

# Freeway Metropolis

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Is Houston the world's most freeway-focused city—the ultimate freeway metropolis? There are many potential competitors for such a distinction, and typically Los Angeles is automatically awarded that title. But Houston's freeways have a certain design feature that elevates the freeway to a higher level of importance in the functioning of the city than nearly all other cities. It's a feature that exists extensively only in Texas, and its prevalence in Houston is unequalled by any other city.

The freeway design feature is, of course, the freeway frontage road. Because of the frontage road, Houston's freeways are more than just transportation corridors. They form the city's principal commercial strips and business centers. Whether you are going to work, going shopping, going out to eat, staying at a hotel, seeking medical care, or buying a car in Houston, there's a good chance your destination will have a freeway address. The frontage road heavily influences development patterns, and the resulting land-use form is perhaps the most freeway-focused in the world.

The frontage road has also influenced many other distinguishing design features of Houston's freeways, including the extensive use of high mast illumination and the five-level freeway-to-freeway interchange. The frontage road increases the physical presence of the Houston freeway, adding at least 120 feet (37 m) to the freeway right-of-way footprint. Better yet, Texans and Houstonians like their frontage roads. The frontage road is almost as much a part of Texas as barbecue, cowboy boots, and oil wells, as the Texas Transportation Commission found out in 2001 when it tried to curtail the use of frontage roads on future freeways.

*(Opposite page)* **A Houston landscape:** The painting *Urban Landscape* (1970) by Houston artist Frank Freed depicts a web of freeways jam-packed with automobiles. Freed (1906-1975) enrolled in a basic painting class at the age of 42, intending to learn painting skills as a hobby. Over the next 27 years he produced a substantial body of work, focusing mainly on "folk art" depicting people and cultural themes. He produced very few paintings of Houston's urban landmarks. Fittingly for Houston, many of his few urban landmark paintings focus on freeways, often showing cars and freeways dominating the landscape.<sup>1</sup> (Source: Collection, The Israel Museum, Jerusalem)



### The Parkway Ideal—Lost in the Beginning of Texas Freeway Time

As other cities developed their freeway systems starting in the 1920s, the freeways were often built around the parkway concept, with landscaping and foliage adjacent to the traffic lanes. New York City led the way with the first limited-access highways, opening the Bronx River Parkway in 1923. Through the 1930s Robert Moses built an extensive system of limited-access parkways around New York City. In the late 1930s plans for the Los Angeles freeway system began to develop. Early concepts for Los Angeles freeways showed wide park-like buffer zones separating the freeway lanes from adjacent areas. L.A.'s first freeway was a parkway, the Arroyo Seco Parkway, which opened in December 1940 and was later renamed the Pasadena Freeway.<sup>2</sup>

Houston, however, would march to its own drummer. The freeway designs of other cities had little, if any, influence on the design for Houston's first freeway, the Gulf Freeway, or any of its subsequent freeways. In 1942 the City of Houston Planning Department released the *Major Street Plan for Houston and Vicinity*, which discussed the need for freeways and parkways. Although it did not go into any specific design details, the document differenti-

ated freeways and parkways. A parkway route was contemplated along Buffalo Bayou west of downtown since most of the corridor was already a park. Other discussed routes, including the Gulf Freeway, were envisioned as freeways.

The origins of the Gulf Freeway's frontage roads can be traced back to at least 1940. On April 12, 1940, Houston Mayor Oscar Holcombe announced the abandonment of the four remaining street car lines in Houston and the transfer of the title of the right-of-way of the Galveston-Houston Electric Railway to the city of Houston. In the announcement Mayor Holcombe disclosed his plans for a new superhighway on the former electric railway right-of-way. The plans included six main traffic lanes for high-speed traffic and two 2-lane sections for local traffic, which would be separated from the high-speed traffic with esplanades. It is likely that the head of the TxDOT Houston office, W. J. Van London, influenced the preliminary design of the freeway. The first detailed realization of the frontage road concept for the Gulf Freeway was reported to have been made by Van London on March 19, 1941, in a perspective drawing of the proposed Galveston-Houston Super Highway. At the time frontage roads were called service roads. Freeways having "pseudo" frontage roads



**Frontage road vision, 1941:** This view of the proposed Gulf Freeway was reported to be the first perspective drawing of the freeway. It was drawn by W. J. Van London, head of the TxDOT Houston office, in March 1941. Even on this semi-rural section of highway, frontage roads were in the contemplated design. In this rendering, the frontage roads are shown as two-way roadways. Plans for frontage roads on the Gulf Freeway can be traced back to at least April 1940, when Houston Mayor Oscar Holcombe announced the purchase of the Galveston-Houston Electric Railway right-of-way for use in a new superhighway. (Source: *Houston Chronicle*, August 1, 1952)

**In the beginning, there were frontage roads:** This circa 1950 view of the Houston's first freeway, the Gulf Freeway, shows the new freeway and its frontage roads. In the first generation of Houston's freeways, frontage roads were intended to provide local access and were not consistently continuous along freeways. In this view looking northbound toward downtown, the southbound frontage road stopped at the railroad crossing. (Photo: TxDOT)



had already been built in other cities in the 1930s, particularly New York City, where several elevated freeway structures were served by ground level roads, many of which existed before construction of the elevated freeways. In Texas, and Houston in particular, frontage roads would become a standard feature of freeway design and construction.<sup>3</sup>

### Only in Texas

Looking at the widespread usage of frontage roads on urban freeways in Texas, a question naturally arises: Why is Texas the only state in the United States to make extensive use of frontage roads? For that matter, why is Texas the only place in the world where frontage roads are used extensively? Frontage roads are used on a limited and irregular basis in many cities in the United States, but in all cases outside of Texas the frontage road mileage is a small percentage of the total freeway mileage. Only three cities with major freeway systems use frontage roads on substantially more than half of their urban freeways: Houston, Dallas-Fort Worth, and San Antonio. All are in Texas. Of the three, Houston and San Antonio have the highest percentage of frontage road freeways. Approximately 81% of Houston's freeways and tollways have frontage

<sup>3</sup> The 81% figure is for freeways and tollways in a region extending approximately five miles outside Beltway 8. Westpark Drive is not considered a frontage road of the Westpark Tollway, but East and West Hardy are considered frontage roads of the Hardy Toll Road.

roads.\* In Los Angeles, the freeway capital of the world, frontage roads are practically nonexistent.

The widespread use of frontage roads in Texas is the result of several factors contributing to an unwritten policy that influenced freeway design starting with the first Texas freeway, the Gulf Freeway, until the present day. Local desire for frontage roads, the financial strength to build frontage roads, access rights of adjacent landowners, traffic operation benefits, and the support of influential TxDOT head Dewitt Greer all contributed to the extensive use of frontage roads in Texas.

Until 1956 local entities in Texas were responsible for 100% of the right-of-way acquisition costs for urban freeways. Right-of-way costs were often as large as, or even larger than, actual construction costs for freeways being built through heavily urbanized areas. TxDOT generally tried to accommodate the wishes of the local governments that had made substantial financial contributions to freeways. Local interests almost always wanted frontage roads, and TxDOT generally accommodated their desires. After all, a tract of land on a freeway frontage road was often a very valuable piece of property, enriching landowners and generating more property taxes for local governments. In addition, frontage roads lessened the need for high-quality arterial streets near the freeway to serve local traffic, relieving local governments of that responsibility and cost. The Federal-Aid Highway Act of 1956 transferred right-of-way costs for the Interstate Highway

### Factors that have influenced the widespread use of frontage roads in Houston and Texas

- ◆ Local governments and businesses wanted them, and TxDOT generally accommodated local desires.
- ◆ Frontage roads provide the legally required access to property adjacent to freeways.
- ◆ The father of the modern Texas highway system, Dewitt Greer, promoted highway access and the use of frontage roads.
- ◆ It was usually feasible to acquire the extra needed right-of-way in Texas' low-density cities.
- ◆ Texas has had the financial strength to shoulder the added cost of frontage roads.
- ◆ The option for staged construction: building frontage roads first and adding freeway main lanes as traffic volumes warrant.
- ◆ Traffic operation benefits.
- ◆ Texans' fondness for frontage roads and the convenience they provide.

System to federal and state agencies, and a 1957 state law made TxDOT responsible for 50% of the costs of right-of-way on non-interstate freeways. In spite of the reduced local contribution, TxDOT continued to meet the local desire for frontage roads. Paul R. Tutt, a TxDOT researcher who coauthored a comprehensive report on frontage roads in 1963, observed, "Once local people see frontage roads, they don't want freeways without them."<sup>4</sup>

Texas has generally had a well-funded highway program with the financial strength to shoulder the additional cost of frontage roads. This added cost applies to both right-of-way acquisition and actual construction. A report published in 2001 by the Center for Transportation Research in Austin stated, "The financial costs associated with frontage road facilities were found to be considerably higher than those associated with non-frontage road facilities." Frontage roads increase the freeway right-of-way requirement by at least 100 feet (30 m) and significantly more if modern design practices are used. Due to the low density of Texas cities, acquisition of the extra right-of-way needed for frontage roads was usually possible in the first wave of urban freeway construction from 1945 to 1980. Prior to 1956, when localities were responsible for all right-of-way costs, TxDOT could focus all of its resources on construction, making more funds available for the increased construction cost of frontage roads. When the federal government launched large-scale construction of the Interstate Highway System in 1956, TxDOT needed to ensure that federal funds would cover the cost of frontage roads. To sell the idea of widespread frontage roads along interstate highways to a somewhat skeptical Federal Bureau of Roads, TxDOT published a comprehensive

research report in 1963 detailing the benefits of frontage roads. In the second wave of freeway construction (post 1980), when new freeways are built mostly through undeveloped land and property displacements typically occur along expansions of existing freeways, relatively low property values keep right-of-way costs affordable.<sup>5</sup>

The issue of access rights for property owners adjacent to controlled-access freeways is something that affects all states. Access-control law is a broad subject that has been influenced by legislation and many legal decisions over the years. In general, property that has access before the construction of the freeway must have its access preserved, and property that becomes "landlocked," such as when a large tract is severed into two sections, must have some kind of access provided. National-level guidelines for access control were developed after the Federal-Aid Highway Act of 1956, and each state developed its own policies and practices for handling access rights issues. Solutions to the access-rights problem included the outright purchase of affected properties, the purchase of access rights, connecting landlocked tracts to a nearby tract with access, and frontage roads. In Texas the frontage road solution was used far more frequently than in any other state. This can be attributed to strong property owner rights in Texas and the preference of officials to promote development along freeways. It is also widely believed that the construction of frontage roads has been more economical than the purchase of access rights.<sup>6</sup>

In Houston the influence of landowners takes on an added dimension. Houston's business, real estate, and land development interests are politically powerful and are often the driving force in getting freeways and tollways built and expanded, either directly with land donations or indirectly using their political influence. The business interests supporting freeways want frontage roads along their freeways. After all, there is probably no better way to increase the value of a property than to build a freeway with frontage roads through it.

Frontage roads also provide important traffic engineering and operational benefits to the freeway. Local traffic is kept on the frontage roads rather than entering the main lanes for short distances. In the event of an emergency freeway shutdown, traffic can be diverted to the frontage roads. Frontage roads provide the option of staged construction, where the frontage roads are built before the main lanes and the main lanes are added when traffic volumes justify their construction. The operational benefits of frontage roads were called into question in 2001, prompting an effort to revise frontage road policies.

The aesthetics of the frontage road freeway are not a problem in Texas. In the early years of freeway construction, promoting development along freeways was seen as a way to help propel a predominantly rural and underdeveloped Texas into the modern era. The idea of commercial development and commercial clutter along freeways is accepted in Texas, especially in Houston. Other states adhere to the ideal of parkway or greenbelt freeways and would never tolerate the commercialism associated with



**The modern Texas frontage road:** This view of the Eastex Freeway in north Houston shows a modern Houston freeway and its frontage roads. Frontage roads generally have three continuous lanes in each direction with additional lanes at merging points and intersections. This section of freeway is unusually free of commercial development. (Photo: September 2002)



**The U-turn:** The U-turn is a standard part of interchange design in Texas and is a characteristic of Texas freeways that is associated with frontage roads. U-turns allow a motorist on a frontage road to turn around and proceed in the opposite direction without having to go through the intersection traffic light. This U-turn is on the North Freeway at FM 1960. (Photo: November 2002)

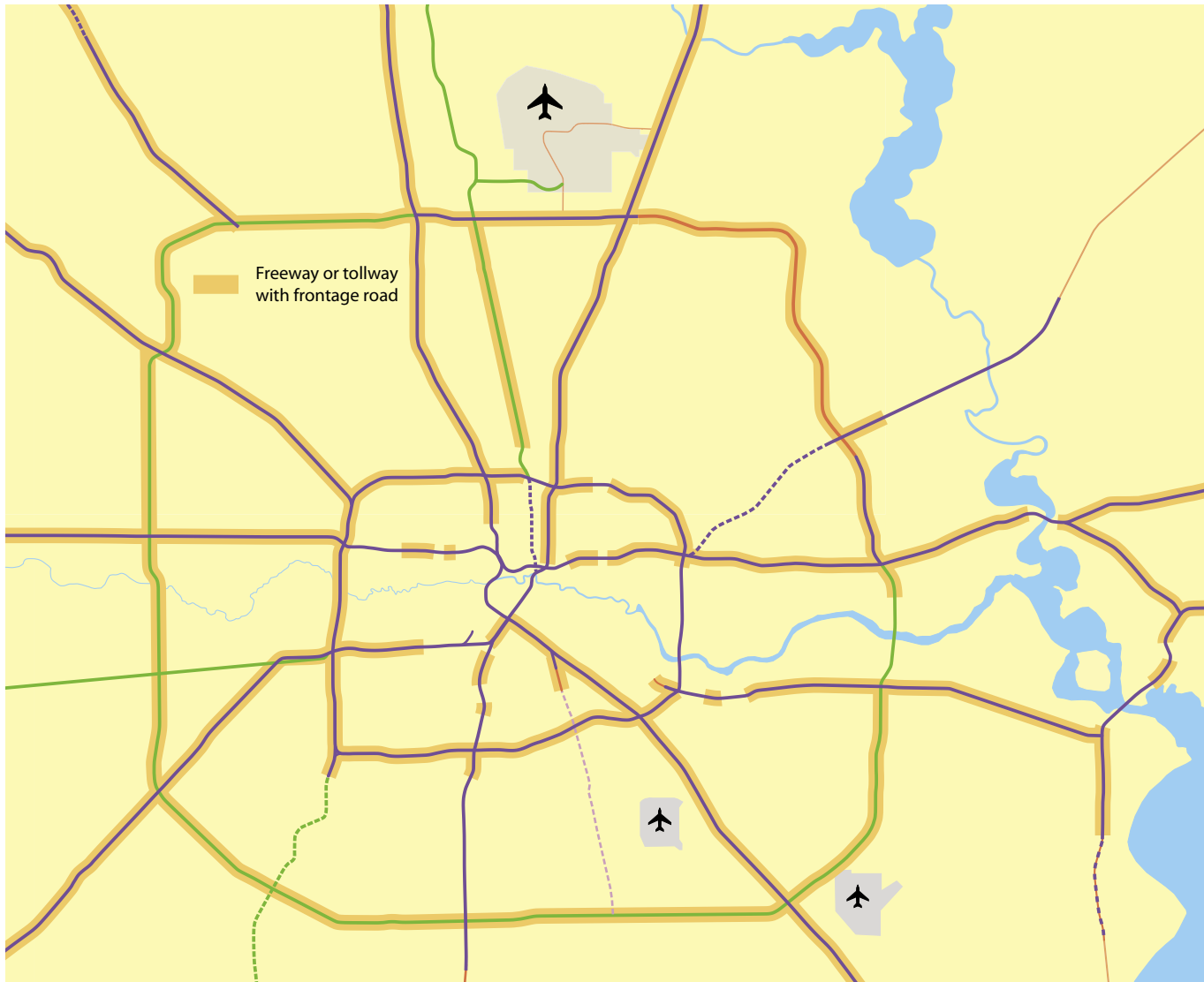
**“Don’t you mean feeder roads?”**

Frontage roads may be the official term, but in Houston they’re most commonly called feeder roads, or simply feeders, by the general population. There are numerous other terms for frontage roads, and every region seems to have its favorite. The Dallas-Fort Worth region prefers to call them service roads, a term which was also widely used in Houston in the 1960s. San Antonio prefers to call them access roads. In El Paso they’re sometimes called gateways. In other parts of the United States, the terms outer roads, utility roads, and marginal roads are used. Houston’s preferred name has the advantage of being more concise and can be used without the term “roads,” for example, “Take the exit and stay on the feeder.”

frontage road freeways. Texans like the convenience provided by the frontage road and U-turn. Motorists can easily find businesses along the freeway without having to stray onto side streets. Frontage road travel is such an entrenched part of daily driving in Texas that a state representative remarked in 2001, “I don’t think any of us would know how to get around without frontage roads.”<sup>7</sup>

Support for frontage roads started at the highest level of TxDOT in the office of Dewitt Greer. Greer presided over TxDOT from 1940 to 1968 and had a tremendous influence on the development of the Texas highway system. He is generally regarded as the father of the modern Texas highway system. Greer was a strong promoter of frontage roads and his influence helped spread them across the Texas landscape. In a March 1954 article in *Texas Highways* magazine, Greer wrote that “frontage roads are built adjacent to the right-of-way line where there is sufficient development of adjacent properties to create the need for such frontage roads to carry the local traffic to the selected points of entry into the express lanes.” In Houston, frontage roads were built not only in the situation described by Greer, but also in just about every instance where they

**Almost everywhere:** The map below shows Houston’s freeways and tollways that have frontage roads. Approximately 81% of complete limited-access facilities in a region extending about 5 miles (8 km) outside Beltway 8 have frontage roads.







**The commercial strip:** Because of frontage roads, Houston's freeways serve the dual purpose of transportation corridors and commercial business strips. This 1974 photo along the Katy Freeway near Gessner shows the typical commercial development that occurs along Houston's freeways. Also in this photo, notice the military aircraft, a Lockheed F-104 Starfighter, on the Memorial City parking lot. It was part of a mall promotion. The first F-104 flew in 1954, and an F-104 set world records in speed (1,404 miles per hour, 2,246 km/h) and altitude (103,395 feet, 31,513 m) in 1958 and 1959. The aircraft was widely used by the United States and its allies in the 1960s. (Photo: Chuck Fuhs)

could practically be constructed. All the managers of the Houston offices of TxDOT, from the end of World War II to the present day, have been supportive of frontage roads and included them in freeway designs.<sup>8</sup>

Finally, a philosophy for Texas-sized construction—bigger and better—has surely had some influence. The frontage road freeway is the ultimate in freeway design, with the biggest footprint and the most lanes.

### **The Frontage Road Matures and Survives Challenges**

In the first generation of Houston freeways, frontage roads were intended mainly for local access. They did not continue through freeway-to-freeway interchanges, usually did not cross railroad tracks, and did not continue through areas where right-of-way acquisition was difficult. With the second wave of Houston freeways, starting around 1980, frontage roads were elevated to a higher level of service. They continued past railroads with grade separations and continued through major freeway interchanges. Major freeway expansions included the addition of missing links of frontage roads. In the most dramatic

**“Highway frontage roads bristling with strip malls are as Texan as pickup trucks with gun racks.”**

*Dallas Morning News*, September 6, 2001

instance of adding a missing link of frontage road, the West Loop frontage roads were trenched underneath the four-level Southwest Freeway interchange in a project that began in 2001. The only all-new freeway constructed in the 1990s, the SH 249 Tomball Parkway, included full frontage roads.

Still, the era of near-universal frontage roads in planned freeways and upgrades in Houston started to come to an end in the 1980s. Houston's first freeway to be constructed mostly without frontage roads, the South Freeway, was completed in 1984. The Harris County Toll Road Authority (HCTRA) was created in 1983, and HCTRA builds tollway main lanes only. The Sam Houston Tollway has frontage roads built by TxDOT, but for the most part new facilities built by HCTRA do not have frontage roads. The Grand Parkway came back to life in the 1980s and the lack





**Billboard alley:** The North Freeway has distinguished itself as having one of Houston's highest concentrations of billboards and commercial clutter. This has always been a rather sore point with local economic development officials, since the North Freeway is one of the main routes leading to Bush Intercontinental Airport and provides the first impression many visitors have of Houston. On July 20, 2003, the *Houston Chronicle* reported on Houston's preparations for the 2004 Super Bowl: "Some civic leaders consider the North Freeway, with its heavy traffic and long stretches of garish signs, strip malls, car lots, topless clubs and modeling studios, such an eyesore that limo drivers may be asked to bring VIPs in on the Hardy [Toll Road]." (Photo: September 2002)

of frontage roads in its planned design was touted as one of its selling points. Without frontage roads, the Grand Parkway would not become another long commercial strip and would truly have some parkway qualities.

A much larger challenge to frontage roads emerged at the Texas Transportation Commission in June 2001. The commission approved a resolution to drastically curtail the construction of frontage roads on future limited-access highways in Texas. In the testimony at the commission meeting, it was stated that frontage roads reduce the operational efficiency of the freeway main lanes by introducing "points of conflict" at the frequent entrance ramps, exit ramps, and frontage road intersections with streets. The cost of frontage roads was not cited as a reason, but an associated resolution passed at the same meeting was intended to shift the responsibility and cost for local access to local governments. "TxDOT will work with local officials to design and construct feasible alternatives that may be less costly and provide equal or better overall operation to the transportation system," a TxDOT official stated. To most observers, this earth-shaking change in Texas policy came suddenly and without warning, but high-level TxDOT officials and the commission recognized the significance of their new policy. "It's huge; it's probably one of the biggest decisions that we've made in a long time," stated Wes Heald, administrative director of

the Texas Transportation Commission. Commissioner Ric Williamson knew there would be some resistance. "We can expect to be deluged over the next year about this because the [commission] views frontage roads and access roads as part of the political milieu of the state, and we'll just all have to [be] prepared to be firm and just say we can't do this anymore."<sup>9</sup>

Word of the new policy started to trickle out. Retail industries were concerned that coveted freeway locations would no longer be available. Local governments were concerned about the added costs of beefing up their street networks and the need to substantially revise their street planning processes. Particularly in the Dallas-Fort Worth region, where many freeways were constructed without frontage roads, local political officials had worked long and hard to get funding for frontage roads on their freeways. With the new policy, they would never get their frontage roads. A series of public meetings was held, and public comment was overwhelmingly negative towards the new policy. In May 2002 the Texas Transportation Commission withdrew the proposed new policies on frontage roads without discussion. Instead, an access management policy would be developed to help manage traffic flow on freeway main lanes. The Texas frontage road would live, and Texas would remain unique in the world with its dedication to frontage roads.<sup>10</sup>



**Houston's first stack interchange:** The West Loop-Southwest Freeway interchange was Houston's first four-level stack when it opened in 1962. Serving the heavily congested Southwest and West Loop Freeways, it has been Houston's busiest interchange since its earliest days. But finally some relief is on the way for the beleaguered interchange. In work that began in 2001, the interchange is being upgraded to a five-level stack by trenching the West Loop frontage roads underneath the interchange (visible on the right side of the interchange in this photo). New high-level ramps will be added, and the Westpark Tollway will terminate at the west (left) side of the interchange. (Photo: November 2002)

### The Commercial Strip and the Scenic Houston Freeway

Every city has its commercial strips, full of retail establishments and associated signs and clutter. Because of the extensive use of frontage roads in Houston, most Houston freeways serve the dual purpose of transportation corridors and commercial strips. Adding to the visual impact is the widespread prevalence of billboards along many Houston freeways. The resulting visual experience can almost qualify Houston's freeways as anti-parkways. If you want nature and landscaping, you shouldn't look for them along Houston's freeways. In contrast, freeways in other cities such as Los Angeles or Atlanta create an entirely different atmosphere—a noncommercial atmosphere.

Even in the 1960s, many in Houston were attempting to alter the visual atmosphere of Houston's freeways. The year 1968 seems to be the beginning of freeway beautification efforts. In June 1968, the Houston Municipal Art Commission published a small report called *Beautification Study: Freeways* in response to "the growing concern in Houston for the preservation or restoration of beauty within the city." The report was certainly practical and modest, simply recommending the addition of landscap-

ing along freeways where it was feasible. Also in 1968, the head of the TxDOT Houston Urban Project Office, Albert Kyser, was urging the city of Houston to ban billboards on the soon-to-be-opened section of the Katy Freeway inside Loop 610, stating, "We have gone to extra expense to acquire extra right-of-way to make this freeway more beautiful, and the city should follow through and pass an ordinance prohibiting billboards along this freeway." The Houston billboard industry was very powerful, so no anti-billboard ordinance would be passed. Any beautification efforts undertaken in that era were minimal and did not last.<sup>11</sup>

Local officials interested in beautification focused their efforts on billboards in the 1970s. By the late 1970s, Houston had about 10,000 billboards that were not associated with the business on the property ("off-premise" billboards), prompting some people to call Houston the "billboard capital of the world." Houston's first anti-billboard ordinance was passed in 1980, banning the construction of any new off-premise billboards in Houston and placing restrictions on existing billboards. In 1985, in response to a state law, the ordinance was amended to prohibit the replacement of damaged billboards and the replacement





**The drive-thru construction zone:** Interchange construction is one of the most impressive events in all of construction. Unlike all other major construction events, the public is able to get right in the middle of the project on a daily basis. This is a view of the Katy Freeway-Beltway 8 interchange construction zone in 1988. (Photo: Allen Moradi)

of wooden billboards with steel billboards. In 1992 the ordinance was again amended to ban nearly all off-premise billboards. An amortization period was established—17 years for wooden billboards and 21 years for steel billboards—after which off-premise billboards would need to be removed. In 12 years, Houston had gone from being one of the most lenient cities in terms of billboards to being one of the most restrictive.<sup>12</sup>

Another powerful tool against billboards was the establishment of scenic districts. Beautification advocates successfully had the entire Beltway 8-Sam Houston Parkway designated as a scenic district in December 1986, preventing the placement of any billboards and strictly regulating on-premise signs. Various other freeway sections have become part of scenic districts in Houston. “Scenic” is a relative term when applied to Houston, of course. Houston can never have a freeway as scenic as the Serra Junipero Freeway (Interstate 280) in Silicon Valley, California, or Interstate 5 north of San Diego, California. Houston freeways would need to be scenic in their own way, showcasing the best that Houston has to offer.<sup>13</sup>

However, there was a big loophole in the anti-billboard laws—the freeway loophole. Federal law requires compensation for lost income for billboards removed along federally funded highway facilities, and it was not finan-

cially viable for government agencies to pay the estimated \$300,000 to \$500,000 cost for each billboard along major freeways. To further complicate the issue, Houston’s freeway expansion program was taking wide swaths of right-of-way along existing freeways, more than 100 feet (30 m) wide in many cases, and large numbers of billboards were located in the right-of-way needed for freeway expansions. TxDOT was not willing to pay the huge cost for billboard removal, so a compromise was reached in 1987. When a freeway expansion necessitated the removal of a billboard, the owners were allowed to move the billboard to another location along a freeway. Billboard owners could move their billboards to any location within Houston and its extraterritorial jurisdiction where regulations allowed them. As of 1998, 202 signs had been authorized for relocation. Naturally, billboard owners tried to move their billboards to other freeway locations with maximum traffic volumes. The result: a concentration of billboards along certain sections of freeways in Houston. Houston may rid itself of most of its off-premise billboards sometime around 2012, but the freeway billboards will likely exist for a long time.<sup>14</sup>

While the long battle over billboards played out, other initiatives were underway to help beautify Houston’s freeways. Landscaping was implemented along some

**The first five-level stack:** The interchange at Beltway 8 and the Katy Freeway launched the second generation of Houston stacks when it was completed in 1989. Unlike the first generation of stacks built around Loop 610, the second generation included continuous frontage roads through the interchanges, requiring an additional level. This stack will also be Houston's shortest-lived, with demolition and reconstruction scheduled for 2004-2008. (Photo: James Lyle, TTI, June 2001)

freeways on a limited basis, but more significant was the trend toward attractive freeway design features that began in the early 1990s and started to bear fruit by the late 1990s. As of the late 1980s, traditional design practices with a disregard for aesthetics were still in use. Examples include the early five-level stack interchanges along western Beltway 8, particularly at the Katy Freeway (completed in 1989) and the Northwest Freeway (completed in 1990). Initial efforts were modest and involved the use of more visually pleasing construction techniques, such as trapezoidal prestressed concrete beams and tapered bridge piers that provided a sleeker, more California-style look. These techniques appeared on the reconstruction of the Eastex Freeway, which began in the early 1990s. New stack interchanges, particularly the Beltway 8-Gulf Freeway interchange (1997) and the Beltway 8-North Freeway interchange (1997/2003), were designed with aesthetics in mind. The reconstruction of the Southwest Freeway near downtown, a project whose first phase was completed in 2002, provided Houston with the first taste of a truly aesthetic freeway with its long-span arched bridges, decorative lighting, and architectural enhancements. Plans were in development to transform the Katy Freeway into a distinctive freeway during its comprehensive reconstruction, scheduled for 2003-2008. In 2002, in conjunction with planning for the Katy Freeway project, TxDOT launched the Green Ribbon project, an effort to define beautification standards for 80 miles (128 km) of Houston's freeways and promote public-private partnerships to implement the improvements.

### Stack City

Built on the coastal plain of the Gulf of Mexico, Houston is nearly a perfectly flat city. But Houston's motorists can escape the confines of flatness on the ramps of Houston's freeway interchanges. Sometimes the freeway interchanges are visible from miles away, starting as a small projection on the horizon and slowly taking form as monumental structures as the driver approaches. Other



times they appear suddenly in front of the driver, almost as if to startle. From below, their gracefully curving, high-flying ramps define a unique geometry that seems to dwarf even the biggest freeway. On the connection ramps, the stack offers the thrill of an out-of-the-ordinary driving experience and a chance for vistas not normally available to the landbound driver.

The multilevel freeway-to-freeway interchange, commonly known as a stack interchange, is one of the signature structures of Houston's freeway system. With the original construction of its first wave of freeways, Houston earned strong interchange credentials with the four-level interchanges around Loop 610 and within the downtown interchange complex. But the second wave of freeway interchange construction, beginning in the mid-1980s, brought a series of new five-level stacks that





propelled Houston into the elite of stack cities.\* Houston and Los Angeles are in a class of their own when it comes to the size and number of multi-level stack interchanges. Los Angeles built the original stack in 1953 and still reigns supreme with its sleek cast-in-place concrete structures. The world's most impressive group of stacks is probably the four stacks along the Century Freeway (Interstate 105) in Los Angeles. But Houston has the larger Beltway 8 collection, which is still a work in progress. If Los Angeles is the king, Houston is the queen. They are the royalty. Other contenders and up-and-comers can only reach the level of high nobility.

Houston's commitment to the multilevel stack interchange is unequalled in the United States. The cloverleaf interchange was banned from consideration in the mid-1950s and the complete stack became the only way to build freeway-to-freeway interchanges. In nearly all other freeway cities, including Los Angeles, the use of multilevel stacks is not exclusive at freeway-to-freeway

**Concrete and steel tour de force:** The Northwest Freeway-Beltway 8 interchange has the highest and structurally most impressive ramps in Houston. The interchange was completed in 1990. (Photo: May 2002)

*(Opposite page upper)* The Gulf Freeway-Beltway 8 interchange features high-flying ramps, symmetric design, a sprawling right-of-way, and architectural enhancements. The interchange was completed in 1997. (Photo: November 2002)

*(Opposite page lower)* This view shows a Beltway 8 frontage road at the Northwest Freeway-Beltway 8 interchange. (Photo: December 2002)

interchanges. Many Los Angeles interchanges include loop connections for low-volume traffic movements or use interchange designs that minimize the number of levels or the height of structures. During the entire history of Houston's freeway system, there has been only one loop connection in all the region's freeway-to-freeway interchanges. That connection, at the Eastex-East Freeway interchange downtown, was removed in 2000 and replaced with a direct connector ramp. A few loop connections exist at freeway-to-highway intersections,

\* In determining the number of levels, the ground level is counted as a level. A four-level interchange consists of a freeway at ground level and three levels of overpasses.









mainly along older sections of freeway. However, two new loop connections will appear at the intersection of the Sam Houston Tollway and the Westpark Tollway, scheduled for completion in 2005.

Houston's first two fully-directional freeway-to-freeway interchanges opened in July 1962 at the Loop 610-North Freeway intersection and the Loop 610-Southwest Freeway intersection. The Loop 610-North Freeway interchange was only a three-level structure and included left-lane exit ramps, a substandard design practice which was being phased out. The four-level Loop 610-Southwest Freeway interchange was Houston's first stack built to modern standards. It was the second four-level interchange in Texas, coming after the Fort Worth Mixmaster, which opened in 1958. The Houston interchange was far

more modern in design than the Mixmaster, which was demolished and replaced with a new structure between 1993 and 2001.<sup>15</sup>

Over the next 17 years stack interchanges were built around Loop 610. By 1979, one three-level and six four-level fully-directional freeway-to-freeway interchanges were complete around Loop 610. Four partial interchanges were also complete by 1988. After the second interchange was completed at the intersection of the West Loop and the Katy Freeway in 1968, a design philosophy shift occurred. The first two four-level interchanges placed freeway main lanes at the top level of the interchange. All future stacks in Houston would have connector ramps at the upper levels. There were two exceptions to this design philosophy. The irregular Gulf Freeway-South Loop and

Gulf Freeway-US 59 interchanges placed freeway main lanes at the top level.

The frontage road has played a key role in defining the design of the second generation of stack interchanges in Houston. In the first generation of four-level freeway stacks, frontage roads did not continue through the interchanges, instead skirting around the edges or stopping short of the interchanges. In the 1980s frontage road service levels were elevated to higher standards. In the second generation of interchanges built around Beltway 8, freeway frontage roads were designed to pass underneath the interchanges. This necessitated adding an extra level, resulting in the five-level stack interchange. All the Beltway 8 interchanges are designed with the frontage roads on the first (ground) level, the intersecting radial freeway main lanes on the second level, the Beltway 8 main lanes on the third level, and connector ramps on the fourth and fifth levels. It should be pointed out, however, that the connection ramps typically do not intersect over a single point. This means that the crossing of a level four and level five ramp may occur at a point where the level four ramp is below its peak. Nevertheless, Beltway 8 still has some of the highest and longest connection ramps in the United States.

Houston's first five-level interchange was completed in 1989 at the intersection of Beltway 8 and the Katy Freeway. The interchange was particularly challenging to design due to limited available right-of-way. It features connection ramps positioned directly over the Katy Freeway frontage roads. The 1990s saw a succession of major stack interchanges being completed around the Beltway, all of them five-level structures except for the four-level interchange at the East Freeway. The interchange at the intersection of the Gulf Freeway and Beltway 8, completed in 1997, probably ranks as Houston's greatest achievement in stack interchange design. It features a sprawling right-of-way, symmetric design, and long, high-flying ramps. Could it be the perfect stack? Maybe. The Beltway 8 stack collection continues to be a work in progress in 2003. The newest addition is the interchange at the North Freeway, completed in January 2003. Work is in progress at the Eastex Freeway interchange to build three connector ramps. Three connector ramps are underway at the SH 249 Tomball Parkway interchange, which will be a partial stack only. In the long term, possibilities exist for new stack interchanges at the South, La Porte, and Crosby Freeways. However, long-range plans in 2003 do not call for construction.

Houston's ongoing program of renewal and modernization will reach a new and unprecedented level with the Katy Freeway expansion program, scheduled for 2003–2008. The expansion program will require the dismantlement and reconstruction of two major stack interchanges: the four-level stack at Loop 610 and the five-level stack at Beltway 8. Houston's first five-level stack interchange, completed in 1989, will have a life span of about 17 years—an unprecedented short life for such a major structure. In another unusual development,

Houston's first four-level interchange, the 1962 Loop 610-Southwest Freeway interchange, is being modernized and converted to a five-level structure with the construction of the Loop 610 frontage roads underneath the interchange. Work is scheduled to be complete by 2005.

The future holds the tantalizing possibility of a third generation of stack interchanges along the Grand Parkway. Preliminary plans show five-level stack interchanges similar to the structures along Beltway 8. However, any stack interchanges along the Grand Parkway are in the distant future.

### Urban Sprawl

Scatteration. Dispersion. Urban sprawl. These were terms the public was beginning to hear from public officials starting in the mid-1950s. Mass-produced and affordable automobiles had been available since Henry Ford launched the automobile culture in the United States, but their real impact on cities became evident in the years after World War II when rapidly rising incomes and advancing technology made widespread suburbanization possible. Around the same time that planners in Houston were formulating Houston's freeway master plan in the early 1950s, urban sprawl was becoming the new face of American cities, and Houston was no exception.

Urban planners in Houston definitely took note of the movement toward low-density development. The era just after World War II was perhaps the most remarkable time in history to be an urban planner. It was an era that provided the opportunity to define the future of cities through the development of freeway networks. In Houston the freeway network would be particularly important since there were no physical barriers and no limits to growth. Leading Houston's effort to deal with scatteration, as he more commonly called it at the time, was Houston planning director Ralph Ellifrit. Ellifrit had graduated from the University of Illinois in 1932 with a degree in landscape architecture, a degree which, at that time, included urban planning. He won the Edward L. Ryerson European Traveling Fellowship after graduation and spent nine months in England, France, Italy, Austria, and Greece studying architecture and urban planning. But the city of the future did not resemble the dense European cities he studied in any shape or form. After becoming director of planning for the city of Houston in 1940, he would lead Houston into the era of sprawl and freeways.

Ellifrit was well aware of the challenges of transportation planning in the low-density city that was taking shape. In a 1957 discussion he stated, "Scattering people so thinly poses tremendous—almost insurmountable—problems in transportation. It means that mass transit—already having rough rolling even in the most densely populated cities—will become impossible under present trends, except in the relatively small and clearly defined central city where population density offers enough passengers to support mass transit. A transit system isn't feasible because of pyramiding costs per passenger mile of pushing service further out into less and less densely





**Freshly minted suburban tract homes, 1952:** These new homes in the Oak Forest subdivision in northwest Houston were part of the movement toward single-family homes and low-density automobile suburbia that was rapidly transforming cities across the United States. By the mid-1950s the issue of urban sprawl was first beginning to receive attention from government officials and civic leaders in Houston. Houston's planners viewed low-density suburbanization as an unstoppable trend and the best strategy was to accommodate it—with freeways. (Photo: HMRC)

populated areas.” The solution, of course, was the freeway and thoroughfare system, but Ellifrit knew that it would be difficult to keep up with demand. “Traffic is increasing far faster than facilities are being provided,” he cautioned. Ellifrit had a vision of the future, and it was already starting to happen in Los Angeles. He cited the Hollywood Freeway, which had sustained a traffic volume increase from 90,000 vehicles per day in 1951 to 160,000 vehicles per day in 1957.<sup>16</sup>

President of the Houston Chamber of Commerce Ben C. Belt was even more dramatic in his assessment. To him, the “explosion of urban population over the countryside surrounding our major cities” was “this century’s paramount problem.” He continued, “This ‘urban sprawl’ produces a maze of metropolitan problems increasing in number and complexity as the metropolitan population increases rapidly.” In the end, it seemed that only one thing could be done. “We will have to learn to live with it,” said Marvin Hurley, executive vice president of the Chamber of Commerce in 1957. To planners in Houston, low-density suburbanization was an unstoppable trend and the only reasonable response was to accommodate it as best as possible.<sup>17</sup>

Ralph Ellifrit and all involved in Houston’s planning process coped quite well, developing a comprehensive

“This century’s paramount problem.”

Houston Chamber of Commerce President  
Ben C. Belt on the subject of urban sprawl in 1956

freeway plan and making great strides in its implementation through the 1960s. Houston reached its peak mobility in 1970 when the first phase of the freeway system was substantially completed. But the most important tool in accommodating urban sprawl, the freeway, would come under attack by 1970. Freeway construction was substantially curtailed in Houston and in every city in the United States starting in the 1970s in response to opposition and the political leadership’s decision to allow transportation investment to decline. But urban sprawl never slowed down. In fact, it continued faster than ever, even without adequate transportation infrastructure. The opposition forces that stopped many freeways could not stop sprawl, and the net result is perhaps the worst of all worlds: sprawl with inadequate freeway infrastructure.<sup>18</sup>

Houston has been better equipped to deal with sprawl than most other cities, largely because of the early planning efforts of Ralph Ellifrit and others to develop Houston’s freeway system. Most importantly, Houston was able to implement most of its pre-1970 planned freeways. The inclusion of Beltway 8 and the Grand Parkway were perhaps the most forward-looking features of early planning efforts, envisioning the sprawl and suburb-to-suburb commuting patterns that developed in practically all large American cities. Houston’s political leadership

“The trend is toward increasing individual mobility—people with their own transportation.”

City of Houston Planning Director Ralph Ellifrit, 1957



has recognized that freeways play an important role in transportation solutions for the sprawling city as well as cost-effective transit solutions. However, Ralph Ellifrit's 1957 observation that it may never be possible to keep up with the public's insatiable demand for automobile transportation infrastructure has certainly proven to be true. With all the demands placed on governments, the political issues involved in highway construction, and the limited resources available to communities, it will probably never be possible to provide the transportation infrastructure that sprawl demands.

There is perhaps another reason why Houston has been able to continue its freeway expansion program to meet its transportation needs. In its 1998 sprawl report, the Sierra Club listed the cities that it designated as the most "sprawl-threatened," including 20 cities in the category of large cities with a population more than one million. Houston did not appear on the list. Houston did not even appear in the "dishonorable mentions" list. This was certainly a surprising result since Houston is sprawling just as quickly as most other large American cities. If the Sierra Club did not find sufficient fault with Houston to place it on the top 20 list, it must be because of minimal environmental impact of sprawl in the Houston region. Certainly there are areas around Houston that have been identified as environmentally sensitive, such as the Katy Prairie. But in comparison to most major cities, Houston has fewer environmental issues. Could it be that the geographic location of Houston is near-ideal for sprawl and freeways? Maybe. And that certainly works in favor of the freeway.<sup>19</sup>

### **Flooded Metropolis**

In Houston, flooding is a way of life. On a regular basis motorists have to contend with accumulations of water on Houston's streets. Usually it's just a nuisance. Every few years a major flood event occurs, inundating parts of the

city, flooding houses, and submerging vehicles. And then there was Tropical Storm Allison in June 2001.

Tropical Storm Allison first visited Houston on June 5, delivering heavy rain and moderate flooding. Allison then drifted north to near Lufkin, Texas. But Allison wasn't through with Houston. The storm changed directions and began meandering southward, returning to Houston with a vengeance the night of Friday June 8. The storm dropped huge volumes of rain and unleashed Houston's worst modern flood event. Twenty-two people died. More than 70,000 homes and 95,000 vehicles flooded. Property damage topped \$5 billion. Areas that had never previously flooded were submerged. One location in northeast Houston received a storm total of 36 inches (91 cm) of rain and 26.5 inches (67 cm) in the devastating 24 hours preceding Saturday afternoon. Much of Houston received between 10 and 25 inches (25 to 64 cm) of rain during the storm, and 10 to 15 inches (25 to 38 cm) during the key 24-hour period.<sup>20</sup>

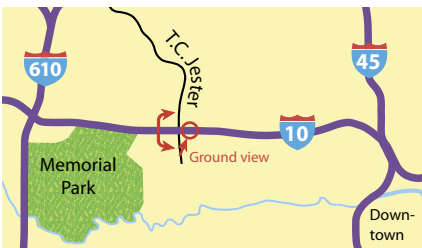
Anything near a stream or bayou was at risk for flooding, and structures below ground level were particularly susceptible to the onslaught of water. In downtown Houston and the Texas Medical Center, basements and tunnels were submerged, causing extensive damage. Many of Houston's freeways are built below ground level, and Tropical Storm Allison unleashed the greatest freeway flood event in Houston's history. Who knows, maybe it was the greatest freeway flood event the world has ever seen. Freeways built below ground level were transformed into a chain of lakes. Abandoned cars and trucks drifted in the water, sometimes washing up on the shorelines of the freeways. Freeways provided some of the most dramatic views of the flood, but the freeways themselves were largely undamaged. After the water receded and wreckers cleaned up the carcasses of vehicles and trucks, the freeways were put back into service and were fully functional by Monday morning.<sup>21</sup>





**A swimming pool for 18-wheelers:** This view looks east along the Katy Freeway (IH 10) at T. C. Jester on June 9, 2001, during the flood caused by Tropical Storm Allison. (Photo: copyright Jim Olive/Stockyard.com)



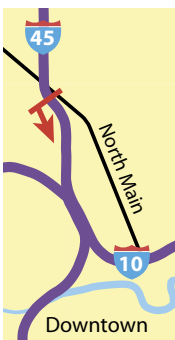


**Receding water:** This ground-level view shows the Katy Freeway as water receded after Tropical Storm Allison. In addition to being caught in the flood, the cab of the 18-wheeler in the foreground also caught fire and burned. (Photo: Loretta Gutierrez)



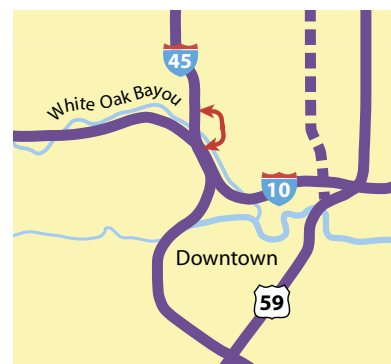
**1992:** Freeway flooding has been a somewhat regular event on certain sections of freeway around Houston. Depressed sections of the Katy, North, and South Freeways have a history of flooding. This view shows the Katy Freeway at T. C. Jester during a flood on March 4, 1992. The head of a swimmer can be seen in the foreground, and a hapless motorist sits on his vehicle underneath the overpass. (Photo: copyright Jim Olive/Stockyard.com)

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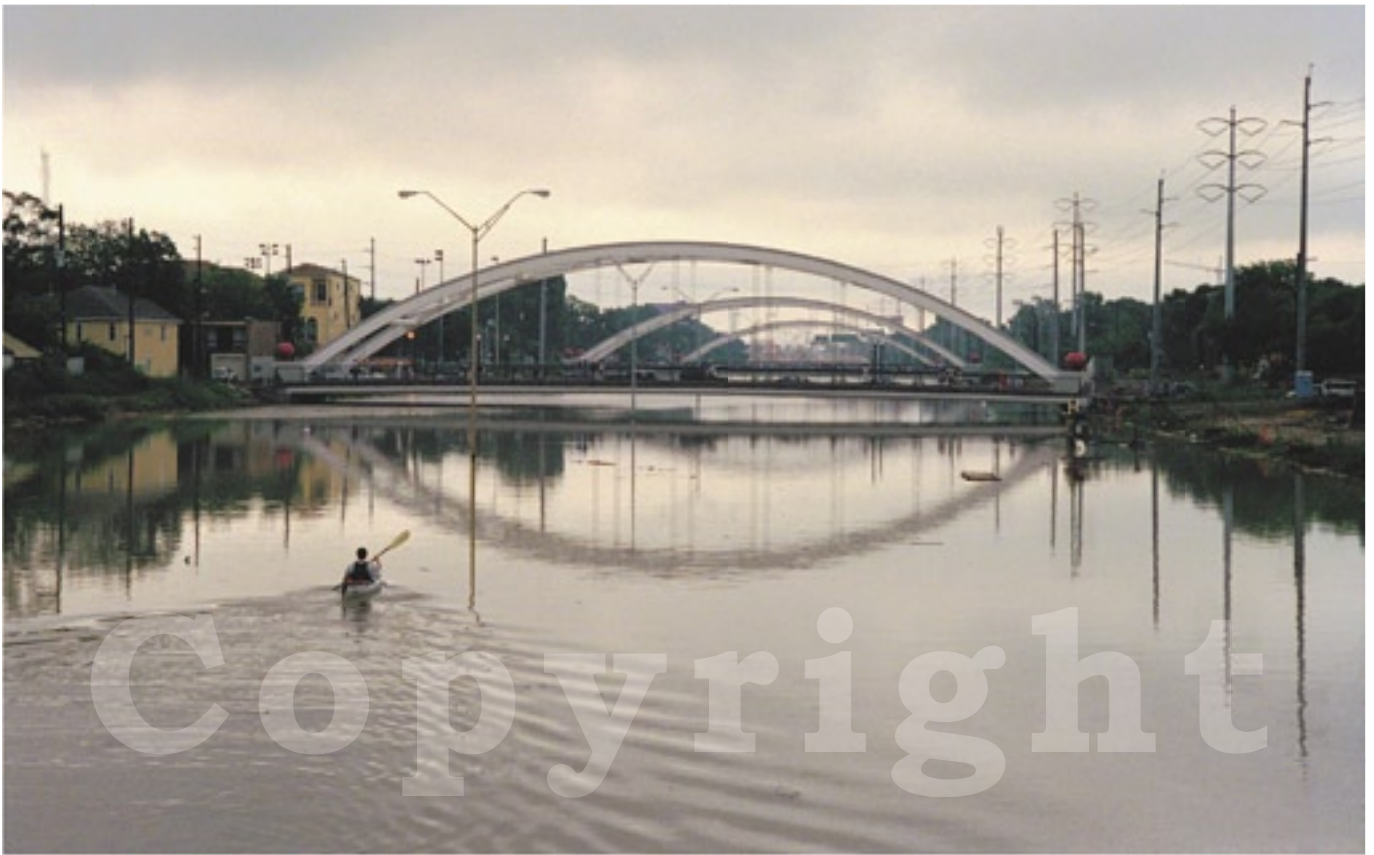


**Beached SUVs:** These sport utility vehicles washed up along the shoreline of the North Freeway just north of downtown during Tropical Storm Allison in June 2001. Like the Katy Freeway, this depressed section of the North Freeway has a history of flooding in major rainfall events. (Photo: F. Carter Smith/Polaris Images)

*(Opposite page)* **Interstate 10 disappears into the water:** This view looks west along IH 10 just west of downtown at the IH 45 interchange. IH 10 drops into the water just ahead of the red 18-wheeler and is located below the elevated structure that continues to the upper part of the photograph. White Oak Bayou overflowed its banks and inundated this section of the freeway. (Photo: copyright Jim Olive/Stockyard.com)







**Multimodalism:** Although the Southwest Freeway was useless for vehicles after Tropical Storm Allison, it was able to serve some waterborne traffic.  
(Photo: © www.malisphoto.com, all rights reserved)







**Flowing water uphill:** Because Houston is nearly perfectly flat, water accumulating in freeways depressed below ground level must be pumped out. The above pump station drains the Beltway 8 trench at the present-day Westpark Tollway, which was constructed on the location of the bridge in the background. In June 2003, TxDOT has 35 operational pump stations in Houston and an additional 5 under construction. (Photo: November 2000)

Inside the pump building, there is typically a wide circular shaft that extends downward. The section of the shaft below the road level is called the well. When rainfall occurs, the depressed freeway drains water into the well, activating a floating switch which turns on one or more pumps to bring the water to the surface. New and recent pump stations use submerged pumps situated in the well area. The pumps are electric-powered, and most pump stations have backup generators to allow continued pumping if a power failure occurs.

So why do depressed freeways flood when heavy rainfall occurs? Each location has its own characteristics for susceptibility to flooding, but generally one or more of the following conditions occur: extremely high water inflow rate into the trench, flooding at the pump discharge, or water backing up through the storm drainage system. Pump stations are generally equipped with ample pumping capacity, but the pumps may not be able to keep up if a bayou is overflowing into the freeway trench. If the discharge area of the pump station is flooded, there is nowhere to pump the water. The water can be pumped up, but it goes back into the freeway trench due to localized flooding around the trench. Backup through the storm drainage system can occur if reverse flow is possible. The South Freeway (SH 288) was originally susceptible to this mode of flooding before its drainage system was modified.

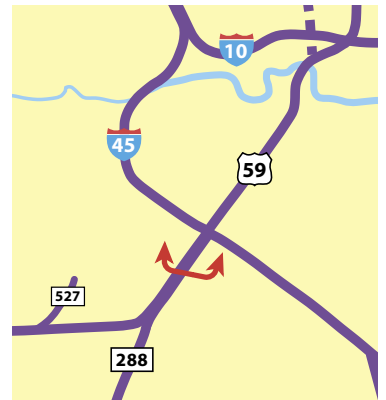


**Bayou breach:** The South Freeway (SH 288), constructed almost entirely below grade between downtown and Loop 610, has been susceptible to flooding. In 1989 the drainage system was modified and pump stations were constructed to prevent flooding. Still, the freeway trench flooded during Tropical Storm Allison in June 2001. The South Freeway has an unusually low crossing over Brays Bayou, actually cutting in the bayou stream bank, as shown in the photo at left. The two low bridges are the South Freeway main lanes; the higher bridge in the background is the northbound frontage road. These low bridges act like a dam when the water is high, contributing to upstream flooding. After Tropical Storm Allison, plans were formulated to raise the bridge 11 feet (3.4 m). The project is expected to begin in 2004. (Photo: June 2003)





**Freeway or waterway?** The wide depressed freeway at the US 59-SH 288 interchange downtown filled with water. (Photo: *Houston Chronicle*)



This ground-level view shows an exit along southbound US 59 downtown. (Photo: Jonathan Miller)