embracing the role of citizen activist, Dealey in 1909 led efforts to organize the Dallas City Plan and Improvement League (CPIL) and in January 1910 launched a civic improvement series in the *Dallas Morning News*. An adjunct of the Chamber of Commerce, the CPIL was designed to study the needs and possibilities of the city and develop a city plan. It was made up of 38 prominent citizens, including Dealey (TxDOT 2004, 11; Wilson 1989, 260).

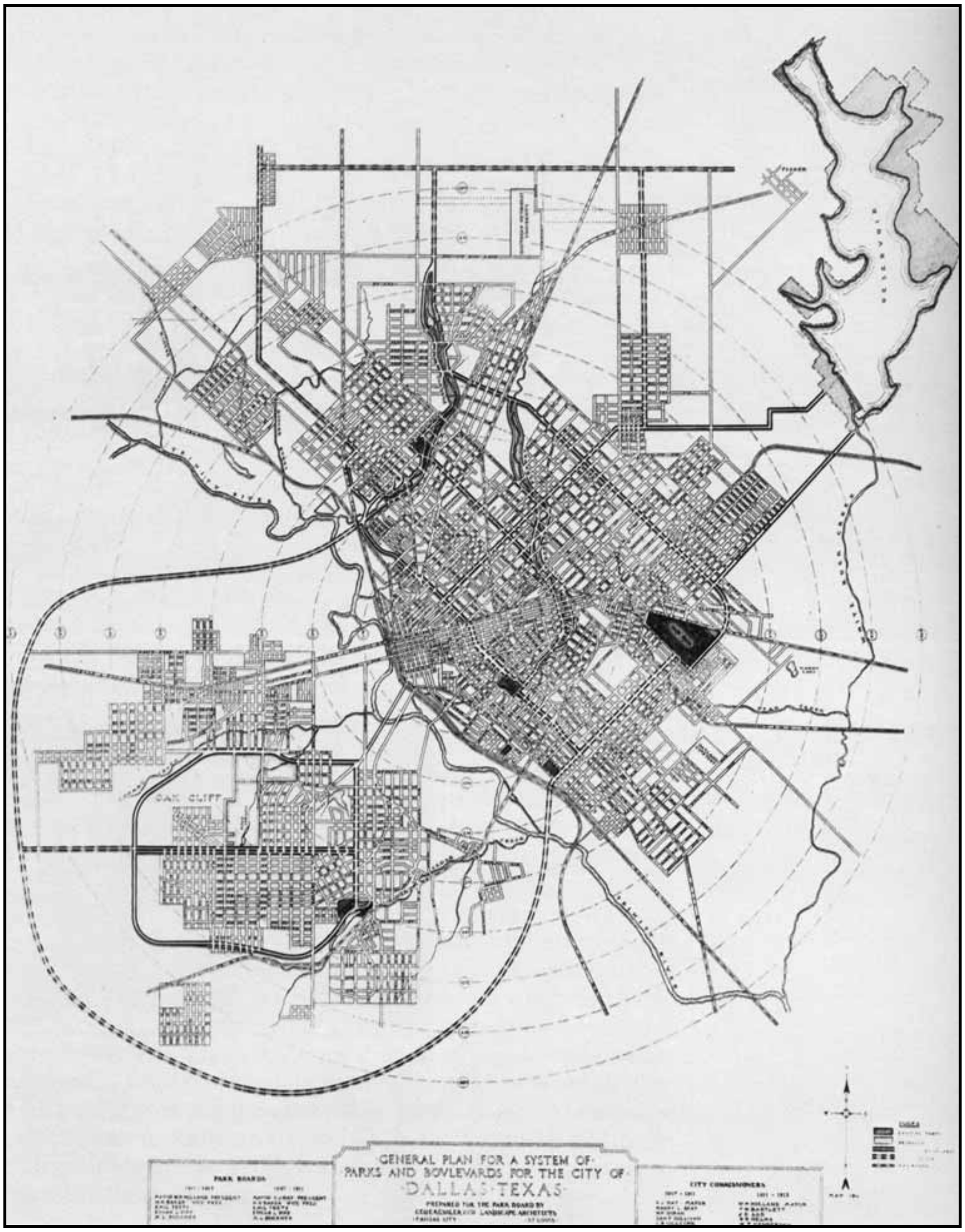
Development of the Kessler Plan

The CPIL sought the expert advice of George E. Kessler, a nationally renowned landscape architect and city planner, to develop a city plan (Fairbanks 1996, 190). Kessler, who lived in Dallas as a young man but settled in St. Louis, had previously worked in Dallas in 1904 to redesign the State Fair Grounds (Fair Park) (Payne 1994, 29). Kessler was one of the leading proponents of the City Beautiful Movement (Wilson 1989). He designed Kansas City's park-boulevard system, and city plans for Cincinnati, Cleveland, Indianapolis, Denver, El Paso, and Syracuse (Maxwell 2009a). Kessler participated in a joint conference with the mayor, the city commissioners, the Park Board, and members of the CPIL. As a result of the meeting the city officials agreed to employ Kessler to develop a 25-year plan to help guide Dallas.

Kessler's 40-page *A City Plan for Dallas* was published in 1911. The Kessler Plan, as it was commonly known, noted planning deficiencies in Dallas and provided specific solutions to correct them. The plan was essentially a City Beautiful blueprint for Dallas (Payne 1994, 30) (Figure E-3). The Kessler Plan proposed directing urban growth with large-scale infrastructure improvements, establishing arterial roads, separating rail lines, creating recreational areas and greenbelts, and preventing flood damage by moving the Trinity River and constructing a floodway. To accomplish these objectives, Kessler specified nine proposed improvements:

- Levees: a levee system to protect the city from floods and to reclaim river bottom land for industrial use by moving and straightening the Trinity River channel;
- Belt Railroad: a beltway railroad line with two loops, one around the city proper and the other around Oak Cliff and West Dallas;
- Union Station: a union passenger station along the belt railroad in the central business district;
- Freight Terminals: separate rail freight terminals;
- Civic Center: one civic center adjacent to the Union Station;
- Grade Crossing: elimination of railroad grade crossings in downtown;
- Street Openings: widening and extension of numerous downtown streets to improve traffic flow;
- Parks, Parkways and Boulevards: building a comprehensive system;
- Playgrounds: building additional playgrounds (Kessler 1911, 9)

In his first recommendation, levees to contain the Trinity River, Kessler noted that the river, together with the railroads on the west bank, constituted a development barrier to the central business district of Dallas (Kessler 1911, 7). The river should be moved to the west and channeled, opening up a large strip of developable land. Kessler felt this undertaking was essential to the continued growth of the city (Foley 1931, 9).



Source: Kessler 1911

Figure E-3. Kessler Plan

The specifics of this plan consisted of moving the Trinity River westward towards Oak Cliff, and confining the new channel within 25-foot-tall levees spaced 1,200 feet apart. To build the eight miles of levees, the earth between them would be dredged. The channeled river would be designed to include a lock, dam, and turning basin to accommodate barge traffic in a Trinity River capable of navigation. Kessler envisioned an industrial area with loading faculties and railroad tracks (Kessler 1911, 9, 10).

Regarding the reclamation of the Trinity, Kessler stated it "will command attention throughout the United States and will attract many men interested in other reclamation projects in other parts of the country who will come here to learn the 'Dallas' way of doing big things" (*DMN* 1933d). From Kessler's statement, it can be construed that the Dallas Floodway project would be an early step in putting the "Big D" in Dallas.

Kessler's proposal perfectly aligned with Dealey's vision for industrial development. Dealey wrote to Kessler: "As I understand your ideas, the one great project necessary for the proper development of Dallas is the reclamation of the Trinity River bottoms and all that will follow." To drum up public support for the Trinity floodway project and the proposed citywide civic improvements, Dealey regularly printed excerpts of Kessler's plan in the *Dallas Morning News* (Payne 1994, 30).

With the Kessler Plan, the city had its first comprehensive plan, but officials carried it out in a piecemeal and haphazard fashion. Citywide supporters rallied around the projects that had a clear direction and that could be accomplished quickly, such as the Union Station, which opened in 1916; a parkway along Turtle Creek; and the widening and extension of several downtown streets (TxDOT 2004, 12). Furthermore, the Park Board had boosted park acreage from 150 acres in 1908 to more than 650 acres by 1923 (Wilson 1989, 276).

No immediate action was taken on the major components of the plan. The more costly proposals, such as the levee/reclamation project, lacked a clear vision on how to proceed and suffered from a lack of city support. Initially city leaders ridiculed the construction of levees for the Trinity River and moving of existing rail lines. The railroads were not initially amenable to adjusting the rail lines to accommodate potential competition from Trinity River navigation. Opposing parties wanted opinions of other engineers and offered an alternate proposal to dam the Trinity River and create a town lake for beauty and recreation purposes. The City Council subsequently retained William B. Parsons, a hydraulic engineer, to study the proposals. The engineering studies corroborated the Kessler Plan and the unstable soil conditions proved unsuitable for the lake (*DMN* 1933e; Foley 1931, 10; Furlong et al. 2003, 2). Thus, the Kessler Plan lay largely dormant. Contributing to the lack of action was the severe national economic downturn of 1913–14, and later, the advent of World War I.

By 1918, the CPIL was essentially defunct (Wilson 1989, 275). George Dealey spearheaded the formation of another improvement association the next year. Called the Dallas Property Owners Association (DPOA), this group urged the reclamation of the Trinity River bottoms, adjacent to the property owners' part of town in the once fashionable West End that was deteriorating. A different group of downtown businessmen, in the Central Improvement League, promoted parts of the Kessler Plan that helped the east end of downtown, but opposed public financing of reclamation of the Trinity River bottoms because they felt it disproportionately helped the West End property owners (Fairbanks 1996, 192). These opposing groups accomplished little but set the stage for the Metropolitan Development Association, a branch of the Chamber of Commerce. DPOA remained independent, specifically to improve the West End and to create a reclamation district in 1920 to straighten the Trinity River and reclaim land. The effort stalled when the cost of the project was revealed (Fairbanks 1996, 195).

Following several years of rapid growth, city officials asked George Kessler to update his plan in 1919. Kessler issued a revised plan in 1920 that blended aspects of the City Beautiful and City Practical concepts of planning. Kessler's revised plan recommended removing the H&TC railroad tracks and developing the right-of-way with a 10-mile-long boulevard from the southern city limits near the Trinity River to Mockingbird Lane. Embodying the City Beautiful concept of a city parkway, Kessler envisioned Central Boulevard as a 200-foot wide parkway consisting of a 70-foot wide center park space, 40-foot roadways on either side of the park, and 25-foot parkways on either side of the roadways (TxDOT 2004, 12).

Kessler also revised the specifications for building levees along the Trinity River. The revised Kessler Plan increased the levee height from the original 25 feet to 30 feet and the floodway width between the levees from 1,200 feet to 2,000 feet (Texas Section American Society of Civil Engineers [ASCE] 1989; Wilson 1989, 261). With these revisions, approximately 4,500 acres of land adjacent to the confluence of the Elm and West Forks of the Trinity River would be protected (Texas Section ASCE 1989).

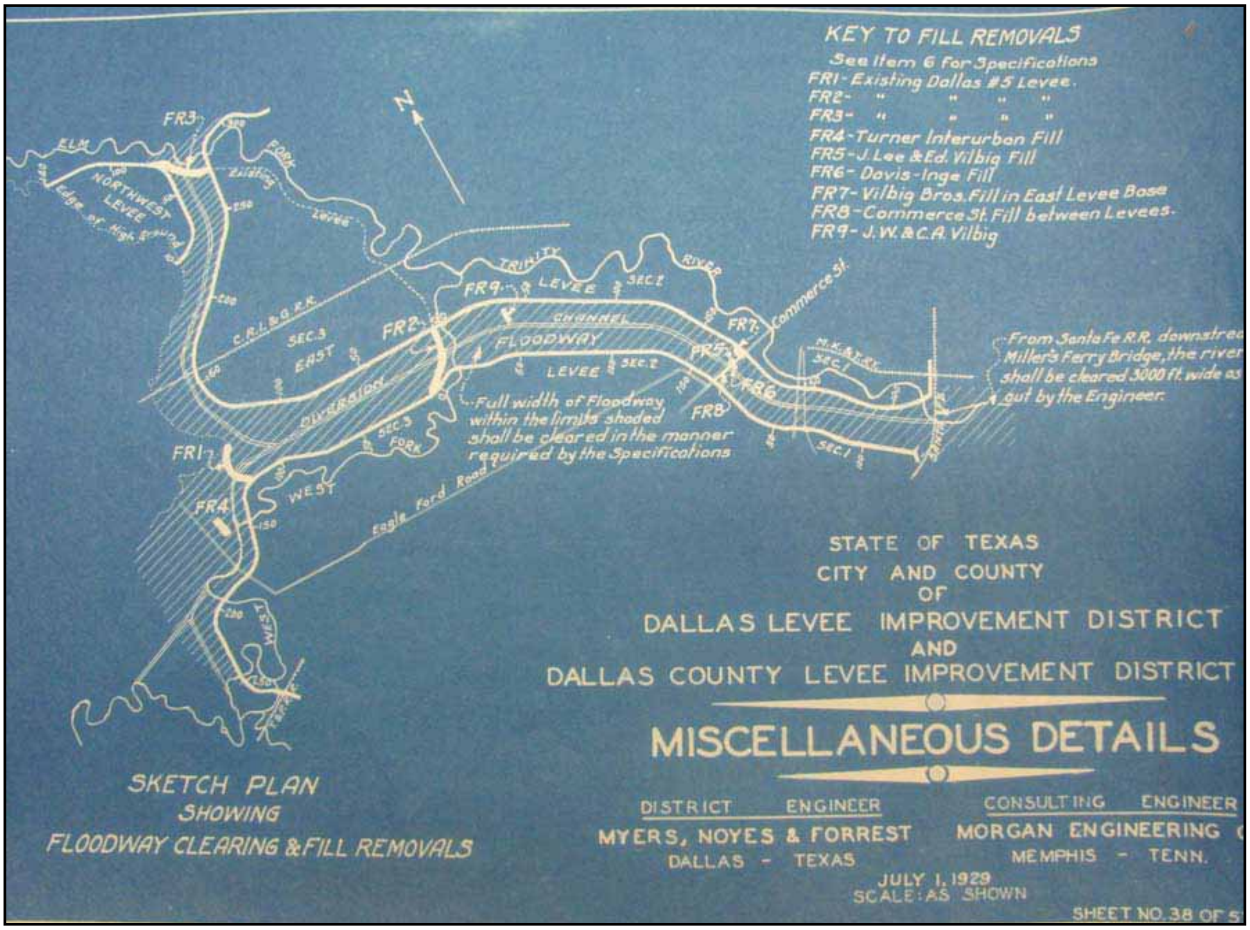
The DPOA and other improvement associations were unable to build interest for the revised Kessler Plan in each of their respective geographic areas, let alone generate a broad appeal. Members of DPOA believed a citywide planning organization would resolve the problem, and thus, in 1924 formed the Kessler Plan Association (KPA). The new KPA promoted citywide comprehensive planning through promoting the Kessler Plan plus its revisions, and civic unity through education and public participation, in the hope of eliminating planning by special interest groups (Fairbanks 1996, 197; Wilson 1989, 269–271). The thinly veiled attempt at unity would prove to be short lived. Accusations soon arose that the KPA was in the shadow of one man, George Dealey, and the organization's "sole purpose is to develop the Trinity River and the west business district" (Wilson 1989, 273).

The Ulrickson Committee and Final Plans of Reclamation

The Dallas County Levee Improvement District No. 5 was formed in 1919 to construct the levee system proposed in the 1919 update of the Kessler Plan (Texas Section ASCE 1989). This levee district consisted of a 4,500-acre footprint located adjacent and upstream of the confluence of the Elm and West Forks of the Trinity River. The Trinity Farm Securities Company owned about 90 percent of the land. By the mid-1920s, levees were constructed in these areas (Figure E-4) to protect against ordinary floods and allow agriculture, but it did not constitute reclamation in a manner that would lead to organized development (Fry 1929, 805).

In 1926, Myers and Noyes (later to become Myers, Noyes and Forrest) Engineers of Dallas developed a modified plan of levees that amended the plan of levees for the Levee Improvement District No. 5 and added levees outside of its limits (Texas Section ASCE 1989). The City and County of Dallas Levee Improvement District (Levee District) was created in July 1926 for construction of the levees downstream of the Dallas County Levee Improvement District No. 5 to the AT&SF Bridge. The property owners in this area agreed to unite to create the Levee District. Leslie Stemmons and the Trinity Farm Securities Company owned the largest amounts of land within the Levee District (Furlong et al. 2003, 3). Leslie Stemmons and John J. Simmons, both prominent local businessmen, were appointed the supervisors of the district. Stemmons was president of Atlas Metal Works (located in West Dallas and flooded in 1908) and the Southwestern Loan Association (Fairbanks 1998, 62). He had supported the Kessler Plan from the beginning. Simmons held no land in the District (Foley 1931, 15; Baker 1988, 46).

In November 1926 the Dallas County Levee Improvement District No. 5 and the Levee District filed the Joint Plan of Reclamation. This plan encompassed the entire levee system and floodway, but went well beyond flood control and included all the basic elements needed to develop reclaimed land. The plan provided for 7,217 acres of reclamation for the Levee District and 3,336 acres of reclamation for the Dallas County Levee Improvement District No. 5. Thus, the Joint Plan of Reclamation included 10,553 acres (approximately 17 square miles) to be reclaimed along the Trinity River (Furlong et al. 2003, 3; Texas Section ASCE 1989). The geographical boundaries of the two districts roughly coincided with the limits of the 1908 flood and covered not only the proposed floodway, but also included what would become an industrial corridor along Industrial Boulevard. Protection for the Houston Street viaduct where it intersects the levee was also detailed (Myers, Noyes and Forrest Engineers 1926).



Source: Supplement to the Plan of Reclamation, 1929

Figure E-4. Floodway Sketch of Previous Levees (1929)

A financing plan for the floodway and reclamation project, as well as other citywide improvements, was provided in the 1927 report "Forward, Dallas!" by the city's Ulrickson Committee. Mayor Louis Blaylock had appointed Charles E. Ulrickson in 1925 to lead a committee to determine the best course for dealing with urban improvements, including the flood control issue (TxDOT 2004, 13). The Ulrickson Committee recommended a $23.9 million bond issue to fund a nine-year capital improvements program. Of this total, a little more than $13 million was the cost of implementing flood control measures and land reclamation in the Trinity River floodplain. The remaining $10 million was for infrastructure and economic development improvements behind the Trinity River levees (Furlong et al. 2003, 3). The latter included the street improvements, development of Central Boulevard, schools, parks, a downtown auditorium, improvements to Love Field, construction of a triple underpass at the western edge of downtown, and four viaducts to span the Trinity (Ulrickson Committee 1927).

The core of the Ulrickson Committee improvements program was flood control drainage systems along the Trinity River. The flood control plan protected approximately 10,500 acres. The levees would be approximately 13 miles long on each side of the river, 30 feet high (9 feet higher than the 1908 flood), 156 feet wide at the base, and 6 feet wide at the crown. Interior drainage would entail seven gravity flow sluiceways, four pumping plants, and five pressure sewer lines. This floodway system would have the capacity to carry 2.5 times the volume of the Trinity River flood of 1908 (Furlong et al. 2003, 3). The Ulrickson plan was the basis of what would eventually be constructed.

The KPA endorsed the Ulrickson financing proposal and touted the benefits for the city to straighten the Trinity River and levee, reclaim the river bottoms, and provide new viaducts that would link Dallas to Oak Cliff. Through the KPA's efforts, the Ulrickson Committee report was approved and bonds were authorized by election (Fairbanks 1996, 200; Furlong et al. 2003, 3).

By December 1927, the comprehensive improvement program, aligned with the 1926 Joint Plan of Reclamation, coordinated private property owners (united together as the Levee District), the city, the county, railroads, and utilities in the nearly $24 million effort to create the floodway and development improvements to streets, utilities, schools, and recreation (Fairbanks 1998, 62).

The 1926 Joint Plan of Reclamation was updated in 1928 with even greater detail and explanation of the purpose of the project, which now described both the public and private improvements within the two districts (Morgan Engineering 1928). Five entities—the city, the county, private land owners, utility corporations and railroads—would move the river, channel it, and reclaim lands for industrial development in a single, unified plan. The plan stated "the betterment plans of Dallas and Dallas County [e.g., construction of Industrial Boulevard, viaducts, and sewer improvements] are so closely interlocked with the plan of reclamation of the Levee Districts…they will be valueless unless the plan of reclamation is carried out" (Morgan Engineering 1928).

The 1928 Joint Plan of Reclamation reached 10 conclusions that outlined creation of both a floodway and infrastructure for industrial development from reclaimed lands. Central among the conclusions were many references to the importance of industrial development resulting from the reclamation (Morgan Engineering 1928):

- **Industrial District** – Create a new area adjacent to the railroad and downtown business district "well suited for the commercial and industrial expansion of Dallas" (Figure E-5, No. 13). Grading and filling of sections of the old river channel with hydraulic fill as part of the plan "should aid materially in making that area attractive to prospective purchasers of commercial and industrial sites." The city would pay for the sewers, the property owners for the fill.
- **Triple Underpass** – Approaches to the reclaimed area on the East Levee by street improvements and underpasses beneath the railroad tracks skirting the bluff (now known as the Triple Underpass near Dealey Plaza) would connect them with "the city proper in a manner that should contribute to their early development" (see Figure E-5, No. 14).
- **Four Bridges** – Construction of four bridges (Corinth, Commerce, Lamar [now Continental], and Cadiz) would provide needed links to Oak Cliff (see Figure E-5, No. 11, 12, 14, and 17).
- **Industrial Boulevard** – A "hard surfaced highway" that will "transverse the entire length of the eastern protected area" and will "aid in developing district lands" (see Figure E-5, No. 6).

The essential floodway components of the plan were as follows (Morgan Engineering 1928):

- **Levees** – 24.5 miles of new levees, paid for by the property owners in the levee district (see Figure E-5, No. 36).
- **New River Channel** – In a direct line down the center of the floodway. Elm and West Forks are to be diverted into this new channel at a new confluence. The diversion channels also would be paid for by the property owners in the levee district (see Figure E-5, No. 36).
- **Floodway** – The newly created floodway was to be kept in an unobstructed condition and "assume ultimately, a park like aspect. They may even become so attractive, that the city will make them public recreation grounds, thereby strengthening the likelihood of perpetual maintenance in a smooth condition."
- **Interior Drainage System –** Funded by a combination of property owners and the city, the system was needed to drain the reclaimed valley lands using the remnants of the old river channel. The interior drainage system was intentionally under designed, with less sluiceway and pump capacity than would be needed in the future and as industrial development occurred. These additional floodway components could be financed through taxation. "This condition is likely to arise after the reclaimed lands have become so far developed that additional costs will not be burdensome."

- **Hydraulic Fill Area –** Paid for by the property owners in the levee district, this area consisted of approximately 600 acres immediately adjacent to downtown, from Commerce Street to what is today Turtle Creek Boulevard, and was the heart of the newly created Trinity Industrial District. The Property Owners Map (Figure E-6) shows the reclamation project in an overlay with the street layout of the Trinity Industrial District. Within this area, the old channel of the Trinity River was to be filled in with 3 million cubic yards of earth borrowed from the floodway and graded by the district. The city would provide a stormwater system for the interior drainage. The city would also pave Industrial Boulevard as part of the reclamation plan. The area was to be "improved in a manner to make it immediately attractive as an extension of the Dallas business and industrial districts" (see Figure E-5, No. 13).

Figure E-7 shows the essential floodway components of the 1928 reclamation plan. The figure also shows the Hydraulic Fill Area where the Trinity River was to be filled from "X to Y," roughly from Turtle Creek Boulevard to Commerce Street and from the East Levee to present-day Stemmons Expressway.

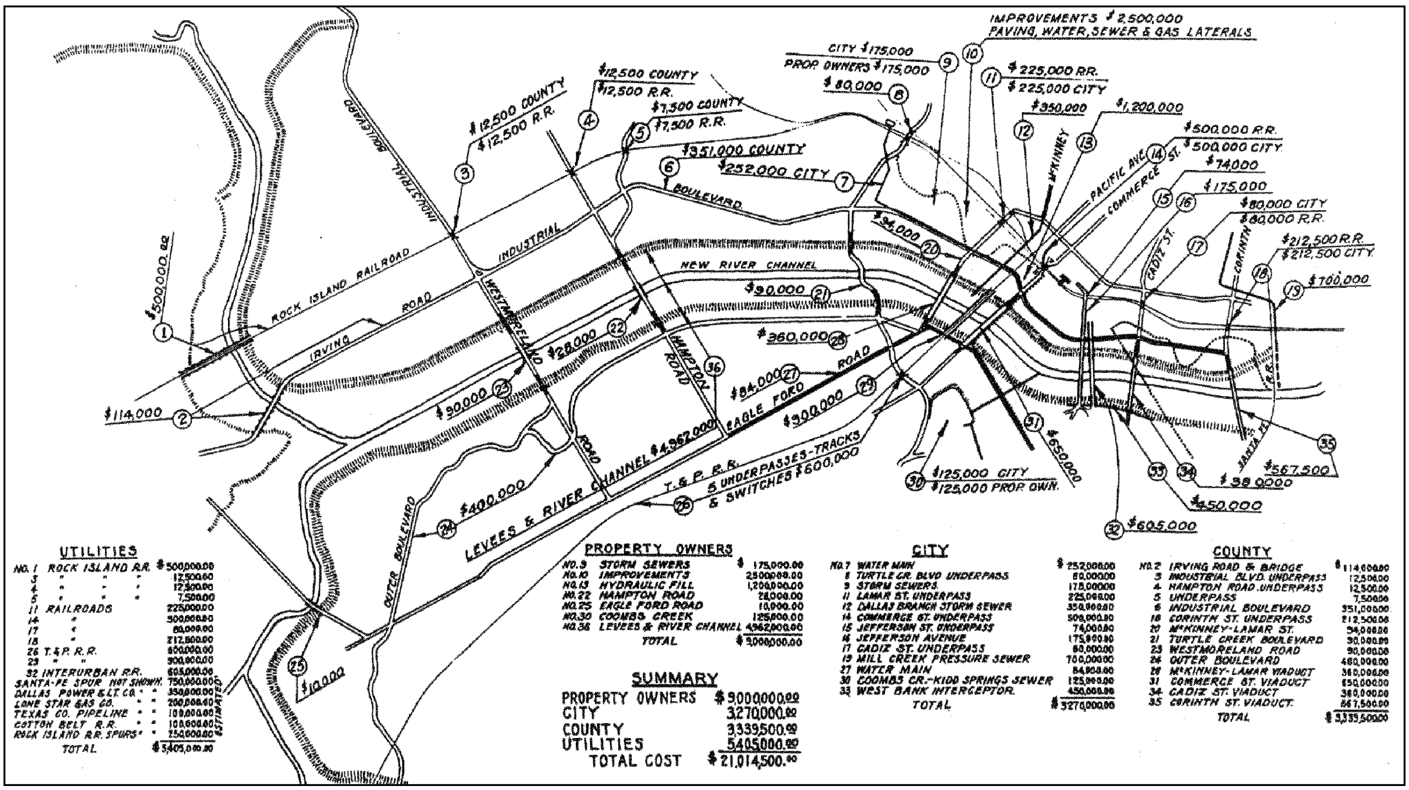


Figure E-5. Physical Features of the Reclamation Plan and Distribution of Expenditures

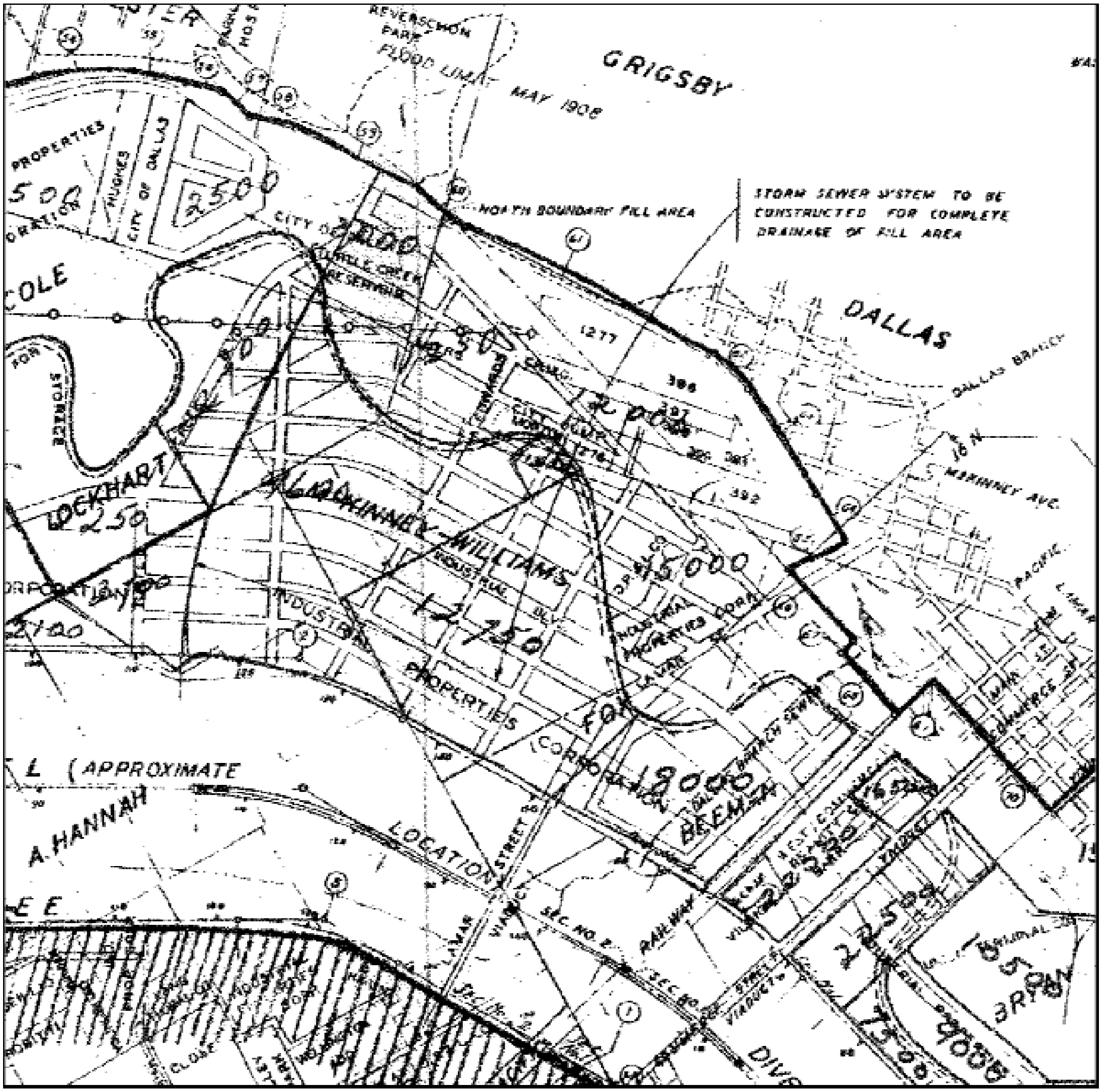
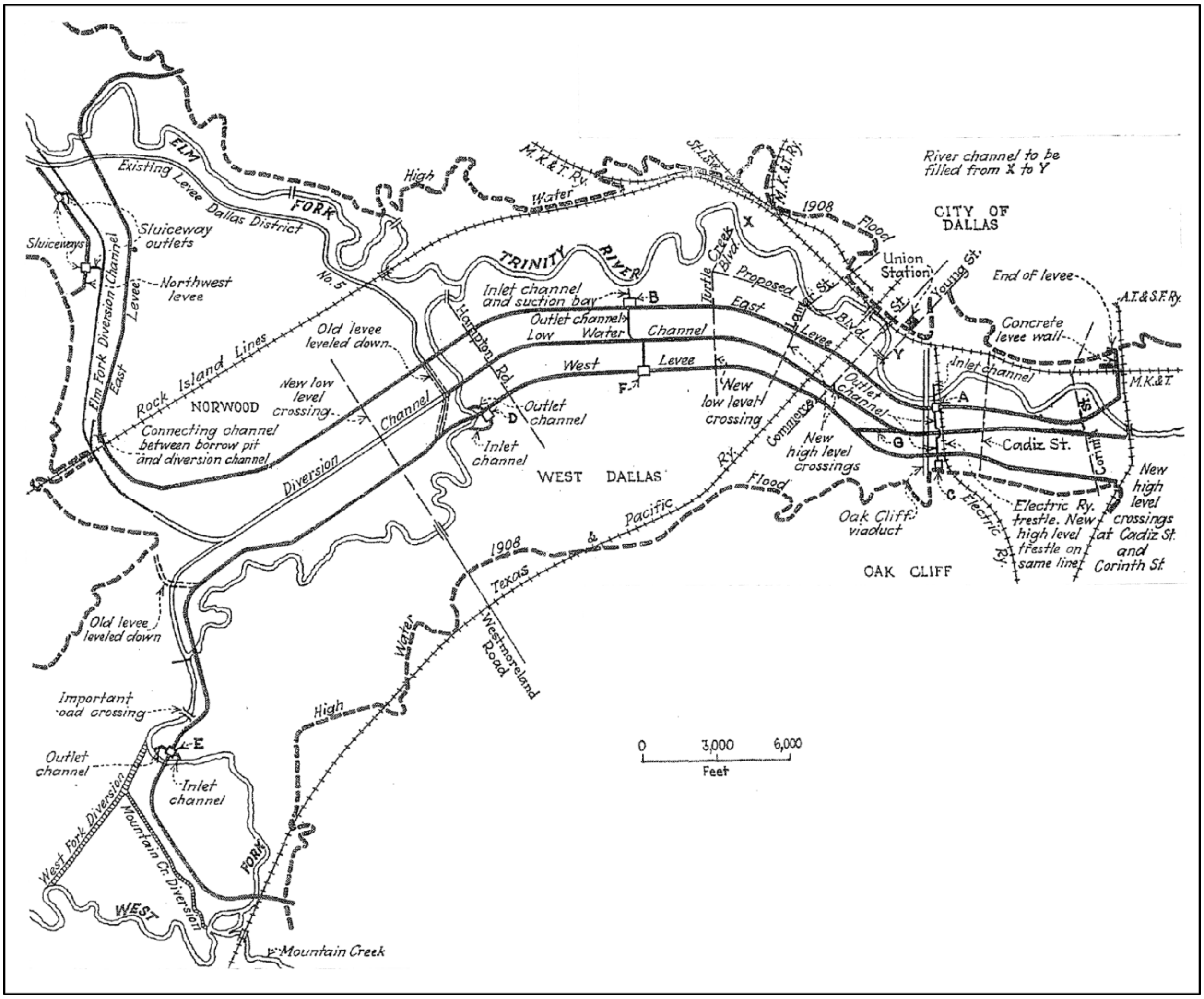


Figure E-6. Hydraulic Fill Area and Planned Trinity Industrial District



Source: Fry 1929

Figure E-7. Dallas Floodway and Reclamation Project (November 1929)

The city moved rapidly on many of the improvements including initiation of the Trinity floodway project, construction of the Triple Underpass, and relocation of railroad tracks (TxDOT 2004, 13). The property owners within the Levee District sold bonds against their properties for $6 million in April 1928 to relocate the river and build the levees. The Dallas County Levee Improvement District No. 5 also sold bonds to contribute $500,000 for this joint effort. In addition, the city of Dallas and Dallas County also sold bonds for a little more than $3 million each to participate in the immediate phase of the Trinity project, while the railroads (Rock Island and the Texas and Pacific) and utility companies dedicated about $1 million to the Trinity River project. Meanwhile, Dallas County provided funds (less than $2 million) to construct the four viaducts across the Dallas Floodway as well as one viaduct (Irving Road Viaduct) across the Elm Fork. Besides the five major viaducts, four minor crossings were also constructed along various parts of the Trinity River. Each of the four new viaducts across the Dallas Floodway was constructed with a 150-foot center span to accommodate the river channel and enough clearance for the bridge decks to be above the levees (Furlong et al. 2003, 3).

The Hydraulic Fill Area of the reclamation and floodway project was immediately attractive to Levee District supervisors Leslie Stemmons and John Simmons. Even though the Ulrickson bond package was approved by voters, when it came time for the Levee District to sell bonds for its portion of the Trinity Reclamation Project, opponents led by the railroads (who initially saw the levees as a step toward navigation of the Trinity River) threatened to file an injunction to stop the bond sale (Baker 1988, 46).

Simmons and Stemmons organized a subset of the property owners in the Levee District: land owners in the reclaimed area closest to the river downtown were united to form the Industrial Properties Corporation, whose goal was to initially develop the 1928 Joint Plan of Reclamation’s Hydraulic Fill Area and eventually expand with successful development. The property owners that formed the Industrial Properties Corporation controlled 75 percent of the 10,500 acres to be reclaimed at an estimated worth of $52 million (Fairbanks 1996, 202). In 1928, the city gave the Industrial Properties Association a charter to develop the reclaimed land as the Trinity Industrial District (TxDOT 2004, 11).

Instead of a public offering of bonds, Stemmons and Simmons arranged a secret, private sale to a Chicago brokerage house. The two men had $6 million in bonds printed in Galveston and sent to Austin for approval by the Attorney General. Signed and then stuffed into eight suitcases, the bonds were driven to Dallas by Stemmons and Simmons at such a high speed that the car caught on fire. Both men were met in Dallas by an armed escort who took the car to Union Station, where Leslie Stemmons put his 90-year-old mother aboard a train with the suitcases to “visit relatives in Chicago.” The bonds were then sold in Chicago in a private sale at the highest price to date for levee bonds in Texas. As soon as word arrived that the bonds were sold, Stemmons and Simmons revealed a petition signed by the majority of the land owners in the district and immediately awarded the contract for construction to the Trinity Farm Construction Company, a subsidiary of the largest landholder in the district (*DMN* 1933b). Construction could now commence.

In a 15-part series on the Trinity Reclamation Project by columnist Lynn Landrum in 1933, the *Dallas Morning News* devoted one part to describing the secret sale entitled “The Runaway Bonds.” Landrum later reported in Part IX, “Getting the Job Done,” that “there are numbers of sincere and reputable people in Dallas who insist there is something ‘crooked’ about the contract” (*DMN* 1933d). The injunction suit to stop the project was never filed.

These actions by the two Levee District supervisors (one of them, Leslie Stemmons, was also the leader of the newly organized Industrial Properties Corporation) raised the question among many members of the community of how much the city should be helping private developers. This and other business practices by the Levee District were widely perceived to run counter to the idea of a bond program operated for the benefit of the city as a whole and was widely seen as catering to special interests. The distrust threatened the consensus the KPA had hoped to create for effective comprehensive city planning.

However, George Dealey threw the weight of the *Dallas Morning News* behind the reclamation project and intensely lobbied city officials on its behalf. The *Dallas Morning News* contained a special eight-page supplement promoting the reclamation and industrial development. Opponents pointed out that Dealey owned property in the bottom lands and would personally benefit.

An angry and bitter battle played out in the local press. George Dealey's *Morning News* was in full support, while the rival *Times Herald* was convinced Leslie Stemmons was "a swindler." The two papers "fought like Tigers." The *Times Herald* would publish accusations, such that as the Levee District Supervisors were not following the Ulrickson Plan or that the city and the Levee District only followed the plan when it was favorable to the District. The *Morning News* would counter with full page sections on the Trinity Industrial District such as the 12 October supplement, reporting it "will be the most exclusive district in the world…a great boulevard nine miles long and 130 feet wide will be available…twenty million dollars were expended by the city and county of Dallas, private land owners in the district, public utilities and railroads to make this paradise for industry." The battle of the two papers would last years and was still smoldering as late as 1935 (Baker 1988, 47–48).

Floodway Construction and Project Cutbacks

Actual construction of the floodway began in July 1928, with George Dealey as the keynote speaker at the dedication ceremony. He told the crowd that the realization came to him in 1903 (it was actually 1902) when he suddenly understood the possibilities inherent in reclamation (i.e., expanding the business district to the west), and the groundbreaking event was "one of the most important in its potential effects" that he had seen in his then 43 years in the city. He then stated, "A blot on the landscape near the heart of Dallas will be removed and a great industrial development will follow." In his dedication speech, Dealey, in the spirit of the City Beautiful Movement, went on to envision a future floodway that would "become an urban park with wildflowers on the levee slopes and sunken gardens, baseball fields, polo grounds, golf courses, bridle paths, archery ranges, trapshooting spaces, winding drives and a two mile long lake with a Coney Island atmosphere" (Payne 1994, 156).

By the time of the dedication, the City Beautiful Movement was on the wane and the emphasis on beautification, aesthetics, and social issues gave way to the City Efficient Movement. This new movement focused less on the big sweeping plans of monuments, boulevards, and parks, and placed emphasis on practicality, stabilization of land values through zoning, separation of urban land uses, and accommodating the automobile (Talen 2005, 117–140).

The Morgan Engineering Company from Memphis, Tennessee, was the consulting engineer on the Dallas Floodway project. Myers, Noyes and Forrest Engineers from Dallas performed additional engineering. As previously described, the Trinity Farm Construction Company was awarded the construction contract as a private letting. The company contractually agreed to complete construction with the available money regardless of any unanticipated circumstances that might arise. To manage the construction effort, the

Levee District appointed a three-person Board of Supervisors led by Leslie Stemmons (Furlong et al. 2003, 3, 4).

The Dallas Floodway project was the second largest flood control project in the nation during its time; only the flood control project along the Miami River in Dayton, Ohio, was larger (Furlong et al. 2003, 4). More than 1,000 men worked around the clock seven days a week for nearly two years to build the Dallas Floodway project (North Texas Public Broadcasting and KERA 2009).

The amount of earth moved to move the river one-half mile west (22 million cubic yards) was five times the volume of the Great Pyramid of Giza and one-tenth the size of the Panama Canal. No deaths occurred during the construction (*DMN* 1933d; Furlong et al. 2003, 4). Figure E-8 shows the floodway and downtown Dallas before the floodway construction began and Figure E-9 shows the floodway under construction in late 1929.

Figure E-8. Downtown Dallas and the Trinity Floodplain Before Reclamation, ca. early 1920s

Figure E-9. Dallas Floodway Under Construction, 1929

The Great Depression intervened in October 1929 and greatly affected the project. By 1930, the mayor announced he would have to raise taxes if he sold all the bonds for pressure sewer development needed by the floodway design. The levee supporters needed $1.1 million to complete the reclamation effort to build the sewer system required. A protest movement ensued, charging the reclamation was a private undertaking and not deserving of more public money. Also of concern was the diversion of bond money for storm sewers from areas of the city that continually flooded to finance sewers for the yet undeveloped Trinity Industrial District (the hydraulic fill area) controlled by the Industrial Properties Corporation (Fairbanks 1996, 203).

The battle for the Trinity River bottoms raged on because the reclamation project had been sold to the public as a better way to link downtown to Oak Cliff, protect the city from flooding, and open land for industrial development, leaving many concerned over what they viewed as a huge public subsidy for a private real estate venture (Fairbanks 1996, 202). Many groups wanted a more even distribution of the bond money spread around the city instead of the city paying for interior drainage for yet undeveloped land controlled by private interests (i.e., property owners of the Levee District and Industrial Properties Corporation).

The public debate over the relationship between public works and private development ultimately ended in a compromise. The compromise provided storm sewers for the rest of the city that was considered neglected, but eliminated several of the interior drainage components and expensive pressure sewers (e.g., Turtle Creek Pressure Sewer) for the reclamation area controlled by the Industrial Properties Corporation, effectively stalling the effort to develop the area as an industrial district (Fairbanks 1996, 207).

In December 1931, the Board of Supervisors and the State Reclamation Engineer approved an amended Joint Plan of Reclamation. The amended plan, prepared by Myers, Noyes and Forrest, reflected the changes to the interior drainage that resulted from the Depression budget and political compromise over the drainage (Myers, Noyes and Forrest Engineers 1931). To appease the citizens of areas of Dallas that were flooding, the city delayed the construction of storm sewers in the Hydraulic Fill Area, rendering it useless for development, and shifted the bond money to fix areas that were flooding (*DMN* 1933c). It was futile for the Industrial Properties Corporation to fill in the area and then taxpayers later pay for it to be re-excavated for storm sewers.

Other significant design changes were made to save costs. The original design for the levees called for a three to 1 (3:1) slope, which was changed to 2.5:1, and in places, 2:1. While all four pump stations in the 1928 Joint Plan of Reclamation were constructed, not all of the interior drainage works were completed. Five of the seven sluiceways were constructed, and only three of the five planned pressure sewers were built (Furlong et al. 2003, 5).

A construction progress report was issued on April 1, 1931, with estimated completion of the now almost $21 million project set at 60 percent. The cost of the project was divided as follows:

Property Owners	43 percent
City of Dallas	14 percent
County of Dallas	17 percent
Railroads and Utilities	26 percent

The flood control works (levees, pump stations, and sluiceways) were essentially complete; however, only $200,000 of the funding remained, while storm sewers and improvements to the Corinth, Commerce, and Continental Street viaducts were not complete. Significant work on the Hydraulic Fill Area and the paving of Industrial Boulevard by the County of Dallas also remained.

Construction of the project as outlined in the Amended Joint Plan of Reclamation of 1931 was essentially accomplished in late 1932 with the completion of the Dallas Branch Pressure Sewer. The lack of adequate drainage, the Great Depression, and World War II combined to insure the reclaimed hydraulic fill area left from the straightening of the Trinity River remained undeveloped until the mid-1940s (Fairbanks 1996, 209).

The KPA in 1932 fragmented under the dual impact of the Great Depression and a bitter dispute over the disposition of storm sewer bond funds from the Ulrickson Plan. KPA urged spending some of the monies in residential areas, while Dealey wanted no monies to be diverted from storm drainage construction in the Trinity River bottoms (Wilson 1989, 275).

The Dallas floodway and reclamation project polarized the city of Dallas, and full completion of the construction as originally planned was delayed for decades (Fairbanks 1996, 205). Kessler’s 1919 statement that “The Trinity River Project is the biggest problem you have today in Dallas” was still true.

FLOODWAY MANAGEMENT, 1932–1959

The project was completed in 1932 but even though the levees were in place with four pump stations on line, there were no funds available during and immediately following the Depression for the maintenance of the floodway or operation of the equipment and facilities used as an integral part of floodway management (Texas Section ASCE 1989). The Levee Districts did not have the funds to maintain the levees because the property owners that comprised the districts were not able to pay taxes. The Levee District bonds went into default several times during the depression years (Baker 1988, 49). This, coupled with the interior drainage issues, led to an overall degrading of the system throughout the 1930s. Meanwhile, development occurring elsewhere in the city increased runoff and demand on the system.

Major floods occurred in Dallas in 1935 and 1942. The 1942 flood produced the largest peak flow along the Trinity River since the 1908 flood. The levees held for the 1942 flood, but they were in poor condition and becoming worse (Furlong et al. 2003, 6–7).

The U.S. Army Corps of Engineers (USACE) Completes the Joint Plan of Reclamation

Through the efforts of John Stemmons, son of Leslie Stemmons, the Texas Legislature created the Dallas County Flood Control District in 1945. This new flood control district was the response to the major flood of 1942. It essentially replaced the previously created flood control districts because of their default on the bonds issued for the construction of the original floodway. The new flood control district acted to repair and maintain the levees and operate the pump stations (Texas Section ASCE 1989). Operations and maintenance of the levees and other floodway components was funded by $25,000 in annual state taxes, which were collected from the property owners within the boundaries of the district (Furlong et al. 2003, 7).

The departments of Agriculture, Commerce, and War conducted several surveys on the development of the Trinity River. In the 1944 Flood Control Act, Congress authorized a program of water and soil conservation, and in the 1945 River and Harbors Act (amended in 1950), Congress authorized deepening the Trinity River channel nine feet from the river mouth to Liberty, strengthening the levees at Dallas and Fort Worth, and building new reservoirs on the upper branches of the river (TxDOT 2004, 28). The USACE was charged with carrying out this public works program.

The USACE began to study expanding and raising the levee system. The Dallas County Flood Control District advised the USACE that the strengthening project “needed to adhere as close as possible to the latest version of the Joint Plan of Reclamation that was the basis to the original Dallas Floodway project completed in 1932” (Furlong et al. 2003, 7). Deviations from the plan would otherwise need to be approved by the two original levee districts. The USACE’s strengthening of the system complied with the Joint Plan of Reclamation in its last amended form in 1931, adding features that the two levee districts foresaw would be needed as development occurred and increased runoff put greater demand on the system. The floodway, levee alignments, and overall design concept from the 1930s remained unchanged. When the USACE finished with the floodway in 1959, it included upgrades in the original design and the completion of the components that had been removed because of the Great Depression and the compromises from the political battle over public works and private development. Figure E-10 shows the exact same view of the Dallas Floodway in 2009 as the 1929 view shown in Figure E-9. The primary change in the two photographs is the successful development of the reclaimed lands made possible by the floodway as envisioned by the 1928 Joint Plan of Reclamation.

Source: Google Maps

Figure E-10. Dallas Floodway, 2009

The USACE strengthening began in January 1953 and was completed in April 1959, 31 years after the first earth was moved for the Dallas Floodway. Rather than obscuring work done earlier in the 1930s, the USACE efforts allowed completion of the floodway and reclamation project by restoring essential features compromised in the original plan (e.g., pressure sewers) and creating components (e.g., additional pump stations) that were needed as runoff from development increased. Nonetheless, the latter components were envisioned in the 1928 Joint Plan of Reclamation. Robert Fairbanks, in his article in the compilation of American planning history titled *Planning the Twentieth Century American City*, states, “Only after the Army Corps of Engineers…committed more than $8 million to strengthen the levees and to develop the pumping plants and pressure sewers for the area, did the last chapter in the Trinity River reclamation begin” (Fairbanks 1996, 209).

Continuation of those efforts resulted in portions of the original Trinity River bottoms being reclaimed as dry land, and development of what became known as the Trinity Industrial District began in 1947. Over the next 15 years, industrial and commercial interests built warehouses, stores, and related support buildings along Industrial and Irving Boulevards.

The city of Dallas and the city of Irving took control of the responsibilities of the Dallas Floodway upon the expiration of the Dallas County Flood District in 1968. Each city became responsible for the portion of the floodway within their city boundaries, while the USACE retained its oversight and inspections of the entire length of the floodway. This division of the floodway's management has allowed the city of Dallas to improve the capabilities of its pumping stations and sumps when needed. In 1963, the city upgraded two pumps at the Delta Pump Station and at the Charlie Pump Station. Additionally, two pumps at the Able Pump Station were upgraded in 1967, and a pump was added to the Hampton Pump Station in 1969 (Furlong et al. 1993, 8).

In 1975, the city constructed a second pump station at both the Hampton and Baker locations. In 1979, it added one pump each to the large Able Pump Station, Charlie Pump Station, Pavaho Pump Station, and Delta Pump Station to increase the capabilities of these locations. The city also constructed the Woodall Rodgers Pressure Sewer as part of the project for the Woodall Rodgers Freeway in the 1970s. The 1980s were a slow time for the levee system, and the city undertook few improvements to the floodway, including six 10- x 10-foot box culverts at the Baker Pump Station (Furlong et al. 1993, 9).

The Irving Flood Control District No. 1 was created in 1971 to maintain the Northwest Levee. In 1974, the district constructed a stormwater pump station and related facilities and enlarged the levee from its 2:1 slope, as built between 1928 and 1932, to a 3:1 slope, as was specified in the original levee design. The levee was also heightened (Fennell 2010). A second stormwater pump station was added in 1995. The district owns and maintains all the flood control structures in the city of Irving, including the Northwest Levee, and has over time, made periodic improvements to them (Skipwith et al. ca. 2007, 6).

URBAN GROWTH AND COMMUNITY DEVELOPMENT

From 1900 to 1920, the city limits of Dallas grew exponentially and the population boomed. In 1900, Dallas was a city of 42,639 people. By 1910 the population was 92,104 and grew to 158,976 by 1920. This growth was precipitated by the movement of people from the rural farms of north Texas to the urban center growing at Dallas and Fort Worth. During this time, Dallas annexed Oak Cliff, bringing Dallas across the Trinity River.

The growth Dallas experienced in the early 1900s was in part, a result of the expansion of the railroads. The first railroad came to Dallas in 1872 and began the early period of development of the city as crops from the surrounding countryside were brought to market in the cities. Following the Panic of 1893, the railroad industry slowed its expansion until the economy could recover. By the early 1900s, the railroads were once again growing as the city moved away from agriculture toward machinery. As of 1902, Dallas led the region in publishing, drug manufacturing, jewelry fabrication, and wholesale liquor distribution (McElhaney and Hazel 2009).

Dallas' new found urban role was challenged by the constant flooding of the Trinity River. The downtown district continually flooded as the river overflowed its banks, damaging businesses, disabling utilities, and cutting off all communication and travel between Dallas and Oak Cliff. Although the city knew the Trinity River would be a constraint to expansion, the flood of 1908 proved to be a turning point in the way the city dealt with the river. By 1912, the permanent bridge between Dallas and Oak Cliff was completed, with plans to expand the number of bridges between the two areas in the works. While cotton continued to be the dominant agricultural endeavor in Dallas County, farmers in the area also contributed to the agricultural industry with large-scale wheat and corn production. As agricultural production in the region surrounding Dallas expanded, so did the emphasis on mechanizing the process of harvesting and transporting the crops. This continued spotlight on agriculture led to Dallas being one of the leading agricultural transit centers in the region, and guided the city to focus on mechanization.

The financial world began to notice Dallas in the late 1800s when William Henry Gaston arrived in the area. Gaston and his partner Aaron C. Camp began the Gaston and Camp Bank of Dallas which allowed commerce and industry to develop. Due to the continued growth of Dallas, city leaders, supported by George B. Dealey of the *Dallas Morning News* contacted well-known landscape architect George Kessler to formulate a city plan. Although features of the city plan included the creation of two parkways, the purchase of five municipal parks, and the construction of a series of Boulevards, the most drastic aspect of Kessler's plan was the creation of a levee system to control the flooding of the Trinity River. The implementation of Kessler's levee system did not occur quickly, and took the creation of the 1927 Ulrickson Committee to be fully implemented.

During the 1920s, financial speculations in the stock market and land development led to increased personal wealth for those involved in industrial expansion. During this era of growth and development, the new wealthy elite began leading the way in roadway advancement. The 1916 Federal Aid Road Act stated that each state must have its own highway department to be eligible to receive federal funds for roadway construction. While Texas struggled to implement a highway system, individual community leaders such as Leslie Stemmons continued to push for Dallas' roadway system.

Also during the 1920s, industry became the leading employer in Dallas. This move from an agricultural to an industrial economy pushed the focus of development in Dallas toward the plans supported by men such as Leslie A. Stemmons and George Dealey.

Industrial Properties Corporation

The 1928 Joint Plan of Reclamation, which came out of the Ulrickson Committee, called for the recovery of a large area of land beside the Trinity River, known as the Hydraulic Fill Area. Although this proposal was passed by voters with a $23.9 million bond issue, opponents of the bonds led by the railroads, continued to threaten to file an injunction to stop the bond sale (Furlong et al. 2003, 3; Baker 1988, 46).

Two of the Levee District supervisors, Leslie A. Stemmons and John Simmons were interested in the development of the Hydraulic Fill Area and organized a group of property owners within the Levee District into the Industrial Properties Corporation. The main goal of the corporation was to develop the Hydraulic Fill Area and continue to expand in that region. The original property owners who formed the Industrial Properties Corporation in 1928 controlled 75 percent of the 10,500 acres set to be reclaimed

(Fairbanks 1996, 202). As explained earlier, Stemmons and Simmons arranged a private bond sale and awarded the construction contract for the Dallas Floodway as a private letting.

The actions taken by Stemmons and Simmons laid the groundwork for the way in which Industrial Properties Corporation would take control of the Hydraulic Fill Area and the urbanization of this area of Dallas. Many community members questioned the amount of help the city should give to private developers as a result of the actions taken by Stemmons. The actions taken by the Dallas Levee Improvement District were believed to run opposite to the idea of the bond program which was meant to operate for the benefit of the city as a whole while the district appeared to operate for the benefit of the landowners. Despite these questions, George Dealey supported the reclamation project and lobbied city officials on its behalf. Dealey went so far as to publish a special eight-page supplement in the *Dallas Morning News* promoting the reclamation and industrial development led by Stemmons. Dealey's support came under fire; however, because he owned property in the bottom lands set to be reclaimed and would personally benefit from the project. The Trinity River Reclamation Project polarized the city and led to a delay in the completion of the project for decades (Fairbanks 1996, 205).

Due to the controversy over private development and public works as well as the Great Depression, the Trinity River Reclamation Project entered into a period of disregard. The mayor of Dallas announced that a tax increase would be needed if he sold all of the bonds for the pressure sewer development portion of the floodway design, leading to a protest movement against the project. The opposition argued that the floodway development was not a public issue, but instead a private undertaking that would benefit the Industrial Properties Corporation and large landowners. Also of concern to community members was the diversion of bond money for storm sewers from areas of the city that continually flooded. The bond money was instead utilized to finance sewers for the yet undeveloped industrial area (the hydraulic fill area) controlled by the Industrial Properties Corporation (Fairbanks 1996, 203). The battle for the Trinity bottoms raged on because the reclamation project had been sold to the public as a better way to link downtown to Oak Cliff, protect the city from flooding, and open land for industrial development, leaving many concerned over what they viewed as a huge public subsidy for a private real estate venture (Fairbanks 1996, 202). Many groups wanted a more even distribution of the bond money spread around the city instead of the city paying for interior drainage for yet undeveloped land controlled by private interests (i.e., property owners of the Levee District/Industrial Properties Corporation).

The eventual compromise between the city and the Industrial Properties Corporation resulted in the completion of storm sewers for the portion of the city that was considered neglected, but the elimination of sewers for the Industrial Properties Corporation lands (Fairbanks1996, 207). The lack of adequate drainage, the Great Depression, and World War II combined to insure the reclaimed hydraulic fill industrial area left from the straightening of the Trinity River remained undeveloped until the mid-1940s (Fairbanks 1996, 209).

Delayed by financial troubles of the Levee District, drainage issues, and World War II, development by the Industrial Properties Corporation began in 1947, and George Dealey's 1902 vision of the private development of the reclaimed lands became a reality.

Plans that had been mothballed for twenty years were updated. Officials visited industrial districts around the country and drew up a list of things not to do in the District (Baker 1988, 49):

- Don't lay out narrow streets.
- Don't get a district too far away from the residences of employees or public transportation.
- Don't overlook the parking problem.
- Don't construct tracks so that a small parcel of land cannot be served.
- Above all, don't do anything that will keep you from maintaining flexibility. Be sure any industry can have the type, shape and size tract suiting its particular needs.

The District acquired its first tenant in 1947, Continental Trailways quickly followed by the Texas and Pacific Freight House and the International Harvester Company (Baker 1988, 51). These companies opened in the south end near Continental Street, where interior drainage worked the best. The Corporation's plan included the development of a large area of land in the Hydraulic Fill Area. This land would then be subdivided and sold for a profit (Baker 1988, 53).

Three railways served the district, the Texas and Pacific, the Rocky Island, and the Cotton Belt making the area attractive to industrial companies that needed to ship their goods across the nation (Baker 1988, 53). By 1953, the Trinity Industrial District included 310 buildings. During this era of growth between 1946 and 1953, Industrial Properties Corporation was under the leadership of John Stemmons, the son of Leslie A. Stemmons. John and his brother Storey had begun working for the Industrial Properties Corporation in the early 1930s under the guidance of their father. Upon Leslie Stemmons' death in 1939, John took control of the corporation. John Stemmons was appointed the President of the Industrial Properties Corporation in 1945 and his brother Storey became the Vice President and General Manager of the corporation in 1946 (Baker 1988, 51).

Trammell Crow and the Stemmons Brothers

A rising Dallas businessman, Trammell Crow began his association with the Trinity Industrial District in 1948 when he constructed a warehouse for the Ray-O-Vac company. When Ray-O-Vac decided to move to larger quarters, Crow put together his first real estate deal. He acquired loans from an insurance company and a local bank to build a warehouse on land he had bought from Mr. Stemmons. He leased half the building to Ray-O-Vac and soon found a renter for the rest. With this success, he realized he wanted to continue and obtained an option for the remaining lots on Cole Street within the Trinity Industrial District. He ultimately built over fifty warehouses and two million square feet of industrial space in the Trinity Industrial District (Baker 1988, 57; *New York Times* [*NYT*] 2009).

Crow partnered with the Stemmons brothers in the early 1950s. Through this partnership, the Industrial Properties Corporation would lease land to Crow who would in turn obtain a mortgage for constructing a building on the property. In order to accomplish this goal, a corporation was created between the Stemmons brothers and Trammell Crow as equal partners in the corporation. The partnership between Crow, Stemmons, and the Industrial Properties Corporation, resulted in the development of properties in the Trinity Industrial District that changed the face of Dallas.

The first success of this partnership was the Decorative Center which opened its doors in 1954. Built to serve the many decorators in Dallas, the Decorative Center was a repository for fine furniture, materials, and antiques that was only open to decorating professionals. When the building opened in 1954, it had 71,335 square feet of space for display. The Decorative Center proved lucrative and the building was enlarged to 130,680 square feet.

Shortly after the success of the Decorative Center, the Furniture Mart (1956) was completed. Then the partnership constructed the Trade Mart (1959), which was double the size of the Furniture Mart; Stemmons Towers (1961), a series of four buildings; and Market Hall (1963). When Market Hall was completed in 1963, it served a civic need for the city of Dallas. In 1962, the executive Vice President of the Dallas Chamber of Commerce approached Trammell Crow with the idea that the city needed a larger space to house traveling groups. While the 1925 Municipal Auditorium was a good venue for many groups, Dallas' appeal was bringing in larger meetings than the auditorium could hold. Crow took the idea for a new meeting hall to the Stemmons brothers and the deal was made.

The next large-scale project Crow and the Stemmons brothers undertook was the Apparel Mart. Upon completion, the Apparel Mart was four stories tall with a large atrium and 1,800,000 square feet of display space. During the 1960s, the four Marts constructed by Trammell Crow and the Stemmons brothers continued to increase in occupancy and they went ten years without a vacancy.

The partnership between Crow and John Stemmons ended in the early 1970s when Crow approached Stemmons about building a World Trade Center in Dallas. John Stemmons, who did not believe in being in debt, did not want any part of the World Trade Center deal and chose instead to have Crow, buy him out of the deal. Crow hoped to further Dallas' standing as a financial center and was determined to complete the deal.

While Trammell Crow moved on to large-scale projects such as the Anatole Hotel, Wyndham Hotel, and the Infomart, the Industrial Properties Corporation led by John Stemmons began to look outside Dallas to expand its holdings. During the 1970s, the Industrial Properties Corporation sold the four Stemmons Towers to the Manufacturers Life Insurance Company of Canada and the Market Center to Trammell Crow.

Forbes in 1971 and the *Wall Street Journal* in 1986 called Mr. Crow the largest landlord in the United States. The *Journal* said the company he founded was then the nation's biggest developer (*NYT* 2009).

Stemmons Expressway

In the early 1950s, the district engineer for the State Highway Department approached John Stemmons about the need for a north-south expressway through Dallas and a corridor through the Trinity Industrial District. To get Stemmons' attention, the state engineer had an artist draw double-decking on Industrial Boulevard as a suggested way to provide the corridor, bypassing Stemmon's properties. Stemmons went into a rage and pledged to fight it until "hell freezes over." Stemmons agreed to donate land that would become Stemmons Expressway (named for his father) in the mid-1950s. One condition of the donation was the creation of access ramps to the Trinity Industrial District from the newest addition to the emerging interstate highway system. It was a move that exponentially increased the value of land held by the Industrial Properties Corporation. The freeway opened in December 1959 (Baker 1988, 55).

Community Growth

The development of Dallas is directly tied to the growth of commerce, industry, and real estate. As families began moving from the rural countryside into the urban core, Dallas moved toward a heavily industrialized city. While agriculture remained a leading source of income in the late 1800s and early 1900s, industry took the forefront after 1920. In the years between 1920 and World War II, industry was the leading employer in Dallas County. This growth in industry led to a growth in real estate. While Trammell Crow and the Stemmons brothers would lead the way in industrial real estate, Leslie A. Stemmons led the way in residential real estate. Stemmons was influential in the development of several neighborhoods within Dallas including the Miller-Stemmons addition, Winnetka Heights, Rosemont Crest, Sunset Hill, Sunset Annex, Sunset Summit, Sunset Heights, and Sunset Crest (TxDOT 2004, 22).

Following World War II, the migration from the country to the city continued in north Texas, leading to an increased population in Dallas. Between 1940 and 1990, the population of Dallas tripled from 294,734 to 1,006,887 and saw a marked diversification of commercial and industrial pursuits. As a result of these growing industries, residential areas in Dallas continued to expand and several areas were annexed into the city limits. The commercial development of the downtown Dallas area began to overrun the early residential areas and forced many people to the newly developed suburbs.

Additionally, the oil and defense industry boom of the 1950s and 1960s helped lead Dallas' focus on a car culture. During that era, personal automobiles became the preferred method of travel and allowed workers to live outside of the city core and still travel to work. This ability to travel to the workplace by private vehicle created an impetus to move to the suburbs and thus led to the creation of a patchwork of freeways. This movement led to the sprawling metropolitan area of the modern-day Dallas-Fort Worth metroplex.

PHYSICAL DEVELOPMENT OF THE FLOODWAY

Original Dallas Floodway Construction, 1928–1932

Construction of the Dallas Floodway began in July 1928. The project was designed to confine a flood of about 2.5 times that which occurred in 1908 (Furlong et al. 2003, 5). Doing so involved moving the Trinity River channel one-half mile west into the middle of the floodplain, and building a series of levees. To move the river channel, the confluence and channels of the Elm Fork and West Fork were moved 3.5 miles west. In total, approximately 15 miles of new river channels were excavated. The main floodway was formed by two parallel levees built along each side of the new channel. The land in the floodplain between the new channel and levees, called the overbank, was cleared of brush, timber, and all other obstructions. The East and West Levees extended approximately seven miles upstream from the AT&SF Railroad Bridge. The floodway then divided into two separate floodways for Elm Fork and West Fork (see Figure E-7). The length of the East and West Levees, including the Elm Fork and West Fork channels, was 11.9 miles and 10.9 miles, respectively. The total length of the Northwest Levee was 2.8 miles. Each levee was 30 feet tall and on average, 156 feet wide at the base and six feet wide at the crown (Furlong et al. 2003, 4).

Four pumping plants, called A, B, C, and D, were constructed. Pumping Plant A includes two pumps at 20,000 gallons per minute (gpm) capacity and is located at the East Levee just downstream from the Houston Street Viaduct (formerly the Dallas-Oak Cliff Viaduct). Also at the East Levee is Pumping Plant B, which includes four, 52,000-gpm-capacity pumps. This plant is located upstream of Sylvan Avenue. At the West Levee are Pumping Plants C and D. Both of these plants each contain two pumps at 60,000 gpm capacity. Plant C is located just downstream of the present-day Houston Street Viaduct, and Plant D is upstream of the Hampton Road Bridge. Pumping Plants A, B, C, and D became Able, Baker, Charlie, and Delta, respectively, in the 1950s when the USACE added pumping plants and strengthened the levees (Furlong et al. 2003, 4–5).

Floodway construction also included gravity sluiceways in the main floodway and one at Eagle Ford along the West Fork. In all, two miles of auxiliary channels were constructed (Furlong et al. 2003, 5).

Three pressure sewers were constructed to carry interior drainage through the levees to the river. The Mill Creek Pressure Sewer (later known as the Belleview Pressure Sewer) has more than 2.6 million gpm in capacity. It is located at the East Levee upstream from the Corinth Street Viaduct. The Dallas Branch Pressure Sewer is located at the East Levee downstream from the Continental Avenue Bridge, and has a capacity of 256,731 gpm. At the West Levee, upstream from the Houston Street Viaduct, is the Coombs Creek Pressure Sewer. Its capacity is a little more than 3.1 million gpm (Furlong et al. 2003, 5).

The old river channel was retained to provide storage for interior drainage, but a specific section from Turtle Creek Boulevard to Commerce Street was to be filled in by the property owners (the city would provide the storm drainage) with hydraulic fill. This was done specifically to create the area for the planned Trinity Industrial District. A dredge floating in the river pumped over the levee to fill the low places and "make it as level as any other part of business Dallas" (*DMN* 1933d).

As explained earlier, the Great Depression and the political battle between public works and private interests resulted in significant design changes to the Dallas Floodway during construction to save costs. The original design for the levees called for a 3:1 slope, but the side slopes on the riverside were changed to a steeper 2.5:1 slope. The slope of the Northwest Levee was 2:1 (Fennell 2010). While all four pump stations were constructed as planned in the 1928 Joint Plan of Reclamation, not all of the interior drainage works were completed. Only five of the seven sluiceways were constructed as planned, and only three of the five planned pressure sewers were built (Furlong et al. 2003, 5).

Construction was nearly complete on the Dallas Floodway in February 1932. The last component to be finished was the Dallas Branch Pressure Sewer in late 1932 (Furlong et al. 2003, 6). Upon completion, the floodway protected 20 districts and reclaimed 10,650 acres of land; 7,317 acres to the west and 3,333acres to the east (Furlong et al. 2003, 4).

USACE Strengthening, 1953–1959

The USACE was mandated by Congress through passage of the River and Harbors Act in 1945 (Public Law 14-79) and as amended in the Flood Control Act of 1950 (Public Law 81-516) to complete various flood control works along the Trinity River, including the Dallas Floodway. After studies documented the poor condition of the levees, the USACE Fort Worth District developed detailed plans and specifications for strengthening and enhancing the Dallas Floodway. Construction began in January 1953 (Furlong et al. 2003, 7, 8).

The USACE as-built drawings of the levee strengthening (Figures E-11 and E-12) show that all the original levees were retained, but additional fill was placed on the river side to change the slope of and enlarge the East and West Levees; the USACE did not strengthen the Northwest Levee (Skipwith et al. ca. 2007, 5; USACE 1956a, 1956b). Fill was added as a cap to thicken the levee system on the river side; the land side levee toe was unchanged. The additional fill increased the average height of the levee to 28 feet and extended the width of the levee crown to 16 feet and its side slopes to 3:1 as specified in the original design. The fill used to strengthen the levees came from the material that was removed from the riverside crown of the existing levees and from excavation of existing and new sumps. The additional fill on the riversides of the levees reduced the width of the Dallas Floodway by approximately 30 feet. Ironically, the four feet added by the USACE in the 1950s is today reduced back to its near original 1929 design height in some areas due to settlement, soil creep, or lack of maintenance. The following excerpt from Volume VI of the *Definite Report on Dallas Floodway* (USACE 1955, 4) provides a detailed description of the levee strengthening:

> "In general, the alignment for the strengthened levee has been set by retaining the existing location for the landside toe of the levee. The new centerline of the levee will be riverward an average distance of about 20 feet. The landside slope of the levee will vary from 1 on 3 to 1 on 4,

depending upon soils conditions, and the riverside slope will be 1 on 3 throughout the floodway…The crown of the levee will be increased in width from 6 feet to l6 feet and will be paved with 12 inches of flexible base material and double bituminous surface treatment. Riprap will be placed on the riverside slope of the levee under the floodway bridges.

Prior to placement of the embankment materials, the side slopes of the existing levee and the necessary additional base area for the enlarged levee will be stripped. Suitable material will be placed in 8-inch layers and rolled with at least 6 passes of a tamper type roller. Where portions of the existing levee extend beyond the slopes and the top of the proposed levee section, the material will be removed and used for the levee strengthening work. All usable material from sump and channel excavation will be placed in the levee. All borrow material taken from the floodway will be obtained by enlargement of the river channel above ground water level. Waste material from stripping operations and sump and channel excavation will be placed in riverside borrow ditches and low spots in the floodway."

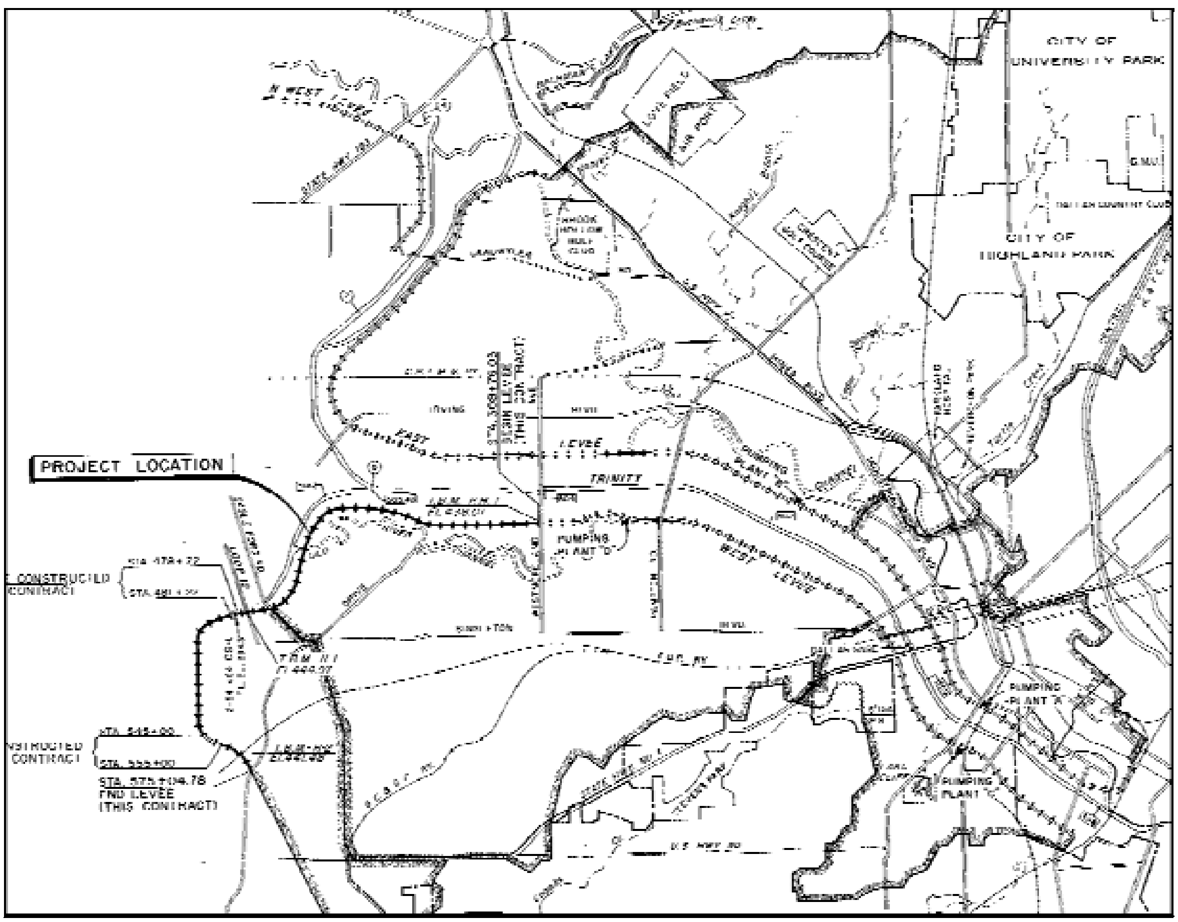


Figure E-11. USACE Levee Strengthening, 1954

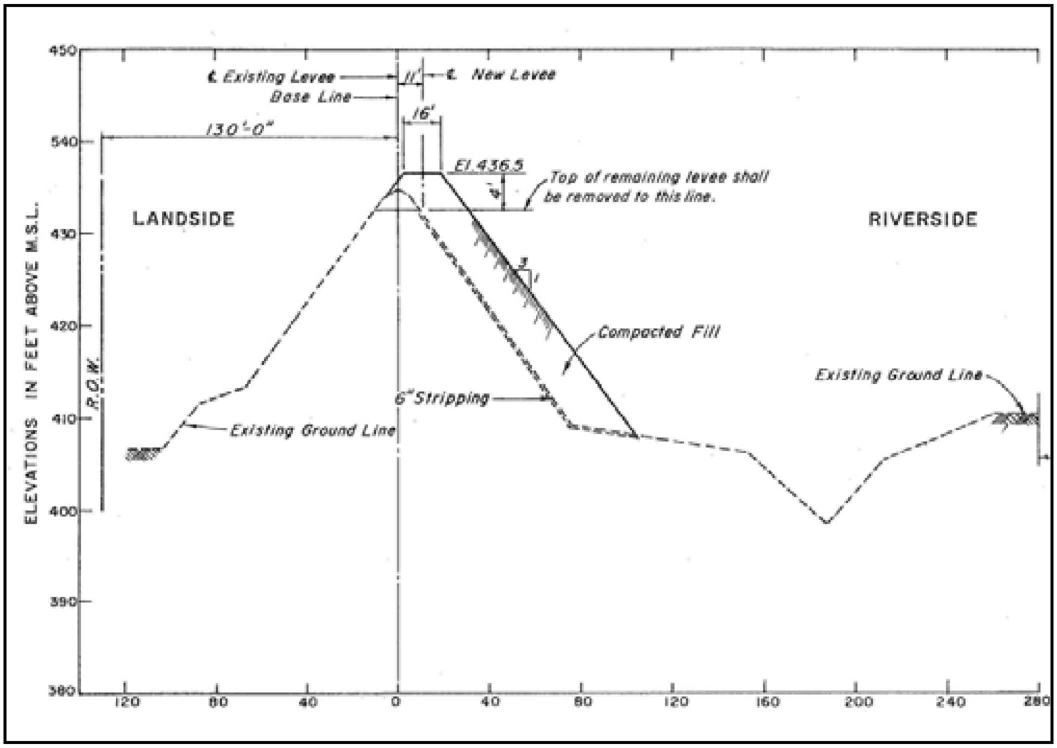


Figure E-12. Typical Section, USACE Levee Strengthening, 1954

In addition to the levee strengthening, sumps were enlarged for storage of local drainage and interior drainage outfalls were cleaned out (USACE 1952, 1954a, 1955). Additionally, the 2,600-foot-long stretch of the diversion channel from the Belleview Pressure Sewer outlet to the Cadiz Street Viaduct (now eastbound IH-35) was moved to the west by 100 feet to address potential levee toe erosion due to the proximity of the river channel (USACE 1955, 11).

The USACE strengthening of the floodway system in the 1950s included additional pumping plants on both sides of the levees (Hampton, Pavaho, and a new Able) and the two pressure sewers not constructed from the original design. Of the new pumping plants, the new Able Pumping Plant includes three pumps at 46,667 gpm capacity each; the Hampton Pumping Plant contains four pumps at 50,000 gpm capacity each; and the Pavaho Pumping Plant has two pumps at 60,000 gpm capacity each (Furlong et al. 2003, 8). The new Able Pumping Plant was built adjacent to the old Able Pumping Plant. The Hampton Pumping Plant is at the East Levee upstream from the Hampton Road Bridge. The Pavaho Pumping Plant is at the West Levee just downstream from Sylvan Avenue. The two new pressure sewers, Lake Cliff and Turtle Creek, carry drainage through the levees. The Turtle Creek Pressure Sewer is located at the East Levee between Sylvan Avenue and Continental Street and has more than 1.7 million gpm capacity, and the Lake Cliff Pressure Sewer is located at the West Levee just upstream from the Houston Street Viaduct and has 396,317 gpm capacity (Furlong et al. 2003, 8). Gravity sluices were also constructed through the levee on each side of the Lake Cliff Pressure Sewer (USACE 1954a, 2).

Other features of the USACE's Dallas Floodway project included construction of two gate-controlled culverts in the existing sump approximately 2,000 feet below Ledbetter Drive outside of the West Levee and an earth fill containing one gate-controlled culvert and one uncontrolled (non-gated) culvert in the existing sump upstream from Grauwyler Road outside of the East Levee (USACE 1952, 1953). Both of these structures are located on the old river channel.

FLOODWAY OPERATIONS

During flood events, interior drainage facilities collect stormwater runoff in ponds, or sumps, in low-lying areas outside of the floodway to the diversion channels within the overbank. Sumps are drainage ditches that collect local stormwater runoff and discharge it into a network of sluices and culverts throughout the floodway system. They are also located next to the land side of the levee walls where stormwater collects at pumping plants for diversion into the floodway.

Intake structures are the openings where water enters into the pressure sewers (Coombs Creek, Lake Cliff, and Turtle Creek) within the interior drainage system. Intakes are located at a distance from the floodway to aid in drainage farther into the watershed's interior. Trash racks at the opening to the intake structures and pumping plants are an important part of keeping large debris from entering the floodway system, as clogging can greatly diminish the floodway's ability to move and pump water (Carter and Burgess 2006).

Stormwater from the sumps and intakes is redirected toward the floodway through a network of sluices or culverts. This is done by either pumping the stormwater through pumping stations or by allowing it to flow by gravity through pressure sewers. The pressure sewers are essentially large gravity trunk lines that discharge directly into the floodway. The inlets of these pressure sewers are located far enough upstream in the Trinity River watershed to develop sufficient head, or water force, to discharge against flood stages in the floodway (Carter and Burgess 2006). Figure E-13 illustrates the points where stormwater enters the Dallas Floodway via all-gravity pressure sewers and the combination of gravity and pumped systems.

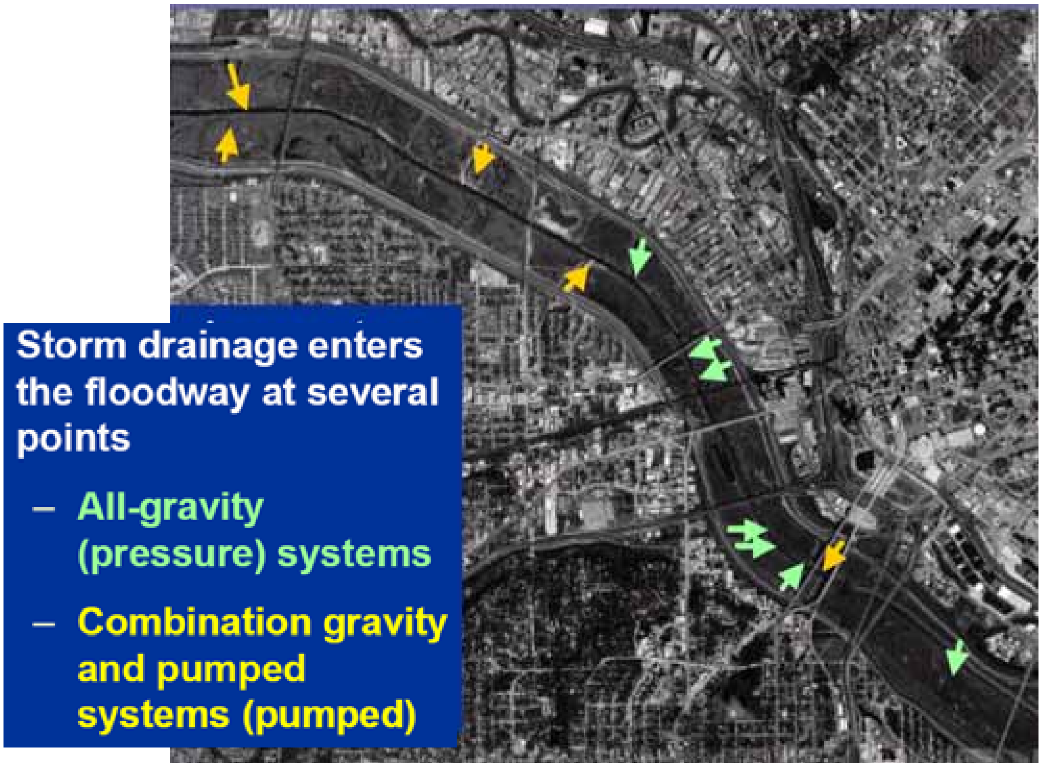
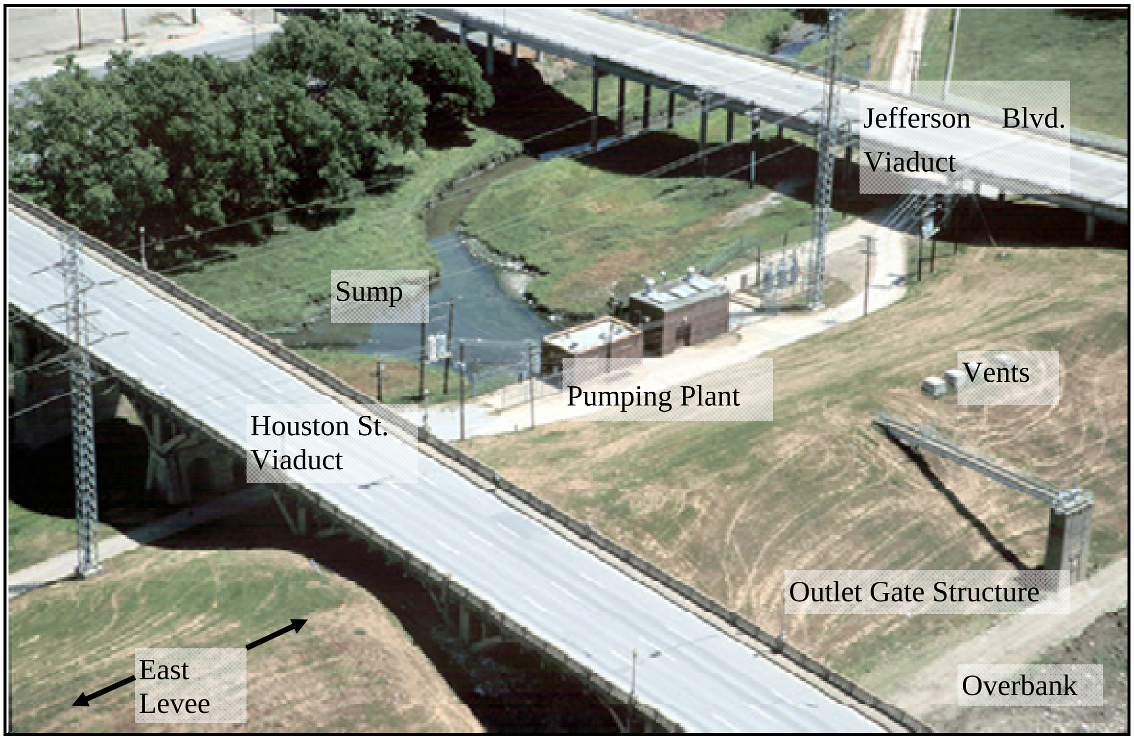


Figure E-13. Primary Drainage Points along the Dallas Floodway Corridor
Adapted from "Trinity River Corridor Project" (CDM 2003)

Stormwater that is directed to pumping plants gets pumped through the levee walls into the overbank. The floodway first consisted of four pumping plants (A, B, C, and D), with two on each bank of the floodway, plus three pressure sewers (Belleview, Coombs Creek, and Dallas Branch). The USACE improved this system during the 1950s by building two new pressure sewers (Lake Cliff and Turtle Creek), and by adding additional pumping stations at three of the existing pumping plants (A, C, and D). The USACE also built two new pumping plants (Pavaho and Hampton Road), one on each side of the floodway. Figures E-14 and E-15 below illustrate the floodway features at a pumping station, here Pumping Station A (Able).



Source: Carter and Burgess 2003

Figure E-14. Floodway Operations at Pumping Plant A (Able)

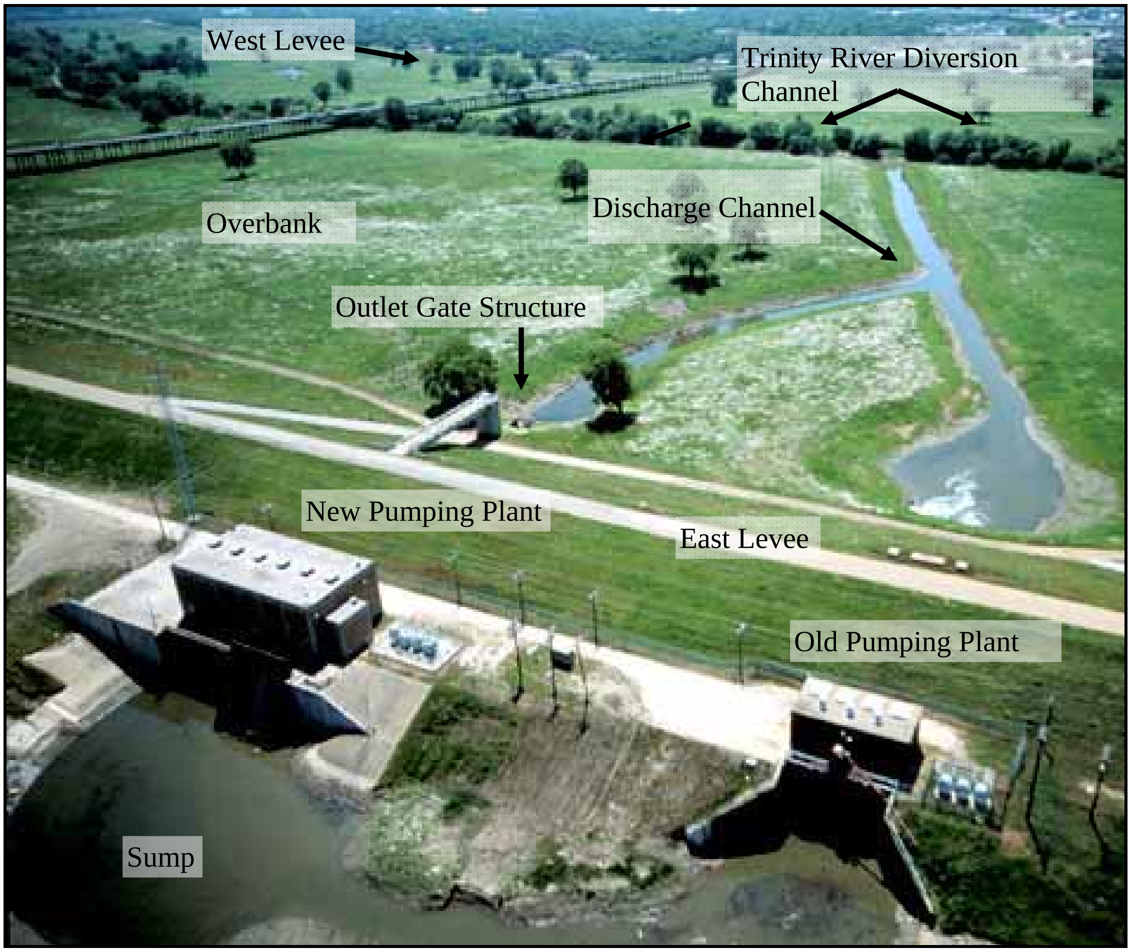
Source: Carter and Burgess 2003

Figure E-15. Floodway Operations at Pumping Plant A (Able), Looking Toward the Floodplain

Sluices connect the pressure sewers and pumping plants to the diversion channel. They carry stormwater through the levee walls and out to the overbank on the levee's river side though outlet gate structures. As the stormwater is pumped into the floodway from the pumping plants, discharge pipes ventilate up through the levee walls in air-relief vents situated on the levee crown. All sluices are controlled by an automatic flap gate as well as a hand-operated sluice gate.

Outlet gate structures are out spill structures that channel and control the stormwater's output into the overbank. Although they are connected to the pumping plants and pressure sewers, they are physically separated from these facilities by the levee walls and their location inside the overbank. The outlet gate structures divert discharged stormwater to the interior of the floodway via concrete box culverts under the levee. Components of the outlet gate structures include tall concrete towers that house gate hoists that operate to open or close the underground sluice gate below the tower.

After the stormwater exits the outlet gate structures, the water travels down discharge channels that lead directly to the main Trinity River diversion channel, the manmade dredged channel that extends down the center of the overbank (see Figure E-16). As the stormwater runoff begins to fill the overbank and the water level rises, the East and West Levees hold in the water to protect the adjacent low-lying areas outside of the floodway from flooding. The East Levee protects Dallas' Industrial District and parts of the downtown Central Business District, while the West Levee protects the city's Oak Cliff and West Dallas neighborhood districts.



Source: Carter and Burgess 2003

Figure E-16. View of the Hampton Pumping Plant, Looking Southeast Downstream

INTRODUCTION

The inventory of the resources of the Dallas Floodway is organized by hydraulic physical feature. The 55 components of the Dallas Floodway comprise 10 different types of hydraulic physical features. Each physical feature includes descriptions of common physical features, materials, its current condition as observed during the field survey, and a summary of the components present in the Dallas Floodway. Photographs of each resource recorded during fieldwork are included. The hydraulic physical feature categories are as follows, and are described below:

Property Type 1	Levees
Property Type 2	Trinity River Diversion Channel
Property Type 3	Overbank
Property Type 4	Pumping Plants
Property Type 5	Pressure Sewers
Property Type 6	Outlet Gate Structures
Property Type 7	Intakes
Property Type 8	Sluices and Culverts
Property Type 9	Sumps
Property Type 10	Emergency Control Structures

The individual hydraulic components of these physical feature categories were inventoried and evaluated as part of the Dallas Floodway. Each of the individual components is listed in Table F-1. A separate physical feature category includes several resources that are within the floodway, but are not components of the floodway and do not contribute to its function. These non-hydraulic physical features, which include bridges, power lines, and a park, were considered in the assessment of ability to convey significance of the Dallas Floodway, but they were not individually inventoried or evaluated for significance. The non-hydraulic physical features are included with the hydraulic physical features in Figures F-1 through F-11 below.

Table F-1. Surveyed Resources Organized by Property Type

Physical Feature	Date Built	Property Type
East Levee	1929–1932; 1953	Property Type 1: Levee
West Levee	1929–1932; 1953	Property Type 1: Levee
Northwest Levee	1929; 1974	Property Type 1: Levee
Parallel Levee Channel	1929–1932; 1960s	Property Type 1: Levee
Trinity River Diversion Channel	1932	Property Type 2: Diversion Channel
Elm Fork Diversion Channel	1928	Property Type 2: Diversion Channel
West Fork Diversion Channel	1928	Property Type 2: Diversion Channel
Overbank	1932	Property Type 3: Overbank
Pumping Plants A (Able)	1929	Property Type 4: Pumping Plants
	1953	Property Type 4: Pumping Plants
Pumping Plant A (Able) Outlet Gate Structure	1953	Property Type 6: Outlet Gate Structures

Table F-1. Surveyed Resources Organized by Property Type (con't)

Physical Feature	Date Built	Property Type
Pumping Plants B (Baker)	1929	Property Type 4: Pumping Plants
	1975	Property Type 4: Pumping Plants
Pumping Plant B (Baker) Outlet Gate Structure	1956	Property Type 6: Outlet Gate Structures
Pumping Plants C (Charlie)	1929	Property Type 4: Pumping Plants
	1956	Property Type 4: Pumping Plants
Pumping Plant C (Charlie) Outlet Gate Structure	1956	Property Type 6: Outlet Gate Structures
Pumping Plants D (Delta)	1929	Property Type 4: Pumping Plants
	1956	Property Type 4: Pumping Plants
Pumping Plant D (Delta) Outlet Gate Structure	1956	Property Type 6: Outlet Gate Structures
Hampton Road Pumping Plants	1956	Property Type 4: Pumping Plants
	1975	Property Type 4: Pumping Plants
Hampton Road Pumping Plant Outlet Gate Structure	1956	Property Type 6: Outlet Gate Structures
Pavaho Pumping Plants	1954	Property Type 4: Pumping Plants
	1975	Property Type 4: Pumping Plants
Pavaho Pumping Plant Outlet Gate Structure	1954	Property Type 6: Outlet Gate Structures
"New" Pump House (Northwest Levee)	ca. 1995	Property Type 4: Pumping Plants
"Old" Pump House (Northwest Levee)	1974	Property Type 4: Pumping Plants
Belleview Pressure Sewer	1928–1931	Property Type 5: Pressure Sewers
Belleview Pressure Sewer Outlet Gate Structure	1950s	Property Type 6: Outlet Gate Structures
Old Coombs Creek Pressure Sewer	1928–1931	Property Type 5: Pressure Sewers
Old Coombs Creek Pressure Sewer Outlet Gate Structure	1989	Property Type 6: Outlet Gate Structures
Dallas Branch Pressure Sewer	1932	Property Type 5: Pressure Sewers
Dallas Branch Pressure Sewer Outlet Gate Structure	1950s	Property Type 6: Outlet Gate Structures
Lake Cliff Pressure Sewer	1952–1955	Property Type 5: Pressure Sewers
Lake Cliff Pressure Sewer Outlet Gate Structure	1955	Property Type 6: Outlet Gate Structures
Turtle Creek Pressure Sewer	1953–1957	Property Type 5: Pressure Sewers
Turtle Creek Pressure Sewer Outlet Gate Structure	1953–1957	Property Type 6: Outlet Gate Structures
Woodall Rodgers Pressure Sewer	1979	Property Type 5: Pressure Sewers
Woodall Rodgers Pressure Sewer Outlet Gate Structure	1979	Property Type 6: Outlet Gate Structures
Coombs Creek Pressure Sewer	1957	Property Type 5: Pressure Sewers
Coombs Creek Pressure Sewer Outlet Gate Structure	1957	Property Type 6: Outlet Gate Structures
Elm Fork Sluice Outlet Gate	1960s	Property Type 6: Outlet Gate Structures
Coombs Creek Intake	1957	Property Type 7: Intakes
Lake Cliff Intake	1950s	Property Type 7: Intakes

Table F-1. Surveyed Resources Organized by Property Type (con't)

Physical Feature	Date Built	Property Type
Turtle Creek Intake	1955–1956	Property Type 7: Intakes
Eagle Ford Sluice	1928–1931	Property Type 8: Sluices and Culverts
Elm Fork Sluice	1928–1931	Property Type 8: Sluices and Culverts
Ledbetter Dike Control Structure Gate (C.S.G.)	1950s	Property Type 8: Sluices and Culverts
Grauwyler C.S.G.	1950s	Property Type 8: Sluices and Culverts
Northwest Levee Sluices	1928	Property Type 8: Sluices and Culverts
	1974	Property Type 8: Sluices and Culverts
Old Trinity River Channel	1929	Property Type 9: Sumps
60-inch Emergency Control Structure	1950s	Property Type 10: Emergency Control Structure
East Bank Interceptor	1950s	Property Type 10: Emergency Control Structure

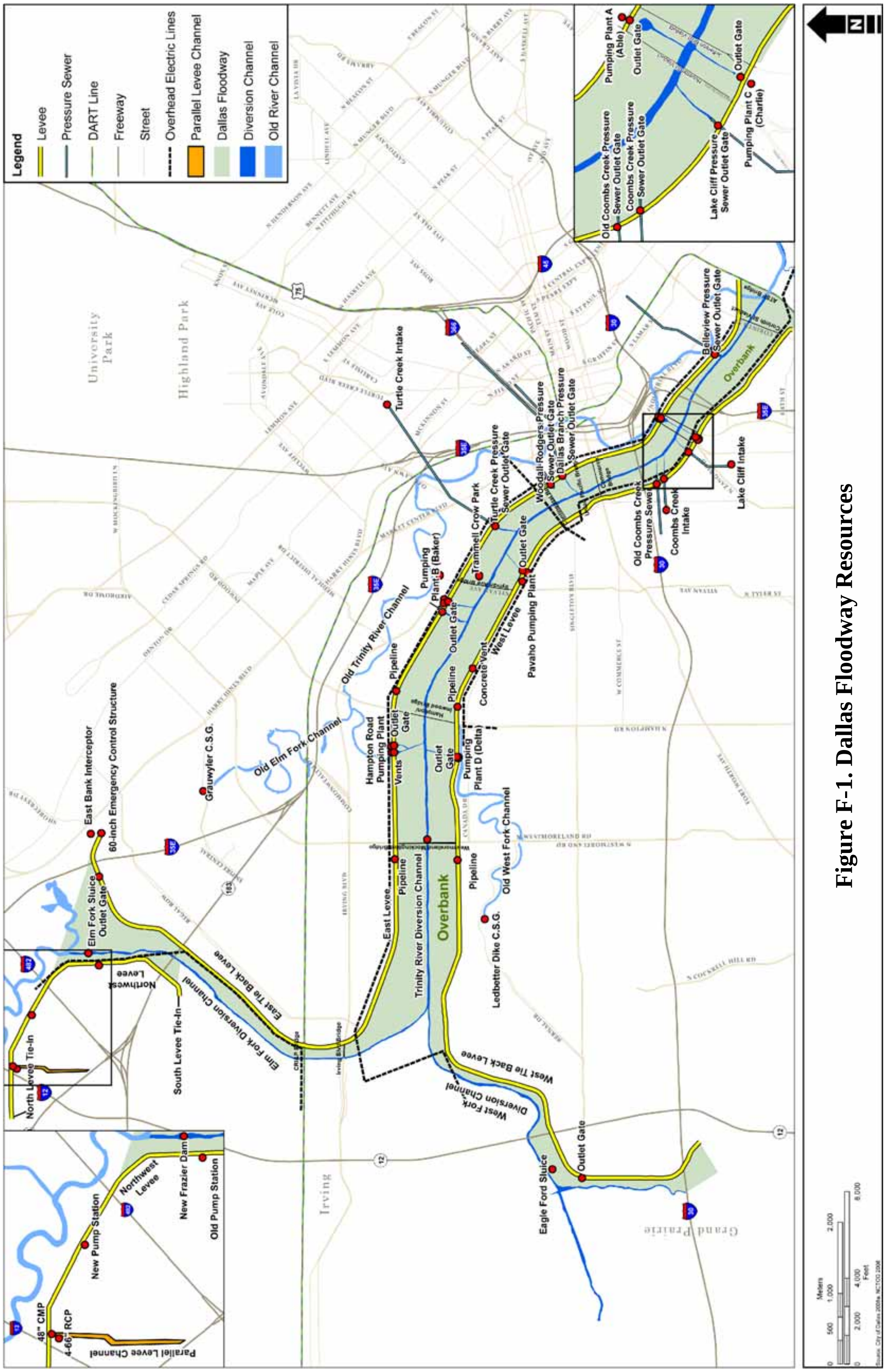


Figure F-1. Dallas Floodway Resources

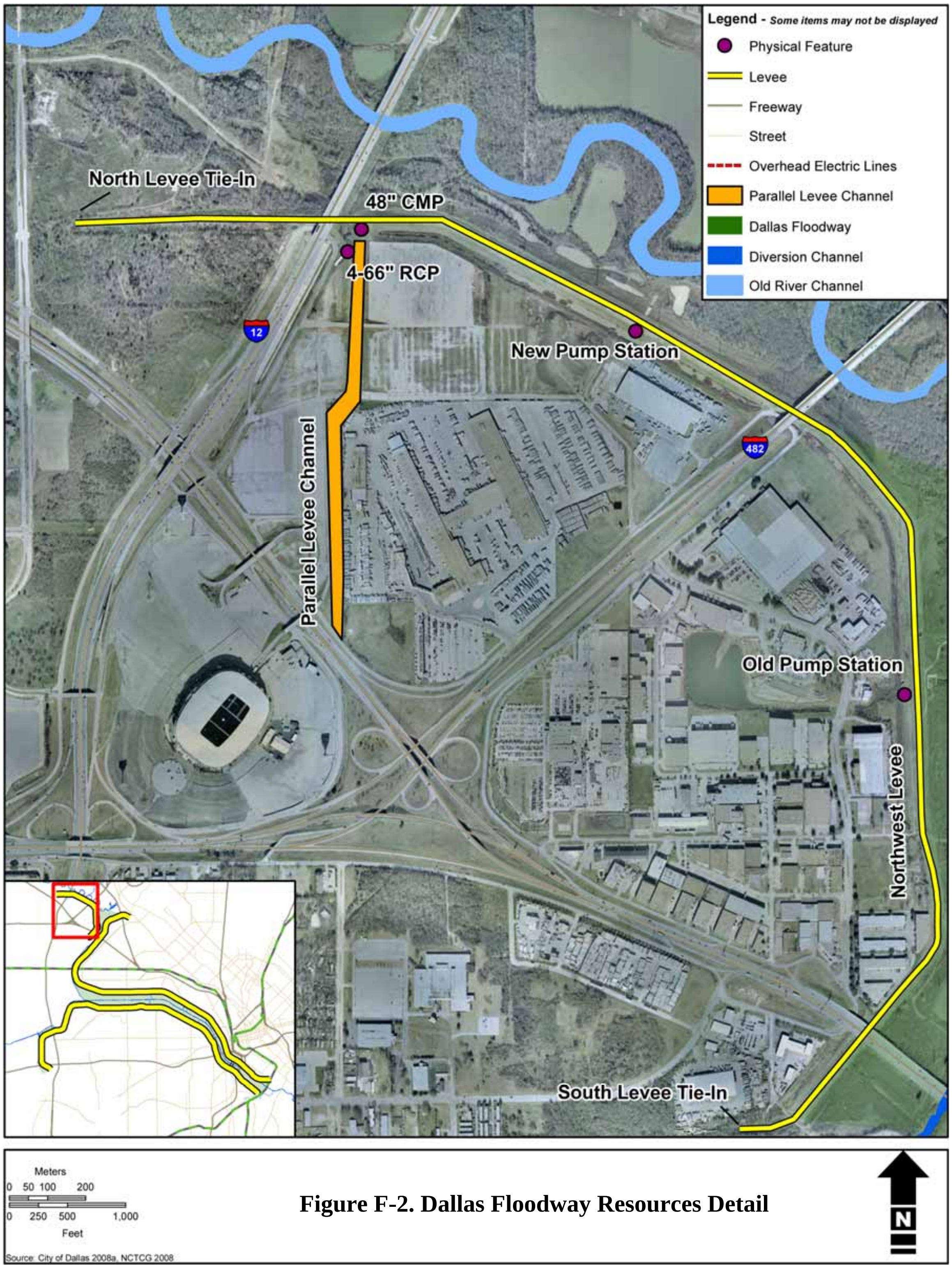


Figure F-2. Dallas Floodway Resources Detail

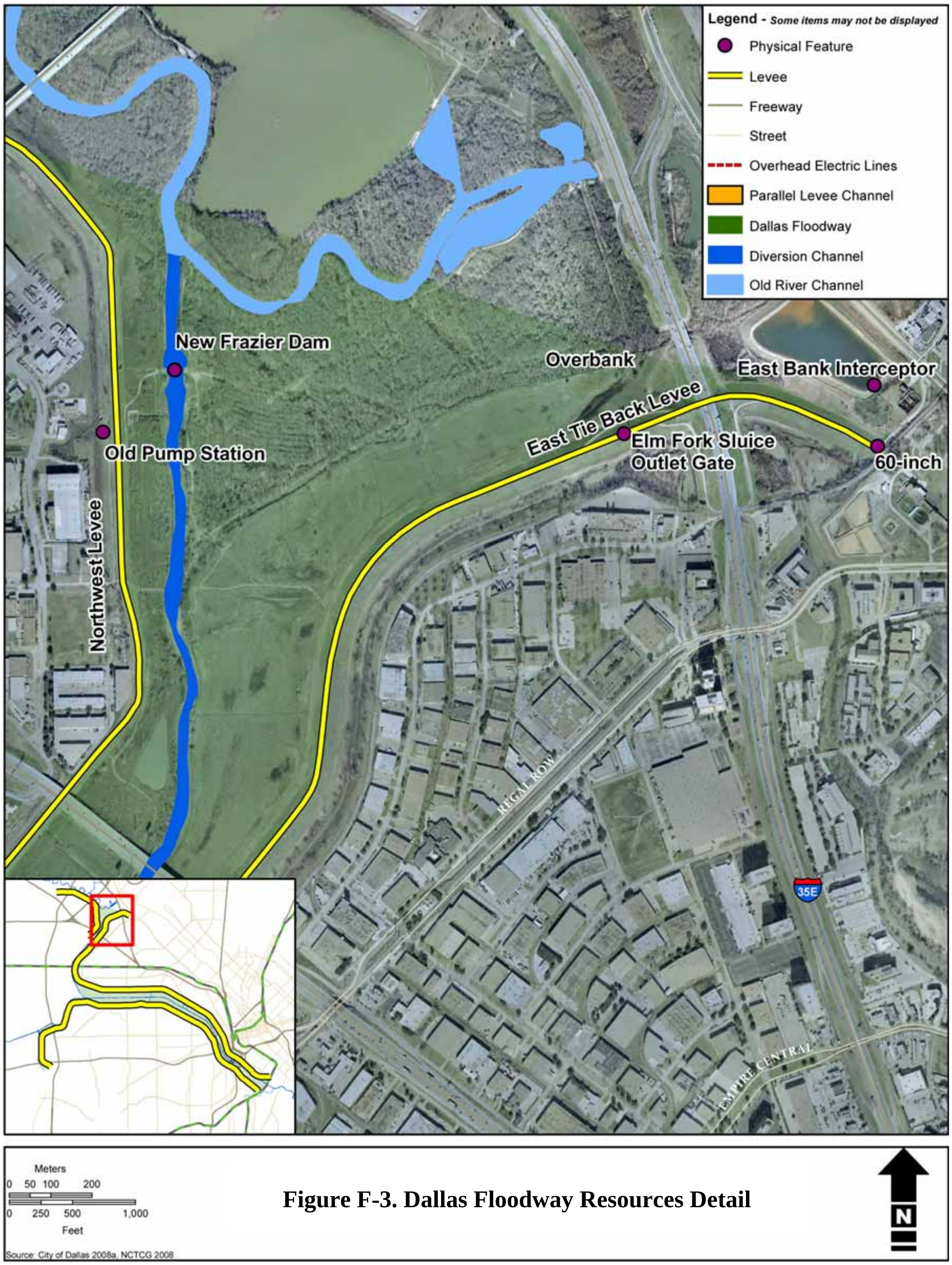
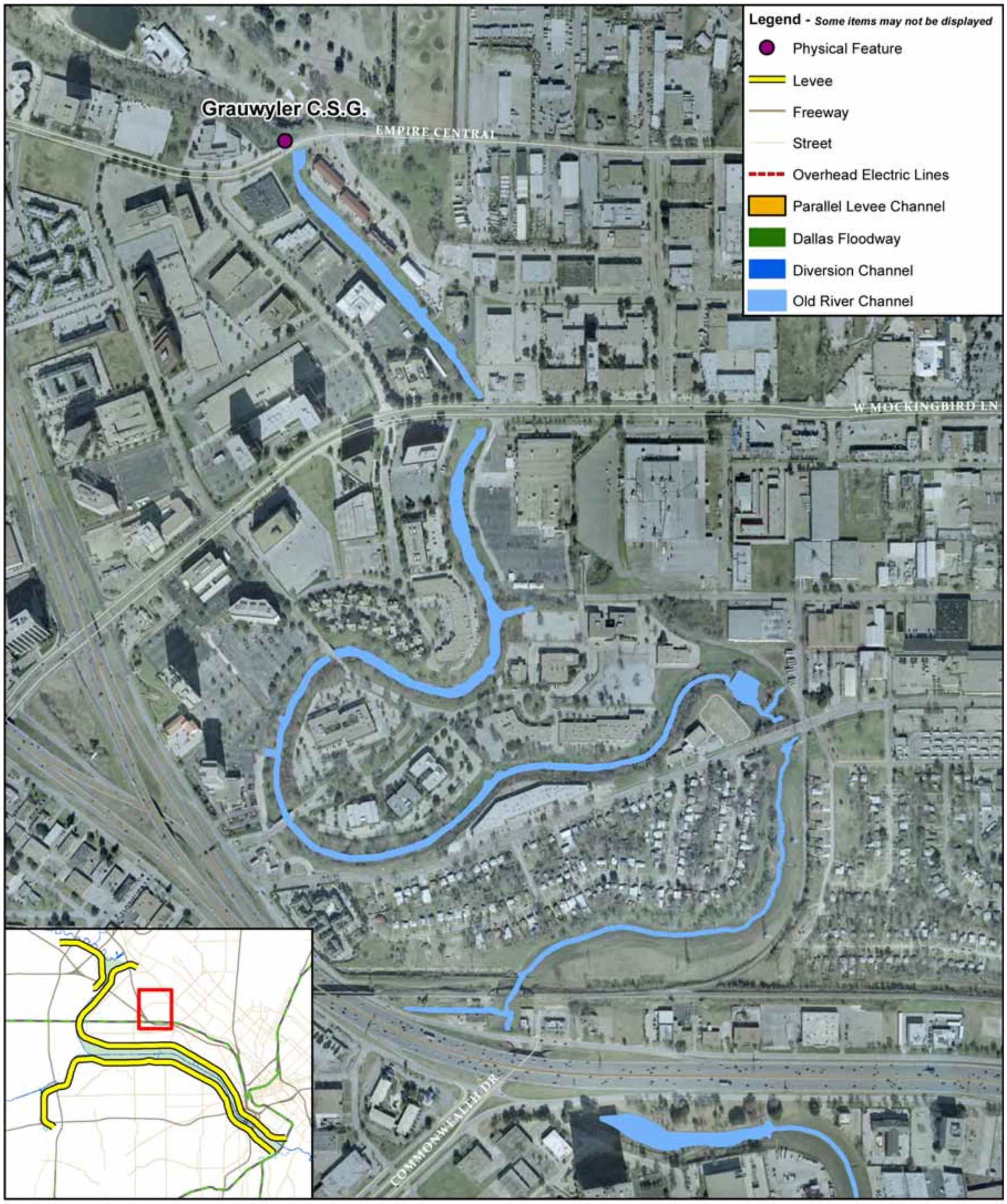


Figure F-3. Dallas Floodway Resources Detail



Meters
0 50 100 200
0 250 500 1,000
Feet

Source: City of Dallas 2008a, NCTCG 2008

Figure F-4. Dallas Floodway Resources Detail

N

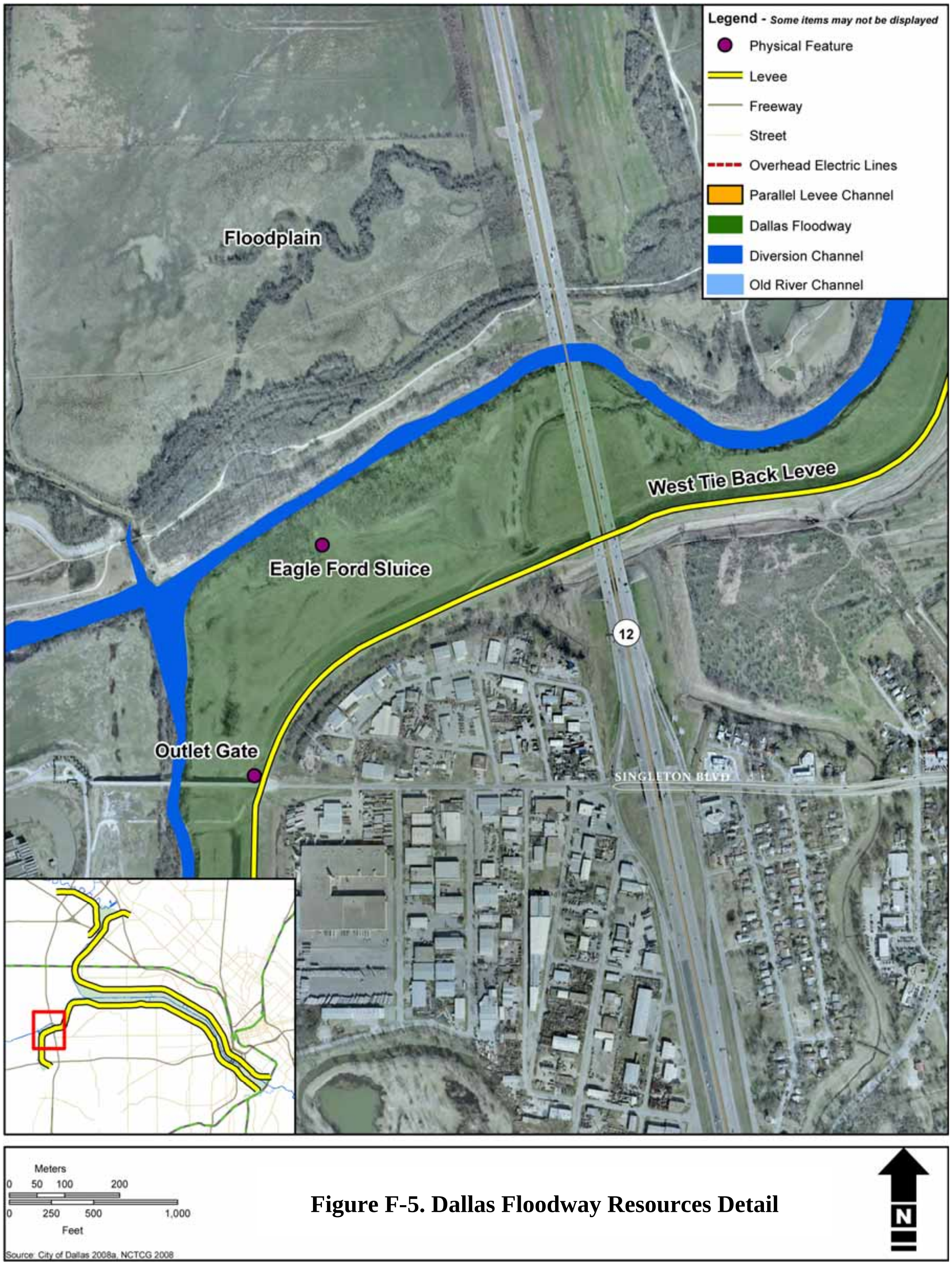


Figure F-5. Dallas Floodway Resources Detail

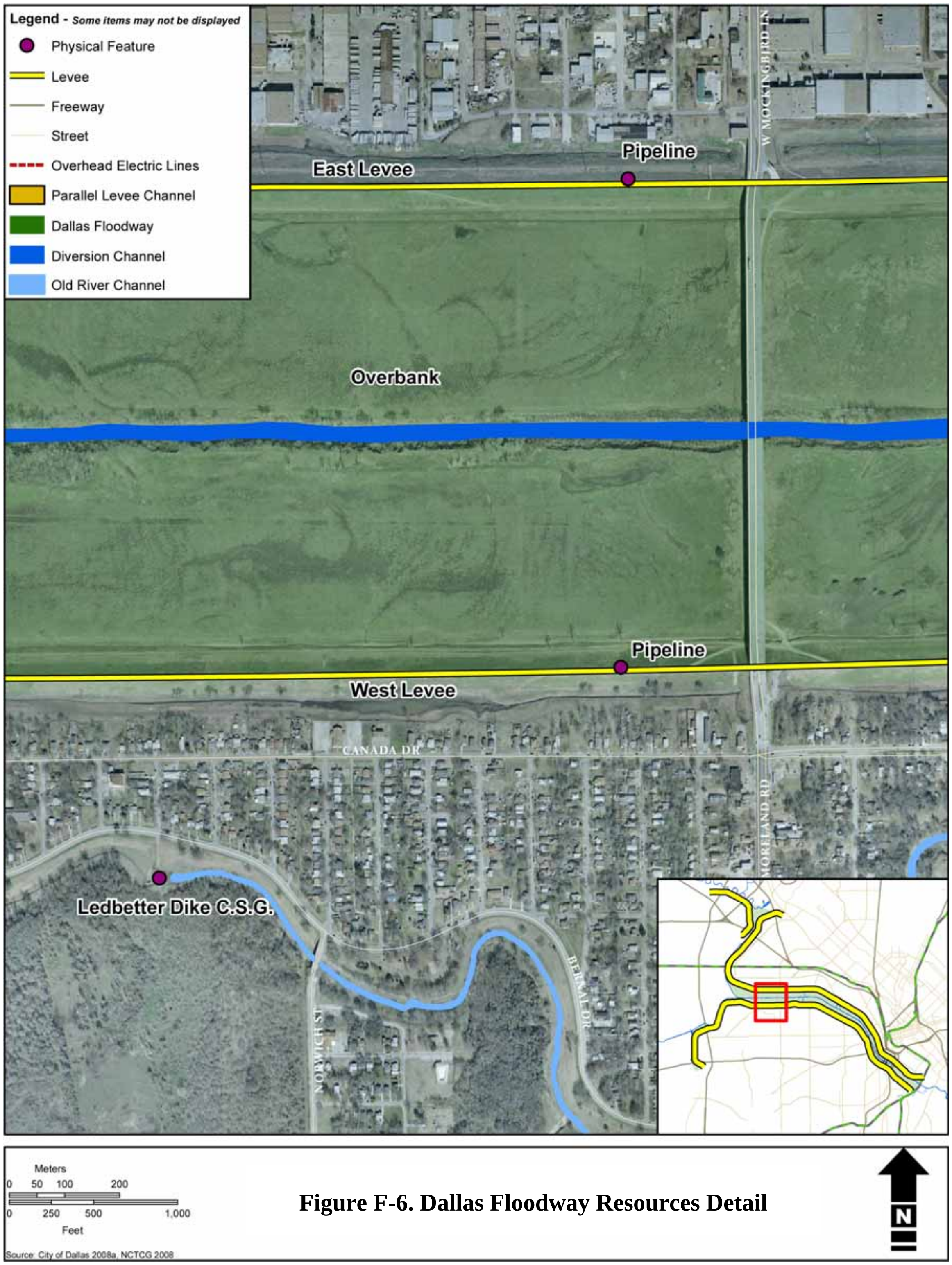


Figure F-6. Dallas Floodway Resources Detail

Figure F-7. Dallas Floodway Resources Detail

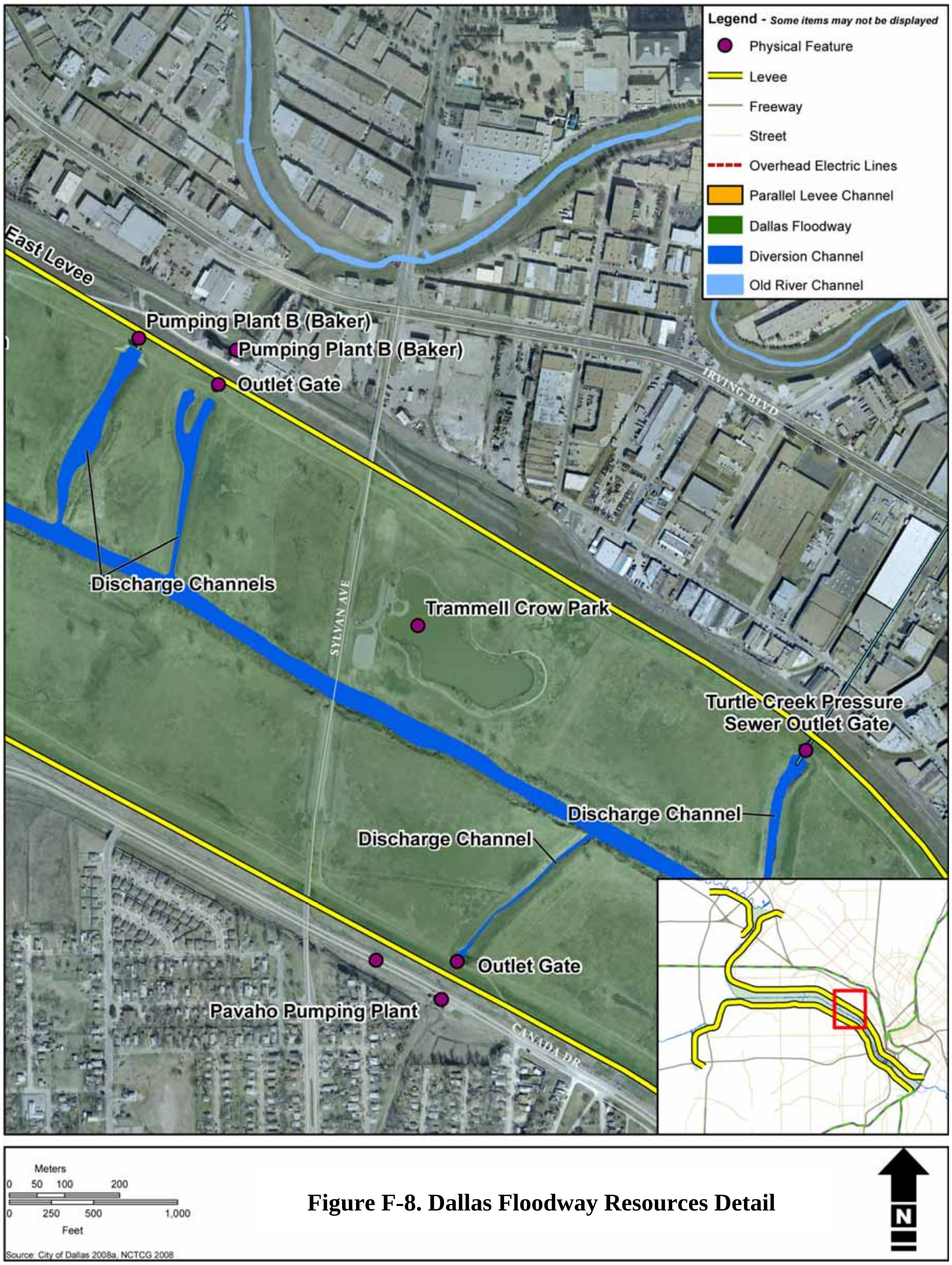


Figure F-8. Dallas Floodway Resources Detail

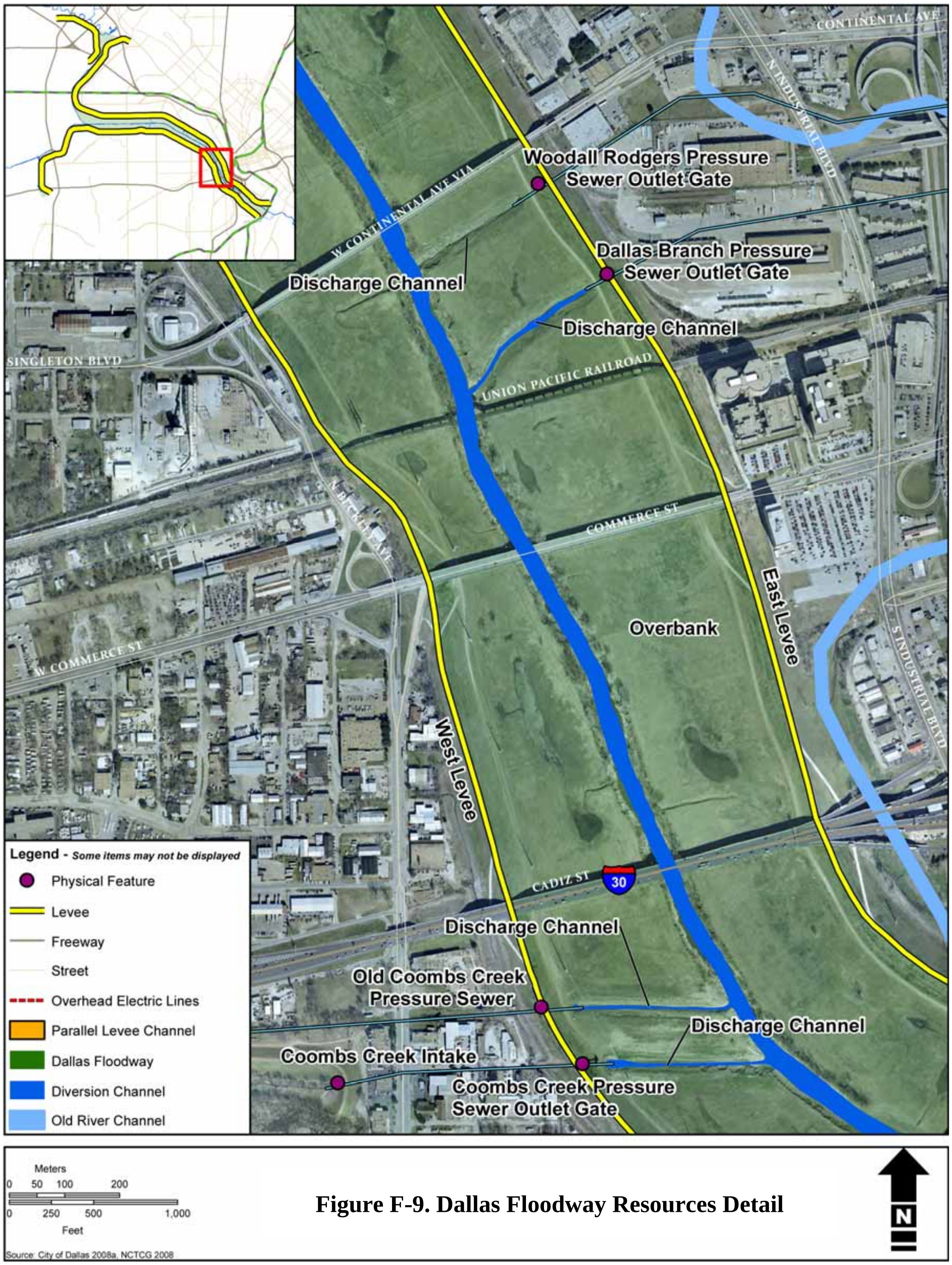


Figure F-9. Dallas Floodway Resources Detail

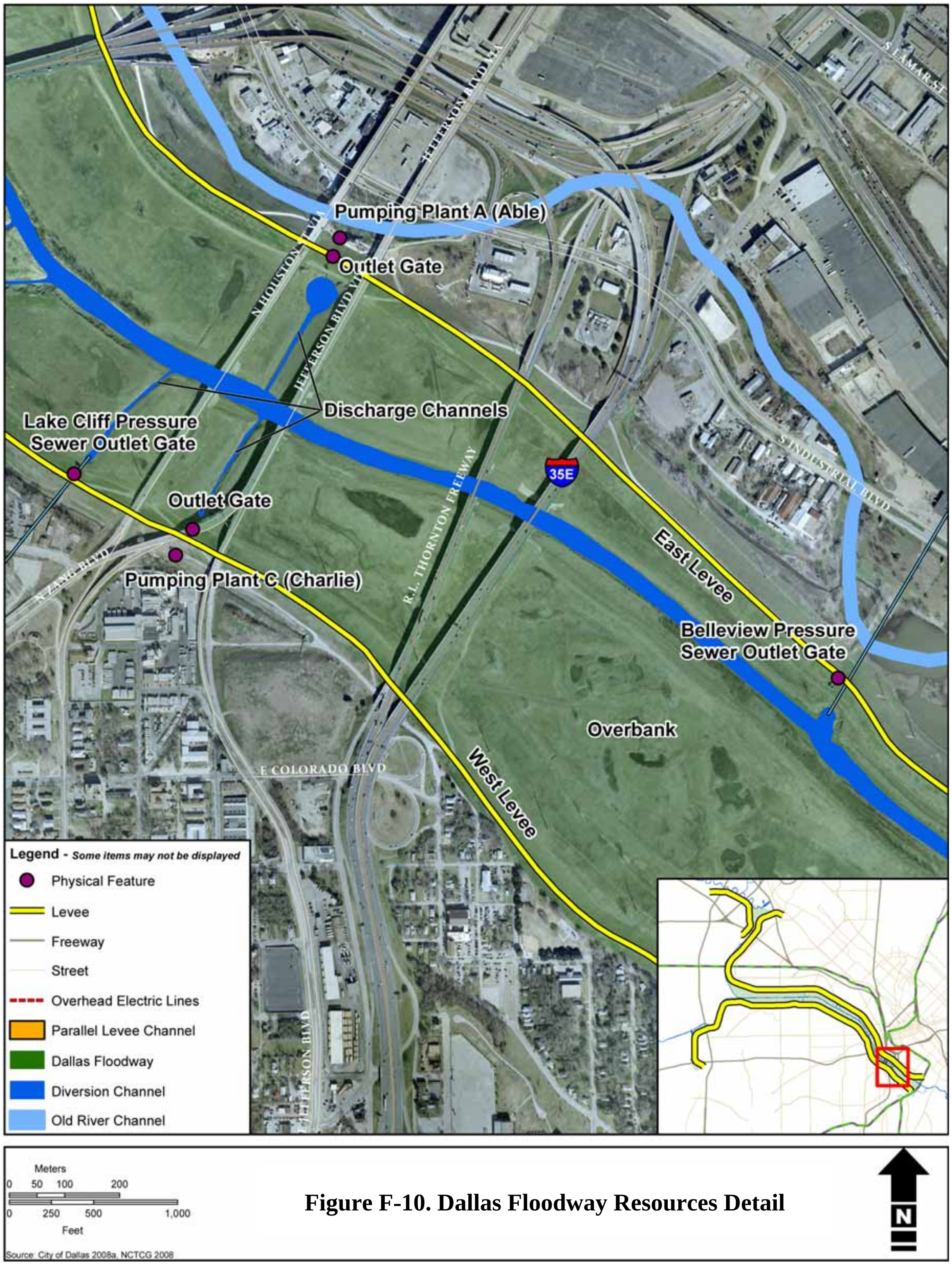


Figure F-10. Dallas Floodway Resources Detail

NEPA Cultural and Historic Resource Inventory Form
Continuation Sheet

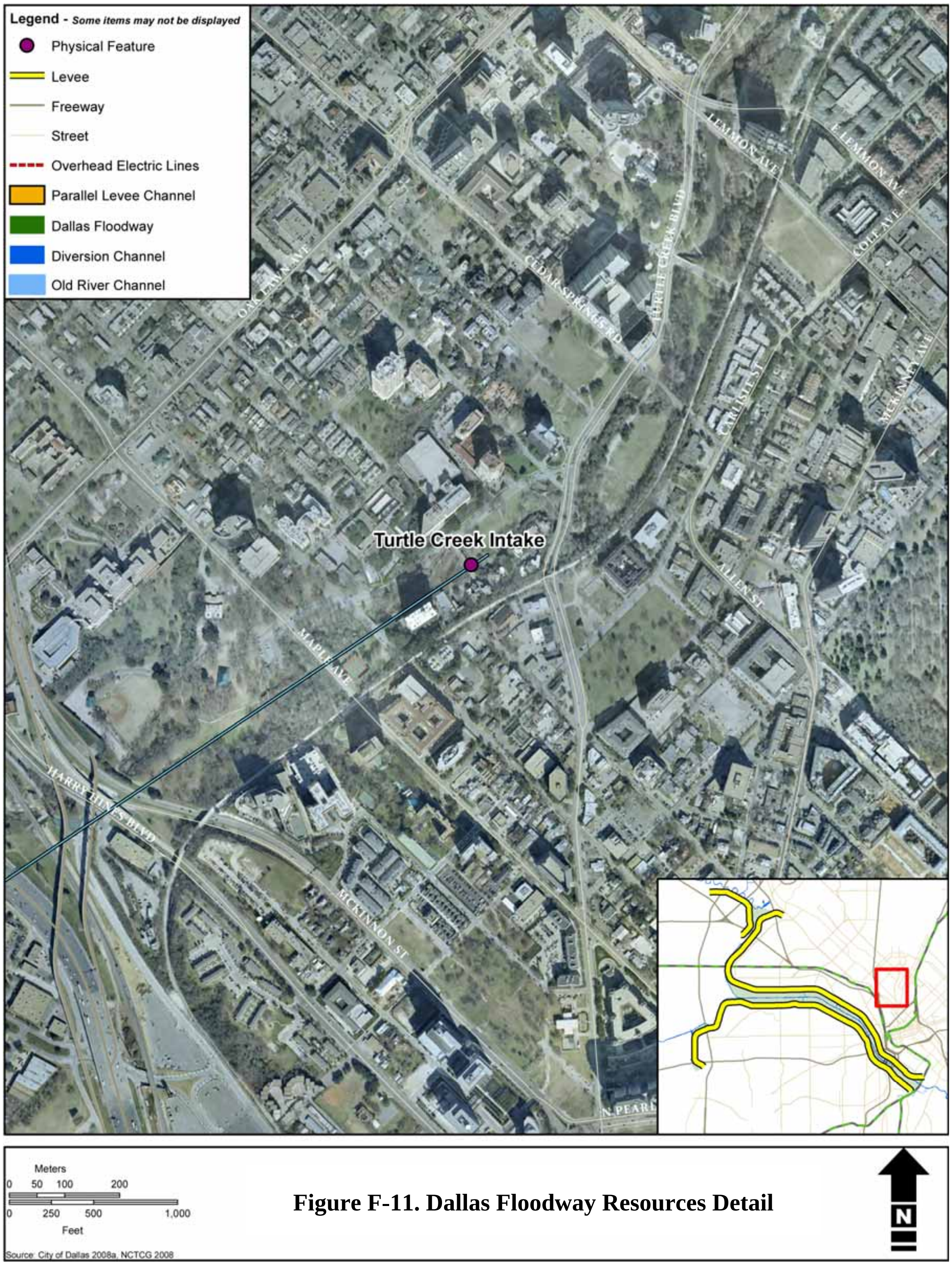


Figure F-11. Dallas Floodway Resources Detail

PROPERTY TYPE 1: LEVEES

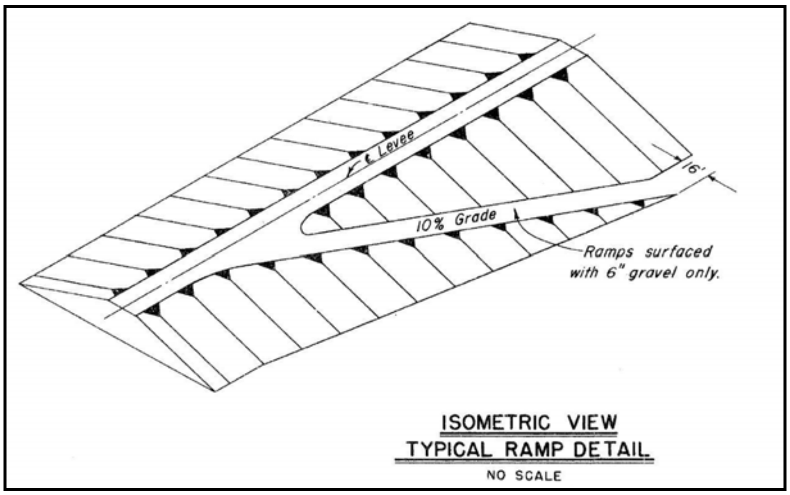
Figure F-12. Levee, viewed from the crown

Physical Description

Levees are battered, manmade earthen embankments that form the outer walls of the Dallas Floodway system's diversion channel and overbank area to contain floodwater (Figure F-12). The Dallas Floodway system consists of three loops: the Northwest Levee, East Levee, and West Levee. The 2.8-mile-long Northwest Levee is located at the extreme northwest area of the floodway system relative to the city of Dallas. While the city of Dallas controls and maintains the East and West Levees, the Northwest Levee is managed by the city of Irving. The Northwest Levee's direct relationship with the floodway at Elm Fork Diversion Channel makes it a component of the entire Dallas Floodway system.

The levee walls form the dominant physical feature and structural backbone of the Dallas Floodway system by holding floodwater within the floodway. The East and West Levees each extend nearly 12 miles along the floodway in a general west-to-northwest downstream direction parallel to the Trinity River diversion channel. The East and West Levees run parallel to each other for approximately seven miles upstream from the AT&SF rail crossing at the south end of the floodway, and then split into two separate floodways at the northwest end of the main channel. At this divide the East Levee turns northeast along the diversion channel's Elm Fork and the West Levee turns to the southwest along the channel's West Fork.

The levee walls are trapezoidal in section and rise approximately 28 feet above the adjacent overbank (see Figure F-13) (HNTB 2009). The components of an earthen levee wall consists of the *crown* at its apex, or top; the *main body*, which comprises most of the levee's interior mass; the *foot* at the lower portion of the levee's base; and the *toe* at the extreme outer edges of the base. The top of the Dallas Floodway levees have a flat 16-foot-wide crown that accommodates an unpaved roadway running the length of the levee walls (USACE 2009a). The battered side walls generally have a 3:1 slope (horizontal to vertical) on both the river side and land side, but some portions of the land side have a flatter 3.5:1 slope. The levee walls are comprised of solid clay fill pierced only by the sluiceways that connect the interior drainage system to the floodway's diversion channel (USACE 1968). The surface is covered in Bermuda grass, along with other invasive grass species, with the exception of the dirt wheel ruts of the levee roadway system (USACE 2007). The East and West Levees are separated by a 2,000-foot to 3,000-foot distance between the levee toes within the floodway for their seven-mile distance along the main diversion channel.



Source: USACE 1954b

Figure F-13. A typical isometric view of a levee

The levee walls incorporate angled earthen ramps that allow vehicular access to and from the roadways at the levee crown. These ramps have a 10 percent grade and are built into the outer levees walls, making the base of the levees wider in these areas. The ramps connect to the dirt roadway at the toe of the levees on the river side roads, and to city roads outside of the levee system. The levees most often continue underneath the numerous bridges that cross the floodway, but in some cases they abut the base of the lowest bridges that predate the levee's strengthening, such as the Corinth, Continental, and Commerce Street Viaducts.

Pipelines laid atop the levee's sloping walls and crown, are uniformly covered with dirt fill. Two covered pipelines were observed during the survey, and were located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge on the East and West Levees. These covered pipelines are typically 4 feet tall and 12 feet wide throughout, making them narrow features crossing over the East and West Levees.

Structural History

The East, West, and Northwest levees were originally constructed in 1928–30 by the Dallas County Levee Improvement District No. 5 and the City and County of Dallas Levee Improvement District. When the levees were originally completed in 1930, they measured a total of 25.4 miles in length and were designed to confine flood waters roughly two-and-one-half times the water level of the 1908 flood. Each levee measured 156 feet wide at the base tapering to 6 feet at the crown, and averaged approximately 26 feet high with a maximum height of 37 feet (HNTB 2009). Although the original design for the levees called for a 3:1 slope, the design was changed to a steeper 2.5:1 slope, and in some places as steep as 2:1, to reduce construction costs. Their construction also lacked moisture control measures. The levees began to deteriorate by the late 1940s as numerous cracks, landslides, and seepage failures began to occur (Carter and Burgess 2006).

Between 1953 and 1959, the USACE Fort Worth District strengthened the East and West levees as part of an undertaking to improve the entire floodway system (see Figure F-12). The USACE did not strengthen the Northwest Levee at this time. Documentary evidence that explains why the Northwest Levee, which was probably in the same condition as the East and West Levees, was not included in the USACE strengthening project was not found. The project involved stripping six inches of surface material on the river side of the levees plus four feet off the crown. The USACE then added an average of three feet of compacted fill on the levees' river side to widen the base by 25 feet and raise the levee to an average height of 28 feet, and a maximum height of about 35 feet (USACE 1969). The USACE designed the new height to have eight feet of levee freeboard in an 800-year flood event as estimated at that time. This 800-year Standard Project Flood (SPF) was uncommon at the time, as a 100-year SPF or 500-year SPF was more universal for flood control levee systems. The USACE used these exceptional design parameters in their improvements due to the Dallas Floodway's location at the confluence of multiple forks of the volatile Trinity River (*DMN* 1993). The USACE's additional fill also accounted for shrinkage that was expected to occur. The levee crowns were widened from 6 feet to 16 feet with a loose-aggregate roadway atop the crown to facilitate maintenance and monitoring. The USACE buttressed the levees' slopes to 3:1 by adding fill to make them wider and flatter. This project consisted of leveling off the levees' surface layer and adding new layers of dirt fill to the crown and river side only. As a result, the levee's base increased toward the river side, and the crown's center point shifted from between 2 to 45 feet toward the river side as well. The average shift in the position of the crown was 20 feet. The USACE then planted Bermuda sprigs for turfing (HNTB 2009).

Changes to the levees include the addition of pipelines placed atop the East and West Levees in accordance with the USACE's *Criteria for Additional Construction Within the Limits of Existing Floodways* (USACE 1977). A USACE project in the late 1990s to improve drainage resulted in slightly flattening small portions of the levees' river side walls to a slope of 4:1 (HNTB 2009).

The levee surface is maintained by mowing and replanting the grass as needed. Access roads are maintained to ensure vehicular access to all areas of the levee system. The levee walls are monitored and repaired for proper drainage to prevent deterioration and erosion. Gated barricades at the roadway entrances to the levee walls prevent access to unauthorized vehicles.

Existing Condition

The East, West, and Northwest levees are currently in fair-to-good physical condition overall. The nature of the levees' solid clay-fill construction and the region's hot, dry summers followed by heavy rainfall events and resulting moisture changes within the levees have caused 23 shallow landslides on the levee walls since the 1950s strengthening project (HNTB 2009). USACE reports on these slides state that they were superficial and did not detract from the ability of the levees to protect against flood events, and were easily repaired (USACE 1968). Most recently in 2009, two embankment landslides occurred on the river side of the West Levee in the area north of the Westmoreland Road Bridge. The USACE repaired these areas in-kind using clay backfill and replaced the grass turf on the embankment walls (HNTB 2009). These actions are part of the regular repair and maintenance of the levee walls. Improvements in the late 1990s to improve drainage and prevent landslides flattened the East and West Levee to a 4:1 slope and raised the crown by an average of two feet downstream of the Continental Street Viaduct. The material fill used to buttress the levees was excavated from the diversion channel widening, and from several borrow pits in the floodway (HNTB 2009).

The Irving Flood Control District No. 1 constructed the Northwest Levee's stormwater pump station and related facilities in 1974. The District has since made some small-scale improvements to the Northwest Levee, including the addition of a small pump station in ca. 1995 (Fennell 2010; Skipwith et al. ca. 2007).

Since the USACE's floodway improvements in the 1950s, the height of the levees has been reduced in some areas due to settlement, soil creep, or lack of maintenance. However, the levee walls have retained their overall trapezoidal form, their alignment within the floodway system is unchanged, the 16-foot levee crowns are intact, and the levee walls generally maintain their 3:1 slope. The limited vehicular use on the levee roadways has helped minimize deterioration of the levee walls, while the grass covering the walls has helped curb erosion as well as can be expected. Although the levee slopes have flattened slightly since the 1950s and have received other small changes, such as the addition of two pipelines, these changes are negligible relative to the levees' total scale, footprint, and dimensions, and thus, the levees remain intact overall to their original construction period between 1928 and 1959. The 2008 Annual Inspection Report rated the Dallas Floodway system as "Very Good," with the levees retaining a freeboard height of less than three feet to over six feet (HNTB 2009). However, the 2009 Annual Inspection revealed the results of the USACE's new National Levee Safety Program that added a much more stringent rating system process for inspections of levee systems. Under these new criteria, the Dallas Floodway system rated 91 items as acceptable, 80 as minimally acceptable, and 43 as unacceptable. An unacceptable rating on any item that would prohibit the floodway system from functioning as intended results in an unacceptable rating for the whole system. Thus, the system is considered unacceptable. Since the inspection, the city of Dallas has corrected 22 items rated unacceptable, and continues to correct or repair others.

Property Type Resources

East Levee

Figure F-14. East Levee, looking northwest

The East Levee is an original resource to the 1929 floodway system (Figure F-14). The levee runs a total of 11.9 miles to form the levee at the east and northeast side of the floodway system (HNTB 2009). It runs parallel with the West Levee for a distance of seven miles starting from the AT&SF Railroad crossing, Cockrell Avenue, and the DART line, running upstream in a northwest direction, turning toward the west before it curves sharply in the northeast direction in the vicinity of Irving Boulevard to follow the Elm Fork of the Trinity River's diversion channel. The East Levee along this latter northeast-southwest direction is also called the East Tie Back Levee, and terminates at the 60-inch E. B. I. Emergency Control Structure near Harry Hines Boulevard, due north of Regal Row. Two covered pipelines were observed during the field survey on the East Levee, and are located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge. Improvements in the late 1990s to improve drainage flattened the East Levee to a 4:1 slope and raised the crown by an average of two feet on the river side downstream of the Continental Street Viaduct. The fill used to buttress the levees was excavated materials from the diversion channel widening and from several borrow pits in the floodway (HNTB 2009).

West Levee

Figure F-15. West Levee, looking south

The West Levee, like the East Levee, is an original resource to the 1929 floodway system (Figure F-15). The levee generally mirrors the East Levee and extends a total of about 10.9 miles to enclose the levee at the west and southwest sides of the floodway (USACE 1968). The West Levee runs parallel with the East Levee for a distance of seven miles starting from the AT&SF Railroad crossing at the south end, running upstream in a northwest direction, turning toward the west before it curves sharply to the south to follow the West Fork of the Trinity River to the Trinity Authority Waste Treatment Plant (USACE 1989). The West Levee terminates just beyond its intersection with IH-30. The West Levee runs adjacent to Oak Cliff at its southern end and borders West Dallas as it moves upstream and to the west. Two covered pipelines were observed during the field survey on the West Levee, and are located in the vicinity of the Hampton Road Bridge and the Westmoreland Road Bridge. Like the East Levee, improvements in the late 1990s to improve drainage flattened the West Levees to a 4:1 slope on the river side and added two feet to the crown in the vicinity south of the Continental Street Viaduct (HNTB 2009).

Northwest Levee

Figure F-16. Northwest Levee, looking north

The 2.8-mile-long Northwest Levee is located in the city of Irving at the northwest part of the Dallas Floodway system. Originally built in 1929 when the East and West Levees were built, the Northwest Levee was not significantly improved by the USACE in the 1950s (Figure F-16). In 1974, the Irving Flood Control District No.1 raised and widened the levee from its original 2:1 slope to its current 3:1 slope. The Northwest Levee forms a continuous, angular semi-circle that extends approximately 2.8 miles around the city of Irving at the northwest portion of the Dallas Floodway. Although the Northwest Levee is continuous, the northwestern-most end of the levee, west of Loop 12, is called the North Levee Tie-In. The opposite southernmost portion is called the South Levee Tie-In. Both Tie-In segments are original to the Northwest Levee's design and construction in 1929–1932.The Northwest Levee currently has a 3:1 slope, but is slightly steeper in some places. The levee rises from 16 and 22 feet high from toe to crown, approximately 428 to 443 feet in elevation. The city of Irving's maintenance ends at the west bank of the Elm Fork diversion channel; Dallas controls the channel itself (Fennell 2010). Although the USACE's 2008 Inspection Report found the levee's pumps and components in good working condition, the Northwest Levee's overall rating was "unacceptable" under FEMA's increased levee certification standards due to repair work that had not yet been completed (Sissom 2008). The Irving Flood Control District removed woody vegetation consisting mainly of mesquite trees from the North Levee Tie-In in 2006. In 2008, the Irving Flood Control District removed tree growth and woody vegetation from the South Levee Tie-In. After the vegetation was cleared, the levee was regraded and resurfaced with grass cover to its original design and construction. The levee was re-covered in grass and was reported in good condition in 2008 (Sissom 2008).

Parallel Levee Channel

A unique sub-feature of the Northwest Levee is the Parallel Levee Channel. The Parallel Levee Channel is a concrete-lined open ditch that runs from State Highway 114 northward to the Northwest Levee's intersection with Loop 12. The channel is an original 1929 feature that drains the 300-acre area encircled by the Northwest Levee. The Parallel Levee Channel is approximately 8 feet wide and 8 feet tall, with concrete walls embedded into the ground and parallel levee berms running along either side of the channel. The channel extends northward, downstream to the north end of the levee, where it conveys rainwater to a long sump area at the Northwest Levee toe. The channel drains its water through a 48-inch corrugated metal pipe (CMP) to the interior sump area. This pipe was built sometime in the 1960s. By 2007, the Parallel Levee Channel walls began to buckle and fail from holding back the earth on either side. The Irving Flood Control District installed steel tie-rods to brace and reinforce its side walls, as well as metal sheet pile along the side walls (Fennell 2010).

PROPERTY TYPE 2: DIVERSION CHANNEL

Figure F-17. Main Diversion Channel

Physical Description

The Trinity River diversion channel is the relocated channel of the Trinity River (Figure F-17). It is a manmade dredged channel that is partially lined with rock rip rap on its banks. The channel extends down the center of the floodway in a northwest-to-southeast direction, and is designed to carry redirected water from the original river bed and from stormwater outfalls of the Dallas Floodway interior drainage system for purposes of flood control and water supply. The Trinity River diversion channel also receives water aided by the pressure sewers and sluiceways that carry stormwater to the channel. Within the Dallas Floodway system, 15 miles of diversion channels and two miles of auxiliary channels divert waters draining to the Trinity River. This system includes the seven-mile main diversion channel that runs in between the East and West Levees from the approximate location of the AT&SF Railroad Bridge upstream to the northwest where the channel divides into the West Fork and the Elm Fork.

Structural History

The diversion channel was created in 1932 when the Dallas County Levee Improvement District relocated the confluence of the West and Elm Forks three-and-one-half miles to the west of the original Trinity River bed. The West and Elm Forks combined to form one main diversion channel running in a straight line down the center of the floodway. The new river channel was excavated on the low-lying floodplain, which was primarily used for agricultural purposes at that time. The downstream portion of the diversion channel in the vicinity of the Corinth Street Viaduct was located closer to the East Levee in order to avoid costly rock excavation. When the Trinity River bed was drained to this new diversion channel, part of the old Trinity River bed was replaced with hydraulic fill taken from the floodplain, while portions of the river bed were left in place to serve as sump storage in the interior. The West Fork diversion channel occurred on November 15, 1928, while the main Trinity River diversion channel was completed in 1932 (HNTB 2009).

The USACE made improvements to the diversion channel in the 1950s by widening and straightening the channel. The USACE moved the river channel 100 feet to the west of its original path between the Belleview Pressure Sewer and the Cadiz Street Viaduct (Furlong et al. 2003).

In the late 1990s, the diversion channel was widened and the excavated material fill was used to strengthen the levees (HNTB 2009).

Existing Condition

The Trinity River diversion channel remains mostly unchanged since the USACE's improvements in the 1950s. Ongoing maintenance concerns include silt deposits, the collection of debris, and areas of erosion at its banks (USACE 2007). The channel's current condition relative to its conception in the 1950s remains unchanged overall.

Property Type Resources

Main Diversion Channel

Figure F-18. Main Diversion Channel

The main diversion channel extends approximately seven miles down the center of the Trinity River floodway from the channel's fork downstream to the approximate location of the AT&SF Railroad Bridge (Figure F-18). This channel runs down the floodway's center, parallel with and in between the East and West Levees at the overbank edges.

West Fork Diversion Channel

The diversion channels' West Fork turns to the southwest and south in the vicinity of the West Dallas neighborhood within the city of Dallas.

Elm Fork Diversion Channel

The Elm Fork begins at the original Trinity River bed near the river's intersection with State Highway 482 and runs downstream to the southwest turning to the southeast near Irving Boulevard, where it meets the West Fork to form the confluence of the Trinity River.

The New Frazier Dam is located at the Elm Fork diversion channel due east of the "old" pump station at the Northwest Levee. The city of Dallas constructed the dam in 1965 for flood control purposes and it is currently owned by the Dallas Water Utilities Department. The New Frasier Dam is a gravity dam measuring 16 feet high and 180 feet long. Its capacity is 651 acre feet and its normal storage is 651 acre feet (Ajemian 2010).

PROPERTY TYPE 3: OVERBANK

Figure F-19. View of overbank near the Hampton Road Bridge, looking southwest.

Physical Description

The overbank is the area of land between the diversion channel and the levees throughout the floodway system (Figure F-19). The overbank contains the Trinity River channel at its center and measures approximately 2,000 to 3,000 feet between the levee toes. The overbank encompasses the area between the West Fork Diversion Channel and the West Tie Back Levee, and the land between the East Tie Back Levee and the Northwest Levee at either side of the Elm Fork Diversion Channel. Beginning at the confluence of these two channels, the main Trinity River Diversion Channel extends the 7-mile distance between the East and West Levees. The outer edges of the overbank adjacent to the levees house the outlet gates and outspill structures associated with the floodway's pumping plants and pressure sewers. These components empty stormwater into narrow discharge channels that redirect the runoff to the main diversion channel.

The overbank primarily consists of a wide, undeveloped stretch of land that is relatively flat. Riparian areas and wetland depressions lie adjacent to wide expanses of open areas with native grasses. Tree growth is dispersed throughout the overbank, and is primarily found in the wetland areas along the banks of the Trinity River diversion channel.

The overbank also includes the pier footings for the bridges that cross over the floodway, with the exception of the 1958 Sylvan Avenue Bridge's on-grade roadway atop the overbank. Other manmade features within the overbank include the Trammell Crow Lake Park, which includes a lake, sports fields, and a boat ramp to the diversion channel, and steel-frame electrical towers in the lower portion of the floodway.

Structural History

The overbank began as a naturally occurring landscape feature that harbored the original winding Trinity River west of Dallas. In July 1926, the land became part of the City and County of Dallas Levee Improvement District, whose footprint extended from the confluence of the West and Elm Forks downstream of the Trinity River to the AT&SF Railroad Bridge.

In 1928, the city of Dallas enclosed the land area with levee walls and it became part of the floodway system. The 1928 Joint Plan of Reclamation called for the overbank to be maintained in an unobstructed condition, but also "assume ultimately, a park like aspect. They may even become so attractive, that the city will make them public recreation grounds, thereby strengthening the likelihood of perpetual maintenance in a smooth condition" (Morgan Engineering 1928). Although the 1928 plans included clearing the trees and shrubs downstream of the AT&SF Railroad Bridge, the work was not undertaken and the tree growth remains in place as the Trinity Forest. Construction was completed in 1932, with the newly realigned Trinity River flowing through an excavated diversion channel down the center the overbank. The floodway included drainage ditches flanking the east and west levees on the river side at the overbank (as well as the land side) as late as the 1950s (HNTB 2009).

New structures added to the overbank since 1959 include an overhead electric line in the lower, downstream portion between Continental Street and the AT&SF Railroad Bridge near the foot of the West Levee and an overhead electric line in the upstream portion near the foot of the East Tie Back Levee between the Chicago, Rhode Island and Pacific Railroad Bridge and SH 183 and near the foot of the Northwest Levee north of SH 183. The city of Dallas created Trammell Crow Lake Park in 1985 as a public park adjacent to the Sylvan Avenue Bridge roadway, which was constructed in 1958 (Ajemian 2010).

Existing Condition

Although portions of the overbank have obstructive tree growth, the majority of the overbank area is maintained as open, grassy flat land for receiving floodwaters. Although the additions of the electrical towers and Trammell Crow Lake Park were not originally planned in the 1928–1932 construction period they do not hinder the overbank's function because of these features' low profile or reduced footprint within the overbank.

Property Type Resources

Open Space

Figure F-20. View of open space near the DART Bridge, looking southwest.

The vast majority of the overbank is open, undeveloped space (Figure F-20).

Roadways

Figure F-21. Roadway on the West Levee crown, left, and down-slope ramp underneath the Houston Street Viaduct, right

Roadways within the overbank consist of the unpaved dirt or aggregate roadways at the levee toes (Figure F-21). These roadways extend virtually the entire length of the overbank along the East and West Levees, and maneuver around the bridge footings as necessary. The only connection between these two levee roadways is via an unpaved east-west road that runs underneath the Hampton Road Bridge and crosses over the Trinity River diversion channel on a low bridge. All of these roadways are restricted access by the city of Dallas maintenance and monitoring, and are not open for public use.

The Sylvan Avenue Bridge consists of flyover bridges over the East and West Levees that descend down to the overbank grade between the levees. This at-grade roadbed is the only roadway of this type within the Dallas Floodway System, and allows for public access to the overbank via the Trammell Crow Lake Park at its east side.

PROPERTY TYPE 4: PUMPING PLANTS

Figure F-22. Aerial view of the Pumping Plant B (Baker) facility

Physical Description

Pumping plants are facilities that contain the pumps necessary for moving water from one location to another. Six plants are located adjacent to the land sides of the East and West Levees (Figure F-22). The East and West Levee pumping plants hold anywhere from two to five pumps and serve to handle any water the sluiceways cannot store. Two pump stations are located at the Northwest Levee, and include one pump each. Pumping plants contain pumps in a room over a discharge chamber, which diverts the water from the plant into the overbank area through an underground sluiceway that leads to the outlet gate structures. Open sump areas are adjacent to the pumping plants to collect drained stormwater.

Structures for the discharge vents are associated with the air-relief valves. They are typically housed in small concrete box structures that house outlet pipes ventilation. These concrete boxes can be atop the levee crowns next to the levee roadway. The boxes include manhole access on the top, and include slots in the concrete side-walls for ventilation (USACE 1969).

Structural History

The four pumping plants that comprise the first generation of plants built in 1929 are A (Able), B (Baker), C (Charlie), and D (Delta). These original ca. 1929 pumping plants are typically composed of red-brick masonry walls, a rectangular footprint, concrete foundation, and either a flat roof enclosed by a low brick parapet, or, as seen in Pumping Plant B (Baker), a gable-front roof that is covered by concrete tiles. The windows are rectangular with concrete headers, with the exception being Pumping Plant B (Baker), which has arched openings. All of the windows have been filled-in with brick. This likely occurred when new pumping plants were built during the USACE's floodway improvement project in the 1950s.

Three pumping plants, New Pumping Plants A (Able), C (Charlie), and D (Delta) were added in 1954–56 adjacent to each respective ca. 1929 pumping plant. The new buildings are built simply of brick-veneer walls with a square or rectangular footprint, flat roof, metal trim, and solid walls lacking windows. These buildings match the brick of their older counterparts, but are more utilitarian in design.

Two additional pumping plants constructed in 1956, Hampton Road and Pavaho, were built either of poured concrete or concrete block with brick veneer, and have rectangular footprints with concrete foundations, and solid, windowless walls.

The city of Dallas upgraded pumps at three pumping plants during the 1960s. In 1963, Pumping Plant D (Delta) received new, upgraded pumps and switchgear in the pump station. Pumping Plant C (Charlie) also received replacement pumps and switchgear in the original 1932 station. In 1967, the city of Dallas replaced the two 20,000 gpm pumps in the original pump station within Pumping Plant A (Able) with upgraded 40,000 gpm pumps. One 2,500 gpm sump pump was added to the Hampton Road Pumping Plant in 1975 (City of Dallas Flood Control District 2010).

Two new pumping plants were built in 1975, one each at the existing Pumping Plant B (Baker) and Hampton Road Pumping Plant. Comprising the most recent generation of plants to date, they were designed larger than their predecessors, and were built either of poured concrete, or in a mixture of poured concrete and brick veneer, as in the case of Pumping Plant B (Baker). Two small pump houses were added to the pumping plants at A (Able), C (Charlie), D (Delta) and Pavaho.

Improvements to the pumping plants in 1989 and in the 1990s included upgraded self-cleaning trash racks at the intakes at A (Able), New B (Baker), New Hampton, and C (Charlie). In the 2000s, additional self-cleaning trash racks with debris conveyors were installed at all of the pumping plants except for Pumping Plant B (Baker) and the Pavaho Pumping Plant. In 1990, six 10- x 10-foot gravity sluices were constructed through the East Levee adjacent to the New Baker Pumping Plant. In 2001, the Pavaho Pumping Plant upgraded its existing 30,000 gpm vertical pump to a 45,000 gpm submersible pump (City of Dallas Flood Control District 2010).

The city of Dallas' improvements primarily took place underground, within, or underneath the existing pumping plant complexes and their pumping houses with the exception of added trash racks, and conveyor systems for debris removal. In some cases, the roofs of the pump houses were modified with openings to accommodate the larger upgraded pumps (City of Dallas Flood Control District 2010). Modifications to the exterior of the pump houses are noted in the physical descriptions of each.

The Northwest Levee has two pump stations, located at the northeast and east portions of the levee. The Irving Flood Control District built the "old" pump station in 1974 and the "new" pump station in ca. 1995, in response to the damage caused by the 1990 flood.

Existing Condition

All of the pumping plants are in good condition as observed in the field, and have been well-maintained since their original construction. The only major alterations observed are the bricked-in windows of the ca. 1929 Pumping Plant A (Able), Pumping Plant B (Baker), Pumping Plant C (Charlie), and Pumping Plant D (Delta).

Property Type Resources

Pumping Plant A (Able)

Figure F-23. Pumping Plant A (Able)

The Pumping Plant A (Able) complex consists of two pump houses, one constructed in 1929 and one in 1953. The 1929 pump house, commonly referred to as Small Able, is a one-story, rectangular building clad in variegated red-brick masonry, with a flat, parapet roof, and a concrete foundation (Figure F-23). The roof is covered in rolled asphalt with a course of tile covering the parapet cap. The tile includes the inscription *W.S. Dickey Texarkana*, possibly indicating where the tile was manufactured. The parapet is distinguished by a course of vertical stretcher-bond brick framed by a single band of protruding horizontal brick course around all four sides of the building. The building retains its original multi-light windows with concrete sills and lintels. The building's south façade contains two windows with concrete lintels that are filled in with brick. The west façade contains one four-light window on the northern bay of the façade, and a metal, overhead, rolling garage door on the southern bay; both have metal lintels. This pump house contains two axial flow pumps manufactured by Fairbanks Morse and Company, a 36-inch gate valve and a 36-inch check valve, two 4- x 4-foot sluice gates, and two 3- x 3-foot sluice gates. Pumping Plant A (Able)'s intake structure was built in 1932 (City of Dallas Flood Control District 2010).

Figure F-24. Pumping Plant A 1929 Pump House at left, 1953 Pump House at right.

The 1953 pump house associated with Pumping Plant A is commonly referred to as Large Able. This building is a one-and-one-half story, rectangular structure clad in variegated, rough red brick with a flat roof (Figure F-24). The south façade contains a one-bay overhead garage door with a metal lintel The east façade contains a set of metal double-doors in its northern bay with a plaque stating "Addition to Pumping Plant 'A' Dallas Floodway Project, Constructed by Corps of Engineers, U.S. Army in Cooperation with Dallas County Flood Control District, 1953." This pump house contains three axial flow pumps manufactured by the Peerless Pump Division, Food Machinery & Chemical Corporation out of Los Angeles, California. Additionally, the pump house holds three lubricating oil reservoirs and oil lines, an 8-ton trolley-type, spur-geared hoist with bridge manufactured by Robbins & Myers, Inc. from Springfield, Ohio; two water level recorders manufactured by Leupold & Stevens Instruments, Inc. from Portland, Oregon; a water level control manufactured by Healy Ruff Company; and an air compressor manufactured by Binks Manufacturing Company from Chicago, Illinois.

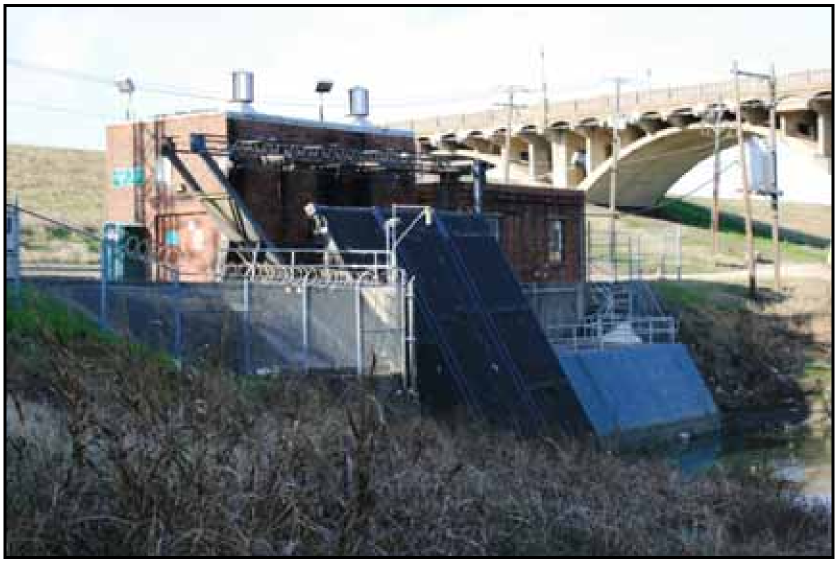


Figure F-25. Pumping Plant A trash rack and sump area, at right.

The sump area for the Able Pumping Plant is located on the north side of the structure. This sump is served by an intake structure that adjoins the two pump houses on the north (Figure F-25). This intake structure consists of approach wing walls and apron, a raking platform, and trash racks. The trash racks are located along the north façade of the pump houses, with the shorter of the two racks associated with Small Able and the larger of the two associated with Large Able.

Pumping Plant B (Baker)

Figure F-26. Pumping Plant B (Baker)

Figure F-27. 1930 Pump House at Pumping Plant B (Baker)

Pumping Plant B consists of two pump houses (Figures F-26 and F-27), an intake structure, four gravity sluices, and an outlet structure. The original pump house, constructed in 1929, is a one-and-one-half story building clad in rough, variegated red brick with a concrete foundation. The building has a medium-pitch, front-gabled roof covered in concrete tiles. The primary entrance to the building is located on the east façade. This metal, double door is located under a brick-in-filled segmental arch and includes multi-light windows above it. Above this entrance is a sheet metal sign which reads “City of Dallas Old Baker Pump Station Flood Control Div.” Four in-filled windows with segmental arches are located on the south façade, while three in-filled windows with segmental arches are located on the west façade. The north façade contains four multi-light windows under segmental arches. These windows appear to be original, but the building’s 1928 construction drawings indicate that fan lights were originally within the arched portion of the window openings that are now covered. Three circular brick design elements are interspaced between the window bays roughly two feet below the roofline. According to the original drawings, these portal window elements have always been blind, i.e. filled-in by a brick panel. The pump house contains four screw-type pumps manufactured by Fairbanks, Morse and Company; four gate valves; one trolley type chain hoist with a chain operated bridge; and two vacuum pumps.

Figure F-28. 1975 Pump House at Pumping Plant B (Baker)

The second pump house associated with the Baker Pumping Plant was constructed in 1975 (Figure F-28). This building is a rectangular, poured-concrete structure with brick panels to match the exterior of the adjacent 1929 pump house. The south façade contains five bays of brick interspersed with concrete. A small, rectangular extension is located on the east façade that measures roughly 10 x 18 feet. The west façade contains an oversized garage bay with a metal door. Within the oversized bay is a personnel door. The north façade contains five vents located within the brick bays. Located along the north façade is the trash rack for the pumping plant.

Pumping Plant C (Charlie)

Figure F-29. Pumping Plant C (Charlie)

Pumping Plant C consists of two pump houses, intake structures, two gravity sluices, and an outlet structure (Figure F-29). The pump house, constructed in 1929, is a one-story, rectangular building clad in horizontal, variegated rough red brick with a flat, parapet roof and a concrete foundation. The flat, parapet roof is covered in rolled asphalt with a course of tile covering the apex of the parapet. Roughly one foot below the apex of the roof, a course of vertical brick flanked by a band of protruding horizontal brick wraps the building. The building contains in-filled window bays with concrete lintels. The north façade contains two in-filled window bays while the west façade contains one in-filled window bay. The east façade contains a metal overhead garage door in the northern bay. The pump house contains two open suction centrifugal pumps, two vertical pumps manufactured by Fairbanks, Morse and Company; two hand-operated gate valves; two sluice gates with two motor driven hoists; and two sluice gates with two hand-operated gates hoists.

Figure F-30. Pumping Plant C (Charlie), 1929 Pump House at left, 1956 Pump House at right.

A second pump house, built in 1956, is located directly east of the 1929 pump house at Pumping Plant C (Figure F-30). It is a utilitarian one-story, rectangular, brick-clad building with a flat roof and a metal overhead garage door on its east façade.

The remaining structures associated with Pumping Plant C include an intake structure that is adjacent to the pump house. The intake structure consists of concrete approach, wing walls, apron, a raking platform, and metal trash racks. Two gravity sluices measuring 4 x 4 feet pass through the levee at Plant C with a gated control structure and a flap gate on the outlet gate structure of each sluice. Additionally, the gated control structure on the riverside of the levee contains two 4- x 4-foot sluice gates run by two hand-operated gate hoists. Access to Pumping Plant C is restricted by a six-foot chain-link fence.

Pumping Plant D (Delta)

Figure F-31. Pumping Plant D (Delta)

Pumping Plant D (Delta) consists of two pump houses, an intake structure, two gravity sluices, and an outlet structure. The pump house, constructed in 1929, is a one-story, rectangular building clad in horizontal, variegated red brick with a flat, brick-parapet roof (Figure F-31). The roof parapet is ornamented by a course of vertical brick flanked by a band of protruding horizontal brick above and below it, and wraps around all sides of the building. The building contains two bricked-in window bays on the north façade, and a metal entrance door on the east façade. The pump house contains two vertical pumps manufactured by Fairbanks, Morse, and Company; two hand-operated gate valves; two sluice gates operated by two motor-operated gate hoists; and two sluice gates operated by two hand-operated gate hoists.

A second pump house, constructed in 1956, is located directly east of the 1929 pump house at Pumping Plant D. This building is a utilitarian one-story, rectangular, brick-veneer structure with a flat roof and a metal entrance door on its west façade.

The remaining structures associated with Pumping Plant D include an intake structure, gravity sluices, and an outlet structure. The intake structure adjoins the pump house and consists of concrete approach wing walls and apron, a raking platform, and metal trash racks. The two gravity sluices associated with Plant D were built in 1932 and are 4 x 4 feet in size. They have a gated control structure on the riverside of the levee and a flap gate on the outlet of each sluice. The gated control structure on the riverside of the levee consists of two 4- x 4-foot sluice gates which are run by two hand-operated gate hoists. The associated outlet structure consists of a concrete headwall, wing walls, and an apron. Access to Pumping Plant D is restricted by a six-foot chain-link fence.

Pavaho Pumping Plant

Figure F-32. Pavaho Pumping Plant

The Pavaho Pumping Plant consists of a pump house and its adjoining building, a discharge chamber, an inlet structure, and an outlet structure (Figure F-32). The pump house, built in 1954, is a two-story, concrete structure with a flat roof and a concrete foundation (Figure F-33). The building contains no windows and has a double door entrance on the east façade. The pump house holds two vertical mixed flow pumps manufactured by Economy Pumps, Inc. from Philadelphia, Pennsylvania; two grease lubricating systems manufactured by the Farval Corporation of Cleveland, Ohio; a water level recorder manufactured by Leupold & Stevens Instruments, Inc. of Portland, Oregon; an 8-ton trolley type spur geared hoist with bridge; a water level control manufactured by Healy Ruff Co.; two motor-operated sluice gate hoists; and two 6- x 8-foot sluice gates. The associated building is a small rectangular building directly west of the pump house with a metal overhead door on the west façade.

Figure F-33. 1954 Pump House

The associated structures include an inlet structure, discharge chamber, sluice, and an outlet structure. The inlet structure consists of approach walls, guide walls, an approach apron, trash racks, and a raking platform. The outlet structure consists of a headwall, wing walls, and apron with flap gates on the outlets. The discharge chamber consists of two 6- x 8-foot sluice gates for control of gravity flow with motor-operated floorstands to operate the gates located in the pump house. Access to the Pavaho Pumping Plant is restricted by a six-foot chain-link fence.

Hampton Road Pumping Plant

Figure F-34. Hampton Road Pumping Plant

The Hampton Road Pumping Plant consists of two pump houses, an adjoining intake structure, four discharge pipes, and an outlet structure (Figure F-34). The original pump house, known as Old Hampton, was constructed in 1956. It is a one-story, rectangular building clad in horizontal, variegated red-brick veneer with a flat roof and metal trim (Figure F-35). The east and west façade each contain one metal door for entrance to the building. This building contains four vertical mixed flow pumps manufactured by Economy Pumps, Inc. of Philadelphia, Pennsylvania; with three phase motors manufactured by Ideal Electric Company of Mansfield, Ohio; four grease lubricating systems manufactured by the Farval Corporation of Cleveland, Ohio; an 8-ton trolley type spur geared hoist; a top running hand-geared crane; a four-element float switch; six metal clad switchgear cabinets housing five oil circuit breakers; control switches and other control equipment; a 10 KVA single-phase dry type transformer; and a 24-volt battery and NEMCO battery charger.

Figure F-35. 1956 Pump House

The intake structure adjoins this building and consists of approach wing walls and apron, a raking platform, and twelve trash racks. Also located at this site are four discharge pipes which run over the levee. Each pipe is provided with a 4-inch air-relief valve and 7-inch vacuum breaker at the top of the levee. The pipes are housed in two square and one rectangular concrete box structures. These structures are located on the crown of the East Levee (Figure F-36).

Figure F-36. Concrete Vents Structures Housing the Air Relief Valves on the East Levee

Figure F-37. 1975 Pump House

A secondary building, known as New Hampton, was constructed due east of Old Hampton in 1975 (Figure F-37). This structure is a utilitarian two-story, rectangular building constructed of poured concrete with a flat roof. This building contains one entrance on the east façade of the building and a small rectangular extension on the west façade. Old Hampton and New Hampton are enclosed by a 6-foot chain-link fence.

"Old" Pump Station (Northwest Levee)

The Northwest Levee's easternmost "old" pump station was built in 1974 and is located adjacent to the New Frazier Dam. The station consists of a small concrete-block building, which houses the pump and sluice gate (Fennell 2010).

"New" Pump Station (Northwest Levee)

The Northwest Levee's "new" pump station located at the northeast portion of the levee was built in ca. 1995. A small concrete-block building houses the station's 40,000 gpm pump and sluice gate (Chovan and Erskine 2008).

PROPERTY TYPE 5: PRESSURE SEWERS

Physical Description

Pressure sewers are systems of pipes that carry stormwater runoff to higher elevations, or in the case of the Trinity River, to the diversion channel. Pressure sewers for the Trinity River are located on both the river and land sides of the levees. The pressure sewer systems along the Dallas Floodway, also known as pressure conduits, consist of concrete structures that carry stormwater from specific outfall regions of the Trinity River watershed through the levees through water-tight pipes to access the overbank's network of diversion channels. The pressure sewers are constructed out of concrete with reinforced metal pipes to handle the water flow between the riverside and landside of the levees. They include a trash rack grate at outspill openings to catch debris.

Structural History

Although the 1928 Plan of Reclamation called for five pressure sewers, only three were constructed. These were the Mill Creek Pressure Sewer (later known as the Belleview Pressure Sewer), Dallas Branch Pressure Sewer, and the (Old) Coombs Creek Pressure Sewer (Furlong et al. 2003, 6).

The USACE strengthening of the floodway system in the 1950s included constructing the two pressure sewers left out from the original 1928 design. These two pressure sewers were the Turtle Creek Pressure Sewer and the Lake Cliff Pressure Sewer. The city of Dallas built the Woodall Rodgers Pressure Sewer in 1979 as part of TxDOT's construction of the Woodall Rodgers Freeway.

Existing Condition

The pressure sewers appear to be highly intact and in good condition overall. The 2009 Inspection Report indicates that repairs are required in areas where wingwalls have been displaced slightly (HNTB 2009).

Property Type Resources

Old Coombs Creek Pressure Sewer

Figure F-38. Enclosed Concrete Culvert Associated with the Coombs Creek Pressure Sewer

The “Old” Coombs Creek Pressure Sewer (also known as Little Coombs) is located at the West Levee, upstream from the Houston Street Viaduct (Figure F-38). It consists of an emergency spillway, storm sewer, and conduit. The pressure sewer itself measures 18.5 feet with a 40-foot trash rack at the intake area. Near the riverside of the levee, an 18.5-foot semi-elliptical conduit transitions to four 8- x 10-foot passages into a gate well. Another four 9- x 11-foot passages lead from the gate well into the outlet, with four gate passages controlled by slide gates. The four associated slide gates are run by hand-operated floorstands or portable hoists provided at the Turtle Creek Pressure Sewer. The storm sewer measures 6 feet and has a gated control and a hand-operated hoist (USACE 1969). Two vertical intakes measuring 7 x 8 feet are protected by trash racks. Its capacity is a little more than 3.1 million gpm (Furlong et al. 2003, 5).

Coombs Creek Pressure Sewer

The USACE built the “New” Coombs Creek Pressure Sewer (also known as Big Coombs) in 1957 during its 1950s strengthening project (USACE 1989). This additional pressure sewer was constructed due south of and parallel to the original 1928–32 Coombs Creek Pressure Sewer to provide additional discharge capabilities. The only physical evidence of this addition that was observed above ground during survey was the additional outlet gate structure for the Coombs Pressure Sewer, described under Property Type 6.

Belleview Pressure Sewer (formerly Mill Creek)

Figure F-39. Berm Covering the Underground Belleview Pressure Sewer

The Belleview Pressure Sewer is located at the East Levee upstream from the Corinth Street Viaduct (Figure F-39). Originally known as the Mill Creek Pressure Sewer, the Belleview Pressure Sewer differs from the other pressure sewers in the Dallas Floodway in design. This pressure sewer has a width of 16 feet and a height of 12.8 feet and is a modified horseshoe shape. The associated storm sewer is controlled by a gated control feature similar to the Dallas Branch Pressure Sewer in its operation; however, the gate on the Belleview Pressure Sewer measures 12 x 17 feet. The Belleview Pressure Sewer has more than 2.6 million gpm in capacity.

Lake Cliff Pressure Sewer

The Lake Cliff Pressure Sewer is located at the West Levee just upstream from the Houston Street Viaduct and has 396,317 gpm capacity. The structure is located within the levees and contains a gated outlet structure, sluices, and intake structure. The associated conduit measures 7 feet in diameter with a 6- x 8-foot box section. A circular intake structure with a diameter of 22 feet is also located at this site along with two circular sluice gates, an 18-inch diameter structure and a 24-inch diameter structure. Each of the sluices associated with the Lake Cliff Pressure Sewer is run by a hand-operated floorstand and portable hoist. Along the levee is a gated outlet structure consisting of a triple 6- x 8-foot sluice gate on the pressure sewer and two 6- x 8-foot sluice gates on the gravity sluices alongside the pressure sewer. Two 8-foot-diameter flap gates are associated with the two gravity sluices on the outlet structure.

Turtle Creek Pressure Sewer

The Turtle Creek Pressure Sewer is located at the East Levee between Sylvan Avenue and Continental Street and has more than 1.7 million gpm capacity. The structure consists of four separate structures including a diversion dam with spillway, an intake structure, a conduit, and a gated outlet structure. The emergency spillway is a 175-foot-high concrete structure with a crest elevation of 419.5 feet adjacent to the pressure sewer intake. Also located at the pressure sewer intake is a trash rack, which has a net area of 460 square feet. The pressure sewer itself is controlled by a gate at the downstream end of the structure and has four 8- x 10-foot sluice gates at the outlet end of the pressure sewer along the river side. The concrete control tower for the pressure sewer is run by four hand-operated gate hoists to control flood levels and is located within the levees.

Woodall Rodgers Pressure Sewer

The Woodall Rodgers Pressure Sewer is located at the East Levee downstream from the Continental Street Viaduct and upstream from the Dallas Branch Pressure Sewer. The line was added to the floodway in 1979 when the Woodall Rodgers Bridge was constructed across the floodway.

Dallas Branch Pressure Sewer

The 1932 Dallas Branch Pressure Sewer is located at the East Levee just downstream from the Woodall Rodgers Pressure Sewer, and has a capacity of 256,731 gpm. A gated control structure manages the 12-foot Dallas Branch Pressure Sewer and consists of one gate 12 feet, 6 inches by 13 feet. This gate is operated by two floorstands that are interconnected and can be operated manually or with a portable power hoist.

PROPERTY TYPE 6: OUTLET GATE STRUCTURES

Figure F-40. Turtle Creek Outlet Gate Structure

Physical Description

Outlet gate structures are outspill structures that carry stormwater from the pressure sewers and pumping plant facilities out to the river channel to avoid flooding. Although they are connected to the pumping plants and pressure sewers, they are physically separated from these facilities by the levee walls, and their location of the inside of the overbank. The outlet gate structures carry discharged stormwater to the interior of the floodway via concrete box culverts (Figure F-40).

Components of the outlet gate structures include tall concrete towers that house gate hoists. These hoists operate to open or close the sluice gate below the tower. The tops of the hoists are accessible at an operation deck atop the tower. Outlet gate structures include concrete towers typically around 30 feet tall and 8 feet deep, while their width parallel to the levee walls can vary from 13 up to 50 feet. The operation deck is connected to the top of the levee wall by a narrow service bridge composed of a steel-plate girder deck and walkway enclosed by a metal-pipe handrail. The bridges vary in length according to the distance spanned, ranging between approximately 45 to 90 feet in length. It connects the top of the intake tower to the river side of the levees just below the crown, where the bridge is anchored into the levee side with concrete footings (USACE 1953, 1956c, 1969).

Below the base of the tower is an outlet opening of the sluiceway that carries stormwater from the pressure sewer or pumping plant to release it into a discharge channel within the overbank. The opening is below the grade of the overbank, has a concrete header at the opening, and flanking concrete wing walls. An automatic flap gate keeps the water from back-flowing into the landside of the levee. Open channels connect the outlet structure to the diversion channel.

The outlet gate structures are associated with all six pumping plant facilities, A (Able), B (Baker), C (Charlie), D (Delta), Hampton Road, and Pavaho; seven pressure sewers, Belleview, Old Coombs Creek, Coombs Creek, Dallas Branch, Lake Cliff, Turtle Creek, and Woodall Rodgers; Elm Fork Sluice; and the 60-inch E.B.I. Emergency Control Structure.

Structural History

The earliest outlet gate structures were constructed by the USACE during the 1950s strengthening project.

Existing Condition

All of the outlet gates observed within the floodway appear to be in good condition and no deterioration was observed. Several of the outlet gate structures had spray-painted graffiti, which is a superficial alteration that does not substantially alter the structures’ condition.

Property Type Resources

Pumping Plant A (Able)

Figure F-41. Pumping Plant A (Able) Outlet Gate Structure, with Concrete Valve Vents in the East Levee

The outlet gate structure base at Pumping Plant A consists of a 4- x 4-foot double box culvert that is 20 feet long (Figure F-41). The tower housing the gates, stems and floorstands is 4 x 11 feet in footprint and 44 feet high. The pump outlet pipes over the top of the levee are 39-inch diameter and 48-inch diameter pipes that are placed on a concrete pad at the knee of the pipe and covered by compacted backfill. Access manholes to the pipe valves are provided at the levee crown with ventilation slots near the top, housed in concrete boxes. The outspill opening consists of concrete cantilever-type retaining walls and a 6-inch concrete paved apron with a cut-off wall at the downstream edge to the discharge channel (USACE 1969).

Pumping Plant B (Baker)

Figure F-42. Pumping Plant B (Baker) Outlet Gate Structure

The outlet gate structure for Pumping Plant B consists of the outlet opening of four 6-foot-diameter gravity sluices that run through the levee to the outlet gate (Figure F-42). All four sluices have corresponding gate control valves housed within the concrete tower. The outlet structure consists of a concrete headwall, wingwalls, and apron (USACE 1969).

Pumping Plant C (Charlie)

Figure F-43. Pumping Plant C (Charlie) Outlet Gate Structure

Pumping Plant C has a gate control structure consisting of two 4- x 4-foot sluice gates with two 4- x 4-foot flap gates and corresponding control valves (USACE 1969) (Figure F-43).

Pumping Plant D (Delta)

Figure F-44. Pumping Plant D (Delta) Outlet Gate Structure

Like Pumping Plant C, Pumping Plant D has a gate control structure consisting of two 4- x 4-foot sluice gates with two 4-foot flap gates and corresponding control valves (USACE 1969) (Figure F-44).

Hampton Road Pumping Plant

Figure F-45. Hampton Road Pumping Plant Outlet Gate Structure

The Hampton Road Pumping Plant has a gate control structure consisting of one hoist and stem. The flap gates on the outlet are recessed at the back of retaining wingwalls. Large rip rap lines the top and sides of the end of the discharge channel.

Pavaho Pumping Plant

Figure F-46. Pavaho Pumping Plant Outlet Structure

The Pavaho Pumping Plant's Outlet Gate Structure lacks a hoist tower, but consists of a headwall, wing walls, and apron with flap gates on the outlets (Figure F-46). The discharge chamber consists of two 6- x 8-foot sluice gates for control of gravity flow with motor-operated floorstands to operate the gates located in the pump house.

Belleview Pressure Sewer

Figure F-47. Belleview Pressure Sewer Outlet Gate Structures

The USACE added the Belleview Pressure Sewer Outlet Gate to the 1928–31 pressure sewer in the 1950s. The sluice gates are housed in the 27-foot tall reinforced concrete tower with a 68-foot access bridge. The tower includes two interconnected floorstand-type hoists.

Old Coombs Creek Pressure Sewer

Figure F-48. Old Coombs Creek Pressure Sewer Outlet Gate Structures

The USACE added the Old Coombs Creek Pressure Sewer Outlet Gate to the 1928–31 pressure sewer in 1989. It consists of four 96 x 120-inch sluice gates housed within a 47-foot concrete tower structure with an 8-foot-wide access bridge (Figure F-48). The outspill opening consists of cantilevered retaining wingwalls, a paved apron with baffle blocks, and end sill. Also included are a structure consisting of a 6-foot-diameter storm sewer by adding a concrete box conduit 7 feet, 6 inches by 7 feet, 6 inches and an outlet structure with cantilever type walls and apron with 8-foot diameter flap gate. The city of Dallas replaced the foundation of the outlet gate's walkway in the 1990s (City of Dallas Flood Control District 2010).

Figure F-49. Coombs Creek Pressure Sewer Outlet Gate Structures

The Coombs Creek Pressure Sewer's Outlet Gate structure was built in the 1957 when the USACE constructed an additional pressure sewer line adjacent to the original 1928–32 line, to the north (Figure F-49).

Dallas Branch Pressure Sewer

Figure F-50. Dallas Branch Pressure Sewer Outlet Gate Structures

The USACE added the Dallas Branch Pressure Sewer Outlet Gate to the 1932 pressure sewer in the 1950s. Sluice gates 13 feet by 12 feet are contained within the 38-foot tall reinforced concrete tower. The bridge is approximately 45 feet long. The gate structure exits into a two-cell box conduit with flared concrete wingwalls and apron. The outspill openings have eight 6- x 6-foot flap gates.

Lake Cliff Pressure Sewer

Figure F-51. Lake Cliff Pressure Sewer Outlet Gate Structures

The Lake Cliff Pressure Sewer Outlet Gate is attached to the pressure sewer's 325-foot conduit, which is flanked on each side by a 6- x 8-foot box culvert that terminates at the gate structure (Figure F-51). The gate structure houses three 6- x 8-foot sluice gates and is 20 feet long by 27 feet, 6 inches wide at the base. The tower portion is 6 feet by 27 feet, 6 inches and houses three stems and hoists. The gate structure includes a three-cell, 8- x 8-foot box conduit 28 feet long, which ends at the outlet opening onto the spillway and discharge channel. This opening consists of flared concrete cantilever wingwalls and a 6-inch concrete-paved apron with a cut-off wall at the downstream edge (USACE 1969).

Turtle Creek Pressure Sewer

Figure F-52. Turtle Creek Outlet Gate Structures

The Turtle Creek Outlet Gate structures consists of four 10- x 10-foot-diameter outspill openings to the discharge channel (Figure F-52). Each sluice includes slide gates at the entrance to the gate-control tower, and four circular flap gates are installed at the portal head wall. The control tower is supplied with electrically-operated gate hoists located on the operation decks. A foot bridge is provided from the tower's operation deck to the top of the East Levee (USACE 1969).

Woodall Rodgers Pressure Sewer

Figure F-53. Woodall Rodgers Pressure Sewer Outlet Gate Structures

The Woodall Rodgers Pressure Sewer Outlet Gate Structure was added to the floodway in 1979 (Figure F-53). It is located upstream (to the northwest) from the Dallas Branch Pressure Sewer, and terminates at the East Levee.

Elm Fork Sluice Outlet Gate

Figure F-54. Elm Fork Sluice Outlet Gate Structure

The Elm Fork Sluice terminates at a gate control structure with one 36-inch diameter circular sluice gate and an outlet structure with trash bars (USACE 1969) (Figure F-54).

PROPERTY TYPE 7: INTAKES

Physical Description

Intake structures are large openings where water enters into the floodway's system of sluiceways and culverts. Intakes within the Dallas Floodway system are associated with the larger pumping plants and pressure sewers in the interior drainage system. Generally, when intake structures within the floodway are associated with the pumping plants, they adjoin the pump houses and consist of concrete approach wing walls and apron, a raking platform, and a trash rack. The aprons associated with the approach wing walls serve to prevent erosion by flowing water. The raking platform and trash rack serve to remove debris from the water held in sump areas before it is moved to the riverside of the levees.

The intakes in the Dallas Floodway are all constructed of poured concrete with metal piping on the interior. The associated wing walls and aprons are also concrete with metal raking platforms and trash racks.

Structural History

The intakes associated with the three 1928 pressure sewers, Coombs Creek, Dallas Branch, Belleview, were located far enough upstream in the watershed to develop sufficient head to discharge against flood stages in the floodway. Construction on the interior drainage began with the construction of these three earliest pressure sewers, and was completed by the USACE in the 1950s. Although the Turtle Creek and Lake Cliff intake structures were part of the original 1928 design of the floodway, they were constructed by the USACE in 1955. The Coombs Creek Intake structure was also constructed by the USACE in the 1950s.

Existing Condition

Only the intake openings could be observed in the field. All intake resources appeared to be in good condition.

Property Type Resources

Coombs Creek Intake

Figure F-55. Coombs Creek Intake

The 1957 Coombs Creek intake structure consists of an 18-foot, 6-inch semi-elliptical concrete conduit opening with a large, angled trash grate attached (Figure F-55). The structure is embedded into the side of the West Levee walls, and includes concrete wingwalls. A metal-pipe handrail sits atop these concrete header and wingwalls.

Turtle Creek Intake

Figure F-56. Turtle Creek Intake

Figure F-57. View toward Turtle Creek Intake and adjacent concrete wall of its diversion dam

The Turtle Creek Intake structure is located near Fairmount Street. It consists of a diversion dam across Turtle Creek, with a 175-foot concrete spillway overflow as well as two earthen overflows that are 100-feet in length (Figures F-56 and F-57). Downstream of the spillway overflow is a concrete stilling basin with two rows of baffle blocks. The entrance to the intake is covered by an angled trash rack, which leads to an underground poured concrete approach channel to the East Levee that is 7,800 feet long (USACE 1969).

Lake Cliff Intake

Figure F-58. Lake Cliff Intake

The Lake Cliff intake structure is a circular spillway located within Lake Cliff in the Oak Park neighborhood of Dallas (Figure F-58). A concrete, cylindrical stem structure rises from the lake bed and opens vertically and is flush with the surface water. The top of this opening is enclosed by a metal-pipe handrail. The base of the structure is then connected to a pressure sewer that runs under the lake and the adjacent Colorado Boulevard (USACE 1969).

PROPERTY TYPE 8: SLUICES AND CULVERTS

Physical Description

Sluices and culverts are water channels controlled by a gate utilized to direct water levels. The gravity sluices in the floodway are typically associated with a pumping plant and are located along the outer edges of the east and west levees. In the case of the Trinity River, the sluiceways are reinforced concrete, gravity structures that are located in areas prone to flooding. The sluiceways along the floodway all utilize automatic and manual gates.

A total of six sluices in the Dallas Floodway were inventoried and evaluated: the Elm Fork Sluice, Eagle Ford Sluice, Ledbetter Dike and Sluice, and three other sluices located in the Northwest Levee. These sluices were part of the original 1928–1932 construction or were included in the USACE's construction drawings for the 1950s enhancement project. All the sluices are controlled by an automatic flap gate as well as a hand operated sluice gate. There are two named culverts with associated Control Structure Gates (C.S.G.); the Grauwyler Road C.S.G. and the Ledbetter C.S.G. Both C.S.G.s help control flood water leading to pumping plants via the former Trinity River channel.

Structural History

In 1928, interior drainage was accommodated by a system of gravity sluices functioning alongside the culverts. The Elm Fork Sluice appears to have been original to the 1928–32 construction of the floodway. Construction plans in 1952 indicate that existing sumps in the locations of Eagle Ford Road and Ledbetter Drive were converted into culverts during the USACE's strengthening project in the 1950s (USACE 1952).

The USACE's 1950s improvements added the Eagle Ford Sluice, the Sluice and Dike near Ledbetter Drive, and the Grauwyler Road Culvert. Plans describe numerous culverts added throughout the floodway's interior drainage system, including three concrete box culverts under Vilbig Road, three under Hampton Road, and two under Westmoreland Road (USACE 1952).

The Northwest Levee originally included three ca. 1929 gravity sluices at the north, east, and southeast sections of the levee (USACE 1989). The sluices at the north and southeast locations were abandoned after the 1990 flood and were replaced by the addition of a second "new" pump station.

Existing Condition

Only the openings of the sluices and culverts could be observed in the field. These visible portions of the sluices appeared to be in good condition in terms of design, materials, and form.

Property Type Resources

Elm Fork Sluice

The Elm Fork Sluice is used to provide drainage water from the Elm Fork. This sluice consists of a 36-inch diameter gate-controlled channel, which passes through the East Levee near Bachman Lake. In the 1960s, the sluice was extended 36 feet on the inlet side and a new 15-foot-wide head wall structure was added. This included a control gate structure with one 36-inch diameter circular sluice gate and trash bars (USACE 1969; City of Dallas Flood Control District 2010).

Eagle Ford Sluice

Figure F-59. Eagle Ford Sluice

The Eagle Ford Sluice is located in the 2,000-acre Eagle Ford and West Fork area adjacent to the West Levee. The sluice is a two-cell 4-foot, 6-inch by 4-foot, 6-inch box conduit with an automatic flap gate and a hand-operated sluice gate (Figure F-59). It includes an outlet structure (USACE 1969).

Ledbetter Sluice and Dike (Canada Drive Sluice and Dike)

Figure F-60. Ledbetter Drive Dike and Sluice

Figure F-61. View of Ledbetter Drive dike

Located in the old channel of the West Fork of the Trinity River adjacent to the intersection of Kilgore Street and Ledbetter Drive, the Ledbetter Dike C.S.G. (also known as Canada Drive Sluice and Dike) contains two drainage ditches with an earthen causeway between them and two pumps within the berm. As designed, the Ledbetter Sluice and Dike is an earth dike with a maximum height of 30 feet with a 10-foot crown, seal coating, and a 3:1 side slope (Figures F-60 and F-61). Additionally, the Ledbetter Dike was designed to contain two 48 x 72-inch concrete sluices with hand-operated hoists to control the gates (USACE 1960). A later modification in the 1960s added a gate-control structure, a two-cell 4- x 6-foot conduit, and an intake and outlet structure for that conduit (USACE 1969). In the 1990s, automated gate operators were added to allow for remote operation and pressure transducers were installed for reading water levels on both the upstream and downstream sides (City of Dallas Flood Control District 2010). The Ledbetter Dike C.S.G. is connected to Pumping Plant D (Delta) via the old river channel of the West Fork of the Trinity River, where the stormwater collects at the pumping plant's sump for drainage into the floodway.

Grauwyler C.S.G.

Figure F-620. Grauwyler C.S.G.

The Grauwyler C.S.G., or culvert, located at Grauwyler Road, consists of an intake structure with a 60-inch diameter sluice gate at the opening of a 60-inch diameter concrete pipe culvert (USACE 1969) (Figure F-62). The original culvert was modified with a Control Gate Structure in 1960. As with the Ledbetter Dike C.S.G., automated gate operators to allow for remote operation and pressure transducers for reading water levels on both the upstream and downstream sides were installed in the 1990s (City of Dallas Flood Control District 2010). The Grauwyler C.S.G. is connected to the Hampton Pumping Plant via the old river channel of the Elm Fork of the Trinity River, where the stormwater collects at the pumping plant's sump for drainage into the floodway.

Northwest Levee Sluices

Both the "old" and "new" pump stations at the Northwest Levee in Irving include a sluice with a sluice gate through which water is diverted through the sump areas on the interior side of the levee wall and discharged to the Elm Fork Diversion Channel. A newer gravity sluice consisting of four 66-inch reinforced concrete pipes (RCP) was added to the area of the Loop 12 highway crossing the levee in 1974. This sluice drains water to the sump area along the toe of the Northwest Levee.

PROPERTY TYPE 9: SUMPS

Figure F-63. Sump ponds near Harry Hines Boulevard

Physical Description

The sumps are drainage ditches that collect local stormwater runoff and discharge it into culverts throughout the floodway system (Figure F-63). They are most often located next to the land side of the levee walls where stormwater collects, with a 15 to 40-foot distance between the levee toe and the sump. The sump's angled sidewalls range from 1:1 to 1.5:1 or 1:3 in slope, and are an average of 20-feet deep. Their shape can vary widely to accommodate the topography or structures in their location. Sumps are typically located adjacent to pumping plants, where large sumps exist outside of the levees. Low-lying sumps, or wetland sumps, often contain permanent water, and thus also contain vegetation.

Structural History

The original sumps constructed in 1928 consisted of the old channels of the Elm Fork, West Fork, and Main Stem of the Trinity River, as well as the borrow ditches created during levee construction. The overbank originally included sumps on both the river side of the floodway as well as the land side, but the river side sumps were removed during the USACE's strengthening project between 1953 and 1959 (USACE 1969). During that time, the USACE upgraded the sumps located at Eagle Ford Drive and Ledbetter Drive with gated culverts and dikes (USACE 1952). The city of Dallas also built six additional 6- x 6-foot concrete box culverts through the East Levee at Pumping Plant B (Baker) (Furlong et al. 2003).

Existing Condition

The sump areas appear to be in good condition overall.

Property Type Resources

In 1969, 373 sumps of all sizes were noted to exist throughout the entire Dallas Floodway system (USACE 1969). They primarily flank the land sides of the levee walls where stormwater collects for drainage into the diversion channel, and thus are primarily associated with the floodway's six pumping plant complexes (refer to Property Type 4 for discussions of these sumps).

The old Trinity River channel is still located in its original meandering path north of the East Levee wall to serve as part of the interior drainage system in the industrial district north of the floodway. It serves as a basin, or sump, in which to collect and divert stormwater to the pumping stations along the East Levee; Pumping Plant A (Able), Pumping Plants B (Baker), and the Hampton Pumping Plant.

Additionally, the Northwest Levee sump serves as the catch basin for the Northwest Levee's two pump stations. The sump area extends along the interior of the levee wall. It typically carries about 6 to 12 inches of water and is covered in mowed grass.

PROPERTY TYPE 10: EMERGENCY CONTROL STRUCTURES

Physical Description

Emergency control structures within the Dallas Floodway allow for the closure of two sanitary sewer lines that cross the East Levee, if necessary, due to excessive leakage or failure during periods of high water. The 60-inch emergency control structure associated with the Dallas Floodway was constructed at a 60-inch sanitary sewer crossing that flows under the East Levee. This structure contains a concrete bulkhead, which can be lowered into a closed position when necessary. The associated building is a one-story poured-concrete structure with a rectangular plan. The building is enclosed by a six-foot chain-link fence.

Structural History

The USACE added the 60-inch Emergency Control Structure at the end of the East Tie Back Levee in the late 1950s during the strengthening project of the Dallas Floodway.

Existing Condition

The emergency control structures appear to be in good condition overall. No changes were observed.

Property Type Resources:

60-inch E.B.I. Emergency Control Structure

Figure F-64. 60-inch E. B. I. Emergency Control Structure

The 60-inch E. B. I. Emergency Control Structure is located at the end of the East Tie Back Levee near Harry Hines Boulevard, due north of Regal Row (Figure F-64). The structure is adjacent to a sump pond and the Park Cities Water Treatment Plant. This facility is a bulkhead gate structure surrounding a 5-foot-high horseshoe conduit, and measures 5 feet, 8 inches by 6 feet in 9-inch-thick concrete (USACE 1969). The structure includes a small outlet gate structure including a concrete tower housing gate hoists for the sanitary sewer culvert below it (USCAE 1956a).

East Bank Interceptor

Figure F-65. East Bank Interceptor

The East Bank Interceptor is located at the East Tie Back levee along with the Emergency Control Building (Figure F-65). It is a valve structure housing a 36-inch diameter concrete pipe. It appears to be housed within a concrete platform at the sump ponds in this area. Access is restricted and the area is enclosed by a chain-link fence.

PROPERTY TYPE 11: NON-HYDRAULIC PHYSICAL FEATURES

The non-hydraulic physical features within the Dallas Floodway engineering system are those that do not contribute to the function of the floodway drainage system, but that physically contact the floodway's overbanks. These include bridges and viaducts, electrical towers and power lines, and a recreation area; these are illustrated in Figure F-66. The bridges, viaducts, and electrical power lines cross over the floodway but include piers that set into the floodway's overbanks.

Bridges

Twenty-two bridges, including the ruins of a former bridge, cross over the floodway (Table F-2). The footprint of the bridges' supporting piers within the overbanks varies by bridge, but generally consists of concrete footings underneath the bridge spans (Figure F-67). These footings do not impact the function of the floodway's overbank area during flood events.

Many of these bridges existed before the Dallas Floodway was created or were built between its initial construction and the USACE's strengthening improvements completed in 1959. Although the bridges are physical features within the floodway, they serve as transportation connections of the greater city of Dallas and do not enhance or detract from the floodway's flood control engineering operation.

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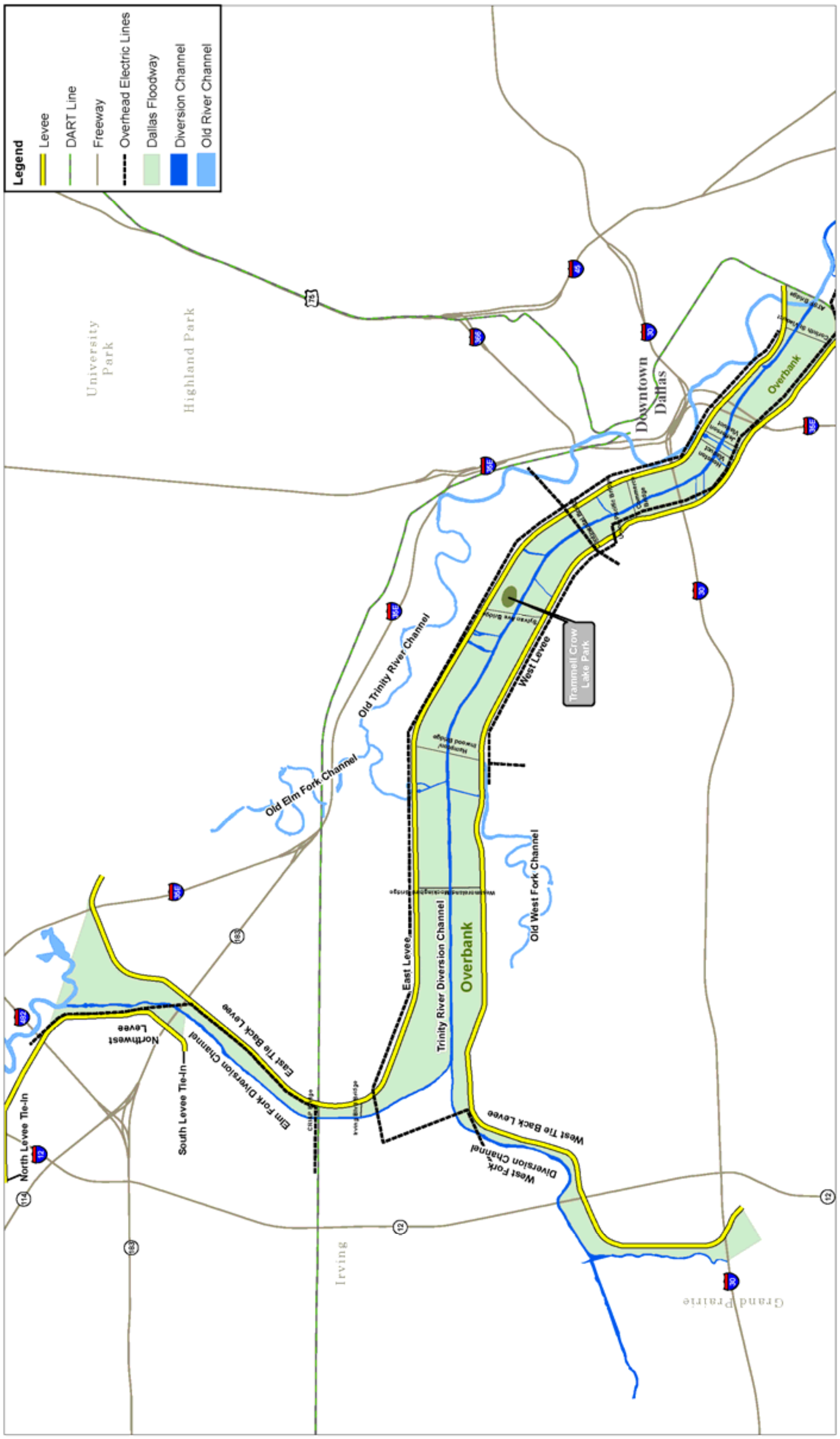

Figure F-66. Non-Hydraulic Physical Features within the Dallas Floodway

Table F-2. Bridges Over the Dallas Floodway

Site Description	Date of Construction	Significance
AT&SF Railroad Trestle	1926	Significant for Association with Design
DART Bridge	1992	Not Significant
Corinth Street Viaduct	1931	Significant for Association with Events
Cadiz Street Viaduct (eastbound side of IH-35E/U.S. 67/U.S. 77)	1929–1931	Not Significant
IH-35E/U.S. 67/U.S. 77 Westbound Bridge	Circa (ca.) 1956	Not Significant
Jefferson Viaduct	1975	Not Significant
Houston Street Viaduct	1911	Significant
IH-30 (Tom Landry Fwy) Bridge	Ca. 1960	Not Significant
Commerce Street Viaduct	1930	Significant for Association with Events and Design (2001)
Union Pacific Railroad Bridge (formerly the Southern Pacific Railroad Bridge)	Pre-1930	Significant for Association with Design
Margaret Hunt Hill Bridge	Under construction	Not applicable (N/A)
Continental Street Viaduct (formerly the Lamar-McKinney Viaduct)	1934	Significant for Association with Events and Design (2001)
Sylvan Avenue Bridge	1958	Not Significant
Hampton Road Bridge	Currently undergoing reconstruction	Not Significant
Westmoreland Road Bridge	1990	Not Significant
SH 356 Bridge	1963	Not Significant
Chicago, Rhode Island, and Pacific Railroad Bridge/DART Bridge	Ca. 1930s; later alterations	Significant for Association with Design
Proctor Street Bridge	Ca. 1930s	N/A (Demolished in mid-1980s; remnants only)
SH 183 (J. W. Carpenter Fwy) Bridge (over West Levee and Northwest Levee)	1959	Not Significant
Stemmons Fwy/U.S. 77 Bridge	Ca. 1959	Not Significant
SH 482 (Storey Ln) Bridge (over Northwest Levee)	1942, 1982	Not Significant
Loop 12 (Walton Walker Blvd) Bridge (over West Levee and Northwest Levee)	1969	Significant

Figure F-67. Union Pacific Railroad Bridge, Looking Southwest

Power Lines

Power lines and electrical towers were included in the original plans set forth in 1928 and again were accommodated in the USACE's plans in 1955. They currently still exist within the floodway overbank. Many of these towers and lines have since been replaced with upgraded structures since the USACE's improvements in the 1950s, as necessary. The towers' footprints within the overbank consist of single piers set into concrete footings (Figures F-68 and F-69). Like the bridges, the power lines are non-hydraulic physical features within the Dallas Floodway that neither enhance nor detract from the floodway's function as an engineering system for flood control.

Figure F-68. Power Line on the Overbank next to the West Levee due South of the Commerce Street Viaduct, Looking Southeast

Figure F-69. Power Line on the Outside of the East Levee, Looking Southeast

Parks

Although parks were part of the original floodway plans for the overbank in 1928–32 and again in the 1950s, they were planned as non-hydraulic physical features that do not contribute directly to the Dallas Floodway's engineering operations. Rather, the existing park and designated open spaces within the overbanks are neutral features that neither improve nor hinder the floodway's operations. These areas are the Dallas County Open Space and Trammell Crow Lake Park.

Dallas County Open Space has a designated 65-acre area adjacent to the West Fork, near Hunter-Ferrell Road and Singleton Boulevard. This area is undeveloped, but provides public access to fishing, canoeing, and boating on the West Fork of the Trinity River (USACE 1989).

Trammell Crow Lake Park, located at 3700 Sylvan Avenue, was constructed in 1985 by the city of Dallas (Figure F-70). The park is approximately 20 acres, and includes a 2.5-acre pond, walkways and benches, a picnic area, landscaping, an open field with sculptures, and a hard-surface parking area adjacent to Sylvan Avenue, due west. The park also has boat ramp access to the Trinity River diversion channel, which runs on the south side of the park. The grassy field adjacent to Trammell Crow Lake has concrete sculptures of life-sized cows. Development of the Trammell Crow Lake Park involved in-filling the land and planting trees for landscaping (USACE 1989).

Figure F-70. Aerial View of Trammell Crow Lake Park (Google Maps)

ANALYSIS

The following sections include an analysis of the significance and ability to convey significance of the Dallas Floodway. It explains the relationship of the resource to types of significance, and proposes a period of significance. The assessment of its ability to convey significance identifies the essential physical features of the Dallas Floodway and is based on a comparative analysis of historic features and existing conditions. Ability to convey significance is assessed for the overall resource as well as for individual structural components.

This analysis categorizes the Dallas Floodway as a single resource system. The floodway comprises an array of engineered components (10 different types of hydraulic physical features) that were designed and configured as one system to prevent floods. The floodway is one large structure made up of numerous interconnected structural components related by function and physical development. The components of the floodway function together to collect, drain, and contain water. The floodway's hydraulic physical features (property types 1–10) are the engineering components that make it operate as a unified unity to control floodwater and bypass urban Dallas. The Dallas Floodway would operate regardless of the presence of the non-hydraulic physical features, such as the bridges and power lines, which are not engineering components of the floodway's operation. Therefore, this inventory analyzes the Dallas Floodway as one contiguous entity that includes all of its underground and aboveground components as one engineering system working in concert.

Significance

The Dallas Floodway has significant historical associations with flood control and the history of city planning and community development in Dallas. It comprises a major flood control and reclamation project that facilitated the physical expansion and growth of Dallas through the middle of the twentieth century.

The floodway possesses local significance in the area of community planning and development for providing regional flood control and stormwater management that was instrumental to the development of Dallas and surrounding communities. The most devastating flood in the city's history occurred in May 1908 and catalyzed city planning in Dallas. At the time of the flood, the city had grown haphazardly on the east side of the Trinity River and was a tangle of streets and railroads. The river isolated the communities to the west and represented a barrier to the growth and development of Dallas. *Dallas Morning News* publisher and civic activist George Dealey persuaded the city of Dallas to hire landscape architect and city planner George Kessler to develop a city plan for Dallas. Flood control and reclamation of the Trinity River, accomplished through a massive engineering program, was at the heart of Kessler's 1911 *A City Plan for Dallas*, the first formal city plan for Dallas. A large-scale public works program remained essential to Kessler's update of the city plan in 1920 and to the 1926 Ulrickson Committee's bond proposal plan for financing a myriad of citywide improvement projects.

By the late 1920s, Dallas ultimately settled on a course of action for harnessing the Trinity: to contain a relocated and channelized river within earth levees with the "necessary appurtenant structures" in order to reclaim more than 10,000 acres in the Trinity River floodplain (Myers, Noyes and Forrest Engineers 1926). As outlined in the Ulrickson Committee's plan, the floodway system was the primary part of a comprehensive plan for public works and civic improvements throughout Dallas that would be financed by property owners within the area to be reclaimed (i.e., bonds issued by the flood control districts), the city of Dallas, the county of Dallas, the railroads, and the utilities. Construction of the Dallas Floodway began in 1928, but the Great Depression thwarted the completion of the entire system as planned, resulting in a two-phase development of the floodway. During the second phase of development between 1953 and 1959, the USACE Fort Worth strengthened the levee system, which had degraded under a lack of funding to maintain the structures, and enhanced the flood control drainage systems by adding three pumping plants and building the pressure sewers that had been left out during the cash-strapped first phase of development. Since its completion in 1959, the Dallas Floodway has effectively controlled flooding, enhancing the safety and welfare of Dallas' citizens and protecting structures (including bridges and viaducts of state and Federal highways) and property.

While the Dallas Floodway was integral to regional flood control and Dallas city planning efforts, just as importantly, it was instrumental (and continues to be) to the actual physical growth and development of Dallas. The floodway facilitated the growth of Dallas by providing thousands of acres of reclaimed land for development. Some development occurred in the vicinity of the floodway during the 1940s and 1950s, including initial commercial development in the Trinity Industrial District, and commercial and residential development in West Dallas. Substantial development occurred after the USACE Fort Worth District built the missing flood control drainage systems to complete the system in the late 1950s. Consequently, development in the Trinity Industrial District exploded in the 1960s and was nearly fully developed by the early 1970s. Stemmons Freeway, an important north-south connector in Dallas, is entirely within the reclaimed area. Stemmons Freeway enhanced the value of the reclaimed land adjacent to it and was a contributing factor to its commercial and industrial development. Trammell Crow and John and Storey Stemmons realized the enormous development potential of the reclaimed areas along the freeway, and along with the Industrial Properties Association, partnered to build several buildings in the 1950s and 1960s that to this day, contribute to the economic vitality of Dallas. They include the Decorative Center, Furniture Mart, Trade Mart, Market Hall, and Apparel Mart. Other important developments in this area include the Anatole Hotel and the University of Texas Southwestern Medical Center and School. The Dallas Floodway changed the face of the city by providing large tracts of dry land that otherwise would not have been capable of meaningful development.

The Dallas Floodway does not have a direct association with the lives of persons significant in our past. Several individuals who made important contributions to the history of Dallas were involved in the Dallas Floodway project. They include George Dealey, Leslie Stemmons, and John Stemmons. Nonetheless, the Dallas Floodway is not the resource that best illustrates the respective important achievements and productive lives of these individuals.

George Dealey had an instrumental role in the development of the floodway. Historical records indicate he was the first to champion the idea of reclamation of the Trinity River for development. He used his newspaper, the *Dallas Morning News*, to raise support for the project and organized a few different planning organizations to spearhead local efforts. Nonetheless, Dealey's contributions to the city of Dallas are many, and the Dallas Floodway is likely not the best example of his historical contributions. The structure itself does not directly illustrate the important achievements of Dealey.

Leslie Stemmons is associated with the development of the floodway system for his role in the establishment of the Dallas Floodway as the creator and supervisor of the City and County of Dallas Levee Improvement District, which developed the Joint Plan of Reclamation and oversaw management of floodway construction between 1928 and 1932. Within the history of Dallas, Leslie Stemmons is also noted as an important business leader and real estate developer. He was the developer of several subdivisions in Oak Cliff, owner and director of the Atlas Metal Works in West Dallas, and director of two other companies (Maxwell 2009b). Thus, although Leslie Stemmons' association with the Dallas Floodway is historically significant, his association with the floodway falls just short of the level of significance required for this historic persons who made contributions to our historybecause his most significant achievements in community development are better illustrated by his other projects in Dallas.

John Stemmons, son of Leslie Stemmons, helped to create the Dallas County Flood Control District, which operated and maintained the Dallas Floodway between 1945 and 1968 and contributed to the cost of strengthening the levees and constructing the missing interior drainage structures in the late 1950s. John Stemmons made important contributions to the history of Dallas through real estate development. John was president and part owner (along with his brother, Storey) of the Industrial Properties Corporation, which developed the Trinity Industrial District into an important business and industrial center in Dallas. The Industrial Properties Corporation, under the helm of John and Storey Stemmons, partnered with commercial real estate developer Trammell Crow in a number of successful commercial real estate ventures on reclaimed land in the Trinity River valley. Their multiple mart developments established Dallas as a leader in wholesale trade (TxDOT 2004, 27). As such, one or more properties associated with their complex of wholesale showrooms, such as Furniture Mart and Trade Mart, or the Trinity Industrial District are the best representatives of the important local historical contributions of John Stemmons, and not the Dallas Floodway. John Stemmons' most significant achievements in community development are not illustrated by the floodway.

In consideration of association with design, the Dallas Floodway is a significant example at the state level of an engineering system designed for flood control in Texas and development enhancement in Dallas. Although the Dallas Floodway is not exceptionally innovative in terms of engineering, it does embody distinctive characteristics of a type, period, and method of construction. The Dallas Floodway moves massive amounts of floodwater rapidly through a highly developed urban area using basic floodway design concepts that have remained largely unchanged in principle but radically changed in execution due to the advances in the application of the science of hydrology. The entire Dallas Floodway as a hydraulic engineering machine clearly illustrates a pattern of features common to floodway resources through its presence of levees, pumping plant complexes, overbanks, pressure sewers, sluices, and all other hydraulic physical features that contribute to its function as a flood control machine.

The Dallas Floodway expresses the visual, associative, and spatial qualities common to large-scale resources that are designed for flood control. As no two floodways are alike, the Dallas Floodway is individually tailored to meet the specific needs of moving Trinity River floodwaters from Dallas' downtown and adjacent areas. Like all levees, the Dallas Floodway's levees are continuous earthen berms that extend along the corridor of a body of water. A unique feature of the Dallas Floodway is the nearly one-half-mile-wide overbank between the two levee walls. The availability of the former floodplain during the 1920s made this distance possible, and it is a character-defining feature as a result.

The Dallas Floodway was designed to be an engineering machine equipped to handle one of the nation's highest-risk areas prone to flooding. To this end, the entire Dallas Floodway system illustrates levee design and floodway engineering between 1928 and the 1950s. The floodway's first phase of construction consisted of steep 2:1-slope levee walls and four relatively small pumping plants. The USACE's strengthening project illustrates the completion and enhancement of the 1920s engineering and design standards through its addition of two more pumping plants and additional pressure sewers, intakes, sluices, and outlet gate structures for all six pumping plants. Additionally, the USACE's 1950s strengthening project exceeded the common 100-year SPF or 500-year SPF by improving the levees to an exceptional 800-year SPF to ensure protection from the floodwaters of the volatile Trinity River, thus enhancing the original design. Although the 1929–1932 levee design is not entirely visible underneath the USACE's 1950s improvements, this historical evolution of engineering is visible through the four 1929 Pumping Plants (Able, Baker, Charlie, and Delta), all of which are still present within the floodway.

Thus, although the Dallas Floodway's engineering may have employed well-established industry standards and designs of the 1928–1959 period, the floodway's historic context demonstrates that the system was a singular and distinguished engineering achievement on the local level in Dallas, and at the state level in Texas. For these reasons the Dallas Floodway has been recognized by the Texas Section of the American Society of Civil Engineers for its reflection of "the practical application of civil engineering practice with respect to providing a solution for a regional flooding problem that aided future economic development of the Southwest region" of the United States (Texas Section ASCE 1989).

The floodway is not a resource that has yielded or is likely to yield information important in history or our understanding of it. There is a plethora of historical documentation about the planning and construction of the floodway and reclamation that provide a comprehensive understanding of the individuals and historical, political, and economical issues behind the project's development. Likewise, historical records and the floodway itself document the design, construction, operations, and technologies of flood control engineering.

Period of Significance

A period of significance is "the length of time when a property was associated with important events, activities, or persons, or attained the characteristics" which make it significant. The period of significance of the Dallas Floodway is from 1928, the year construction began on the floodway, to 1959, the year construction was completed on the USACE's strengthening of the system.

The floodway is associated with the historic trend of flood control and reclamation of land for commercial and industrial development in Dallas; therefore, the period of significance is the span of time in which the floodway actively contributed to this trend. In this case, it is necessary to consider the span of time in which the floodway achieved the character on which this significance is based. The significance of the floodway began in 1928, when construction started on the levees and other components of the floodway. The period of significance extends to 1959, when construction of the entire floodway system as originally designed was completed. It does not end in 1932, when the construction of some of the original floodway components was finished because the Great Depression prevented completion of all the structural components necessary for the entire engineering system to work, i.e., prevent floods and drain the land for reclamation. While the levees held in the floods of 1935 and 1942, these floods demonstrated the poor condition of the system and the likelihood it would fail in the near future. Likewise, development was not practicable within the entire 10,000-plus-acre reclamation area after 1932 because of the incomplete nature of the system. Full implementation of a flood control system and reclamation for Dallas was not achieved until the USACE constructed the remaining components of the floodway and added structures to increase the capacity of the floodway. Upon completion of the floodway in 1959, Dallas finally secured long-term flood protection and thousands of acres of reclaimed land for commercial and industrial development; thus, 1959 terminates the period of significance.

Ability to Convey Significance

A resource that conveys its historic significance possesses several, and usually most, of these seven aspects: location, design, setting, materials, workmanship, feeling, and association.

> A ***character-defining feature*** is a prominent or distinctive aspect, quality, or characteristic of a historic and cultural resource that contributes significantly to its physical character.
>
> An ***essential physical feature*** is a feature that defines both *why* a historic and cultural resource is significant and *when* it was significant. Essential physical features are the features without which a historic and cultural resource can no longer be identified.

To convey its historic identity, it is not necessary for a resource to retain all its character-defining physical features or characteristics, but it must retain its *essential physical features*.

As an engineered flood-control system, the Dallas Floodway's primary significance is its impact on community planning and development by enabling reclamation of the natural Trinity River floodplain. Its character-defining features are those that contribute to the Dallas Floodway's historic significance for associations with events and design. They include the following:

- Water features: diversion channel, discharge channels, and sump areas
- Spatial organization: the floodway's footprint in the city of Dallas, the width of the floodway between the levees, and its relationship with the adjacent urban areas outside of the levees
- Vegetation: planted or natural growth that allows the levees and the overbank areas to be unencumbered to aid the floodway system operations
- Topography: the approximate height of the levee walls that bracket the low, flat areas of the overbank area
- Circulation: the maintenance roadways at the levee crowns and toes
- Structures: the six pumping plants, pressure sewers, associated outlet gate structures, sluices, intakes, dikes, and emergency control structure

The essential physical features *required* to identify the Dallas Floodway are as follows:

- The levees (East and West), comprised of trapezoidal cross sections of earthen material designed to contain stormwater inside a floodway;
- The diversion channels, to divert and redirect the natural flow of the Trinity River and its Elm and West Forks; and
- The overbanks, to contain stormwater in concert with the levees.

These physical features are essential because they define why the Dallas Floodway is significant as a flood control structure built to protect Dallas from floodwaters and allow community development. These physical features are also essential to defining when the floodway was significant. The historical appearance of the floodway was defined by the East and West Levees, the diversion channels, and the overbanks. This is illustrated when one compares aerial photographs of Dallas before the construction of the levees and diversion channels and clearance of the overbank (Figure E-8), during their construction in 1929 (Figure E-9), and the present character and appearance of the floodway (Figure E-10). Without these essential physical features, the Dallas Floodway cannot effectively convey its significance. Without either the East or West Levee, it is not a floodway. Without the diversion channel, there would be no rechanneled Trinity River. Without the overbanks, there is not a way to contain the volume of floodwaters between the levees.

Other physical features of the floodway comprise the aboveground interior drainage structures (i.e., the pumping plants, sluices, outlet gate structures, intakes), floodwater retention features (the old Trinity River channel), and the transportation nodes (bridges). These features are not essential physical features because they are not necessary to the identification of the floodway as a hydraulically-engineered system for flood control. The interior drainage structures function to convey water from the outside of the floodway to its interior. The old Trinity River channel functions as part of the interior drainage. The interior drainage structures support the eligibility of the Dallas Floodway through their function and design, but the Dallas Floodway can be identified easily regardless of the presence or absence of any particular interior drainage structure, which is dwarfed by the immense size and scale of the essential physical features that define and dominate the identity of the resource (Figure F-71). The bridges are also physical characteristics of the floodway even though they are not a component of the floodway itself and do not contribute to its function. The presence or absence of any particular bridge is not essential to convey the significance of the floodway. Although the bridges are visible across the floodway, they are relatively small in scale compared to that of the essential physical features of the floodway, which encompass 5.7 square miles.

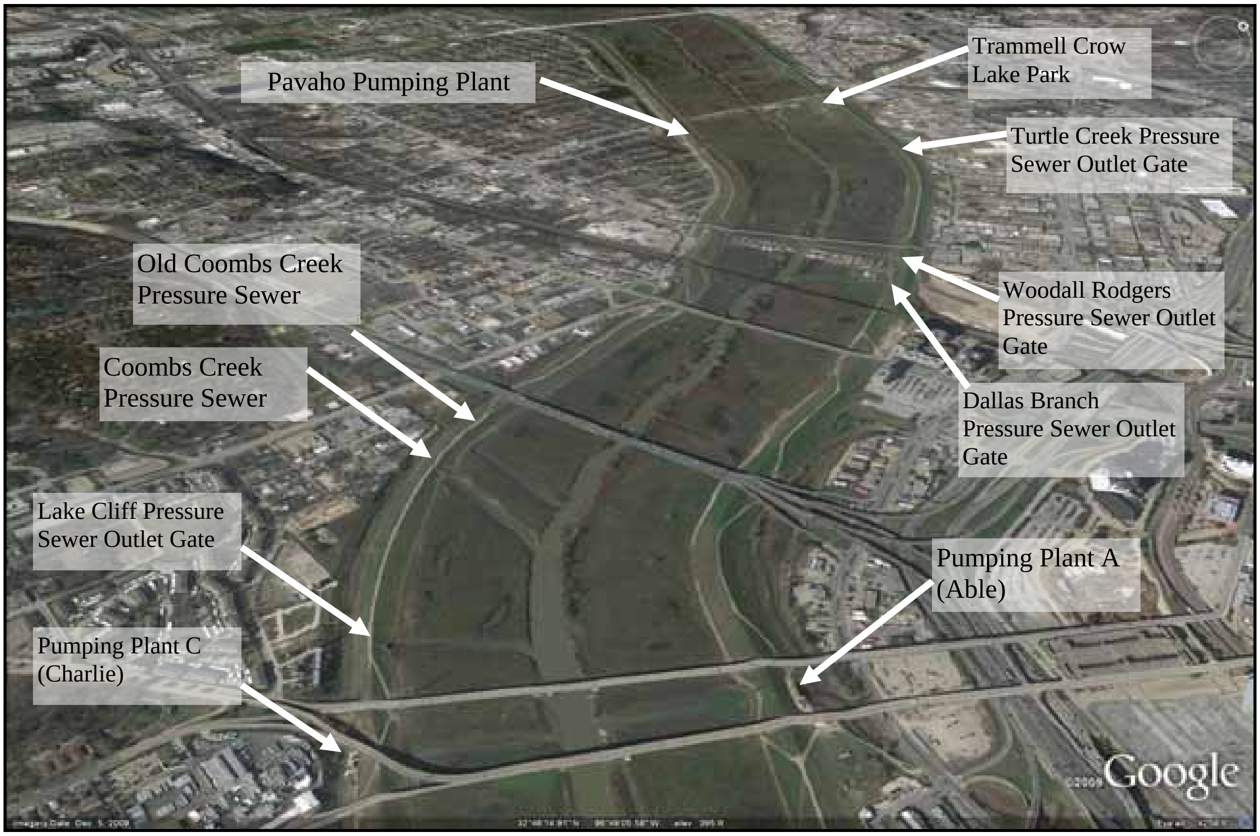

Figure F-71. Aerial view of Dallas Floodway Looking Northwest above Jefferson Viaduct

The Northwest Levee is not an essential physical feature because it does not help to identify when and why the Dallas Floodway is significant. If the Northwest Levee was removed, the Dallas Floodway could still be identified as the same engineered flood control system that was under construction in 1929 (Figure E-9). The same could not be said if either the East Levee or West Levee was removed. Furthermore, even though the Northwest Levee was initially related to the original floodway, it physically and operationally became divorced from the Dallas Floodway by its exclusion from the USACE enhancement project. The Northwest Levee was “officially” separated from the Dallas Floodway in 1968, when its operation and maintenance was transferred to the city of Irving as a hydraulic feature related to that city’s flood control system (Skipwith et al. ca. 2007).

. A resource’s significance and essential physical features are the basis for determining which aspects its ablility to convey significance are most important. The aspects that are more important for the Dallas Floodway to convey its historical significance for association with events are *Location*, *Setting*, *Feeling*, and *Association*. In order for the Dallas Floodway to convey its significance in engineering , retention of *Design*, *Materials*, and *Workmanship* are more important than the other aspects. The Dallas Floodway is a dynamic and continuously functioning engineering system. As such, it requires routine maintenance and periodic repairs and upgrades. The assessment of the ability of the resource to convey its significance, especially its design and workmanship, takes this into consideration.

Ability to Convey Significance for Association with Events

Location

The floodway retains the ability to convey significance the aspect of *location*. The diversion channels and overbanks are in their original locations and although some channel erosion has occurred due to the dynamic nature of these hydraulic physical features, they generally follow their original alignment. No segments of the East or West Levees have been moved or re-aligned to take a different course. During the strengthening project between 1953 and 1959, which is within the period of significance, the USACE reestablished the 3:1 slopes from the original design by adding new layers of dirt fill to the crown and to the river side of the East and West Levees. As demonstrated in the cross sections of the working drawings (see Figure E-12), this shifted the levee crown’s center alignment by an average of 20 feet toward the river channel. However, the levees occupy the same base as to when they were constructed in 1929–1932; the strengthening of the East and West Levees added to the existing base by adding fill on the river side. The geographical linear footprint of the levees has not changed since completion of the USACE’s strengthening project in 1959.

All the other hydraulic physical features of the floodway, such as the sluices, pressure sewers, and pumping plants, remain on the original sites in which they were built. Because the essential physical features as well as the other hydraulic physical features of the floodway are in the same place as where they were constructed, the floodway retains its ability to convey its significance in local community planning and development from 1928 to 1959 through location.

Design

For its historical significance under for association with design, design considers the larger-scale qualities of the Dallas Floodway design, such as the scale, configuration, and original intent and functionality, for its purposes in flood control and urban development. The important design elements of the Dallas Floodway are the levees, diversion channels, and overbanks, which collectively work to prevent flooding. In its earlier period of development, the floodway was designed with earthen levees constructed on each side of a relocated Trinity River and the river’s confluence with the West and Elm Forks. The diverted route of the river was designed as a straight channel excavated one-half mile west of its original snaking course, in the middle of the floodplain (the overbanks), which was cleared of obstructions save for a few telephone and power lines and the piers of existing and future vehicular or railroad bridges and viaducts. The new confluence of the West and Elm Forks with the Trinity River was also placed in the middle of the floodplain. The spatial arrangement of all the hydraulic physical features comprised a long and broad corridor of open land contained within embankments (the levees) that cut through the dense urban environment of Dallas: its central business district on the east and the communities of Oak Cliff and West Dallas on the west.

During the 1950s period of enhancement of the Dallas Floodway by the USACE, the intent and functionality of the design of the floodway remained the same as in the earlier period of its development. As such, the design of the essential physical features for the 1950s enhancement shares the same overall design attributes from the early period of floodway development: trapezoidal earthen levees containing a broad corridor of flat, nearly open land (the floodplain) through the city, and diverted river channels on straight alignments in the middle of the floodplain.

The Dallas Floodway retains all the hydraulic physical features from its original *design*. Most importantly, the essential physical features of the floodway—the East and West Levees, the diversion channels, and the overbanks—are intact. However, the configuration of two segments of the levees has been altered by the addition of two new pipelines within the past ten years (Figure F-72). Earth and gravel cover the pipes as they extend over the levees. The pipes are approximately four feet tall and 12 feet wide. The pipes are then buried beneath the floodway proper (the overbanks). Given their relatively small size and scale in comparison to the levees (28 feet high and 10.9 and 11.7 miles long [West and East Levee, respectively]), the pipelines have an inconsequential impact on the design of the floodway (Figure F-73).

Figure F-72. View South-Southwest of the Overbank Showing one of the New Pipelines on the Riverside Wall of the East Levee

Figure F-73. Aerial View Looking West Showing Scale of Pipelines Relative to Dallas Floodway

The addition of the New Frazier Dam in 1965 comprises a relatively minor modification to the Elm Fork Diversion Channel. The city of Dallas built the dam for enhanced control of runoff. As a straight, dredged channel to carry redirected floodwaters, the Elm Fork Diversion Channel still physically and functionally performs as originally designed. No design changes to the Trinity River or West Fork diversion channels were observed.

The original design for the floodway took into account crossings by five major viaducts and four minor roads, as one of the goals of preventing floods was to allow more reliable connections between Dallas and West Dallas and Oak Cliff. The levees were originally designed around the existing Houston Street Viaduct (Figure F-74), and the foundation of the viaduct was protected during construction of the main diversion channel (Myers, Noyes and Forrest Engineers 1926). During the 1950s strengthening project, the USACE designed the crown of the levees to be at or below the superstructure of existing bridges and viaducts and the side slopes to envelope existing bridge piers (USACE 1954b) (Figure F-75). The design also took into account the structures of bridges and roads that were under construction in the mid 1950s: U.S. 67 (the current westbound IH-35E/U.S. 67/U.S. 77), the Dallas Fort Worth Turnpike (the current IH-30), and the Sylvan Avenue at-grade crossing.

Several more bridges (e.g., Jefferson Viaduct, Westmoreland Road, Irving Boulevard, SR 356, westbound SH 482, Loop 12, and DART) presently cross over the floodway, but the heights of the new bridges are nearly the same as that of the older bridges, so the spatial relationship of the new bridges to the floodway is quite similar. The decks of the post-1959 bridges are several feet above the crown of the levees (Figure F-76). Nonetheless, construction of these bridges did not alter the form, structure, or plan of the levees or other floodway component structures. Furthermore, the City and County of Dallas Levee Improvement District and the Dallas County Levee Improvement District No. 5 accounted for future bridges to cross over the floodway, and as such, specified in the Joint Plan of Reclamation certain design guidelines for bridges to protect the function of the levees, diversion channels, and overbank. The plan states: "Existing and future structures such as bridges, viaducts, trestles, etc., crossing the floodway shall be without embankment between the levees with a channel span of approximately 150 feet, the balance of the structure to be trestle or pier and girder construction. The bottom of the superstructure of all bridges or other structures crossing the floodway shall be at or above levee grade and the structures shall be free from longitudinal bracing below levee grade" (Myers, Noyes and Forrest Engineers 1926). The foresight of the districts to plan for and provide specific design attributes for the inevitable addition of more bridges over the floodway has ensured the historic design and overall historic character of the floodway remain intact.

Figure F-74. View Northwest of Arch of Houston Street Viaduct Spanning the East Levee

Figure F-75. View Northwest of Continental Street Viaduct (behind Woodall Rodgers Pressure Sewer Outlet Gate) Spanning the East Levee

Figure F-76. View East-Southeast of the Houston Street Viaduct, Jefferson Boulevard Viaduct, and I-35 Bridge on and Over the West Levee

The intent and functionality of the design of the floodway has remained the same as in its period of development between 1928 and 1959. Although a number of new physical features have been added to the floodway, they are largely consistent with the original design qualities and attributes of the floodway system. The Dallas Floodway still retains a sufficient amount of its historic *design* elements to convey significance for its historical associations with community planning and development in Dallas from 1928 to 1959.

Setting

Because much of its historical significance derives from the impact of the flood control system on the urban development of the city, setting must consider the intent of the Dallas Floodway to reclaim land for the expansion of the metropolitan area. During its early period of development, areas adjacent to the downstream end of the floodway consisted of urban commercial and residential development. The mid-rise buildings of downtown Dallas rose to the east beyond the vacant hydraulic fill area. Bordering the west side were the residential neighborhoods of Oak Cliff and West Dallas. Largely undeveloped areas bordered the upstream sides of the floodway. By the later part of the period of significance, the development of the existing areas had intensified. A few high rises punctuated the Dallas skyline. Commercial and industrial development had expanded farther west, adjacent to the upstream half of the floodway. Only a small amount of industrial development had occurred in the hydraulic fill area.

At the present time, the setting surrounding the floodway exhibits both continuity and change. The floodway system still defines the western edge of the business district and also delineates the east boundary of the communities of Oak Cliff and West Dallas. The floodway itself comprises open space between the two urban areas, linked by road and rail bridges. This same type of urban environment exists today, only the density of development in the communities on either side of the floodway has changed. Since 1959, the hydraulic fill area was completely developed into the Trinity Industrial District, and commercial, industrial, and institutional properties fill in the areas all along the north side of the floodway in great density. West Dallas completely encompasses the area south of the floodway, with low-rise residential, commercial, and industrial properties.

Setting often reflects the basic physical conditions under which a resource was built and the functions it was intended to serve. The intent of the Dallas Floodway was not only to provide an open swath of land next to the city to contain discharged stormwater, but also to reclaim an otherwise undevelopable floodplain to enlarge the surface area of buildable land near Dallas' central business district so the city could continue to grow. Thus, it is only natural that the setting of the area surrounding the floodway has changed since the USACE completed construction in 1959. No urban landscape is frozen in time. The urban environment surrounding the floodway evolved between the first and second phases of construction of the floodway, and it continued to evolve after the system was completed in 1959. Land reclaimed as a result of the floodway system was intended to be developed, and indeed, has been.

Considering the dynamic urban environment within which the floodway was built and continues to exist, the Dallas Floodway retains the *setting* to convey its significance with community planning and development in Dallas between 1928 and 1959.

Materials

Because the historical significance of the Dallas Floodway is largely derived from its function, the assessment of materials evaluates whether changes to the use of materials have affected the function or historic character of the floodway and its essential physical features. The original materials of the levees consisted of compacted clay soil covered with grass. The source of the fill used in the original construction of the levees is not known, but for the USACE strengthening project, the fill came from the material that was removed from the river side crown of the existing levees and from excavation of existing and new sumps in the floodway. After the levees were strengthened in the 1950s, their crowns were widened and graded for a roadway. Riprap, instead of grass, covered the river side slopes of the levees under bridges over the floodway. For the Trinity River diversion channel, riprap was used to line portions of its dirt banks. Because preparation of the overbanks meant clearing the floodplain of timber, brush, and other obstructions, the historical materials of the overbanks comprise dirt and grass.

The materials of the levees has been somewhat diminished, as some fill has been removed and replaced with new fill in selected segments of the levees where erosion, cracking, or subsidence has occurred. New fill material has been used to stabilize the affected areas; however, the majority of fill used to construct the levees during the period of significance still makes up the majority of the existing levee system. In some cases, fill for repairs is obtained from borrow pits in the overbank. In the case of the late 1990s project that flattened the river side levee slopes to 4:1 on the East and West Levees downstream of the Union Pacific Railroad Bridge and Continental Street Viaduct, respectively, excavated material came from overbank borrow pits and the widening of the Trinity River diversion channel downstream of the Continental Street Viaduct (HNTB 2009). Grass covers the areas of new fill, so the non-historic material is not visible.

Pylons of some of the post-1959 bridges pierce the levee walls. In addition, the sides of the levees where the bridges cross them have been covered in concrete or riprap. As a result, original fill material has been removed, altered, or obscured in these areas. The use of concrete on levee slopes under selected overhead bridge crossings is inconsistent with the historic character of the levees. Although this has affected the materials of the levees, the affected areas encompass a relatively small area of the levees compared to its overall surface area, and does not affect the ability of the levees to perform their intended purpose.

Within the overbank, the only material change noted was the addition of two asphalt-paved parking areas at Trammell Crow Lake Park. The function and character of the overbank is not affected by the parking lots because it is still a flat stretch of open land. Additionally, these paved surface areas cover a considerably small area of the overbank, so they do not compromise the material of the overbank. No significant material changes to the diversion channels were observed.

The essential physical features of the floodway—the levees, overbank, and diversion channels—retain most of their historic materials. In comparison to the larger surface area and volume of the floodway's essential physical features, the amount of new materials that has been added is small. Because the use of the small amount of new materials does not inhibit the function or compromise the historic character of the essential physical features, the Dallas Floodway still retains the *materials* to convey significance for its historical associations with community planning and development in Dallas from 1928 to 1959.

Workmanship

Workmanship is an aspect that is of less relevance to the ability of the Dallas Floodway to convey significance for its historical associations with mid-twentieth century community planning and development in Dallas than location, setting, materials, feeling, and association. The floodway is a type of engineering structure that exhibits minimal amounts of craftsmanship. Workmanship is not readily applicable to the essential physical features of the Dallas Floodway. For instance, excavation of the diversion channels and sumps in the overbanks, and placement of embankment materials and soil compaction of the levees was completed mechanically with construction equipment. Likewise, the continued maintenance of these hydraulic physical features is by mechanical equipment.

The floodway's essential physical features historically have lacked evidence of any notable workmanship. As the floodway's essential physical features are still characterized by minimal amounts of craftsmanship, the Dallas Floodway meets the threshold of workmanship to convey its local significance in community planning and development between 1928 and 1959.

Feeling

Assessing the impact of changes in design, setting, and materials (location is unchanged) is helpful in determining whether the floodway sufficiently conveys the historic sense of a flood control system during the period of significance. The form and arrangement of the essential physical features remain largely unchanged since 1959. Collectively the grass-covered earthen berms (levees) and flat, grass-covered floodplain bisected by a straight water channel clearly identify the function of this resource, despite a bit of vegetative intrusion and a few more bridges crossing over it. The addition of new fill to repair segments of the levees or accommodate a flatter slope at the downstream ends is not discernible to the average Dallas resident and does not impact the visual or functional qualities of the levees. The physical and visual relationship of the Dallas Floodway with the adjacent urban environment has continued from the period of significance, even though land use and the density of surrounding development have changed.

The feeling of this system is most apparent in the middle of the floodway, whether at grade or on a bridge overlooking the overbank. Here, the feeling of this massive public works project, with its long levees, linear river channels, drainage structures, and wide, open basin, is apparent (Figures F-77 and F-78). It is clearly evident when the floodway is full and the levees contain stormwater (Figure F-79).

Figure F-77. Panoramic View Southeast from the Commerce Street Bridge

Figure F-78. Panoramic View Southeast from the East Levee near the Confluence

Figure F-79. View East-Southeast of the Dallas Floodway During 1990 Flood (photo provided by the City of Dallas)

Because the Dallas Floodway remains identifiable as a flood control system and retains the physical, functional, and visual qualities that evoke a sense of time and place within the period of significance, the floodway possesses the aspect of feeling to convey its significance for historical associations with community planning and development in Dallas from 1928 to 1959.

Association

The floodway retains its *association* with flood control and development enhancement in Dallas. The hydraulic physical features of the floodway system are in place and intact. The historical association between the floodway and urban corridor has been maintained and substantial development has occurred around the floodway as intended. There are no intrusions in the floodway that have blocked or changed its view sheds or site lines from within the floodplain. All the character-defining features that existed when the floodway attained significance are still present today and largely unchanged since the period of significance. Thus, the Dallas Floodway conveys its historical *association* in community planning and development because it is still serving its original function in flood control and drainage of developed land as in its historic period of significance.

Ability to Convey Significance for Association with Design

Location

The floodway retains the ability to convey significance of through the aspect *location*. The diversion channels and overbank are in their original locations and although some channel erosion has occurred due to the dynamic nature of these hydraulic physical features, they generally follow their original alignment. No segments of the East or West Levees have been moved or re-aligned to take a different course. As discussed under the assessment of location for association with events, the base of each levee is in the same location as when they were originally constructed. The bases of the East and West Levees were broadened on the river side during the USACE strengthening project in the 1950s. No segment of the levees has been moved since the completion of the USACE's strengthening project in 1959. All the other hydraulic physical features of the floodway remain on the original sites in which they were built. Therefore, since the geographical linear footprints of the essential physical features have not been moved and the other hydraulic physical features of the floodway remain in the same place where they were constructed, the floodway retains its ability to convey significance of *location* as an important statewide example of an engineering system designed for flood control and development enhancement from 1928 to 1959.

Design

As an important example of an engineering system for flood control and development enhancement, the aspect of design focuses on the structure itself in terms of the form and combination of the system's hydraulic physical features. In its earlier period of development, the form of the levees was trapezoidal, with steep 2.5:1 slopes (as built), a narrow crown, and an average height of 26 feet. The form of the levees, however, was changed by the USACE in its design to strengthen them. The East and West Levees retained a trapezoidal profile, but the size of the levees was augmented by additional fill, resulting in a flatter slope (to 3:1) and a broader base and crown. The average height of the levees also increased to 28 feet.

Repairs to segments of the levees have modified their form. In the late 1990s, a drainage improvement project involving the East and West Levees included flattening the river side levee slope to 4:1 downstream from approximately 300 feet south of the Union Pacific Railroad Bridge on the East Levee, and downstream from approximately 900 feet north of the Continental Street Viaduct on the West Levee (HNTB 2009). This was undertaken to strengthen the levees and prevent slides of the walls. The change in the design slope occurred on only the river side portions of the levees and is not visually apparent when observing the levees, nor the floodway as a whole. These segments of the East and West Levees still retain the trapezoidal cross section that characterizes their form and structure. Otherwise, repaired areas of the levees are built to preserve the existing 3:1 slope of the levees.

Flood control at the north end of the Elm Fork Diversion Channel was enhanced in 1965 when the city of Dallas built the New Frazier Dam across the channel. From a design aspect, a very small segment of the diversion channel was affected by the addition of the 180-foot-long gravity dam. The channel itself retains its original design attributes of a straight, dredged channel for carrying redirected floodwaters.

The interior drainage structures, i.e., the pumping plants, pressure sewers, sumps, sluices, etc., are the “necessary appurtenant structures” for land reclamation. To drain the “overflowed lands,” the design of the floodway from its earlier period of development provided five separate areas on each side of the levees, two on the east and three on the west, with sluice gates and conduits (pressure sewers) and/or pumping plants to allow stormwater to pass through to the interior of the floodway. With three more pumping plants and two more pressure sewers added during the 1950s improvements, the arrangement of these interior drainage structures next to and through the levees remained. The design for the system was augmented by the addition of interior drainage features (sluices and culverts) in the old channels of the West and Elm Forks. The old West and Elm Fork channels are natural conduits for run-off into the floodway interior. The culverts and other structures associated with these features were of standard concrete construction.

Since 1959, the design of the floodway’s drainage system has been augmented a few times with additional interior drainage structures to enhance the floodway capacity. Three pumping plants (New Baker, New Hampton, and New Pavaho) were added in 1975. Each was built next to the existing 1929 and/or mid-1950s pumping plants. Two pressure sewers and outlet gate structures, Woodall Rodgers and Coombs Creek, have also been added (1979 and 1989, respectively). Like the new pumping plants, the pressure sewers were built next to existing ones. Thus, the distribution and configuration of the floodway's later interior drainage structures and the spatial relationships between them is consistent with the floodway design from the period of significance.

The continuing urban development made possible by the floodway has resulted in increased runoff, and combined with changing design standards, has resulted in numerous comparatively small changes to the system and its design since 1959. However, the overall design of the system has not changed since 1959. The Dallas Floodway still conveys the identity for which it is significant by possessing the essential physical features of the original 1928 and 1950s design: the levees, the diversion channel, and the overbanks. Moreover, all the original 1929 pump stations are intact with few alterations, as is the 1950s additions by the USACE. Therefore, the Dallas Floodway retains its aspect of *design* to convey its significance as an important example at the state level of an engineering system for flood control and urban development.

Setting

The setting of the Dallas Floodway as an important example of an engineered water control system relies heavily on the qualities and character of the land contained within the floodway (between each levee and diversion channel) during the period in which it attained significance. During the period of significance, the setting within the floodway was characterized by flat, open land with wide vistas of the floodplain and the city beyond. Breaks in the grass-covered overbanks were provided by the linear edges of the diversion channel or periodic sumps. A few trees here and there dotted views up and down the floodway. The grass-covered embankments of the levees not only physically contained the floodplain, but because of their height, also visually defined its edges. Visual elements along portions of the levees included power lines. Extending across and above the broad plain of the downstream end of the floodway were a few bridges during the early period of the floodway's development; by the 1950s enhancement several more of these linear structures characterized both the downstream and upstream portions of the floodway.

The setting inside the floodway is still largely characterized as a broad swath of flat, open grassy land with extensive views within and beyond the floodplain landscape (Figures F-77, F-78, F-80, and F-81). The tall, grass-covered levees visually define the sides of the overbanks, which contain many more trees, primarily along the banks of the diversion channel. The floodway setting inside the floodway has experienced some change since the USACE completed construction in 1959.

Figure F-80. Panoramic View Northwest from Commerce Street Bridge

Figure F-81. Panoramic View East from East Levee at Hampton Pumping Plant

Several non-hydraulic physical features have been added within the floodway: additional bridges, power transmission lines, and Trammell Crow Lake Park. Although additional bridge crossings over the floodway have been constructed after the period of significance, they are still consistent with historic patterns of development; as described above, the design and development of the floodway system included provisions for multiple transportation crossings. Figures F-75, F-76, F-80 and F-81 show the overhead power lines that are within the overbank or are next to the land side of the East Levee. These utility lines consist of skeletal steel towers that comprise a very small footprint in the land area of the overbank. They do not create a physical or visual barrier in the floodway system. More importantly, the presence of utility lines in the floodway is not inconsistent with its setting from the period of significance. The USACE as-built drawings of the Dallas Floodway in 1955 depict several power lines (USACE 1955). Segments of two of the current power lines follow the same routes as power lines that were present in 1955. Furthermore, the 1926 Joint Plan of Reclamation and 1928 plan update included provisions for utility lines in the floodway: "All gas, oil, water and other pipe lines, telephone, telegraph and power and light lines and other structures within the [levee districts] will necessarily be required to conform to the plans of the [Levee] Districts" (Myers, Noyes and Forrest Engineers 1926). The 1985 Trammell Crow Lake Park, which includes a lake, boat launch, and parking lots, lies within the overbank (Figure F-82). However, the features of this park retain a low profile and the park has no buildings and structures to obstruct the overbank. The construction of the park, which encompasses approximately 20 acres or 0.03 square miles, is a relatively minor change in the floodway when considered within the larger scale of the Dallas Floodway engineering system, which covers roughly 5.7 square miles (Figure F-83). Moreover, the presence of the park in the floodway is not contrary to the original conception of the physical character of the overbank. In the 1928 Joint Plan of Reclamation, the designers of the Dallas Floodway acknowledged that because of the necessity to perpetually maintain the overbank in an unobstructed condition, it would "assume ultimately, a park like aspect" and create the potential that "the City will make [the overbank] public recreational grounds" (Morgan Engineering Company 1928).

Figure F-82. View East of Trammell Crow Lake Park

Figure F-83. Aerial View of Dallas Floodway Looking Northwest

The post-1959 non-hydraulic physical features in the floodway are dwarfed by the scale of the floodway and do not significantly impact the setting. The Dallas Floodway remains a large, linear, open green space between the urban environs of Dallas on the east and West Dallas and Oak Cliff on the west with non-hydraulic physical features that are still consistent with patterns of development in the floodway that date back to the period of significance. The Dallas Floodway, therefore, retains its *setting* to convey its significance as an important example of an engineering system designed for flood control and development enhancement from 1928 to 1959.

Materials

For its significance in the area of engineering, the assessment of *materials* considers the effects of material alterations on the ability of the engineering system to convey a sense of place and time. The earlier section on the materials for association with events describes the materials that were historically used to construct the floodway's essential physical features, and what non-historic materials have been added since 1959. As indicated previously, portions of the levees have been repaired with new fill, poured concrete has been added to the levee walls under selected bridges to prevent erosion and subsidence, and two asphalt-paved parking lots for Trammell Crow Lake Park have been built in the overbank. The Dallas Floodway is an ongoing, dynamic system. It was designed to change as engineering needs increased to meet continuing development. Therefore, it is not surprising then that some of the essential physical features of the floodway structure have been repaired or modified since their construction as needs have changed.

The original materials of the other hydraulic physical features of the Dallas Floodway, although not essential physical features, vary by the type of structure. All the pumping plants built in 1929 and all but one of the pumping plants built in the 1950s by the USACE are brick; one of the 1950s pumping plants (Pavaho) was constructed of reinforced concrete. Structures associated with the pumping plants, such as intake structures and outlet structures, are poured concrete and the intake opening is covered by metal grates (i.e., the trash racks). Intakes for the pressure sewers were built the same way as the intake structures at the pumping plants: reinforced concrete walls and metal trash racks over the opening. Valve vents, culverts, emergency control structures, and pressure sewer outlet gate structures, whether from the floodway's earlier period of development or the 1950s enhancement, were also constructed of reinforced concrete. For the latter, steel I-beams support the concrete walkway and steel tube guard rails.

These hydraulic physical features of the floodway retain sufficient original *materials*. Records were not found concerning repairs or improvements to the gates of the outlet structures. However, it can be assumed that some of the gates have been repaired or replaced over the years with ones of the same or similar materials and design. Changes of this nature are expected and do not impair the ability of the structures to convey their function and significance to the system. Due to natural material degradation, riprap has been removed or replaced around intakes and outlet structures and new riprap had been added at the outlet gate structure of the Hampton Road Pumping Plant's discharge channel to prevent erosion. This is to be expected given the dynamic nature of these hydraulic features, and does not compromise the overall quality of materials lof the structures. The materials of the four 1929 pumping plants ("Old" Able, Baker, Charlie, and Delta) is somewhat diminished by the removal of some original windows and infilling the openings with brick, but the rest of these structures appear to be intact (Figure F-84). No alterations or modifications to the 1950s pumping plants were observed.

Figure F-84. View East of 1929 Able Pumping Plant (1953 Able Pumping Plant in Background)

The essential physical features of the Dallas Floodway retain most of their historic *materials*. Non-historic materials have been introduced, but represent a small amount when considered within the large scale of the surface areas of the floodway's physical features. Some non-historic materials also have been incorporated in minor elements of the other hydraulic physical features. These do not represent substantial alterations that compromised the overall historic character of the physical features. Therefore, the floodway still retains a sufficient amount of its *materials* to convey significance as an engineering system for flood control and development enhancement.

Workmanship

For consideration of *workmanship*, the floodway is a type of engineering structure that exhibits minimal amounts of craftsmanship. This aspect is not readily applicable to the essential physical features of the Dallas Floodway. For instance, excavation of the diversion channels and sumps in the overbanks, and placement of embankment materials and soil compaction of the levees was completed mechanically with construction equipment. Likewise, the continued maintenance of these hydraulic physical features is by mechanical equipment. Qualities of workmanship are more apparent on the other physical features of the floodway. The only example of craftsmanship in the floodway system is on display on the exterior of the 1929 pumping plants, which feature modest decorative brickwork and clay tile coping (Figure F-84). The brick pumping plants from the 1950s exhibit plain brick laid in a traditional common bond pattern. The 1954 Pavaho Pumping Plant, built of reinforced concrete, exhibits a bit of ornamental embellishment with three recessed bands below the parapet (Figure F-33).

The floodway's hydraulic physical features historically have lacked evidence of any notable workmanship. As the floodway's hydraulic physical features are still characterized by minimal amounts of craftsmanship and no changes have occurred to the few modest displays of architectural details on the pre-1960 pumping plants, the Dallas Floodway meets the threshold of workmanship to convey its significance at the state level as an example of an engineering system for flood control and development enhancement between 1928 and 1959.

Feeling

The floodway retains the design, location, materials, and setting to convey the *feeling* of an engineered flood control structure from the mid-twentieth century. The combined effect of these aspects illustrates how the structure possesses significance (refer to the section on feeling of the floodway for association with events). Comparative "then and now" photos of historical conditions during the 1950s strengthening project and existing conditions illustrate the extent that the of *feeling* of the resource remains. These photos demonstrate that the floodway system retains those features and qualities that evoke a sense of time and place from the period of significance. Therefore, the Dallas Floodway possesses the *feeling* to convey its significance as an example of an engineering system for flood control and development enhancement from 1928 to 1959.

Association

The Dallas Floodway retains its *association* as an example of a mid-twentieth century engineered flood control system through the retention of the natural and built physical features within the floodway system. The engineering system is still in place and the floodway remains effective in controlling flooding. The hydraulic physical features of the floodway and the relationship among them are largely unchanged since the period of significance. The Dallas Floodway remains identifiable as a flood control system, and thus, retains its association to convey its significance in engineering as a flood control and drainage system during the period of significance.

Supporting and Non-Supporting Physical Features

The Dallas Floodway includes 42 hydraulic physical features that support the significant Dallas Floodway and 13 hydraulic physical features that do not support its significance, as summarized below in Table F-3. Supporting features of the Dallas Floodway are those physical features that survive from the period of significance (1928–1959), are associated with the areas of significance for the floodway, and retain sufficient ability to convey significance to represent their historic appearance and function and convey the character of the floodway at that time. Conversely, non-supporting physical features are those that have become part of the floodway since the period of significance and do not support the areas of significance of the floodway, or are features surviving from the period of significance that no longer possess the ability to convey significance.

Overhead power lines located within the overbank have existed in the floodway since its period of significance between 1928 and 1959. The Joint Plan of Reclamation accounted for the inclusion of power lines in the floodway, and in 1955, the USACE's plans accommodated existing power lines as well. Two power lines have remained in the same location since the end of the period of significance in 1959, and a few new lines have been added since then. Similarly, the majority of the bridges that cross over the floodway were built between 1911 and 1959 and continue to cross over the floodway today. Neither the power lines nor the bridges create a physical or visual barrier in the floodway system, and as a result, these features have not diminished the historic character of the floodway or its ability to convey its historic significance. Nonetheless, the power lines and bridges, as well as Trammell Crow Lake Park, are not engineered hydraulic physical features of the Dallas Floodway and do not support its significance.

Table F-3. Hydraulic Physical Features of Significant Dallas Floodway

Hydraulic Physical Feature	Property Type	Construction Date(s)	Supporting/ Non-Supporting
East Levee	Property Type 1: Levee	1929–1932 (B)* 1953 (M)*	Supporting
West Levee	Property Type 1: Levee	1929–1932 (B) 1953 (M)	Supporting
Northwest Levee	Property Type 1: Levee	1929–1932 (B) 1974 (M)	Non-Supporting –outside boundary of floodway and insufficient ability to convey significance
Parallel Levee Channel	Property Type 1: Levee	1929 (B) 1960s (M) 2007 (M)	Non-Supporting –outside boundary of floodway and insufficient ability to convey significance
Trinity River Diversion Channel	Property Type 2: Diversion Channel	1932 (B)	Supporting
Elm Fork Diversion Channel	Property Type 2: Diversion Channel	1928 (B)	Supporting
West Fork Diversion Channel	Property Type 2: Diversion Channel	1928 (B)	Supporting
Overbank	Property Type 3: Overbank	1932 (B)	Supporting
Pumping Plant A (Able)	Property Type 4: Pumping Plants	1929 (B)	Supporting
Pumping Plant A (Able)	Property Type 4: Pumping Plants	1953 (B)	Supporting
Pumping Plant A (Able) Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1953 (B)	Supporting
Pumping Plant B (Baker)	Property Type 4: Pumping Plants	1929 (B)	Supporting
Pumping Plant B (Baker)	Property Type 4: Pumping Plants	1975 (B)	Non-Supporting – built after period of significance

Table F-3. Hydraulic Physical Features of Significant Dallas Floodway

Hydraulic Physical Feature	Property Type	Construction Date(s)	Supporting/ Non-Supporting
Pumping Plant B (Baker) Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1956 (B)	Supporting
Pumping Plant C (Charlie)	Property Type 4: Pumping Plants	1929 (B)	Supporting
Pumping Plant C (Charlie)	Property Type 4: Pumping Plants	1956 (B)	Supporting
Pumping Plant C (Charlie) Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1956 (B)	Supporting
Pumping Plant D (Delta)	Property Type 4: Pumping Plants	1929 (B)	Supporting
Pumping Plant D (Delta)	Property Type 4: Pumping Plants	1956 (B)	Supporting
Pumping Plant D (Delta) Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1956 (B)	Supporting
Hampton Road Pumping Plant	Property Type 4: Pumping Plants	1956 (B)	Supporting
Hampton Road Pumping Plant	Property Type 4: Pumping Plants	1975 (B)	Non-Supporting – built after period of significance
Hampton Road Pumping Plant Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1956 (B)	Supporting
Pavaho Pumping Plant	Property Type 4: Pumping Plants	1954 (B)	Supporting
Pavaho Pumping Plant	Property Type 4: Pumping Plants	1975 (B)	Non-Supporting – built after period of significance
Pavaho Pumping Plant Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1954 (B)	Supporting
"New" Pump House (Northwest Levee)	Property Type 4: Pumping Plants	ca. 1995 (B)	Non-Supporting – outside boundary of Dallas Floodway and built after period of significance
"Old" Pump House (Northwest Levee)	Property Type 4: Pumping Plants	1974 (B)	Non-Supporting – outside boundary of Dallas Floodway built after period of significance
Belleview Pressure Sewer	Property Type 5: Pressure Sewers	1928–1931 (B)	Supporting
Belleview Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1950s (B)	Supporting
Old Coombs Creek Pressure Sewer	Property Type 5: Pressure Sewers	1928–1931 (B)	Supporting
Old Coombs Creek Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1989 (B)	Non-Supporting - built after period of significance

Table F-3. Hydraulic Physical Features of Significant Dallas Floodway

Hydraulic Physical Feature	Property Type	Construction Date(s)	Supporting/ Non-Supporting
Coombs Creek Pressure Sewer	Property Type 5: Pressure Sewers	1957 (B)	Supporting
Coombs Creek Pressure Sewer Outlet Gate	Property Type 6: Outlet Gate Structures	1957 (B)	Supporting
Dallas Branch Pressure Sewer	Property Type 5: Pressure Sewers	1932 (B)	Supporting
Dallas Branch Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1950s (B)	Supporting
Lake Cliff Pressure Sewer	Property Type 5: Pressure Sewers	1952–1955 (B)	Supporting
Lake Cliff Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1955 (B)	Supporting
Turtle Creek Pressure Sewer	Property Type 5: Pressure Sewers	1953–1957 (B)	Supporting
Turtle Creek Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1953–1957 (B)	Supporting
Woodall Rodgers Pressure Sewer	Property Type 5: Pressure Sewers	1979 (B)	Non-Supporting – built after period of significance
Woodall Rodgers Pressure Sewer Outlet Gate Structure	Property Type 6: Outlet Gate Structures	1979 (B)	Non-Supporting – built after period of significance
Elm Fork Sluice Outlet Gate	Property Type 6: Outlet Gate Structures	1960s (B)	Non-Supporting – built after period of significance
Coombs Creek Intake	Property Type 7: Intakes	1957 (B)	Supporting
Lake Cliff Intake	Property Type 7: Intakes	1950s (B)	Supporting
Turtle Creek Intake	Property Type 7: Intakes	1955–1956 (B)	Supporting
Eagle Ford Sluice	Property Type 8: Sluices and Culverts	1928–1931 (B)	Supporting
Elm Fork Sluice	Property Type 8: Sluices and Culverts	1928–1931 (B)	Supporting
Ledbetter Dike C.S.G.	Property Type 8: Sluices and Culverts	1950s (B)	Supporting
Grauwyler C.S.G.	Property Type 8: Sluices and Culverts	1950s (B)	Supporting
Northwest Levee Sluices	Property Type 8: Sluices and Culverts	1928 (B)	Non-Supporting – outside boundary of Dallas Floodway
Northwest Levee Sluices	Property Type 8: Sluices and Culverts	1974 (B)	Non-Supporting – outside boundary of Dallas Floodway and built after period of significance
Old Trinity River Channel	Property Type 9: Sumps	1928; 1932 (B)	Supporting
60-inch Emergency Control Structure	Property Type 10: Emergency Control Structures	1950s (B)	Supporting
East Bank Interceptor	Property Type 10: Emergency Control Structures	1950s (B)	Supporting

The Dallas Trinity River Floodway (Dallas Floodway) is located within the city of Dallas in north central Texas (Figure G-1). The Dallas Floodway includes the levees, river channel, six pumping plants, seven pressure sewers, and numerous gravity sluices, and extends from the Loop 12 crossing of the West and Elm Forks of the Trinity River to the existing Atchison, Topeka & Santa Fe Railroad Bridge. The Dallas Floodway area encompasses approximately 5.7 square miles (3,648 acres).

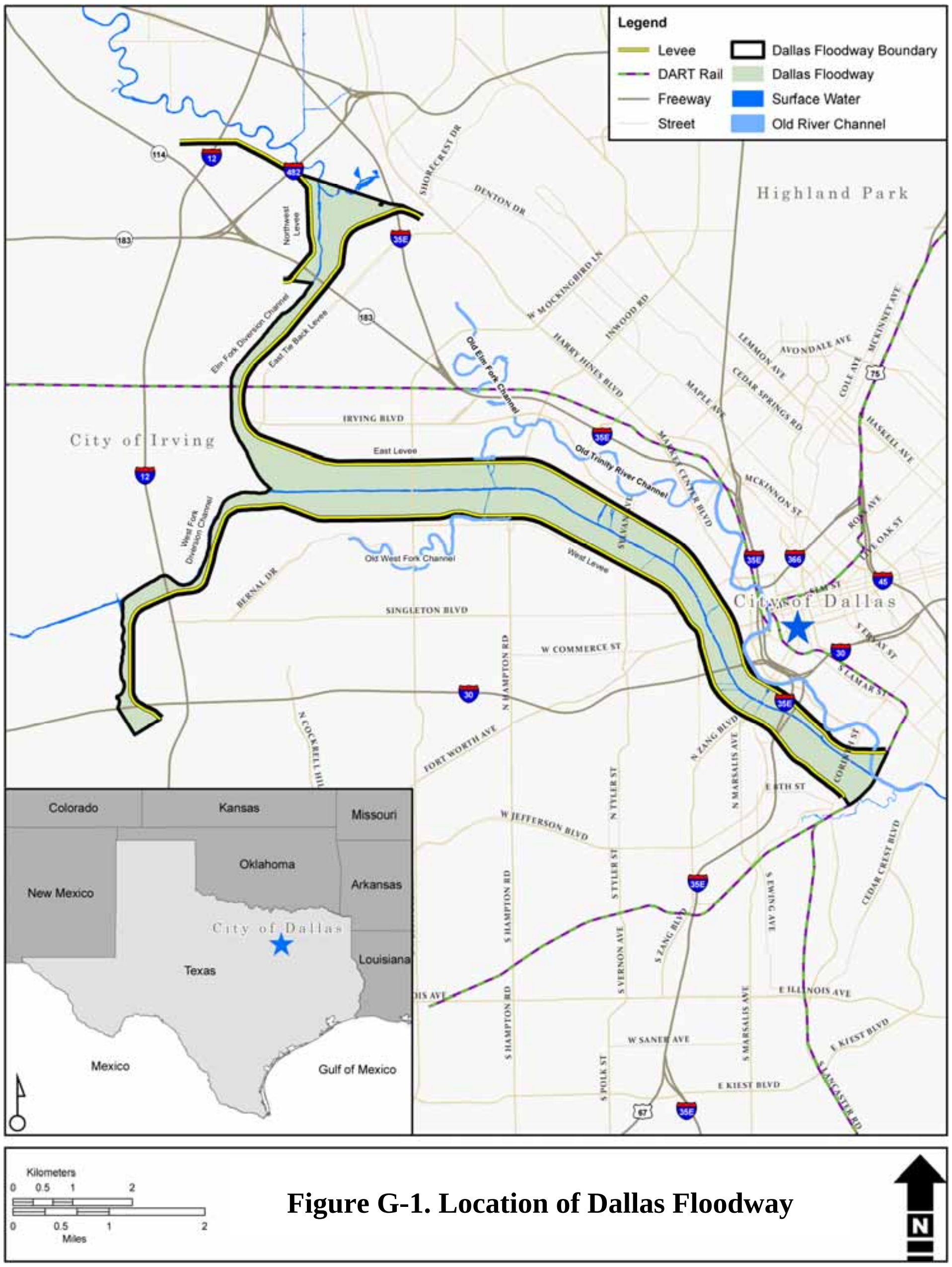

Figure G-1. Location of Dallas Floodway

INTRODUCTION

The goal of this investigation was to conduct an intensive-level inventory and analysis of the Dallas Floodway and its component hydraulic physical features. Four tasks were required to achieve the project objectives: 1) literature review, 2) archival research, 3) field survey, and 4) data analysis. A literature review of secondary sources was conducted to gain an understanding of the development of the project area. Archival research was conducted to identify changes to the floodway since its construction and to develop the historic context for the evaluation of floodway. The field survey collected information on the design, materials, construction, and condition of the floodway as a whole system and its individual engineering components. The archival and field data were then synthesized and the types of significance were applied to analyze the ability of the Dallas Floodway and its components to convey their historic significance.

Literature Review

To understand the development of the project area TEC staff reviewed secondary sources on the history of Dallas. The *Handbook of Texas Online* gave researchers an overview of the history of the area. Other resources consulted included the *Dallas Morning News*, *Dallas Then and Now, A History of the Big 'D'*, and *Dallas Rediscovered: A Photographic Chronicle of Urban Expansion 1870–1925*. This review revealed that commerce, industry, transportation, and urban planning were dominant themes in the development of the project area. Based on this background research, historians developed basic historic contexts of the project area. The contexts also incorporate historical information and data set forth in a historic context study developed by the USACE in November 2009 (USACE 2009b).

Archival Research

During the initial site visit to the project area on December 16–19, 2009, archival resources at the Dallas Public Library were reviewed. Joseph Murphey, Historic Architect, USACE Fort Worth District, and Don Lawrence, Systems Analyst, city of Dallas Flood Control District, were interviewed to obtain information about alterations and other changes to the structures in the floodway. Archival research was undertaken to develop a historic context to aid in the evaluation of the floodway.

During the week of December 14–18, research of primary and secondary source materials was undertaken at the Dallas Public Library and the USACE offices in Fort Worth. Floodway histories, newspaper articles, maps, historical photographs, and inspection reports were consulted. Additionally, the research gathered numerous records and materials about floodway development that are available on the internet.

Additional documentary research was conducted during the field survey in order to obtain additional property-specific information. As-built drawings of selected floodway structures from the USACE were reviewed, as were operations manuals. These records provided information on the original construction and design of the hydraulic physical features, and aided in evaluating their ability to convey significance.

Field Survey

The field survey of the Dallas Floodway was conducted on December 16–19, 2009, and included all visible hydraulic physical features within the floodway, listed in Table F-1. The survey was limited to exterior inspections of the pumping plants. Field notes were taken on the current use, materials, alterations, setting, and existing condition of each floodway component. All components surveyed were identified according to existing information regarding the construction of the floodway.

The field survey supplemented the written data with photographs of each physical feature. The photographs record principal views, architectural or structural details, or other notable features that were deemed relevant to the historical evaluation of the resource. The photographs were mapped and logged.

Data Analysis

The inventory and analysis categorized the Dallas Floodway as one structure consisting of 55 hydraulic physical features. The floodway comprises an array of engineered physical features (10 different types of hydraulic physical features) that were designed and configured as one system to prevent floods. The components of the floodway function collectively to drain, collect, and contain water. Thus, this report analyzes the floodway as one large structure made up of numerous interconnected engineering components related by function and physical development.

Focused research questions included the following:

1. The Plans of Reclamation were a series of comprehensive plans involving flood control, transportation and urban development of the reclaimed land. What is the relationship between these aspects of the plan and can they be evaluated individually?
2. What constitutes the physical and spatial boundaries of the Dallas Floodway?
3. What are the physical features of the Dallas Floodway? Which are hydraulic physical features and which are non-hydraulic physical features?
4. Where do viaducts (bridges and railroad trestles) that cross over the floodway fit within the analysis of the floodway system?
5. If there is historic significance, what are the character-defining features of the Dallas Floodway?
6. If there is historic significance, what are the essential physical features of the Dallas Floodway?
7. Have the various repairs and changes to the Dallas Floodway's hydraulic physical features, or the presence of the non-hydraulic features, diminished the floodway's ability to convey its significance?

8. Is the Dallas Floodway a collection of objects united by plan and physical development (a complex) or it a single unified engineering entity designed to contain and direct floodwater?

Consideration of Question #8 during the project resulted in an evaluation of the Dallas Floodway as one single unified engineering entity that is, in effect, a flood control machine. The floodway's physical features, such as levees, pumping plants, and pressure sewers, are the engineering components that make it operate in unity. As a machine to control floodwater and bypass urban Dallas, it operates as a unified entity. The Dallas Floodway would operate regardless of the presence of the bridges, which are not engineering components of the floodway. Therefore, although an analysis could apply to the collective physical features of the Dallas Floodway as a complex of varied elements, this evaluation categorizes it as a single interconnected engineering structure because of the nature of the floodway's numerous underground elements. This inventory's single-resource analysis is rather a selective intensive survey of the floodway as one contiguous entity that includes all of its underground and aboveground components as one engineering system working in concert.

To reiterate, the Dallas Floodway is one engineering structure consisting of contiguous engineered aboveground and underground components. For this survey, however, the underground components were not assessed because they are not experienced by the viewer of the floodway, and thus, cannot convey their significance.

The objective of this inventory is to determine whether the floodway system possesses engineering or historical significance and retains the ability to convey significance by applying the four types of significance., The significance of a resource can be determined only when it is evaluated within its historic context. A historic contexts is "those patterns or trends in history by which a specific occurrence, resource, or site is understood and its meaning (and ultimately its significance) within history or prehistory is made clear." Historic contexts compile information about the time period, the place, and the events that created, influenced, or formed the backdrop to the historical resources. A single resource may represent more than one historic context, and conversely, numerous resource types may represent a single historic context.

A resource must demonstrate significance within its historic context. Significance is assessed by applying the four types of significance, which define the kind of significance that a resource can represent. These are as follows:

Association with events that have made a significant contribution to the broad patterns of our history;

Association with the lives of persons significant in our past;

Embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant or distinguishable entity whose components may lack individual distinction; or

Have yielded, or may be likely to yield, information important in prehistory or history.

The Dallas Floodway and the structural components in this inventory were analyzed within the framework of the historic context for the level (i.e., local, state, or national) and type of significance and for ability to convey significance. Information relevant to the history of the Dallas Floodway, its land use, and the history of the floodway structures was included in the analysis, based on the types of significance.

The final step in the data analysis is to determine whether the resource conveys its period of significance. This is based on why, where, and when a resource is significant. The ability of a resource to convey significance depends upon defining the *essential physical features* that must be present for a resource to represent its significance, and determining, based on the essential physical features and the type and level of significance, which aspects are particularly vital for the property to convey its significance. Essential physical features are "those features that define both *why* a resource is significant and *when* it was significant. Except for archaeological sites, significant cultural resourcesrequire visible essential physical features to convey their significance. The underground (non-visible) features of the floodway do not help to identify the floodway system, and thus, were not analyzed.

There are seven aspects, or qualities, that define the ability of a resource to convey significance. A resource that retainsits ability to convey signficance will embody several, and usually most, of these seven aspects:

1) *Location* is the place where the historic and cultural resource was constructed or the place where the historic event occurred;
2) *Design* is the combination of elements that create the form, plan, space, structure, and style of a historic and cultural resource;
3) *Setting* is the physical environment of a historic and cultural resource;
4) *Materials* are the physical elements that were combined or deposited during a particular period of time and in a particular patter or configuration to form a historic and cultural resource
5) *Workmanship* is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory;
6) *Feeling* is a resource's expression of the aesthetic or historic sense of a particular period of time; and
7) *Association* is the direct link between an important historic event or person and a historic and cultural resource.

An assessment of the ability to convey significance considers the degree to which a resource retains original fabric and design elements and the impact of changes made to the resource. It is used to evaluate the extent to which a resource can convey its significance in relationship to its period of significance. Due to the function and technical nature of the Dallas Floodway, the floodway components often are continually repaired and upgraded with the latest technology and, as a result, may no longer retain those qualities or physical features that convey their significance. For example, if a component is significant for its association with a defined period or specific event, modifications made after-the-fact may have compromised its ability to convey significance. Alternatively, if a component significant to the period of significance continues to perform its original function, later modifications may illustrate the evolution of the physical feature.

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Appendix G

USACE Implementing Guidance and Section 405 (a) of Public law 111-212

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

CEMP-SWD

OCT 19 2010

MEMORANDUM THRU Commander, Southwestern Division

FOR Commander, Fort Worth District

SUBJECT: Implementation Guidance for Section 405(a) of the FY2010 Supplemental Disaster Relief and Summer Jobs Act (Public Law 111-212)

1. Section 405(a) of the FY2010 Supplemental Disaster Relief and Summer Jobs Act (P. L. 111-212) provides that the Secretary is not required to make a determination under the National Historic Preservation Act of 1966 (16 U.S.C. 470, et seq.) for the project for flood control, Trinity River and tributaries, Texas, authorized by Section 2 of the Act entitled ''An Act authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes,'' approved March 2, 1945 [59 Stat. 18], and as modified by Section 5141 of the Water Resources Development Act (WRDA) of 2007 [121 Stat. 1253].

2. This guidance applies to all USACE actions that may impact pertinent features of the existing Dallas Floodway and any modifications to that project or features defined by Section 5141 of WRDA 2007. These features may be located at any point along the Trinity River upstream from the AT&SF Railroad Bridge at Trinity River Mile 497.37, to the confluence of the West and Elm Forks at River Mile 505.50, thence upstream along the West Fork for approximately 2.2 miles and upstream along the Elm Fork approximately 4 miles.

3. In accordance with Section 405(a) of P. L. 111-212, the built environment that comprises the Dallas Floodway Project, as modified by Section 5141 WRDA 2007, will be examined, described and considered only as a cultural resource within the context of the scope of impacts that must be analyzed under the National Environmental Policy Act (NEPA). For administrative and public information purposes, a clear and concise descriptive narrative on the development, function, composition and current operation of the Dallas Floodway will be prepared to satisfy the requirements of NEPA. This narrative will focus on the Dallas Floodway as an engineering system and may contain discussion of the significance of this cultural resource's inherent structural features or relationships between the Dallas Floodway and the historical development of the City of Dallas. Any discussion of the significance of cultural resources shall be devoid of explicit reference to the criteria used to determine eligibility for the National Register of Historic Places.

4. As part of the NEPA process for the Dallas Floodway Project, as modified by Section 5141 of WRDA 2007, Fort Worth District shall document and consider project alternatives and their potential to affect the quality of the built environment. In addition to describing effects of various project alternatives on the Dallas Floodway as an engineering system, the district shall

also document and consider mitigation measures. These mitigation measures shall be developed to avoid, reduce, compensate or eliminate affects to those qualities of the built environment that contribute to the cultural resource's significant structural features or that affect those elements of the built environment that contribute to the relationship between the Dallas Floodway and the historical development of the City of Dallas.

5. It should be noted that the same limitations on the scope of impacts that must be analyzed as identified in paragraph 3, above, also apply to features included in the Balanced Vision Plan which require approval under 33 USC 408; and for analyses conducted pursuant to Section 404 of the Clean Water Act, 33 USC 1344 or Section 10 of the Rivers and Harbors Act of 1899. This guidance includes analyses for any permits required by the City of Dallas to complete repairs or other actions necessary to correct deficiencies noted in the Periodic Inspection Report issued in March 2009. This guidance also includes any actions necessary to enable the authorized project to provide at least a 100 year level of protection while a more comprehensive solution is pursued under Section 5141 of WRDA 2007.

6. In summary, the built environment and other evidence of human activities identified within the geographic areas and associated projects or programs covered by section 405(a) will be examined, described and considered only as cultural resources within the context of the scope of impacts that must be analyzed under NEPA. There will be no determinations made under the National Historic Preservation Act of 1966 in accordance with Section 405(a) of P. L. 111-212.

FOR THE COMMANDER:

STEVEN L. STOCKTON, P.E.
Director of Civil Works

SEC. 405. (a) The Secretary of the Army shall not be required to make a determination under the National Historic Preservation Act of 1966 (16 U.S.C. 470, et seq.) for the project for flood control, Trinity River and tributaries, Texas, authorized by section 2 of the Act entitled ''An Act authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes'', approved March 2, 1945 [59 Stat. 18], as modified by section 5141 of the Water Resources Development Act of 2007 [121 Stat. 1253].

(b) The Federal Highway Administration is exempt from the requirements of 49 U.S.C. 303 and 23 U.S.C. 138 for any highway project to be constructed in the vicinity of the Dallas Floodway, Dallas, Texas.