APPENDIX A. PHYSICAL EVOLUTION OF NAMED HIGHWAYS IN TEXAS

This appendix presents detailed technical information regarding the physical evolution of historic named highways in Texas. Technical aspects of road building discussed herein include paving, grading, and construction of bridges and grade-separation structures. The appendix is structured according to the same time periods as the historic context, as set forth below:

- Early Texas Roads and Trails: 1680–1880
- County Roads and the Good Roads Movement: 1880–1916
- Initiation of the Highway System: 1917–1932
- Depression, Mobilization, and War: 1933–1944
- Postwar Road Expansion: 1945–1956
- Effects of the Interstate Highway System: 1957–1980

EARLY TEXAS ROADS AND TRAILS: 1680–1880

Early roads throughout Texas were extremely primitive and difficult to traverse. Often these roads were dirt cow trails at worst and wagon ruts at best, rendering the roads impassable in wet conditions. No formal engineering was used in the construction of most roads through 1880, as very few people in the United States had engineering degrees through the late nineteenth century, and the country's few formally trained engineers commonly designed infrastructure in large cities or they worked for railroad companies.[1]

Prior to the nineteenth century, roads often followed the natural topography that avoided obstacles such as hills, tree stands, and forests, and crossed waterways at the most narrow and shallow points.[2] Early routes in Texas passed near springs in order to have a reliable clean water supply for travelers, horses, and livestock. As a result, the earliest roads often connected water source to water source.[3] As the population in Texas increased during the nineteenth century, road builders could no longer construct roads as topography or water sources dictated because they had to route roads around private properties. In fact, some roads were constructed along property and county boundaries to help delineate them on the landscape.

In the 1820s, the Mexican government became involved in the establishment of roads, and decreed that city governments in Texas were to construct straight roads lined with trees and paved (likely with stone or brick) and lighted with street lamps when possible.[4] However,

lack of funding made this endeavor nearly impossible, and the advent of an overland mail system in 1835 did little to improve the conditions. In 1836, the Republic of Texas authorized county courts to subsidize the construction of roads and bridges, establish ferries, and contract for toll road construction. The continued lack of funding led most counties to permit private landowners to operate ferries. A few communities with adequate funding, such as San Antonio and Nacogdoches, had timber footbridges, which were likely crude wood structures with a timber deck atop timber piles and abutments.

When the 1848 state legislation allocated control to the counties for road construction, the legislation divided the roads into two classes. First-class roads had a minimum 30-foot clear width and tree stumps were no more than six inches from the ground. Causeways or bridges had a minimum 15-foot clear width. Second-class roads were to have a minimum 20-foot clear width with bridges exhibiting at least a 12-foot clear width. The counties could also design new roads, decommission old roads, and classify new and existing roads. However, the dirt roads did not have adequate drainage and were difficult, if not impossible, to traverse in wet conditions.[5]

Between 1850 and 1870, private corporations in Texas built timber and stone toll bridges. Simple, triangular-shaped metal truss railroad bridges appeared in Texas after the Civil War, when the railroad extended into the state. Civil engineers working for the railroads designed alignments that were properly graded and often provided short, efficient connections between locales. As a result, many early roads paralleled railroad tracks to take advantage of the established alignments. The bridges and crossings on the early roads as well as rest stations were constructed of timber or stone, and roads generally were earthen (dirt) facilities.

In 1875, state legislation further refined the road classification system. First-, second-, and now third-class roads were characterized by their clear width: first-class roads were 60 feet wide, second-class roads were 40 feet wide, and third-class roads were 20 feet wide. Tree stumps were still to be no higher than six inches from the ground.[6] The majority of roads continued to be wide dirt paths, with a few plank roads in larger and more prosperous communities.

[1] Pamela Mack, "Engineering Education in the 19th Century," Clemson University, http://www.clemson.edu/caah/history/FacultyPages/PamMack/lec122/eng19.htm (accessed May 28, 2013).

[2] Texas Department of Transportation, *Historic Road Infrastructure of Texas, 1866–1965, Multiple Property Documentation Form* (2013), Section E.

[3] Gunnar Brune, *Springs of Texas*, vol. 1 (College Station, TX: Texas A&M University Press, 2002) 31.

[4] Ellen Marshall, *Some Phases of the Establishment and the Development of Roads in Texas, 1716–1845* (Masters of Art Thesis, University of Texas, 1934), 46.

[5] Texas Department of Transportation (2013), 8.

[6] Ibid., 17.

COUNTY ROADS AND THE GOOD ROADS MOVEMENT: 1880–1916

The period between 1880 and 1916 on Texas roads marked the transition from rudimentary transportation on cleared paths to the emergence of the engineered roadway. At the center of this transition was the widespread implementation of a primary tenet of modern roadway engineering: proper drainage. Also during this time period, culvert and bridge construction throughout the state began a slow progression from locally available materials (particularly wood) to materials that were manufactured and transported to water crossings. Largely through the efforts of the Office of Road Inquiry, the road associations, and universities, a burgeoning group of college-trained engineers established the foundation of professional design and construction of roads, bridges, and culverts. These efforts, along with the availability of new construction materials, changed the face of road transportation in Texas.

INNOVATIVE CONSTRUCTION METHODS AND ENGINEERING DESIGNS

At the close of the 1870s, the majority of Texas roads were often cleared swaths of right-of-way where little if any work was done to construct a roadway. As a result, roadways were often difficult to traverse in dry conditions and virtually unusable in wet weather. Additionally, roads sometimes had sharp curves and right-angles to follow the natural topography of the landscape and, in some cases, to follow property lines. During the 1880–1916 period, county control of highway development meant that local entities had to establish an internal organizational structure to handle road and bridge construction and maintenance. The commissioners' court determined which roads were built and upgraded in the county, and they established road and bridge departments to complete construction projects.[7] As the Good Roads Association report "Treatment of the Gravel and Macadam Roads of Texas" noted, many of the county road departments were highly political entities, and roads were "built without regard to line, to grade or to permanence…and many so-called roads are not roads, but trails and in many instances hardly passable trails."[8] Around the turn of the twentieth century, some local entities gained an appreciation and understanding of how all-weather roadways could help farmers and local industries. Dictated by limited funds and lack of education about proper construction techniques, attempts to construct roads, bridges, and culverts without consulting an engineer occurred often. As noted by one Office of Road Inquiry engineer working in the Wichita Falls area, "Good construction is often sacrificed in favor of more mileage."[9] Furthermore, after construction, maintenance of these poorly constructed facilities exhausted county road funds.

At the heart of the problem of most non-engineered roadways in Texas was the lack of proper grading and adequate drainage. Engineers advocated two solutions to these problems: building a bowed surface, or a "crown" in the road surface, and the construction of ditches on either side of the roadway. The slightly convex surface of the crown would allow water to run off the roadway and into the ditches, which eliminated water from settling on the road itself. When water sat on roads, it led to muddy earthen roadways and loose, dislodged gravel roadways. With proper drainage, even earthen (or dirt) roads were recommended by the Office of Road Inquiry engineers.[10]

According to the U.S. Geological Survey's Map of Road Types in the United States, there appear to be three main groups of road materials in use by 1916. (See *Figure A-1.*) The first and poorest quality group included earth, sand-clay, and gravel. The intermediate type of road materials included macadam roads, and the highest quality type of materials were brick, concrete, and bituminous concrete.[11] The lowest grade materials were the least expensive, and they made up the majority of roadway types in Texas in the 1910s, as shown in *Figure A-1*. This data also corresponds to the American Highway Association records in December 1914, which show that Texas had a total of 10,527 miles of road with improved, gravel, sand-clay, and other unimproved surfaces. Of that amount, only 703 miles had hard-surface roads including macadam (511 miles), bituminous macadam (181 miles), and concrete (11 miles) roads, although historic documentation does not specify where in Texas these roads were located.[12]

The lowest grade roads were constructed with the following types of materials: earth, sand-clay, and gravel (including rock and shell). As the name infers, earthen roads were dirt roads. These were sometimes graded and improved with drainage ditches in the late nineteenth and early twentieth centuries, but mostly they were simple dirt roads that were impassable during wet weather such as the road shown in *Figure A-2*. One Office of Road Inquiry engineer observed the San Antonio to Corpus Christi Road in 1910 and noted that "in several places [the road] is yet simply a wagon trail through pastureland, and for one-fourth of the distance no improvement has been made except to clear and fence the roadway."[13] When graded and drained, some earthen roads (particularly in the Panhandle and western part of the state) provided a sufficient driving surface except during heavy rain events. Sand-clay roads included a combination of sand and clay with the ideal mixture of 75 percent sand and 25 percent clay. Working together, the clay acted as a binder within packed sand.[14] If good quality aggregate was available nearby, gravel roads were preferable over earthen and sand-clay roads.

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Figure A-1. U.S. Geological Survey Map of Road Types by State, Edition 1916, Reprinted 1919 (Courtesy of the National Archives, College Park, Maryland). This map shows three classes of road types, with bituminous concrete, concrete, brick, and other "high" types being the highest road quality. The concentration of these high quality roads are seen in the most populous and industrial areas of the United States. Of the three classes of roads, the majority of roads in Texas in 1916 were constructed with the poorest road surface type.

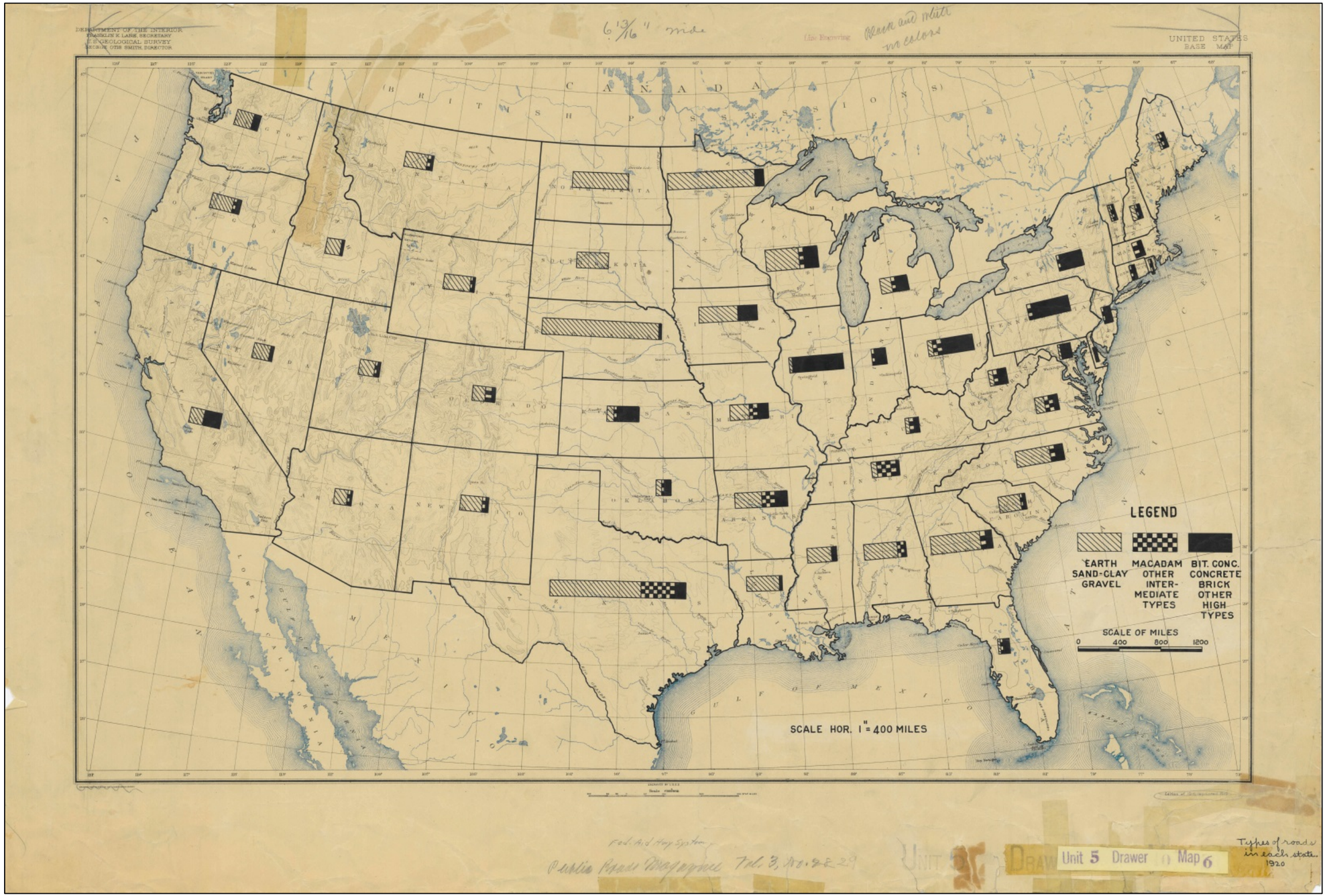


Figure A-2. This image illustrates an earthen road that was not graded or properly drained. Note the depth of the rutted surface. Source: History of the Texas Highway Department, n.p., n.d., Good Roads Association Papers, Box 13, Folder 9 (Courtesy of the Cushing Memorial Library and Archives, College Station, Texas).

Made of varying crushed rock sizes, gravel roads were constructed with a variety of different rock types, including limestone, dolomite, chert, granites, basalt, caliche, and conglomerates.[15] Some of the best road-building rock was a limestone mined in Jacksboro, Texas, that is referenced in several sources. As a result, many roads near Jacksboro were likely constructed with this material. Another material type was shell, which was often categorized with gravels. Shell roads had a road surface made primarily of crushed shells. To improve the wearing surface, a treatment of oil, bitumen (naturally occurring asphalt), or sand was sometimes added to strengthen it.[16] Within the hierarchy of roadway construction, gravel and shell roads were considered superior over earthen and sand-clay roads.

The type of materials used for roads was dependent upon the proximity to good quality road-building materials. Additionally, the presence or absence of adequate transportation from the sources of materials to the project site dictated what types of roads would be found in certain regions. For example, within 100 miles of the Gulf Coast in Texas, the best locally available road-building material was crushed shells.[17] In Central Texas, gravel roads were more popular because good quality limestone, dolomite, and granites from the area could be crushed for gravel roads. Due to the lack of quality materials in West Texas and the Panhandle, earthen roads were more likely.[18]

The width of earth, sand-clay, gravel, and shell roads varied greatly because there were no design standards for their construction at a state or regional level. While the state legislature mandated right-of-way widths in 1875, the actual width of the roadways depended upon the road type. For example, if an earthen road was constructed without grading and drainage, the roadway width could be as wide as the right-

of-way; however, if the road was improved with grading and draining, the road bed would be delineated by drainage ditches. The roadway width of most graded and drained roads ranged from between 14 and 18 feet.[19]

The next group of roads was macadam roads, which were some of the first consistently engineered roads in the state. According to the 1914 Good Roads Yearbook, "Class A" roads were macadam roads or their equivalent.[20] Created by British engineer John Loudon McAdam and first used in the United States in the 1820s in Maryland, a macadam road required that road builders crush rock into small angular pieces measuring less than one inch in diameter (rounded rocks were discarded). The gravel was laid in a layer 6 to 10 inches deep. Due to the angularity and small size of the rock, the pieces wedged together when flattened, which reduced the need for a separate binding agent to keep the gravel surface intact. McAdam's design included drainage ditches and a slight crown in the roadway to allow for proper drainage. McAdam's design modified and improved upon the roadway design created by another British engineer, Thomas Telford. Unlike Telford's design, McAdam eliminated the rock foundation Telford used, and McAdam's gravel layer was placed directly on the earth.[21] Both Telford and McAdam's designs called for a 30-foot-wide roadway with a crown and drainage ditches. While Telford's designs may have been used throughout the United States, McAdam's simplification of Telford's design was widely adopted in Texas during the late eighteenth and early nineteenth centuries.

Macadam roads in Texas fell into two main categories, water-bound and bituminous macadam roads. A contemporary of Telford and McAdam, Richard Edgeworth created water-bound macadam roads by adding stone dust and water to the roadway surface, which created a smoother riding surface and allowed water to shed off the road more efficiently. As automobiles became more widespread in the early twentieth century, they created excess dust when they drove on water-bound macadam roads (and other non-macadamized gravel roads). To help eliminate the problem of excess dust, another British engineer, Edgar Purnell Hooley, created bituminous macadam roads (also called "tar-bound" macadam roads).[22] Bitumen, a naturally occurring asphalt that is a thick liquid or semi-solid material, would be applied to the macadam roadway. Bitumen deposits were located in Central and south-central Texas, with the largest deposits located near Uvalde, Texas (west of San Antonio).[23] Similar to bitumen, tarvia was another viscous material. Made from coal tar, it was also applied to macadam roadways. While not as popular or as widespread as bitumen, tarvia may have been used on roads near coal-producing areas of Central and East Texas. Although bituminous macadam roadways were preferred over water-bound macadam roads, water-bound macadam roads could often be constructed more easily with locally mined materials (of adequate

quality), but bitumen had to be transported to the project site and was more expensive. As a result, during the early years of constructing the Texas road network, water-bound macadam roads were more widespread than bituminous macadam roadways.

During this time period, macadam roads were often found in urban settings, as well as between large towns and commercial centers, because cities often had the money to pay for these types of roads. The engineers from the Office of Road Inquiry note in their various reports that there are macadam roads within towns such as Wichita Falls and leading out of towns such as San Antonio.[24] The width of macadamized roads was governed by local conditions and traffic needs, as illustrated by a Road Object Lesson Report from Paris, Texas, which noted that the "usual practice is to make the macadam from 12 feet to 16 feet in width depending upon the amount and character of the traffic."[25] The general practice was to have 10- to 20-foot wide macadamized surfaces, and in urban areas, one-way roads could be as narrow as eight feet wide.[26]

Throughout the United States, the highest quality roads were constructed of brick, concrete, and bituminous concrete. These high quality materials required industrial processes for their creation, and they provided the most durable and consistent smooth wearing surface for motorists. However, as noted above, they were not widely adopted in Texas during this time period. The state had less than a dozen miles of concrete roads and no brick roads recorded in the state at the end of 1914. As Dr. James P. Nash, an engineer at the University of Texas, noted in December 1917, "concrete and brick have hardly a place in Texas road building as yet, but it is firmly believed that they are road materials with a future."[27] Since these high quality road types were used sparingly until the late 1910s and early 1920s, they will be discussed and described in later sections of this study.

The engineering community also focused their design efforts from 1880 to 1916 on culverts and bridges. While many culverts and bridges were still constructed of wood, a movement away from wood construction occurred during this time to reduce maintenance and improve the longevity of the structures. Culverts prior to 1880 were rarely built on rural roads, and when constructed, they consisted of simple timber box structures or small crossings. They were routinely built too small and collapsed often due to poor construction and the weight of vehicles, particularly as automobiles became more popular. As new roadways were constructed and the movement toward engineered roads emerged in the late nineteenth and early twentieth centuries, engineers began advocating for better culvert construction. In particular, engineers recommended that construction crews build culverts to accommodate more water flow than they normally handled in order to withstand intensive flood events. One Office of Road Inquiry engineer discouraged the use of small wood culverts, "except on roads that are

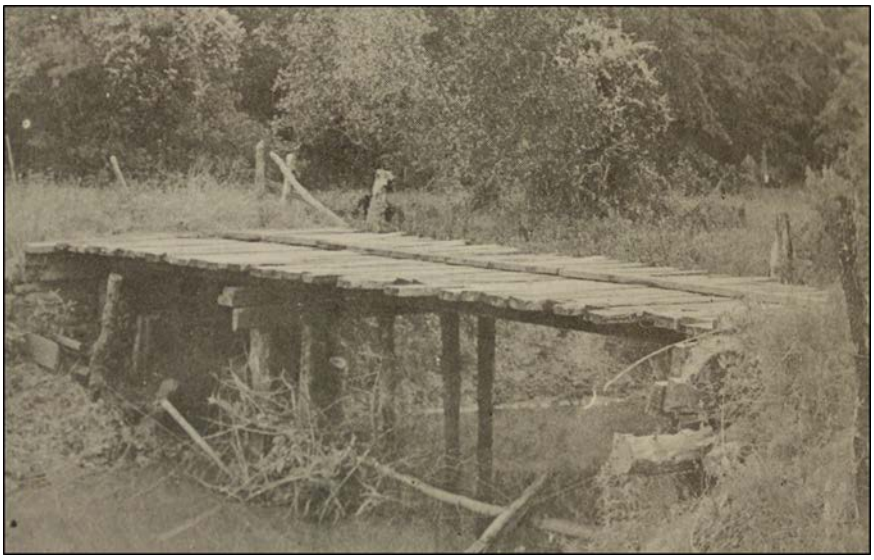


Figure A-3. This image shows a typical example of a timber bridge found on roadways throughout Texas. Source: History of the Texas Highway Department, n.p., n.d., Good Roads Association Papers, Box 13, Folder 9 (Courtesy of the Cushing Memorial Library and Archives, College Station, Texas).

little travelled…."[28] Instead, the engineer recommended using vitrified clay pipe, corrugated metal pipes made of iron (not galvanized steel), or concrete culverts (the shape—box or pipe—are not specified).[29]

Bridge design also evolved during this time period. While wood construction of bridges was still widespread (such as the bridge shown in *Figure A-3*), cast iron, wrought iron, and steel truss structures were constructed in a variety of configurations throughout the state. These metal bridges spanned longer distances, could sustain heavier loads for vehicular traffic, and survive flood events better than their wood counterparts. Detailed information about the bridge types and construction materials used in Texas during the late nineteenth and early twentieth centuries can be found in the TxDOT study of historic road infrastructure.[30]

Signage along roadways was also completed on a county-by-county basis, and the erection and maintenance of road signs and markers were dictated by county commissioners. The road laws passed in Travis County in 1891 provide insight into what signage was required at the county level. Such signage included mile-post and directional road signs. Mile posts were likely similar to modern-day mile markers, and indicated the travelers' location by indicating the distance from a starting point along the road. Since roads during this time were not officially named or numbered, directional road signs were erected at intersections and forks of public roads, and they denoted where each of the roads led.[31]

Many of the construction techniques and design methods developed from 1880 to 1916 resonated in highway engineering and construction for much of the twentieth century. In particular, the emphasis on constructing roads with proper grading and adequate drainage became one of the primary elements of road design. Additionally, the materials

developed and used during this time were used in subsequent decades. Therefore, as the Federal Aid Road Act was passed in 1916, the basic fundamentals of road and bridge construction were in place, allowing for rapid construction of road networks in the years to follow.

[7] "Treatment of the Gravel and Macadam Roads of Texas," n.p., n.d., Cushing Good Roads Association Papers, Folder 3, Box 6, Cushing Memorial Library and Archives, Texas A&M University, College Station, TX, p. 2.

[8] "Treatment of the Gravel and Macadam Roads of Texas," p. 2.

[9] Letter to Vernon M. Peirce, January 15, 1912, Box No. 45, General Correspondence, 1893–1916, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD.

[10] Letter to Vernon M. Peirce, November 26, 1910, Box No. 46, General Correspondence, 1893–1916, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD.

[11] U.S. Geological Survey, Map of Road Types in the United States, 1916, Unit 5, Drawer 10, Map 6, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD.

[12] Peter J. Hugill, "Good Roads and the Automobile in the United States 1880–1929," *Geographical Review* Vol. 72, No. 3 (July 1982): 339.

[13] Letter to Vernon M. Peirce, November 26, 1910.

[14] James P. Nash, "Road Materials of Texas," *Bulletin of the University of Texas*, No. 62 (1915): 10.

[15] The term "gravel" refers to the size of rock, not a type of rock material.

[16] "Expert Discusses Best Material Available for Building Texas Roads," *Dallas Morning News* (December 16, 1917): 6.

[17] Letter to M. O. Eldridge, November 2, 1904, Box No. 20, General Correspondence, 1893–1916, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD.

[18] "Expert Discusses Best Material Available for Building Texas Roads," p. 6.

[19] It should be noted that sources providing specifications for roadways, such as the Records of the Bureau of Public Roads at the National Archives and Records Administration, are heavily focused on depth of materials rather than width of the road surface, and only a few sources provide roadway widths.

[20] *Official Good Roads Year Book* (Washington, D.C.: American Highway Association, 1914): 3.

[21] T. U. Taylor, "County Roads," *Bulletin of the University of Texas* (March 1890): 9–15.

[22] Sidney M. Levy *Public–Private Partnerships: Case Studies on Infrastructure Development* (Reston, VA: American Society of Civil Engineers, 2011), p. 85.

[23] Donald A. Brobst and Welden P. Pratt, eds. *United States Mineral Resources* (Washington, D.C.: United States Government Printing Office, 1973), p. 102.

[24] Letter to Vernon M. Peirce, November 26, 1910; Letter to Vernon M. Peirce, January 15, 1912.

[25] "Paris, Texas Object Lesson Road Report," Box No. 89, General Correspondence, 1893–1916, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD, p. 2.

[26] *Official Good Roads Yearbook*, 1914, 119.

[27] "Expert Discusses Best Material Available for Building Texas Roads," p. 6.

[28] C. R. Thomas, "Report on Bond Issues for Road Improvements in Precinct 2, Montague County, Texas, " Box No. 46, General Correspondence, 1893–1916, Records of the Bureau of Public Roads, Record Group 30, National Archives and Records Administration, College Park, MD, p. 7.

[29] Thomas, pp. 7–8.

[30] See TxDOT, *Historic Road Infrastructure of Texas, 1866–1965 Multiple Property Documentation Form*, Section E, available at the Texas Historical Commission.

[31] William Von Rosenberg, Jr., *Revised General and Special Road Laws, Applicable to Travis County Texas: Law Governing Roads, Bridges and Ferries* (Austin, TX: Eugene Von Boeckmann Printer and Bookbinder, 1891).

INITIATION OF THE HIGHWAY SYSTEM: 1917–1932

Prior to the creation of the Texas Highway Department in 1917, the practice of constructing new roads or grading and draining existing roads in Texas was an ad hoc practice with little professional oversight and uniformity. By contrast, the 1917 to 1932 era of road construction is characterized by the highway department's efforts to create a functional and standardized vehicular transportation system that was more consistent from county to county. The passage of the Davidson–Perkins Patrol Act and the creation of the Texas Highway Department's Maintenance Division improved the consistent and routine maintenance of roads. Lastly, safety became a new major focus of the Department's roadway designs, and landscaping became a driving desire of local groups and the highway associations.

During the agency's infancy, progress in the advancement of construction techniques and materials was slow. Although the 1916 Federal Aid Road Act authorized federal funds for the construction of roads, United States entry into World War I halted the Act's implementation for the next two years. During the war, the federal government enforced rationing of oil- and asphalt-based construction materials and eliminated spending on non-essential projects until the war's end. Following the war, however, the military decommissioned and repurposed the surplus of motor vehicles (trucks and automobiles) and other machinery for highway construction. The equipment included machines that graded sub-bases and rollers that flattened gravel surfaces, and equipment that the military used for their own purposes, such as pipes (re-purposed as bridge railings) and re-locatable sectional steel bridges.[32]

After the end of World War I, construction began in Texas at a fevered pace due to the influx of road-construction money. However, the Texas Highway Department was only acting as the middleman between the federal government, which provided the funding, and county governments, which retained the responsibility of building and maintaining roads within their respective jurisdiction. While the State Highway Engineer oversaw construction, roads were still being built in an unsystematic way, and there was little uniformity through the late 1910s and early 1920s.

In 1922, the War Department declared several main highways as essential for military operations along the Mexican border. These included segments of the Meridian Highway (from San Antonio to Laredo) and the entire route of the Old Spanish Trail due to its proximity to southern military bases and the border than any other highway in the United States.[33] Although these roads were designated as truck highways by the War Department, it appears that such a designation

provided little impetus for improvement, since the Meridian Highway was gravel from San Antonio to Laredo through the mid-1920s, and many portions of the Old Spanish Trail consisted of gravel and earthen roadways through the mid- to late 1920s.

During the 1920s, highway associations lobbied for better roads and uniformity in roadway design; however, they could only influence rather than dictate road design standards. In fact, some organizations like the Bankhead National Highway Association established suggested design guidelines on roads designated as the Bankhead Highway, but they had no means of enforcing these standards. Not surprising, the Bankhead National Highway Association's 1917 recommendations included grading, draining, and surfacing roads with suitable materials, which could include earth, sand-clay, and gravel. They did not require macadamized road surfaces, concrete, bituminous concrete, or brick roads.[34] The Bankhead Highway standards included minimum roadway surface widths of 16 feet and noted that crowns and slopes should be designed in accordance with federal standards or standards issued by the respective state highway departments where the road was located. They also called for all bridges and culverts to be constructed to carry 15-ton trucks.[35] The nearly dozen Bankhead National Highway Association design guidelines also included specifications regarding safety, which included geometric specifications (such as site distance requirements and turning radii on curves), straightening roads, eliminating railroad crossings outside towns where possible and posting speed limits. All of these safety standards hinged on their requirement to have roads and bridges uniformly designed for automobiles traveling at 20 miles per hour (mph) "without injury or discomfort to the occupants of the machines." [36]

Uniformity in roadway design was finally imposed on states and local entities with the Federal Aid Act of November 1921. The Act not only provided funding allocations, but it also required that states take over all construction and design activities by November 1924. The law also provided basic requirements for roadways that were constructed with federal-aid monies. It required that all primary (or first-class) roads and those roads that connected state-to-state (such as the Bankhead Highway and the Meridian Highway) required a road surface of at least 18 feet wide. If such a width could not be constructed on a new road or an existing road could not be upgraded to such a standard, the federal agency had to approve a narrower roadway.[37] However, it should be noted that road surface included the road itself and any curbing (if required). Therefore, in towns, the wearing surface could be narrower than 18 feet, such as a segment of the Bankhead Highway (SH 1) in the town of Strawn (Palo Pinto County). The Bureau of Public Roads (BPR) inspection of the completed roadway noted that the brick surface in the community only measured 15 feet wide, but it had one and one-half-foot-wide concrete curbs flanking the roadway.[38]

Soon after the passage of the 1921 Federal Aid Act, the Texas Legislature passed the Davidson-Perkins Patrol Act in 1922. This law charged the Texas Highway Department with maintaining Texas' roads and created a new hierarchy of roadways within the state with specific requirements for each road class. First-class roads included all state highways and roads leading to the county seat from adjoining counties. County commissioners could also designate other roads with heavy and constant traffic as first-class roads. Second-class roads were main arteries leading to first-class roads, and carried less traffic than first-class roads. Third-class roads connected to first- and second-class roads, as well as other undesignated roads.[39] All the named historical highways in Texas were considered first-class roads.

In 1925, the Legislature mandated that the Texas Highway Department take over complete control of roadway design and construction, relieving the counties of those duties. While counties were still required to provide all right-of-way acquisition, they were no longer recipients of federal aid funding for highway construction. As such, the 1925 legislative mandate provided the framework for uniform design of Texas roads, utilizing professional standards and quality materials.

In 1926, the Texas Highway Department revealed their new requirements for design and construction of all new highways that were designed and approved by professional engineers. These requirements included a provision that counties must provide all right-of-way that measured at least 80 feet wide and was fully fenced. The requirements also noted that new state highways should follow the "shortest and most feasible route," eliminate all sharp turns (no curves over six degrees), and eliminate steep grades (no grades over five percent). The new provisions also required that bridges measure no less than 20 feet wide and all culverts measure no less than 24 feet wide.[40] No state and federal monies could be spent until counties purchased the 80-foot wide right-of-way, so that the road base, asphalt, shoulder, and ditch work could be completed.[41] The idea of public involvement was also introduced during this time. Specifically, when determining the location of the new state highways, the Texas Highway Commission required that the Texas Highway Department balance local interests and the engineering needs of economic design and safety. The commission encouraged engineers not to ignore "the local view point."[42]

Uniformity in design began with knowledge of materials used to build Texas roads, and labs for the testing and analysis of road and bridge materials were established at Texas Agricultural and Mechanical College in College Station and The University of Texas in Austin.[43] Tests of rocks, gravels, asphalt, bitumen, brick, and all other construction materials were completed at these institutions. The pre-approval of materials had to be obtained before contractors could use particular suppliers. These institutions reported their results to the Texas Highway Department's

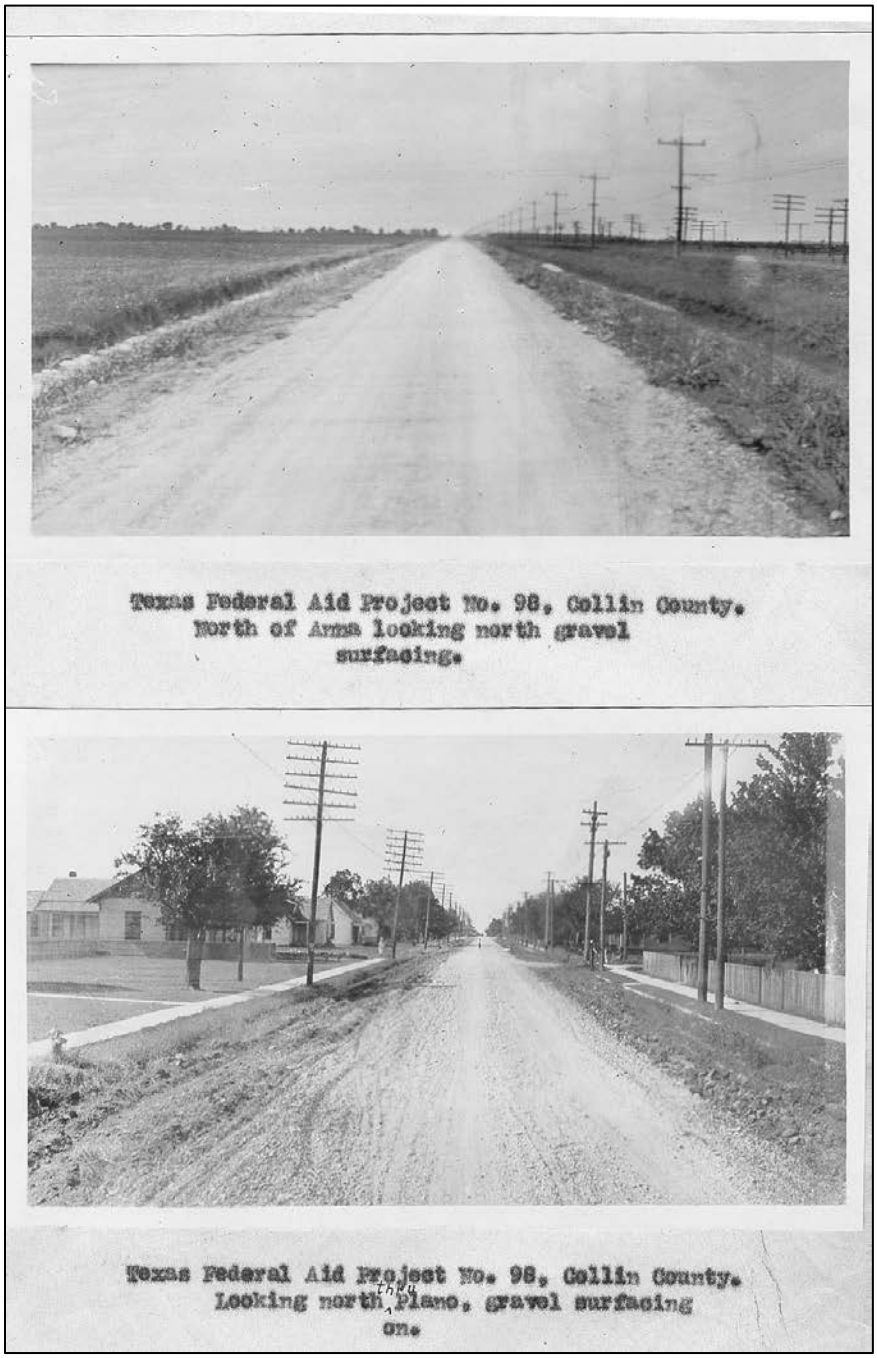
newly established Construction Division. As vehicle traffic increased on highways, the Bureau of Public Roads also conducted tests on the impacts of vehicles and trucks on roadways, such as testing the speed, weight, and type of tires on a truck (wood wheels, solid rubber tires, cushioned tires, or pneumatic tires).[44] The results of these tests were published in the Bureau of Public Road's publication, *Public Roads*, and the Department's annual reports and administrative circulars.

With their knowledge of roadway materials, the Texas Highway Department engineers constructed more smooth surface, high-quality roadway surfaces during the 1920s. Prior to 1920, high-quality pavements were only commonly found in urban areas. As noted in a Good Roads Magazine article, by 1921, there were only 15,281,173 square yards (less than five square miles) of hard-surfaced roads (such as brick and concrete roads) in Texas, mainly in larger urban centers. The cities with the most hard-surfaced roads in 1921 included Dallas, Fort Worth, El Paso, San Antonio, Houston, and Galveston.[45] Although construction of gravel roads was still common on state highways in rural areas that had low traffic volumes (see *Figure A-4*), the 1920s ushered in the era of smooth pavement surfaces, which included brick, concrete, and bituminous concrete (asphalt) roads.

Although brick was historically the oldest type of paved road in the world, the use of brick in the United States did not begin until the early 1870s, when brick was used to build a city street in Charleston, West Virginia. Through the late nineteenth and early twentieth centuries, brick roads were common in Unites States cities. While brick roads required intensive hand labor that resulted in high costs, their durability made them an ideal choice for heavy traffic areas. During the early application of their use, however, some problems with brick roads became evident, such as holes forming and bricks tilting after just a few years of use. These problems were solved by constructing a level and consistent base with "unyielding support."[46] This required the construction of a road bed and sub-grade, made of good gravel, broken rock, vitrified clay or slab, or concrete (for the best road base). In rural locations, when contractors built a concrete base for brick roads, the curbs were often poured monolithically with the base and the curbs were flush with the brick pavers.[47] (See *Figure A-5*.) While Texas road builders used brick sparingly throughout Texas, brick roads were constructed on the Bankhead Highway in north-central Texas due to the road's proximity to the bituminous coal mining and brick-producing town of Thurber, Erath County, Texas.

Concrete was another material used for Texas highways during this time. Although they were first constructed in the late nineteenth century in the Unites States in Bellefontaine, Ohio, concrete did not gain general acceptance as a road construction material until the 1910s. The quality and durability of concrete roads depended upon the quality of

Figure A-4. These photographs show a gravel road in Collin County completed under Federal Aid Project 98. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.



the aggregate used and the depth of the slab. Slab depths were typically between four and six inches (see *Figure A-6*).[48] The biggest hindrance to constructing concrete roads was the cost. While they were durable and required little maintenance after construction, the cost of cement and the process of forming the mixed concrete appropriately were expensive. As a result, they were used less frequently than bituminous concrete roads.

Figure A-5. This photograph shows the construction of the Bankhead Highway in north Central Texas. The concrete foundation with monolithically poured curbs is visible in the foreground and bricks were placed between the curbing. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

Figure A-6. This photograph shows the construction of a concrete road in Tarrant County. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

Bituminous concrete—known as asphalt today—was the most commonly used material for smooth-surface roads in Texas and enjoyed greater popularity over brick and concrete roads due to their ease of construction, relative low cost, and excellent quality smooth surface. They were constructed by first laying a bottom course of compacted aggregate earth or sand and then creating the top course by thoroughly mixing bituminous materials (while hot) with gravel and/or larger stone prior to laying the materials on the road. Doing so created a unified, monolithically formed road surface.[49] In 1917, the American Highway Association recommended using rocks with relatively high absorption

rates to allow for better adhesion to the bituminous materials. While bituminous concrete created a uniform and durable surface, the Good Roads publication notes that bituminous concrete roads had to have aggregates of sufficient toughness (numeric rating scale of rock toughness dictated what was considered sufficient) to handle moderate to heavy traffic loads. The publication also noted that the mixture should be transported quickly from a central location (or if possible a mobile facility that can keep the bituminous mixture hot) so the mixture did not cool too much prior to laying it. Consequently, these roads were often constructed in proximity to urban areas or mixing facilities. After spreading the mixture with heated shovels, the material was rolled and a seal coat was laid. *Figure A-7* shows a crew constructing a bituminous concrete road in Tarrant County in 1922.

The Texas Highway Department's control over state highways allowed for uniformity in bridge and culvert design as well. Soon after the establishment of the Department, the agency created several sets of standardized plans. Engineers designed these "standard plans" to be used at a variety of crossings of several standard lengths. Standard plans were created for a variety of bridge railings, bridge superstructures (including the deck and steel or concrete members that carried the deck), and bridge substructure (support elements under superstructure such as the abutments, piers, and bents). During this time, the Department created standard plans for many different types of bridges, including timber, steel I-beam, concrete slab, concrete girder, steel pony truss, and steel through truss bridges. Standard plans were also available for culverts, and these included culverts constructed of cast iron, concrete, and stone slabs.[50]

Construction of shoulders and curbs was also part of the Department's uniform design of roadway during this time. Shoulders provided a place for motorists to pull their vehicles off the roadway safely. State highways in Texas during this time were often earthen or gravel of varying widths, and at times, the shoulders were overgrown or barely recognizable. (See *Figure A-8.*) Prior to the 1920s, curbs were only found in urban locations, but after the highway department began building roads, they were constructed on many state highways in rural locations. (See *Figure A-9*.) At the time, they were used to keep vehicles on the road's wearing surface and prevent vehicles from driving off the roadway; however, as speeds increased in the late 1920s and 1930s, curbs became hazards and were eliminated from roadway designs. Curbs were constructed of wood planks, stone slabs, concrete, or brick (particularly in urban locations).[51]

Figure A-7. These photographs show a construction crew laying a bituminous concrete road at the edge of a community in Tarrant County. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

Another way the Texas Highway Department improved safety was the use of standardized road signs. In March 1925, the Department hired one contractor (H. Steckol) under a six-year contract to produce all mile posts, guide posts, and highway markers on state highways. The sign posts were erected at one-mile intervals that denoted the number of miles along a highway, and road markers warned drivers 300 feet ahead of upcoming turns or curves. Guide posts were placed at intersections, and indicated which town a road led to and the distance from the intersection to the town. All signs had to denote the highway number and name (if applicable). The signs per highway had to be a uniform color and all signs had to be 10 feet above the ground.[52]

Figure A-8. This photograph shows an earthen shoulder alongside a bituminous concrete roadway in Tarrant County. The shoulder is vegetated on both sides of the roadway. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

Figure A-9. This photograph shows a completed bituminous roadway with curbs in a rural area of Tarrant County. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

Safety concerns at railroad crossings were becoming more apparent in the late 1920s and early 1930s. As one author noted, since the creation of the Texas Highway Department, the demands of increasing traffic called for "better and safer roads, and the construction of previous years, involving sharp curves, short sight distance and railroad grade crossings, is fast becoming obsolete."[53] Together with funding from the railroad companies, the Department attempted to eliminate at-grade railroad crossings, particularly outside cities, as part of their objective in establishing a good quality, safe highway system. The number of accidents was so prolific that in 1932, several major railroad companies in the state requested that the Texas Highway Commission order new

specifications to be created for railroad grade separation structures.[54] While initiatives to construct grade separation structures were established during the 1917–1932 period, the construction of grade separation structures occurred on a programmatic basis and with federal assistance in the 1933 to 1944 period and is further discussed later in this section, *Depression, Mobilization, and War: 1933–1944*.

Beautification of highways was another aspect of Texas highway design that began to emerge during the 1917–1932 time period. During the early years of the Texas Highway Department, engineers often considered landscaping, and particularly large trees, adjacent to the roadway as safety hazards and, as a result, trees and bushes were often removed alongside highways. However, in the 1920s, women's and garden clubs advocated for the preservation of trees and planting of wildflowers along the state highways. They also promoted a ban on billboards within the state's right-of-way. Promotional materials, such as "Roadside Planting and the Care of Trees and Shrubs along Highways," provided guidance for appropriate distances between plantings and the roadway. The publication recommended suggestions regarding planting in areas where site distance may be a problem, plantings near intersections, and regional native plants that may be appropriate within right-of-ways.[55] It was not until Judge Walter R. Ely from Abilene joined the three-member Texas Highway Commission that landscaping along Texas highways became widespread. Ely convinced Texas Highway Department State Highway Engineer Gilchrist to institute a new policy of saving existing trees and scattering wildflower seed along the highway right-of-way. As part of this effort, roadside parks were also conceived. Additional beautification efforts were promoted by roadway associations. For example, the Old Spanish Trail Association lobbied for "nicer fences and attractive gateways" along the San Antonio to Boerne, Texas section of the Old Spanish Trail.[56] The Old Spanish Trail Association also lobbied for the construction of wayside parks along the Old Spanish Trail. These parks would provide a place for travelers to stop and relax along their trip. It was not until 1930, however, that the Department decided to build the first roadside parks in Texas; they were constructed along SH 87 in Newton County and SH 71 near Smithville. The SH 87 roadside park was a swimming hole along Cow Creek with bathhouses, while the SH 71 park was along a creek lined with live oak trees and included tables and benches (see *Figure A-10*).[57] In order to build safe roadside parks and plant roadside landscaping without adversely affecting safety to drivers, the highway commission established the Bureau of Roadside Development in 1931 to lead these efforts.[58]

In sum, the 1920s and early 1930s reflected the early years of the Texas Highway Department and its construction efforts. During this era, the Department provided design standards, completed construction projects throughout the state, and took over the maintenance of the

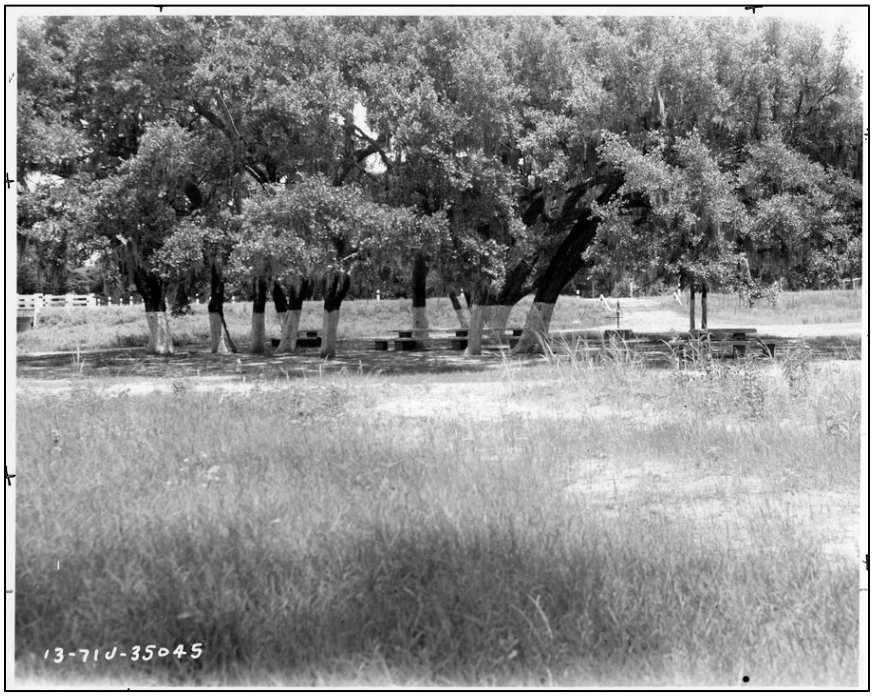


Figure A-10. One of the first roadside parks in Texas was along SH 71 between Smithville and LaGrange. This undated photograph is of the entrance driveway leading from the main highway to a stand of trees shading picnic tables and benches. The park remains in use today. Source: Texas Department of Transportation, Travel and Tourism Division, Austin, Texas.

highway system. The period marked a shift of road building and design from the county level to the state level, which fostered improved and safer roads to meeting the rising popularity of the automobile in Texas and the Unites States.

[32] "Army Materials Ingeniously Used by States for Road Construction," *Public Roads*, Vol. 4, No. 7 (November 1921): 22-24.

[33] Harral B. Ayres, "Progress of the Old Spanish Trail," n.p., 1923, Old Spanish Trail Collection, St. Mary's University Library, San Antonio, Texas, 10.

[34] "General Standards Suggested for the Bankhead Highway Association," Folder 66.1.3.7.7, John Asa Rountree [sic], Sr. Papers, Birmingham Public Library, Birmingham, Alabama.

[35] The design load of a two-axel 15-ton truck is similar to the more modern-day rating known as "H-15."

[36] "General Standards Suggested for the Bankhead Highway Association," Folder 66.1.3.7.7, John Asa Rountree, Sr. Papers, Birmingham Public Library, Birmingham, Alabama.

[37] "The Federal Highway Act," *Public Roads*, Vol. 4, No. 8 (December 1921): 17–21. The process described herein is called a "design exception" and requires the federal agency's approval for deviating from the prescribed dimensions. This process is still required today and occurs between state agencies and the Federal Highway Administration.

[38] Bureau of Public Roads, Inspection of Project Number 383, May 9, 1925, Box No. 45, Bureau of Public Roads Project Files Federal Aid Projects 380 Through LL285, Record Group 30, National Archives and Records Administration, Fort Worth, Texas.

[39] T. H. Webb. *Texas State Highway Commission Maintenance Manual: Inaugurating the Patrol System of Maintenance* (Austin, Texas: n.p., 1922), 7.

[40] Texas Highway Commission, Texas Highway Commission Official Minutes, No. 3 (July 13, 1926): 169.

[41] Ibid., No. 4 (December 18, 1928): 451.

[42] Ibid. (February 21, 1928): 239.

[43] *The History of the Texas Highway Department* (n.p., n.d.), available at the Texas Department of Transportation Travel Division.

[44] Earl B. Smith, "The Motor Truck Impact Tests of the Bureau of Public Roads," *Public Roads*, Vol. 4, No. 8 (December 1921): 1-16.

[45] "Pavements in Texas Cities," *Good Roads*, Vol. XLI, No. 5 (August 3, 1921): 64.

[46] Pennybacker , J. E. ed. *Good Roads Year Book*. Washington, D.C.: American Highway Association, 1914, 419.

[47] Ibid., 420.

[48] "The Trend of Concrete Street Paving Specifications," *Concrete Highways and Public Improvements Magazine*, Vol. XIII, No. 3 (May–June 1929).

[49] Other ways to use bituminous materials include driving the viscous material between gravel or rock after it is placed on the road (also known as a bituminous macadam road surface) and applying bituminous materials to a finished surface of gravel or broken rock as a coating. Unlike creating bituminous concrete, these processes do not thoroughly incorporate the rock and gravel with the bitumen.

[50] For detailed information about bridge design and their selection on Texas roadways, see Section E of TxDOT's *Historic Road Infrastructure of Texas, 1866-1965 Multiple Property Documentation Form*.

[51] Pennybacker , 420.

[52] Texas Highway Commission, Texas Highway Commission Official Minutes, No. 3 (March 25, 1925): 20–21.

[53] *The History of the Texas Highway Department*.

[54] Texas Highway Commission, Texas Highway Commission Official Minutes, No. 7 (April 6, 1932): 483.

[55] "Roadside Planting and the Care of Trees and Shrubs along Highways," Old Spanish Trail Collection, St. Mary's University, San Antonio, Texas.

[56] "Report of the Managing Director to Old Spanish Trail Members," August 1, 1926, Old Spanish Trail Collection, St. Mary's University, San Antonio, Texas, 23.

[57] Hardy·Heck·Moore, Inc., *Preliminary Guidelines for Assessing NRHP Eligibility for Texas Roadside Parks*, Prepared for the Texas Department of Transportation, 2005, 13.

[58] Gregory T. Cushman, "Environmental Therapy for Soil and Social Erosion," in *Environmentalism in Landscape Architecture,* ed. Michel Conan (Washington, D.C.: Dumbarton Oaks Research Library and Collection, 2000) 52-53.

DEPRESSION, MOBILIZATION, AND WAR: 1933–1944

Depression-era funding programs and World War II were among the dominant factors that affected highway construction during the 1933 to 1944 period. While road construction and upgrade of existing highway infrastructure occurred during the era, the primary focus of road-related construction was the improvement and refinement of the existing state highway system that was created in the previous era. These efforts included reconstructing existing roads, increased safety measures, and a statewide emphasis on landscaping and improving the driving experience for motorists.

The work-relief programs were main driving forces of highway construction from 1933 until the direct United States involvement in World War II in 1941. The emphasis of the Depression-era work-relief programs was on employing skilled and unskilled workers and, on Texas roadways, this often resulted in the construction of cut-stone masonry structures, utilizing materials quarried near project sites. With an average of 26,300 men working on Texas highways monthly, WPA built or improved 6,233 miles of roads in Texas, and constructed 3,724 miles of new roads in 1936. While work-relief projects were an important part of highway construction in general during this period, the majority of the roads constructed with WPA funding occurred on the secondary road system (also known as feeder roads), and it was not focused on improving or aiding the already well-established truck highway system.[59]

Upgrading and improving roads for increased safety were major focuses of highway construction in the 1933 to 1944 period, since over 10,000 vehicles used roads such as SH 1 (Bankhead Highway) in 1936, and speed limits were in the range of 40 to 70 miles per hour (mph).[60] Numerous projects along the named highways included the upgrade, straightening, and widening of roads. The introduction of better road surface materials such as concrete, brick, and asphalt was the most common type of improvement. While concrete and brick roads could withstand substantial wear and heavy loads without significant deterioration, they were three times more expensive per mile than asphalt roads.[61] As a result, the Texas Highway Department continued the practice of building concrete and brick roads in high-traffic urban areas and constructing asphalt roads in rural locations.

During this period, the Texas Highway Department was also focused on eliminating the “high dump” roadways, which referred to roads that could “dump” a person off a roadway if they purposely or unintentionally drove off the roadway wearing surface. These “high dump” roads had high-crowned surfaces, steeply cut embankments, deep ditches, sharp curves, steep grades, narrow roadway widths, and

narrow bridge and culvert widths. This was a consequence of railroad engineers attempting, unsuccessfully, to transfer knowledge about railroad construction to roadway construction. Improvements in roadway design called for wider wearing surfaces that accommodated consistent two-way traffic (at least 20 to 22 feet wide), broad shoulders constructed of stable materials, wider decks on bridges and culverts, and more gently graded crowns and ditches. Such improvement was completed on SH 2 (Meridian Highway) from the Williamson/Travis County line to 5.58 miles south of the county line. Although SH 2 originally had a good-quality concrete wearing surface, it had a steeply pitched crown, deep embankments, and narrow shoulders. As a result, several accidents occurred on this stretch of highway in the 1920s, and the Department rebuilt the roadway in the mid-1930s by widening the crown, shoulders, and flattening the ditches.[62]

Simplifying signage was another safety initiative during this time. Based on traffic studies initiated by Julian Montgomery, the Texas Highway Department state highway engineer, numerous highway markers at intersections, especially in urban business districts, were causing traffic concerns. In a November 1937 article, Montgomery stated that "the traveler is forced to stop traffic while studying these markings, thus creating a traffic hazard." [63] Department officials argued that the Bureau of Public Roads and the American Association of State Highway Officials (AASHO) created the U.S. route numbering system in the 1920s to simplify highway markers for the traveling public. As a result, Texas was one of 35 states that used U.S. highway markers exclusively beginning in the late 1930s (with no other roadway designation signs) on U.S. highways.[64] This initiative likely began a widespread elimination of many named highways' signs on U.S. highways.

Attempts to eliminate railroad at-grade crossings first occurred in the early 1920s; however, with the federal funding provided to the state after the passage of the National Recovery Act of 1934 and the Emergency Relief Appropriation Act of 1935, construction of new grade-separation structures increased in the mid- to late 1930s. In July 1936, over 110 grade-separation projects were undertaken in the state.[65] Grade-separation structures built as part of this program could carry either the vehicular traffic or railroad tracks. There was little difference in the bridges that crossed waterways and those that crossed railroad tracks, except the need for a high vertical clearance (often at least 20 feet) over the railroad tracks. This was accomplished by building up the bridge approaches with fill material, which created a vertical curve (commonly called a "hump") in the road. Forthcoming *Figure A-11* shows a steel I-beam bridge constructed as part of the 1935 Emergency Relief Appropriations Act funding in Austin County.[66]

Grade-separation structures that carried railroads over highways were somewhat different structures from bridges that carried vehicles,

Figure A-11. Railroad grade separation structure carrying US 90 over the Gulf, Colorado, and Santa Fe Railroad in Sealy, Austin County. The vertical curve (or rise in the road) illustrates the need for high vertical clearance under the highway bridge. Source: Blanton & Associates, Inc., 2013.

primarily due to the heavy load requirements to carry railroad cars. (See *Figure A-12*.) Bridges that carried railroads over roadways were often constructed of concrete girders, steel plate girders, and steel I-beams.[67] Concrete girders had deep reinforced concrete members that would be closely spaced longitudinally under the tracks. Steel plate girder bridges were often constructed with the girders extended on either side of the tracks (called a "through" configuration). These bridges would be constructed of especially deep girders on the outside of the tracks, with perpendicular floor beams spaced closely together under the tracks. Steel I-beam bridges were also used to carry railroad tracks over roads. These bridges were constructed with several closely spaced steel I-beams running longitudinally under the tracks. While concrete girders and steel I-beams were often more economical than steel girders, they could not span as far as steel girder bridges.

Standardization of bridge and culvert design was a well-established practice by the 1933–1944 time period, and new designs were largely an improvement on previous designs to carry heavier loads or to increase span length. The Texas Highway Department also designed bridges for particular crossings when the locale was not suitable for a standard bridge design. One such bridge was the SH 2 bridge on the former Meridian Highway alignment (now IH 35) that spanned the Guadalupe River (National Bridge Inventory Number: 150460001611016), as shown in *Figure 180* in previous Section II.2. The reinforced concrete open-spandrel arch bridge, constructed in 1934, served as a gateway bridge into the community of New Braunfels. With its Art Deco detailing, the 818-foot-long bridge showcased the

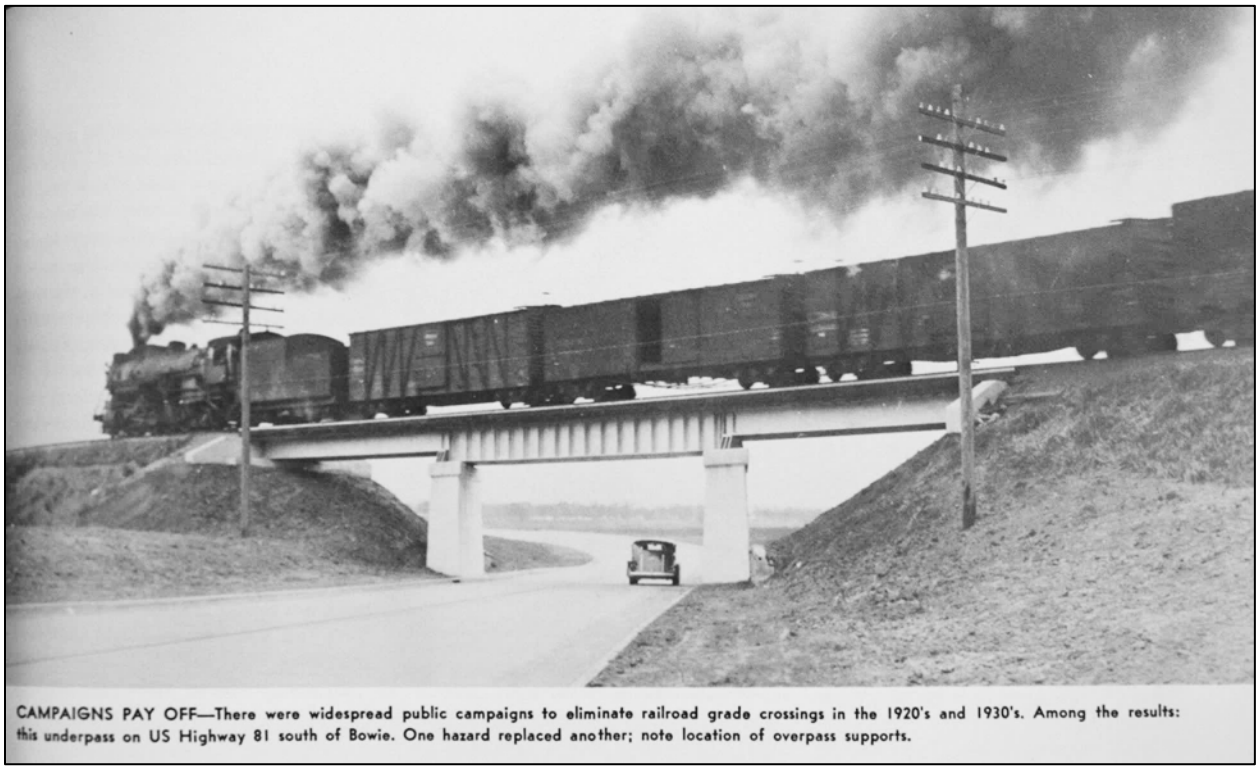


Figure A-12. Grade separation structure carrying a railroad over a roadway. Note the narrow width of the horizontal clearance under the bridge deck. The abutment walls and center pier are directly adjacent to the travel lanes, allowing very little room for driver error. In later years, engineers designed grade separation structures with more horizontal clearance. Source: Texas Highways 50: Golden Anniversary Texas Highway Department 1917-1967, 110, Good Roads Association Papers, Box 6, Folder 5, Cushing Memorial Library and Archives, College Station, Texas.

Department's commitment to aesthetic design that was pervasive during the 1930s.[68]

Another priority during the 1933–1944 period was improving the aesthetic appearance of the road through design elements and landscaping. A *Texas Parade* article on the highway system notes that the Department's highway engineers in the 1930s had four primary objectives, among them the "aesthetic value of the highway … and preservation of its scenic beauty."[69] During this era, an emphasis on decorative features was common, particularly on urban bridges. As noted above, Art Deco detailing was used on the Guadalupe River Bridge, and the type "D" railing was a standard rail type that also reflected Art Deco influences (see *Figure A-13*). Another example is the construction of the Trinity River Bridge on Highway 1-C in Fort Worth. The bridge was decorated with longhorn cow heads on inset panels (see *Figures A-14* and *A-15*).

This emphasis on aesthetic beauty of Texas highways was led by the Texas Highway Department's Office of Landscape Architect, which was established in 1933.[70] In March of that same year, the Department hired a chief landscape architect named Jacobus "Jac" L. Gubbels.[71] The Dutch-born and German-educated immigrant believed that trees and shrubs should line Texas roads, and should subtly mark hilltops, curves, bridges, culverts, and signposts.[72] Landscaping Texas roadsides faced some resistance within the agency, as engineers were worried that trees planted too close to the roadway would introduce potential traffic

Figure A-13. Type "D" railing was a Texas Highway Department standard rail that exhibited modest Art Deco detailing in the vertical elements of the railing. Source: Blanton & Associates, Inc., 2013.

hazards, and that pruning of trees would require excessive maintenance costs. However, Gubbels successfully quieted his opponents by emphasizing the safety aspects of landscaping, primarily helping the driver respond to curves and hills and paying better attention to the natural topography and the roadway. Landscaping also helped to combat soil erosion, which was a major problem of early roads built by the Department.[73]

In 1935, Gubbels and Gilchrist wrote "Suggestions for Roadside Development," which included detailed instructions for planting trees and shrubs at the outside edge of the right-of-way to focus attention on hidden curves, hazards, and traffic signs. Gubbels advocated planting vegetation that required little maintenance.[74] The Texas Highway Department used hundreds of different plantings, many of which were native trees such as Honey Locust and Texas Red Oak; however, they also used non-native species, such as Silver Leaf Poplar and Chinese Elm. Many of the trees and plants they used were drought tolerant, grew well in poor soil types, were fast-growing, and were well suited for a variety of environments.[75] While new trees were planted in large numbers, the preservation of existing trees was also part of Gubbels' initiative to beautify Texas highways. The Landscape Division estimated in 1936 that their efforts to educate contractors and workmen saved a half-million large trees and three million small trees along Texas roadways.[76] Flowering plants, such as Paul's Scarlet Rose and Bird of Paradise, were also used along roadsides and medians (in urban areas) to enhance the roadway.

In addition to plantings along the Texas roadways, Gubbels also promoted the use of roadside parks as locations where Texas drivers could stop along the highway and relax. His designs included a semi-circular gravel road extending from the highway leading to a tree-covered area landscaped with vegetation and wooden or stone benches and picnic tables. Gubbels' parks were simple in their design, and he envisioned the picnic areas to be situated on a half- to one-acre parcel

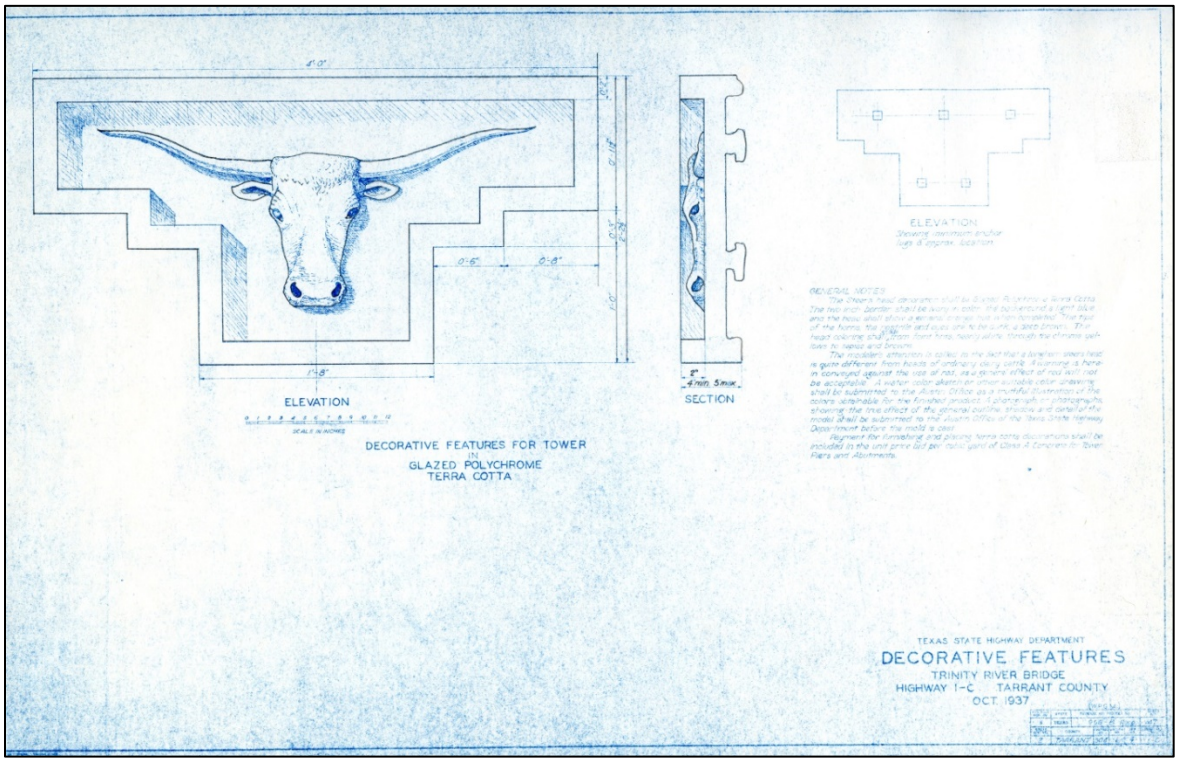


Figure A-14. 1937 design of the longhorn cow motif on the Trinity River Bridge on SH 1-C in Fort Worth. Source: Photo Collection, Texas Department of Transportation, on file at the Texas Department of Transportation, Communications Division, Media Production, Photo Library.

Figure A-15. Photograph of the longhorn cow head inset on the Trinity River Bridge. Source: Photo Collection, Texas Department of Transportation, on file at the Texas Department of Transportation, Communications Division, Media Production, Photo Library.

Figure A-16. Roadside park north of Round Rock, Texas, along the Meridian Highway, 1939. This park is an example of the simple, rustic design of roadside parks common in the 1930s. The park has simple stone benches, tables, and masonry walls. It also has a 1936 Centennial marker located on the semi-circular path, in the middle-right of the photo. Source: "The Portal to Texas History," University of North Texas Libraries Portal to Texas History http://texashistory.unt.edu/ark:/67531/metapth167247/ (accessed on May 2, 2013).

of land, located approximately every five to 10 miles along main highways. Usually a stone wall or wooden railing alongside the gravel road separated a landscaped or sodded area adjacent to the highway from the receded park area.[77] A contract between the Texas Highway Department and the Depression-era federal National Youth Administration (NYA) resulted in NYA-constructed and improved roadside parks across the state. As a result, design aesthetics of many roadside parks in Texas followed the rustic architecture style promoted by the National Park Service. The use of masonry and rough-hewn timber blended with the surrounding environment, creating a rustic and natural feeling to the parks.[78] An example of this simple design approach was seen in a roadside park located along the Meridian Highway just north of Round Rock (*Figure A-16*).

When it came to selecting the locations of individual roadside parks, the Texas Highway Department district maintenance foreman handled this task. As a result, personal preference, natural topography, and the willingness of private landowners to donate land for the parks dictated the parks' design, size, and location. Some parks were more elaborate than Gubbels' template, with sodded areas, flower beds, masonry walls, benches, tables, paths, and fireplaces.[79] If near a spring or creek, the park would often be oriented toward the water feature. For example, the no-longer extant San Felipe Park along a spur of the Old Spanish Trail (SH 3) in Del Rio was constructed in 1936 and exhibited large-scale landscaping oriented toward San Felipe Creek (see *Figure A-17*).

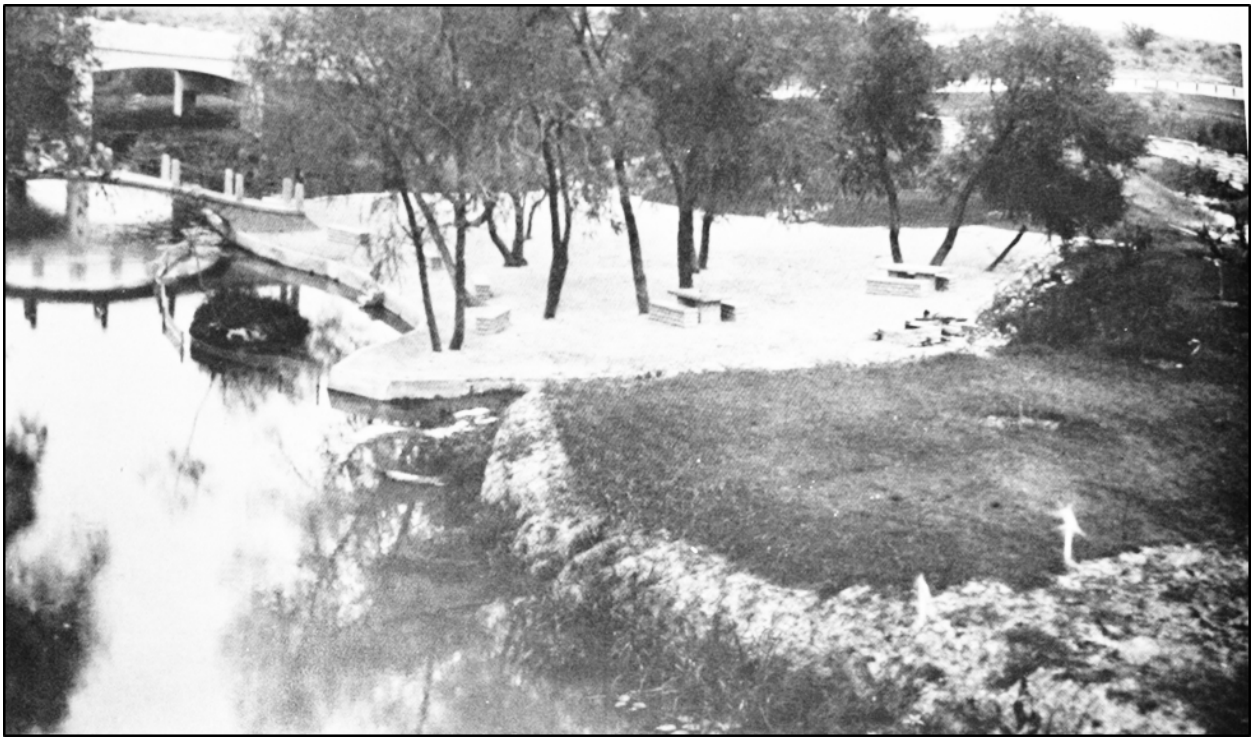


Figure A-17. Roadside park at San Felipe Creek on the Old Spanish Trail in the vicinity of Del Rio. This park is an example of a more elaborately landscaped park with walkways and masonry benches, tables, walls, and a pedestrian bridge. Source: Texas Highways 50: Golden Anniversary Texas Highway Department 1917–1967, 168, Good Roads Association Papers, Box 6, Folder 5, Cushing Memorial Library and Archives, College Station, Texas.

Designs for roadside parks varied by region and materials. In East and North Texas, the availability of timber resulted in predominantly wooden structures (benches, tables, and walls), such as those constructed along the Bankhead Highway in Bowie County (see *Figure A-18*). In southwest Texas in the Del Rio area, roadside parks included stone picnic tables with concrete table tops. In West Texas, due to the general lack of tree cover, arbors were constructed to provide shade. Early arbors were timber frames with palm roofs, supported by brick or stone piers, as seen in Pyote, Texas, along the Bankhead Highway (see *Figure A-19*).[80]

Turnouts alongside highways were also constructed during this period. Engineers and project planners believed that motorists needed a place to rest and to repair their cars if necessary. These turnouts differed from roadside parks in that they often had no amenities and provided only a resting stop, rather than a place to recreate. Often, sites were chosen on hilltops or other vantage points, and a low stone wall would separate the turnout from the main lanes.[81] To coincide with the state's Centennial celebrations in 1936, the Texas Highway Department also erected pink or gray granite markers along state highways. These markers had an inset bronze star and featured inscriptions with topics relating to local and state history.[82] Some of the Centennial markers were located at the turnouts alongside highways, such as the Centennial marker commemorating Taylor County, located along the Bankhead

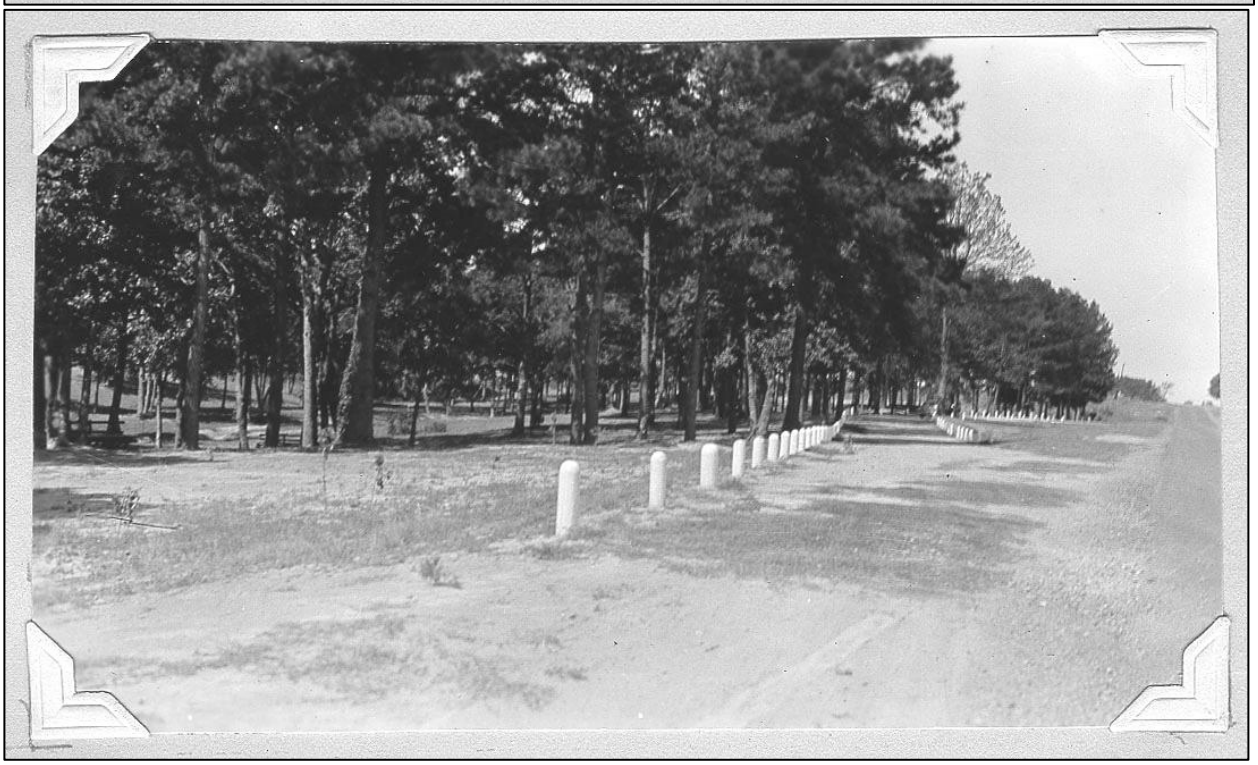


Figure A-18. Roadside park along SH 1 (Bankhead Highway) outside of Simms, Texas. The park features the typical semi-circular gravel road lined with posts leading to and from the main highway. Since the park is located in East Texas, it has predominantly timber construction included timber benches and tables. Source: Photo Collection, Texas Department of Transportation, on file at the Texas Department of Transportation, Communications Division, Media Production, Photo Library.

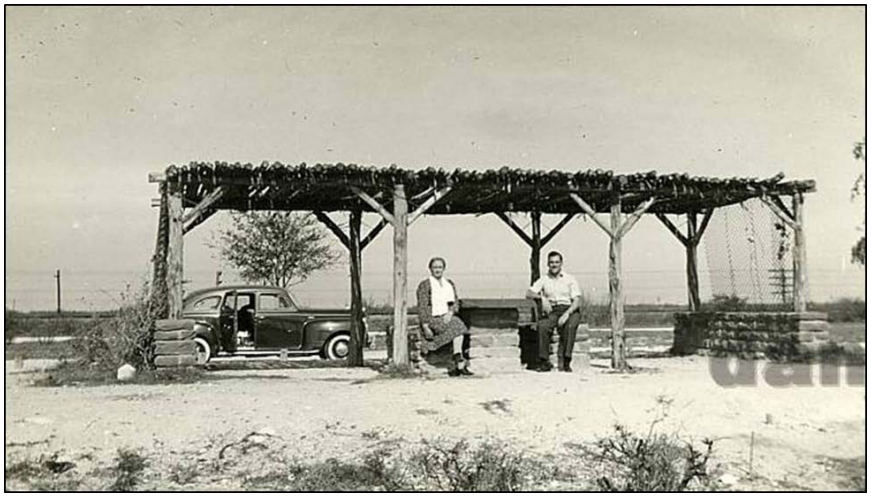


Figure A-19. Roadside park along SH 1 (Bankhead Highway) outside of Pyote, Texas, in the western part of the state. The park features a timber arbor with stone piers, benches, and table. Source: Pyote, Texas Roadside Park, May 8, 1945, T. Lindsay Baker Collection, Texas State Library and Archives Commission, Austin, Texas.

Highway on the west side of Abilene. Another type of marker that was found on Texas highways were stone markers in the shape of Texas. These markers, located at the Texas state line, were also erected in the 1930s and 1940s. (See *Figure A-20*.)

The beginning of World War II virtually ended the initiation of new highway projects in Texas and throughout the country, as the federal government concentrated on the war effort. Many of the materials used to construct roads (such as steel, tar, and petroleum products) and to manufacture vehicles (such as oil and rubber) were rationed. Speed limits were reduced in an effort to help moderate the use of these products.

During the war, there was an emphasis on connectivity between military bases, naval bases, and industrial facilities where products for the war effort were produced, and virtually all of the highway construction focused on improving roads such as SH 1 (Bankhead Highway), SH 2 (Meridian Highway), and SH 3 (Old Spanish Trail) that were identified as part of the Texas Strategic Military Network. Improvements in rural and urban highways near or connecting military facilities and manufacturing centers were the focus of the wartime construction efforts, which included the upgrade of pavements to hard-surface, high-quality pavements for year-round vehicular travel, and grade separations at highway intersections and railroads. Another part of these efforts included increasing load carrying capacity of bridges from H-15 (equivalent of carrying a truck weighing 30,000 pounds) to H-20 (equivalent of carrying a truck weighing 40,000 pounds), and widening bridges to accommodate large trucks and tanks. The federal-aid monies, WPA funds, and funding from the War Department were all used and funneled to creating an improved highway system during the war.[83]

Figure A-20. A state line marker at an unknown location. These markers were erected outside of the pavement edge and within the right-of-way of state highways and roads. Source: Texas Highway Department, History of the Texas Highway Department, 29, Good Roads Association Papers, Box 13, Folder 9, Cushing Memorial Library and Archives, College Station, Texas.

With the inactivity in more general highway construction during World War II, the Texas Highway Department focused on engineering and planning future projects to correct many of the deficiencies in the highway network. As early as 1943, highway engineers were already considering ways to improve mobility on highways and provide better connectivity between cities and shipping points (like airports and major railroad freight stops). Additionally, these considerations led Texas Highway Department engineers to design expressways and freeways with entrance and exit ramps to provide uninterrupted traffic flow, particularly in and out of cities.[84] Additionally, with talk of the Colson–Briscoe Act and a new farm-to-market road system on the horizon, the Department's engineers also began to conceive ideas to construct highways quickly and economically. While expressway and farm-to-market road plans sat on the shelves until after the end of the war in 1945, the design concepts were conceived prior to the war's end.

[59] Charles E. Simons, "On Texas Highways," *Texas Parade* Vol. 1, No. 7 (December 1936): 21.

[60] Charles E. Simons, "The Evolution of a Highway," *Texas Parade* Vol. 1, No. 11 (April 1937): 12.

[61] Calculations based on road construction costs for concrete and brick roads, compared to the cost of asphalt roads, which were published in the August 1936 issue of *Texas Parade*. "On Texas Highways," *Texas Parade* Vol. 1, No. 3 (August 1936): 22.

[62] Frank Maddox, "Know the Roads You Ride On," *Texas Parade* Vol. 1, No. 2 (July 1936): 26.

[63] Simmons, "On Texas Highways," 21.

[64] Ibid.

[65] Maddox, p. 27.

[66] Plans for Control Section Job 0271-03-001 (1936), G.C.&S.F. R.R. and SH 36 Overpasses in Sealy, Texas Department of Transportation.

[67] The difference between steel plate girders and steel I-beams is in their fabrication. A steel plate girder is fabricated in a shop with three different pieces constructed together with rivets or welds in the shape of an "I." An I-beam is fabricated in one-piece in the shape of an "I."

[68] For more information about bridge design during the 1930s and early 1940s, see Section E of the *Historic Road Infrastructure of Texas, 1866–1965 Multiple Property Documentation Form*.

[69] Maddox, p. 7.

[70] Texas Highway Department, *History of the Texas Highway Department*, n.d.

[71] Texas Highway Commission Meeting Minutes, Minute Order 7457 (March 30, 1933), Texas Department of Transportation, Austin, TX.

[72] Cushman, p. 57.

[73] *Texas Highways 50: Golden Anniversary Texas Highway Department 1917–1967,* p. 160, Good Roads Association Papers, Box 6, Folder 5, Cushing Memorial Library and Archives, College Station, TX.

[74] Ibid.

[75] A wide range of plants and trees were noted in the Texas Highway Commission Meeting Minutes, the Bureau of Public Road Records, and contemporary newspaper articles.

[76] Maddox, p. 27.

[77] Hardy·Heck·Moore, Inc., p. 16.

[78] National Park Service, "Rustic Architecture: 1916–1942," http://www.nps.gov/history/history/online_books/rusticarch/part5.htm (accessed April 30, 2013).

[79] Hardy·Heck·Moore, Inc., pp. 13–17.

[80] Hardy·Heck·Moore, Inc., p. 15.

[81] Maddox, p. 27.

[82] Texas Department of Transportation, Depression-Era Roadside Parks Collection.

[83] "Texas Highway System Is Vital Factor in National Defense Problem, Bobbitt Asserts," *The Tulia Herald (Tulia, Texas)* Vol. 31, No. 1 (May 23, 1940): 5. Robert Lee Bobbitt, "Texas Military Highways," *Texas Parade* (1943). Thomas H. MacDonald, "Roads for National Defense" (1940), Box 7, Folder 7, MacDonald Personal Papers, Thomas H. MacDonald Collection, Cushing Memorial Library and Archives, Texas A&M University, College Station, TX.

[84] Wilbur Simonson, "Advanced Designs for Post-War Highway Needs: Survey of Current Development with Thoughts to the Future," *Landscape Architecture: A Quarterly* (July 1943): pp. 130–131.

POSTWAR ROAD EXPANSION: 1945–1956

The Texas Highway Department suspended nearly all of its construction activities during World War II; however, engineers did not waste this time of inactivity in road construction. They took the opportunity to continue designing roadways and structures knowing that construction would resume after the war. Their design work, including new freeway designs and dozens of new standard plans for bridges, was quickly utilized soon after the war's end. With new funding infused into the Department coffers following enactment of the Federal Aid Highway Act of 1944 by Congress and the Colson–Briscoe Act by the Texas Legislature in 1949, roadway construction substantially increased. From 1944 to 1954, the Department constructed over 25,500 miles of state-maintained roads in 11 short years, which nearly equaled the number of miles of roads the Department built since the establishment of the highway department a half-century earlier.[85]

Another major development in the history of highway construction between 1945 and 1956 was the development of controlled-access highways. The Federal Aid Highway Act of 1944 designated a new network of roads to connect major metropolitan areas, industrial facilities, and important military installations within the United States. Many of the roads that were upgraded as part of this funding program were the former named highways, such as SH 1 (Bankhead Highway), SH 2 (Meridian Highway), and SH 3 (Old Spanish Trail). With a mandate to create this system, and using railroad systems as a model, Texas Highway Department engineers began designing controlled-access highways in the 1940s. The term "controlled-access" means that the design of the highway limited accessibility to adjacent properties and intersecting roads. The Department designed two types of controlled-access roadways–controlled-access freeways (also known as expressways) and controlled-access thoroughfares. Controlled-access freeways provided few access points and were designed to allow the movement of large numbers of vehicles with the minimum number of obstructions at high speeds (see *Figure A-21*).[86] Controlled-access thoroughfares provided numerous access points and intersections could be at-grade (see *Figure A-22*). While controlled-access freeways were more commonly constructed along Texas' roads in and between urban areas, controlled-access thoroughfares were more commonly found in small communities and in rural locations.

One of the main character-defining features of controlled-access freeways were interchanges at intersecting roadways, which always included grade-separated structures (see *Figure A-23*). As part of the design, egress and ingress on freeways were only possible via ramps, which allowed drivers to slow their speed as they exited the highway

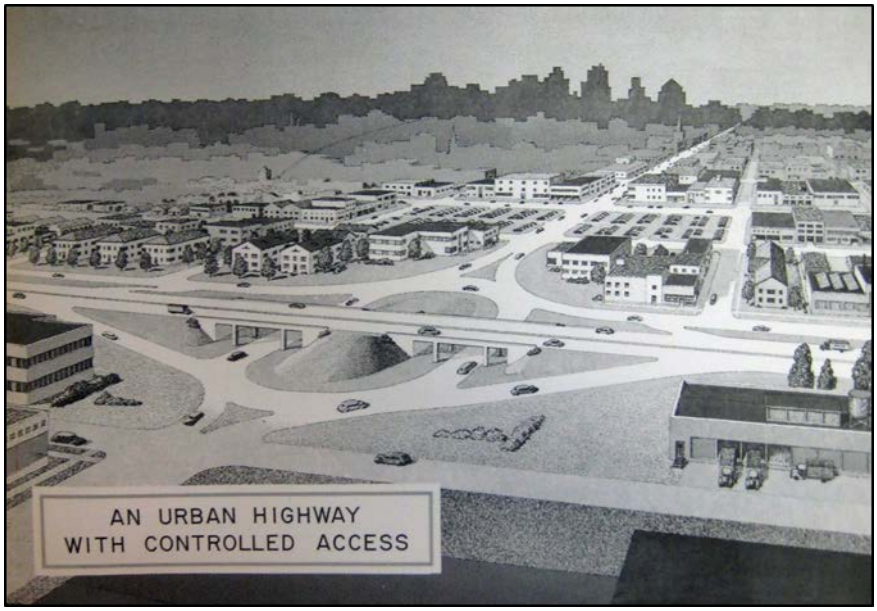


Figure A-21. Texas Highway Department 1946 drawing of a typical urban controlled-access freeway, showing a divided highway with grade-separated structures and entrance and exit ramps. Source: Texas Highway Department, "Illustrated Studies of Controlled Access Highways," No. 12 (April 1, 1946): 26.

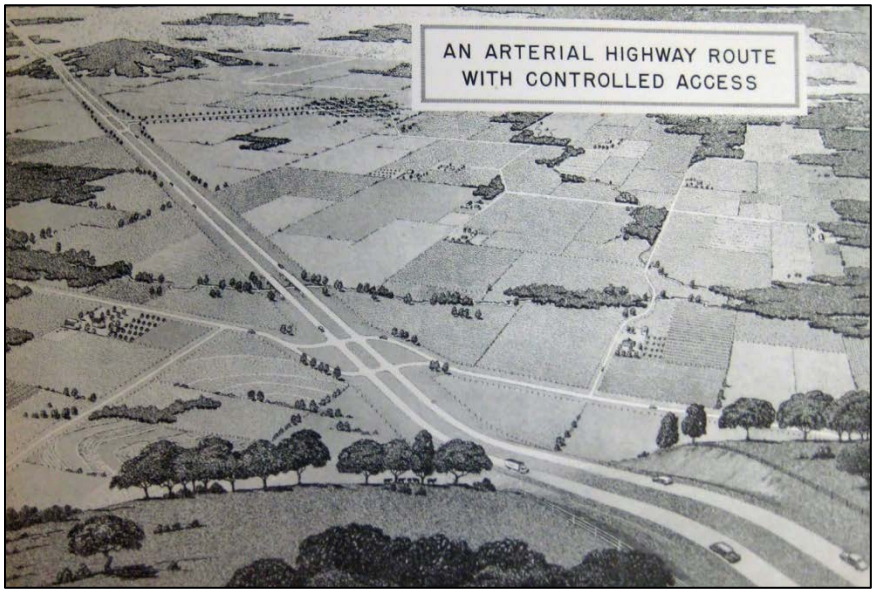


Figure A-22. Texas Highway Department 1946 drawing of a controlled-access thoroughfare, showing a divided highway with at-grade intersections. Source: Texas Highway Department, "Illustrated Studies of Controlled Access Highways," No. 12 (April 1, 1946): 11.

and accelerate with adequate distance and space to merge with high-speed traffic. These highways always included at least four lanes, with two lanes in each direction, and sometimes they included access or frontage roads that paralleled the highway in urban areas.[87] As such, they became major features on the landscape and, in urban areas, often divided sections of neighborhoods from each other. With significant right-of-way widths (from 120 to 160 feet wide),[88] connectivity on either side of the freeways was severely hampered because the only way across the freeways on foot, bicycle, or automobile was by using the grade-separation structures.

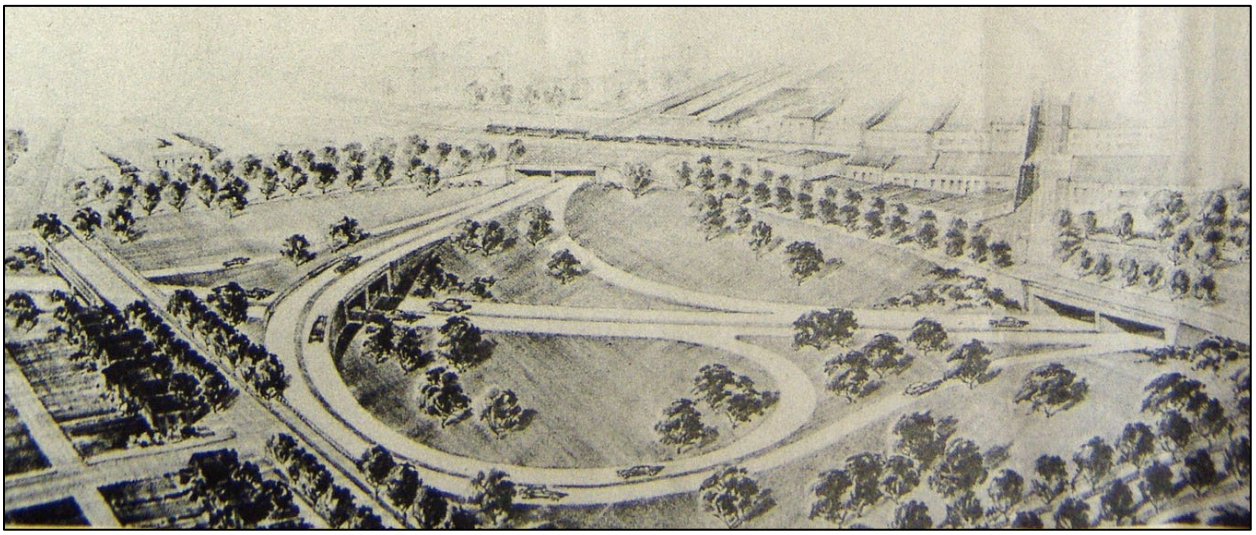


Figure A-23. Drawing included in a 1946 Texas Week article that illustrates an "engineered interchange," that prevents accidents at intersections between roads and railroad. Source: "Texas' Highway Program, Stalled by War, Gets Going," Texas Week (May–August 1946) included in the Dallas Public Library Vertical Files.

Soon after World War II, the Texas Highway Department's first experiment constructing elements of a controlled-access freeway were completed on a short segment of US 77 in Gainesville.[89] The Department chose Gainesville as the location of the prototype because it was in a smaller urban setting than a major city.[90] After the construction of the Gainesville freeway, the Department constructed the Gulf Freeway in 1948 between Galveston to Houston and the Dallas–Fort Worth Expressway in 1949 between eastern Dallas and Fort Worth. Controlled-access freeways diverted traffic off the former named highways including SH 1 (Bankhead Highway) that carried east/west traffic between Dallas and Fort Worth.

The early freeways in Texas were patterned after the Pasadena Freeway in California and Merritt Parkway in Connecticut. Yet, there were a lot of problems with the early freeways designed in the late 1940s and early 1950. Several had pavement structures that were not adequate to withstand high volumes of traffic and heavy loads, and they had poor lane alignments, narrow lane widths, narrow bridge widths, high curbs, steep grades, and short exit and entrance ramps. Furthermore, some freeways such as US 81 (also SH 2 or Meridian Highway) in downtown Austin had many of the early freeway deficiencies, and they were designed without future development in mind (see *Figure A-24*). To accommodate grade-separated intersections, the road was depressed, and reinforced-concrete rigid-frame bridges were used, such as the one photographed in *Figure A-24*. These bridges had integrally constructed superstructures and abutments, and the entire bridge worked together as one unit. While extremely strong and able to carry heavy loads, these bridges could not be widened or lengthened due to this design. As a result, expanding some of these early freeways was difficult and required reconstruction. In the case of US 81 in downtown Austin, the facility was considered obsolete within 10 years of its construction. Due to the severity and frequency of accidents along the first freeways,

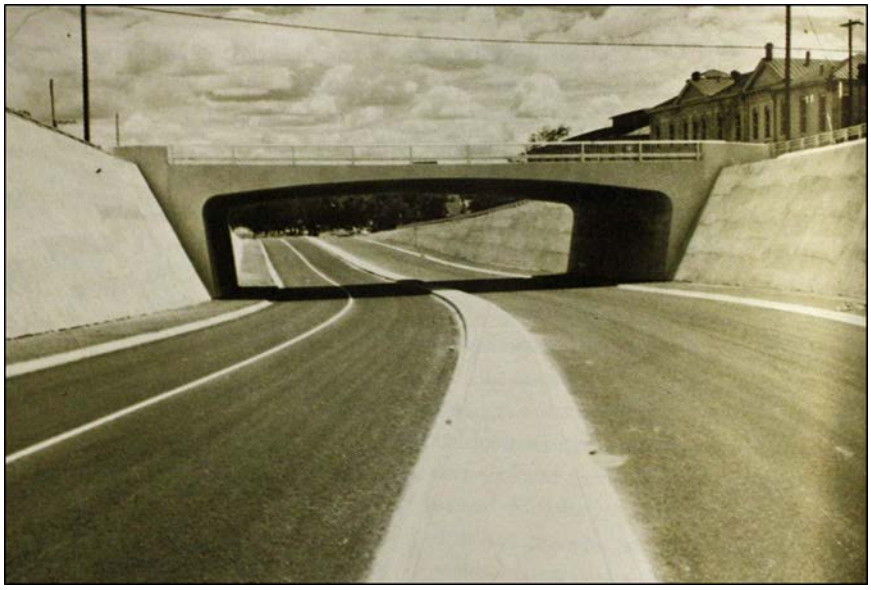


Figure A-24. SH 2 freeway section through downtown Austin showing the deficiencies of the first generation of freeways, including narrow roadway width, high curbs directly adjacent to the travel lanes, and no space for future expansion. Source: Texas Highways 50: Golden Anniversary Texas Highway Department 1917–1967, Good Roads Association Papers, Box 6, Folder 5, Cushing Memorial Library and Archives, College Station, Texas.

Texas Highway Department engineers learned several lessons quickly, such as eliminating left exit ramps (where possible), constructing shoulders, eliminating all curbing within 10 feet of travel lanes, constructing 12-foot-wide travel lanes, building longer entrance and exit ramps, and designing longer distances between ramps.[91] Additionally, later iterations of freeway design did not depress the highway to allow for future expansion.

In addition to building hundreds of miles of controlled-access freeways between 1945 and 1956, the Texas Highway Department also upgraded many two-lane roads to four-lane facilities and built many controlled-access thoroughfares. With the increase in the number of automobiles and trucks on America's highways, the need for more capacity on Texas roads was crucial for safety and further contributed to a growing and robust state economy.[92] As one El Paso County sheriff noted in 1952, "We're using Model T highways – highways built for speeds of 20 to 25 miles an hour – not for the highway speeds and heavy traffic of today."[93] As a result, high accident rates occurred on many two-lane facilities, and the Department determined which roads to upgrade based on their daily traffic counts. If a two-lane road carried 4,000 or more vehicles per day, it was prioritized for widening to four lanes.[94] For improved safety, the Department designed four-lane roadways with a grassy or concrete median (at least four feet wide) separating on-coming traffic. (See *Figure A-25*.) In an article promoting four-lane divided highways, the author recounted numerous accidents along US 80 in El Paso County (much of which followed the former Bankhead Highway alignment), and used it as an example of Texas' need to divide highways with high traffic counts. He also highlighted the section of US 90 between Houston and Beaumont (much of which followed the

Figure A-25. This photograph shows a divided highway included in a 1952 article promoting the construction of divided highways. Source: James W. Glasscock, "Do We Need More Divided Highways," Texas Parade Vol. 12, No. 2 (April 1952): 22.

former Old Spanish Trail route) as a "horrible example" of a two-lane road with high rates of fatality crashes.[95]

Another major development in road construction between 1945 and 1956 was the expansion of the farm-to-market road system. What made the farm-to-market system so unique was the rapid expansion of the highway system and the Texas Highway Department's efficient and economic development of the system. The expansion of the farm-to-market system was considered a means of "expanding the state's agricultural economy," and it affected 43 percent of the state's residents.[96] After completion of the farm-to-market system, 60 percent of the state's rural residents lived within one mile of a paved road, and 74 percent lived within two miles of a paved road.[97] The main tenet of farm-to-market road design was that farm-to-market roads were all-weather roads that were graded, drained, and paved. They were typically two-lane facilities with at least 10-foot-wide travel lanes and shoulders. All-weather bridges typically could withstand high water events and could carry trucks weighing at least 20,000 pounds (or an H-10 design load).

As the Texas Highway Department was completing numerous freeway and farm-to-market road construction projects throughout the state, the agency began the widespread implementation of flexible base pavements on rural roadways. While flexible base pavements were tested in the late 1930s, their widespread use in Texas did not occur until the post-World War II era. Flexible base roads contain several layers of grade materials topped with bituminous materials or asphalt. They are called "flexible" because the entire pavement structure bends and "deflects" under traffic loads.[98] They could also expand and contract in response to temperature changes. This contrasted with rigid base pavements, which were more commonly used in the pre-World War II era. Rigid base pavements only had two or three layers of grade

materials and were substantially stiffer, requiring several lateral expansion joints.[99] Although flexible base pavements were less expensive to construct than rigid pavements, they required rehabilitation or maintenance every 10 to 15 years. In contrast, rigid pavements were more expensive to construct, but could withstand heavy traffic loads and last 20 to 40 years with little to no maintenance. In general, the Department constructed flexible base pavements in rural locations, and built rigid pavements in urban locations with high traffic volumes.[100]

Although funding was available and designs were ready for construction of Texas roads, the Texas Highway Department had to contend with shortages of materials throughout the 1945–1956 period. Supplies of steel, rubber, and oil remained low through the late 1940s, and just as supplies were rebounding, steel rations began again with the Korean War in the early 1950s. As a result, during most of the 1945–1956 time period, steel was expensive and in high demand. Although steel shortages were problematic, engineers found ways to avoid the use of high quantities of steel.

One of the ways Texas Highway Department engineers minimized the use of steel was to routinely construct reinforced concrete bridges throughout the state, except when long spans were needed.[101] As part of this effort, Department engineers created two new reinforced concrete bridge types that could be rapidly constructed with the use of little steel: the pan-formed girder bridge and the FS slab bridge.[102] Pan-formed girder bridges were constructed by placing reinforcing steel bars, also known as rebar, into reusable steel pans and pouring concrete into the pans. Pan-formed girder bridges could be constructed by nearly any contractor with a set of forms, and no special understanding of falsework or formwork was needed. Pan-formed girder bridges were specifically designed by Department engineers in 1944 and 1945 for construction on farm-to-market roads. At the same time, Department engineers created another new bridge type for short spans in Texas called the FS slab. These bridges had a concrete slab strengthened with rebar and had monolithically poured large curbs that helped carry the load. Designed for short spans, both the pan-formed girders and FS slabs were inexpensive to construct and easy to build. While Department engineers initially designed these bridges to carry light loads (the equivalent of a truck weighing 20,000 to 40,000 pounds), by the 1950s, Department engineers designed pan-formed girders and FS slabs to carry heavier loads. By 1955, certain designs of pan-formed girder bridges could carry as much as a 3-axel truck carrying 72,000 pounds. The pan-formed girder and FS slab bridge types were constructed on state highways and U.S. highways in the 1950s, and they constituted approximately 75 percent of the bridges built between 1945 and 1956.[103]

This period of rapid construction and heavy reliance of standard plans helped change the face of Texas' highways and former named roads. As the federal government planned and states prepared for the implementation of a new interstate system, the Texas Highway Department already had experience constructing controlled-access freeways and highways with speed and efficiency. As a result, with the passing of the Federal Aid Highway Act of 1956, Texas was ready for the massive interstate building campaign that would follow.

[85] Bureau of Public Roads Highway Statistics from 1917 to 2004, included in Maryellen Russo, "Reinventing Reinforced Concrete: Post-war Bridges in Texas," Society of Industrial Archeology Annual Conference (2008), San Jose, California.

[86] David R. Levin, "Limited-Access Highways in Urban Areas." *American City* (1959): 77.

[87] Ibid.

[88] James W. Glasscock, "Do We Need More Divided Highways?" *Texas Parade* Vol. 12, No. 2 (April 1952): 26.

[89] *Texas Highways 50: Golden Anniversary Texas Highway Department 1917-1967,* Good Roads Association Papers, Box 6, Folder 5, Cushing Memorial Library and Archives, College Station, TX, p. 110.

[90] *Texas Highways 50: Golden Anniversary Texas Highway Department 1917-1967*, p. 110.

[91] Ibid., p. 108.

[92] In 1930, 26 million cars and trucks were on America's roads, and in 1949, 43 million vehicles were on the road. Leslie Carpenter, "Uncle Sam Prodding Texas to Speed Up Highway Building," *The Daily Times Herald* (November 10, 1949), 8-1.

[93] Glasscock, p. 26.

[94] Ibid., p. 21.

[95] Ibid., p. 23.

[96] Hayes.

[97] Ibid.

[98] "Pavement Types," http://classes.engr.oregonstate.edu/cce/winter2012/ce492/Modules/02_pavement_types/02-1_body.htm (accessed May 7, 2013).

[99] "Pavement Types."

[100] "Pavement Types." TxDOT Construction Division, Materials & Pavements Section, *Pavement Design Guide*, January 2011. http://onlinemanuals.txdot.gov/txdotmanuals/pdm/manual_notice.htm (accessed May 7, 2013).

[101] It is important to note that the span refers to the distance between substructure supports, such as between two abutments or between a pier and an abutment. The shorter the span, the closer the substructure supports are to each other. Longer spans were required for crossings such as canyons and large rivers.

[102] Note there is no suggestion in the research what "FS" indicated; however, some authors have speculated that it may stand for "flat slab."

[103] TxDOT Bridge Inventory Database (March 2006), Texas Department of Transportation, Austin, TX. For more information on bridge types used during the 1945–1956 time period, see the *Historic Road Infrastructure of Texas, 1866–1965 Multiple Property Documentation Form.*

EFFECTS OF THE INTERSTATE HIGHWAY SYSTEM: 1957–1980

From 1957 to 1980, transportation in the United States and Texas changed drastically as federal and state transportation agencies embarked on planning, designing, and constructing the Interstate Highway System authorized by the Federal Aid Highway Act of 1956. Efforts were also underway to upgrade the farm-to-market road system, and advances in road construction, particularly in the mass production of concrete and steel products, aided the booming transportation sector. As a result, many of the former named highways were subsumed into other larger highways, or some segments were abandoned.

In 1956, AASHO set forth design standards for the interstate system that included minimum standards such as: 12-foot width for traffic lanes, 36-foot-wide medians in rural settings and in areas with level terrain, 16-foot-wide medians in urban and mountainous/hilly areas, 10-foot usable shoulder widths, and 14-foot vertical clearances for bridges and overpasses.[104] Additionally, controlled access, grade separations, and frontage roads became hallmarks of the interstate system in Texas. Exit and entrance ramps were designed to control access to and from the highway, and to allow for the most efficient movement of traffic. As discussed in the Texas State Archives Library Commission online exhibit "From Pioneer Paths to Superhighways," State Highway Engineer Dewitt Greer wanted highways to be used by the general public as well as travelers and truckers, so "Texas interstates were built with more points of entry than most other parts of the country."[105]

Additionally, to avoid purchase of new right-of-way and construction of new road corridors, the majority of interstate highways and intrastate freeways within Texas were constructed along existing state, county, and local roads. As a result, many of the former named highways were incorporated into the interstate and freeway system, either as part of the main travel lanes or the frontage roads. These included portions of the former Bankhead Highway incorporated into IH 20, sections of the former Meridian Highway subsumed by IH 35, and portions of the former Old Spanish Trail roadway incorporated into IH 10. Many of the existing roads were two-lane or four-lane undivided roadways, and the construction of controlled-access freeways and controlled-access thoroughfares continued into the late 1950s and 1960s. In an attempt to create more efficient travel between freeways, the Texas Highway Department developed multi-level interchanges at intersections of major highways.[106] The Department constructed the first three-level interchange in 1953 in Baytown, and five years later, constructed the first four-level interchange at the juncture of IH 35 and IH 20 in Fort Worth (see *Figure A-26*).[107]

Figure A-26. Photograph of the first four-level interchange constructed in Texas at the intersection of IH 20 (US 80) and IH 35 (US 81). Source: National Archives and Records Administration, Record Group 30, Box 366, College Park, Maryland.

Frontage roads became central to the design of the interstate highways in Texas. The state's design differed from other states in three areas: 1) shorter ramp-to-traffic signal distances for vehicles exiting the highway onto the frontage roads, 2) less restrictions on commercial and residential development at ramp and frontage road intersections, and 3) encouragement of direct access to businesses from the frontage road rather than from adjacent collector roads.[108] Greer was a major proponent of frontage roads and the economic development that they incurred in communities. Consequently, frontage roads in Texas were much more extensive than in other states.[109]

In addition to the construction of the freeway and interstate highways in the late 1950s, the construction of the farm-to-market system continued. According to a *Houston Chronicle* editorial from 1957, there were 26,000 miles of farm-to-market roads in that year, and by 1965, there were over 33,000 miles of farm-to-market roads in the state.[110]

With the growing number of freeways and farm-to-market roadways, segments of the former named highways were subsumed into other roadways or completely abandoned.

The former named highways were upgraded or abandoned because they were not designed to carry the high traffic volumes and could not meet TxDOT's highway design standards of the mid- to late twentieth century. As noted in the Texas Good Roads Association's *Texas Highways Fact Book* from 1959, the highways had specific standards that included design speeds, number and width of lanes, and right-of-way widths as they related to traffic volumes. The fact book includes a table of design standards, based on a 1956 survey, and re-created below (*Table A-1*).

Table A-1. Design standards based on a 1956 survey.

	Average Daily Traffic (1956)				
	Over 6,000 vehicles per day	3,500–6,000 vehicles per day	1,800–3,500 vehicles per day	1,000–1,800 vehicles per day	Under 400 vehicles per day
Design Speed (Miles Per Hour [mph])*	70-60-50 (60)	70-60-50 (60)	70-60-50 (50)	70-60-50 (50)	60-50-40 (40)
Number of Lanes	4 or more divided	2	2	2	2
Width of Lanes (feet)	12	12	12	12	10
Usual Right-of-Way Width (feet)	300	(*no width provided*)	120	120	80

*Speeds shown are for: Flat topography – Rolling topography – Mountainous topography – (Urban sections). These are desirable design speeds; the minimum design speed is 10 mph lower. Source: Texas Good Roads Association, *Texas Highways Fact Book,* 1959, p. 14.

By 1958, there were 51,368 miles of road in Texas, of which 51,202 miles were paved, 134.9 miles were still dirt or earthen roads, and 30.51 miles were gravel roads. Of the paved roads, the Texas Highway Department maintained 10.4 miles of brick-surfaced roads, 2,630 miles of concrete roads, and 47,871 miles of asphaltic-surfaced roads.[111]

Likewise, if bridges and culverts were to remain in use on the former named highways, many of them had to be upgraded to carry more lanes of traffic and heavier loads. Advancements in bridge and culvert construction techniques during this period were seen in many of these replacement structures. Pre-stressed concrete, first used in the United States in 1949, allowed for longer span lengths, less susceptibility to cracking, and lower maintenance requirements.[112] Promoted by concrete manufacturers and some state highway departments (such as Florida), pre-stressed concrete construction was different from reinforced concrete construction because it used steel wires rather than

steel reinforcing bars to strengthen the concrete. Texas began using pre-stressed concrete in its bridge designs in the mid-1950s. Pre-stressed concrete was widely adopted throughout Texas in the late 1950s, and is still the primary construction material for bridges in the state and across the country. Utilizing the welding skills of World War II veterans, all-welded steel bridges were widely used during this period for long spans, replacing the need for riveting steel bridges. There were also innovations in the use of light-weight concrete decks, which used synthetic materials in place of aggregate to lighten the weight of the structure itself (this weight is called the dead load). Composite decks were also introduced during this period, which allowed the superstructure beams and deck to work as one unit. All of these innovations were also produced on a massive scale, coinciding with the boom in transportation and infrastructure construction during this period.[113]

Other highway design advancements and research by the Texas Highway Department also appeared on many of the former named highways, and included slip form pavement sections for faster and less expensive construction; asphalt binders for stronger, longer-lasting asphalt roads; and grooved pavement for safety under inclement weather conditions.[114] Signage was also improved, and included the introduction of standardized interstate signs with a red, white, and blue color scheme. The interstate numbering system provided for two digits and could not carry the same number as any other U.S. route.[115] In the mid-1960s, new breakaway road signs were first designed (see *Figure A-27*). These signs were designed with driver safety in mind, consisting of steel I-beam posts called "breakaway posts" that "swing away on impact."[116]

While speed limits were as high as 70 mph in 1956, as noted in the table above, the energy crisis in the 1970s directly impacted national and state speed limits. In response to the oil embargo by the Organization of the Petroleum Exporting Countries (OPEC), the United States aimed to reduce gasoline and oil consumption in the country.[117] A national speed limit of 55 mph was implemented across the country and was not repealed until 1995.[118]

Figure A-27. Advertisement in the December 1967 issue of American Road Building journal illustrating the testing of breakaway signs on highways. Note the steel breakaway posts swinging away from the car upon impact. Source: Good Roads Association Collection, Box 24, No Folder Numbers, Cushing Memorial Library and Archives, College Station, Texas.

[104] Penick, Monica and Gregory Smith. *Route 66 Texas MPS*, National Register of Historic Places, [ca.2005]. www.nps.gov/rt66/HistSig/Rt66TexasMPS.doc (accessed May 30, 2013): 105.

[105] Texas State Library and Archives Commission, "From Pioneer Paths to Superhighways," https://www.tsl.state.tx.us/exhibits/highways/greatage/page3.html, accessed May 6, 2013.

[106] Texas Good Roads Association, *Texas Highways Fact Book,* 1959, p. 14.

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