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16. Abstract
Constructing frontage roads along freeway corridors has been Texas' primary solution to providing property access while linking freeway main lanes to cross streets. In 2002, however, the Texas Transportation Commission decided to limit frontage roads inclusion to only special cases as described in §15.54 (d) section of Texas Administrative Code (TAC §15.54 (d)). Kockelman et al's (2003) extensive analysis of frontage road design policies including legal statutes, land development, traffic operations, safety, and cost perspectives found that freeway main lanes and arterial systems operate better in combination with frontage roads only in heavily developed areas. And the cost of building frontage road facilities is considerably higher than building facilities without frontage roads except in cases where high access-right values exist. Furthermore, Kockelman et al (2003) developed design policies and procedures for both new limited-access roads and highway upgrade projects by applying the findings of this study. In the second phase of the project, they implemented these policies in the assessment of frontage roads as an element of controlled-access facilities of several actual Texas corridors that are likely to require upgrades in the near future. In the third stage, the project team described both potential and practiced access management and corridor preservation strategies that state highway departments can apply to improve safety and facilitate traffic flow. Finally, they documented these design considerations and recommendations and sent them to the Texas Department of Transportation (TxDOT) district and design division for use by its Human Resources department in the training of engineers

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Freeway Design Decisions for Revised Frontage Road Policy: Final Project Report

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Project Engineer: Kara Kockelman

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Freeway Design Decisions for Revised Frontage Road Policy: Final Project Report

1.1 ABSTRACT

Constructing frontage roads along freeway corridors has been Texas' primary solution to providing property access while linking freeway main lanes to cross streets. In 2002, however, the Texas Transportation Commission decided to limit frontage roads inclusion to only special cases as described in §15.54 (d) section of Texas Administrative Code (TAC §15.54 (d)). Kockelman et al's (2003) extensive analysis of frontage road design policies including legal statutes, land development, traffic operations, safety, and cost perspectives found that freeway main lanes and arterial systems operate better in combination with frontage roads only in heavily developed areas. And the cost of building frontage road facilities is considerably higher than building facilities without frontage roads except in cases where high access-right values exist. Furthermore, Kockelman et al (2003) developed design policies and procedures for both new limited-access roads and highway upgrade projects by applying the findings of this study. In the second phase of the project, they implemented these policies in the assessment of frontage roads as an element of controlled-access facilities of several actual Texas corridors that are likely to require upgrades in the near future. In the third stage, the project team described both potential and practiced access management and corridor preservation strategies that state highway departments can apply to improve safety and facilitate traffic flow. Finally, they documented these design considerations and recommendations and sent them to the Texas Department of Transportation (TxDOT) district and design division for use by its Human Resources department in the training of engineers.

1.2 INTRODUCTION

AASHTO's green book (1995) considers frontage roads to be "the ultimate in access control". Frontage roads were believed to be Texas' less expensive solution to providing access along freeways. Deeper economic studies (Kockelman, 2000) of frontage-road construction, however, have dispelled such belief, which indicates a need for further analysis. In addition, recent concerns with issues such as congestion, safety, sprawl, cost, route circuity, and the undermining of mass transit modes necessitates a comprehensive examination of frontage road policies. In 2002, the Texas Transportation Commission decided to limit frontage road inclusion to only special cases such as when "it is necessary to unlandlock the remainder of a parcel that has a value equal to or nearly equal to the cost of the frontage road; the appraised damages, resulting from the absence of frontage roads at the time of planning, would exceed the cost of the frontage roads; or it is necessary to restore circulation of local traffic due to local roads or streets being severed or seriously impaired by the construction of the controlled access highway, or an economic analysis shows the benefits derived more than offset the costs of constructing and maintaining the frontage roads." (See TAC §15.54 (d) for complete list of these cases). Kockelman et al (2003) developed an inclusive evaluation of frontage road design policies including legal statutes affecting public access to roadways, policy, land development and pattern effects, traffic operations, safety, and construction cost perspectives. They further developed design policies and procedures for new controlled-access facilities and highway upgrades. These policies were then used in the assessment of frontage roads inclusion in design and improvement plans of several actual Texas corridors that are likely to require upgrades, such as San Antonio's SH281. They included potential and practiced access management and corridor preservation techniques that state highway departments can use to improve safety and facilitate traffic flow on public roadways. Finally, the project team documented and sent the design considerations and recommendations to TxDOT design division for use by its Human Resources Department in the training of engineers.

Best frontage-road policy is likely to depend primarily on present land uses along freeway corridors, local zoning designations, expectations of future development, public sentiment, and design constraints. The results of this work will enable TxDOT to objectively weigh the costs and benefits of frontage roads and modify practices to produce the best projects for the state and its communities. In the future, TxDOT engineers will be required to justify the inclusion of frontage roads based upon economic, operational, and safety analysis and arguments. The TxDOT Transportation Planning and Policy Division draft guidelines for freeway design, state that the Commission "may consider exceptions when…there is no other feasible means to maintain safe and efficient operation of the state highway system." The guidelines also allow the provision of frontage roads when "unlandlocking the remainder of a parcel of land which has a value that exceeds the cost of the frontage road (or)…the appraised damages, resulting from the absence of frontage roads, would exceed the cost of frontage roads" (TxDOT 2001) [4].

This report discusses recommendations for design policies and procedures. Then, it proceeds to explain the results of their implementation to actual case studies located in Texas. Next, access management and corridor preservation techniques that are of possible use or are practiced in Texas and elsewhere are described. Finally, educational materials prepared for TxDOT engineer training and for presentation of research recommendations and results to the public are illustrated.

1.3 DESIGN POLICIES AND METHODS

(Highway Upgrade and New Freeway Construction Projects)
To evaluate frontage road inclusion in new and upgraded freeway facilities, the project team recommends the following steps;

1. *Determine if any prior agreements, commitments, or contracts guarantee frontage road (FR) construction.*
   Designers, first, must determine whether any prior legal agreement exists with local governments, metropolitan planning organizations (MPOs), or property owners, to provide FR service. In that case, either frontage roads must be built or other feasible alternatives, such as backage roads or local access roads must be considered and evaluated in lieu of frontage roads.

   When evaluating alternate access options, other parties should be consulted to confirm their acceptance of these alternatives. And, to acquire the land required for alternate solutions, TxDOT must either negotiate with the owner of the land or use its power of eminent domain. TxDOT, however, is required to consider the number of parcels that the alternate solution will serve, since it cannot use its power to only serve one parcel. For this power to be used properly, there must be multiple properties serviced or similar "public need" satisfied.

2. *Examine the current status of existing access to the facility or proposed Right-of-Way (applied only to highway upgrade projects).*
   Owners of property parcels with access to a public roadway are entitled to continuing access to the public road network or must be paid the fair payment for compensable damages to the property.

   Analysts must refer to the *TxDOT Access Management Manual[5]* to determine whether there will be any changes to the form of access permitted to adjacent landowners. Depending upon land development and the local road network, TxDOT may consider other methods of granting continuing access besides FR services. However, it may prove to be both financially and technically impossible to avoid FRs in order to service land parcels along freeways in certain cases.

   TxDOT should work with local governments and property owners to review existing points for mobility, safety, and the efficient operation of the highway facility and reasonable conformance with the *Access Management Manual*.

3. *Establish the cost of purchasing access rights from affected landowners (applied only to highway upgrade projects).*
   To evaluate inclusion of frontage roads when upgrading highways to freeway standards, the analyst should estimate and compare the cost of building FRs against the cost of buying access rights. If the cost of buying access rights is considerably higher than building frontage roads, they may be considered in the design. This cost estimation is more complicated where commercial developments exists on both sides of the freeway considered. In the cost estimation process, one should remember to include the considerable savings in Right-of-Way acquisition cost when frontage roads are not included in the design.

4. *Examine the proposed facility design and establish the interchange density (ID), which is defined as the number of interchanges per mile. Determine whether FR segments are needed to improve the safety and operations of the main lanes.*
   The purpose of this step is to establish the number of interchanges and associated weaving areas per centerline mile and to determine whether FRs are needed based on safety, traffic operations, and geometric design considerations. Interchange spacing, regardless of interchange type, impacts the free flow speed, travel time, and capacity on the main lanes of the freeway. Frontage roads can contribute to the number of vehicles entering or exiting the main lanes and thus, their traffic impacts must be evaluated. TxDOT aims to maximize the mobility, safety, and efficiency of the State highway system.

5. *Examine any proposed FRs and examine the access density (AD), which is defined as the number of driveways or unsignalized intersections (access points) per edge mile of FR.* Access density for frontage roads associated with the existing or proposed facility must be established. TxDOT is required to limit access density along an approved frontage road by getting landowner cooperation in using alternatives, such as shared collector roads, in lieu of individual frontage road access to reduce access density of a given frontage road segment.

6. *Examine the facility, where it intersects the local road network, to evaluate any damage to the network's integrity and connectivity.* It must be determined whether the new or upgraded facility causes landlocked conditions for parcel owners, traffic circuity, or causes the intersected network to suffer loss of LOS or capacity.

   When upgrading the existing highways to freeway standards, many access points to and across the facility are lost. If this highway has become an integral part of the local network, closing these multiple access points will have an immediate and lasting effect on the ability of the local network to move traffic across the ROW.

7. *Determine if the lack of an FR would cause major circuity damages to the properties whose points of access to the network are changed, which may result in the owner's legal right for compensation.* The additional distance that current access holders will have to travel should be considered to forestall possible legal challenges to designs that do not include an FR for segments of the facility. Landowners who have an existing access to the highway are entitled to similar access to the facility after it is upgraded. When the upgrade is to freeway status, this access usually takes the form of an FR, but FR traffic is usually one-way. This means that some landowners may find themselves having to travel to the nearest downstream intersection to turn around and head in the opposite, intended direction.

Where the facility crosses an existing road network, roads severed by the facility were usually connected by some form of access road included as part of the design. Future highway upgrades to freeways will not automatically include FRs, so these severed roads become dead ends where they meet the ROW. Users of land parcels along Residents of these new dead ends will incur additional circuity (additional time, distance, or both) to reach destinations on the other side of the facility.

Kockelman et al (2003) developed flowcharts to display the steps mentioned in designing new freeways or upgrading existing highways. The flowchart for highway upgrades is shown below.

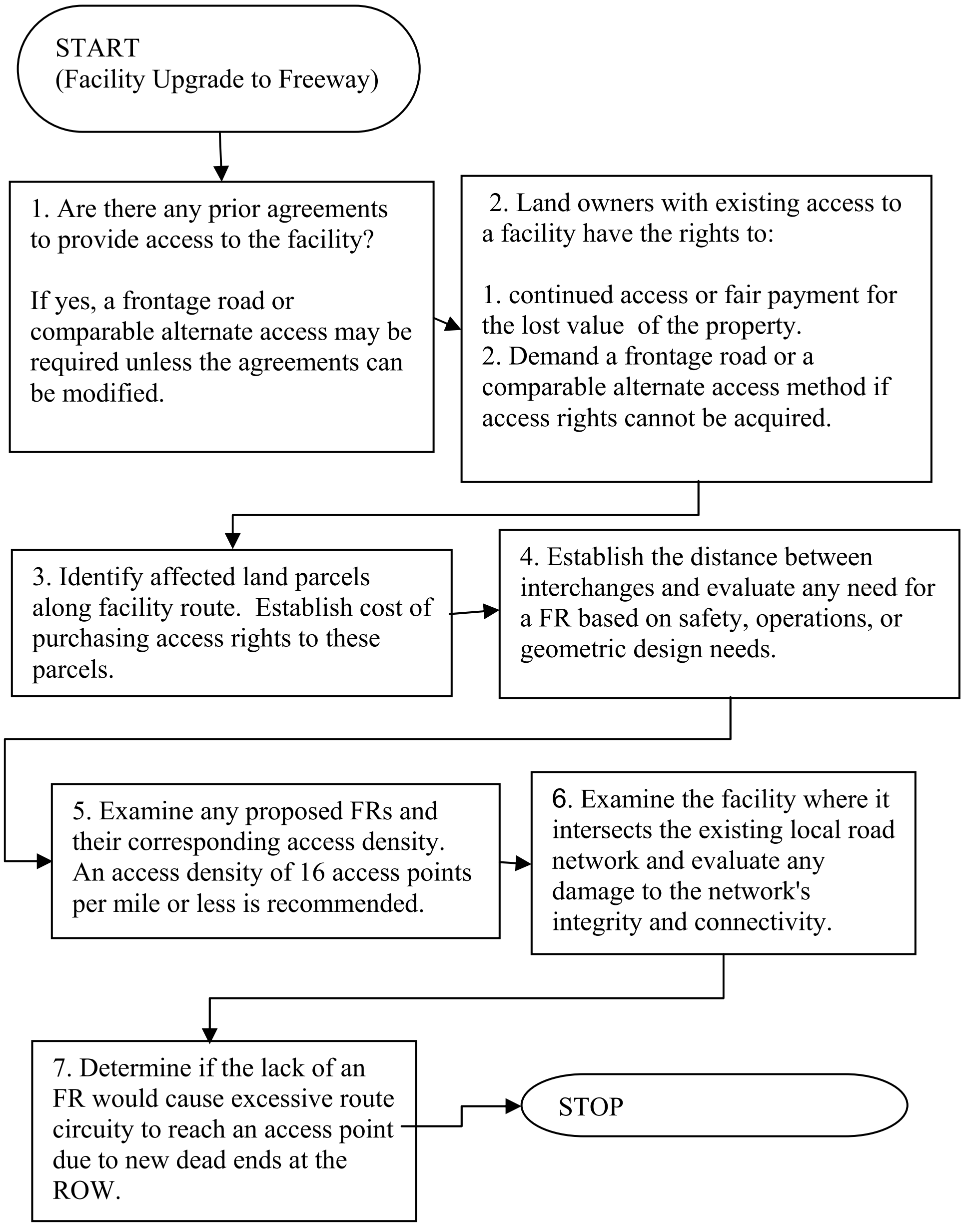

Figure 1. Facility Upgrade Analysis Flowchart

1.4 CASE STUDIES

Kockelman et al (2003) implemented the design policies and recommendations in the assessment of frontage roads as an element of controlled-access facilities of several actual Texas corridors that are likely to require upgrades in the near future. These cases included upgrading segments of three different existing highways in Texas; US 290, US 281, and SH Hwy 71. Based on analysis performed using the design decision policies, the project team recommended frontage roads only for US 281. As a supplement to TxDOT Project 5-1873, they also examined the structural and design features of U.S. interstate highways, I-10 and I-35 and compared sections within Texas to those outside of the state. Studies of US 290, US 281 and I-10 & I-35 cases are presented in detail as follows.

Case Study: US 290

Project Description

This project included upgrading of a segment of an existing highway (US 290). Real estate developments are mostly commercial on the western end, single-family dwelling and some small business on the eastern end, and scattered mixed use in between. The facility is along a heavily used path between Austin and Houston. The proposed facility will have three main lanes and three frontage road lanes in each direction. All lanes will be 12 feet in width. The median saved for future HOV lanes is 54 feet in width. Table 1 displays facility intersections and overpasses in the project area.

Table 1.1 Facility Intersections and Overpasses by Intersection Name (US 290)

Proposed FR Intersections Along Route:	Eastbound Frontage: FM 973, N. Burnett, N. Lexington, N. Caldwell, N. Bastrop, Gregg-Manor, Parmer, SH 130, Decker, Harris Branch, Crofford, Johnny Morris, Arterial "A", Springdale, (Unnamed X5) Westbound Frontage: FM 973, Gregg-Manor, Parmer, SH 130, Decker, Blue Goose, Harris Branch, Crofford, Johnny Morris, Reservoir, Arterial "A", Chimney Hill, Springdale, Tuscany Way, Cross Park, (Unnamed C9)
Proposed Interchanges Along Route:	FM 973, Gregg-Manor, Parmer, SH 130, Decker, Harris Branch, Crofford, Johnny Morris, Arterial "A", Springdale, Tuscany Way

Recommendations

Frontage roads are not recommended for the entire facility. An intersection for Chimney Hill Road is recommended to service the single family dwelling subdivision in lieu of using eminent domain powers to acquire the land and build a connection to the road network. This recommendation was based on cost comparisons, safety of any proposed frontage roads, and effects on main lane operations as noted below:

- Lack of frontage roads would not affect main lane operations. The project's interchange density is 1.28 (1.39 if the Chimney Hill interchange is built). However, including frontage roads would not reduce the negative effects of this density level.
- The number of proposed frontage road intersections would have a noticeable effect on frontage road safety.
- The existing road network would not be seriously affected by changes in travel patterns if frontage roads were not included.[1]

The following table compares the cost of segment upgrade with and without frontage roads.

Table 1.2 Cost Comparison of the Facility Upgrade with and without Frontage Road

Build FR		*Do Not Build FR*	
Construction Cost	$27 million	Access Rights Cost	$36 million
		Savings Due to Not Buying Additional ROW	($38 million)
		Circuity Cost	$27 million
Total:	$27 million		$25 million

It is recommended that an interchange be built to service Manor High School. The cost of such an interchange is estimated to be $100,000 (Kockelman, 2000) and is much less than the $7.62 million that may be due to the ISD as part of circuity compensation.

Case Study: US 281

Project Description

This project is an upgrade of an existing four-lane highway. The proposed facility is three freeway (access controlled) lanes in each direction separated by a narrow median with a concrete traffic barrier and three frontage road lanes in each direction.

Inspection of the aerial map shows that the land within the area of interest is on the edge of a major urban area (San Antonio) and is being developed rapidly, primarily for use in single- and multi-family housing projects. A large rock quarry flanks the west side of the facility, limiting major development to areas north of the quarry and east of the facility. Large single-family-dwelling subdivisions are located north and east of the quarry, with most located at least ¼ mile away from the ROW. Areas adjacent to the ROW on the TxDOT-supplied aerial map have been identified for possible planned development. These areas fronting the ROW are best suited for high-density multi-family dwellings and small to medium sized retail development. Table 3 lists the proposed named road intersections and interchanges.

Table 1.3 Facility Intersections and Overpasses by Intersection Name

Proposed FR Intersections Along Route:	NB FR: Redland, Encino, Evans, Encino Commons, Stone Oak, Marshall SB FR: Redland, Evans, Stone Oak, Marshall
Proposed Interchanges Along Route:	Redland, Evans, Stone Oak, Marshall

Recommendations
Frontage roads are recommended for the entire segment. This recommendation is based on cost comparisons, as the lack of frontage roads would have no appreciable effect on the local road network or on the operations of the main lanes.

The following table compares the cost of upgrading with and without frontage roads.

Table 1.4 Cost Comparison of the Facility Upgrade with and without Frontage Road

Build FR		*Do Not Build FR*	
Construction Cost	$9.4 million	Access Rights Cost	$19.4 million
		Savings Due to Not Buying Additional ROW	($7.35 million)
		Circuity Cost	$22.2 million
Total:	$9.4 million		$34.3 million

Case Study: I-10 & I-35 Comparison

Project Description
Kockelman et al (2003) examined the structural and design features of two major east-west and north-south US Interstate highways, I-10 and I-35 and their adjacent road systems and compared sections within Texas to those outside of Texas. In order to determine the significant differences in the average values of all network variables that were available, they studied and analyzed the I-10 data set, the I-35 data set, and a combination of the two. The studied variables were frontage road length percentage, on/off ramp density, intersection density, local network density, distance to the nearest parallel roadway, and distance to the nearest parallel arterial road.

Results

The results of these studies are summarized in the following table. From this, one can conclude that frontage roads are much more prevalent in Texas than in other states. Furthermore, network, ramp, and intersection densities are generally higher in Texas than in other states; in Texas, the nearest parallel road or arterial is generally closer to the facilities when compared to other states, and road networks around major highway facilities in Texas are not underdeveloped, and may actually be more developed, as compared to other states.

Table 1.5 Case Study I-10 &I-35 Comparisons

Cases (Urban)	Frontage RD Length Percentage (%) of the Facility		On/ Off Ramp Density On/Off Ramps / Mile		NO. of Intersecting Roads Intersections/Mile	
	Texas	Outside Texas	Texas	Outside Texas	Texas	Outside Texas
I-10 and I-35 Cases Combined	80	30	1.5/1.43	1.17/1.18	8.75	4.82
I-10	Higher (2)	Lower (2)	Higher	Lower	10	5
I-35	Higher	Lower	Higher by .46	Lower	Higher by .15	Lower

Cases (Urban)	Network Densities Center-Lane Miles/ (Mile)2		Distance to the Nearest Parallel RD (FT)		Distance to the Nearest Parallel Major Arterial RD (FT)	
			Texas	Outside Texas	Texas	Outside Texas
I-10 and I-35 Cases Combined	Higher (1)	Lower (1)	480	740	3120	2720
I-10	21	17.9	(4)	(4)	Farther (NSSD)(3)	Closer (NSSD)
I-35	Higher by 4.89	Lower	Closer	Farther	NSSD	NSSD

(1) At 20 center-lane miles per square mile the density of the road network surrounding the facility is about 3.5 miles greater than those in other states.

(2) None of the Texas cases has truly continuous frontage roads on both sides for the entire length of the two-mile segment studied.

In fact, Tucson, Arizona, is the only urban case with continuous frontage roads on both sides of the I-10 segment studied.

(3) NSSD stands for No Statistically Significant Difference

(4) In the Texas cases, the nearest parallel roadway to the north lies an average of approximately 350 feet closer to the facility than on urban segments outside Texas (p-value = 0.19), while the nearest to the south actually lies an average of 180 feet further away inside Texas than outside (P-value = 0.54). It seems unlikely that anything significant can be drawn from this finding though, since there is not a statistically significant difference in those lying to the south

Cases (Rural)	Frontage RD Length Percentage (%) of the Facility		On/ Off Ramp Density On/Off Ramp / Mile		NO. of Intersecting Roads Intersections/Mile	
	Texas	**Outside Texas**	**Texas**	**Outside Texas**	**Texas**	**Outside Texas**
I-10 and I-35 Cases Combined	50	20	NSSD (1)	NSSD	0.92	0.73
I-10	Higher (2)	Lower (2)	NSSD	NSSD	Slightly Higher (by .2)	Lower
I-35	Higher	Lower	0.23/.23	0.19/.19	Higher (NSSD)	Lower (NSSD)

Cases (Rural)	Network Densities Center-Lane Miles/ (Mile)2		Distance to the Nearest Parallel RD (FT)		Distance to the Nearest Parallel Major Arterial RD (FT)	
	Texas	**Outside Texas**	**Texas**	**Outside Texas**	**Texas**	**Outside Texas**
I-10 and I-35 Cases Combined	NSSD	NSSD	2050	2200	NSSD	NSSD
I-10	NSSD	NSSD	Closer (3)	Farther	Closer (NSSD) (4)	Farther (NSSD)
I-35	Higher (NSSD)	Lower (NSSD)	NSSD	NSSD	NSSD	NSSD

(1) NSSD stands for No Statistically Significant Difference

(2) Even though all of the cases in Texas have frontage roads, none of them is continuous on both sides on any entire segment. In fact, the only case where this is true is in New Mexico

(3) Parallel roadways (when they exist) seem to lie closer to the mainlanes in Texas than elsewhere by an average of one-half mile on either side of the facility

(4) In Texas, major arterials appear to lie closer to the facilities, but the difference is not statistically significant.

1.5 ACCESS MANAGEMENT AND CORRIDOR PRESERVATION

Access management and corridor preservations are two forms of policy used for long-term access control on public roads with or without frontage roads. Access management techniques determine the location and spacing of access points along public roadways in order to improve safety and facilitate traffic flows. Corridor preservation is a series of steps that state highway departments can use to gain control of or protect the right-of-way for planned transportation facilities. Kockelman et al (2003) includes and describes some access management and corridor preservation techniques that are possible or are practiced in Texas and elsewhere. These strategies are briefly discussed below.

General Strategies Practiced in Other US states or Other Countries

Local governments play a significant role in corridor preservation and access management. Most US states and other countries have developed specific codes containing techniques, legal requirements, and guidance for engineers and developers. For example, the Texas Transportation Commission is allowed to acquire additional rights-of-way to protect a corridor from intense development, or limit subdivision and driveway spacings in order to facilitate frontage-road flows while enhancing safety.

Westerman (1990) found that developing large frontage parcels to reduce the number of access points needed, and moving access points to the rear of the properties, rather than allowing them along the main road, are two strategies useful in Australia. Based on their review of state codes and practices, Williams et al (1994) suggested the following regulatory techniques supportive of access management in the report "Model Land Development and Subdivision Regulations That Support Access Management."

- regulating driveway spacing, sight distance, and corner clearance
- restricting the number of driveways per existing parcel on developing corridors
- increasing the minimum lot frontages along thoroughfares
- encouraging joint access and parking lot cross access
- reviewing lot splits to prevent access problems
- regulating flag lots and lot width-to-depth
- minimizing commercial strip zoning and promoting mixed use and flexible zoning
- regulating private roads and requiring maintenance agreements
- establishing reverse frontage requirements for subdivision and residential lots
- requiring measurement of building setbacks from future right-of-way line
- promoting unified circulation and parking plans

The New Jersey codes confine the number of vehicles that can access the highway from a new development. If the additional traffic caused by development exceeds the projected capacity of the road, developers must pay to alleviate the impact by adding or extending turn lanes or adding traffic signals at an access point.

The implementation and rules governing access management vary widely by state. For example, local governments in Florida are not permitted to impose more restrictive access standards than state policy describes, while Oregon's state access standards are a minimum requirement and a municipality is allowed to enact stricter standards if it deems necessary (Williams and Forester 1996, p. 24).

AASHTO discusses techniques for corridor preservation including government inducements, such as transferring the right to develop to other locations through planning agencies and use of police powers to acquire land and control access. Land acquisition may include the application of purchase options, exercise of eminent domain, and use of surplus government-owned land (AASHTO 1990). The AASHTO Task Force on Corridor Preservation suggests that corridors meeting any of the following criteria be considered for protection: (1) without protection the corridor could force the project into an environmentally sensitive area, (2) significant land development in the corridor is imminent, (3) land values are escalating rapidly, (4) the need for a project has been identified in the corridor, (5) the proposed transportation improvement is expected to be a priority within the next 10 to 15 years, (6) failure to protect the corridor ultimately could result in many more relocations of businesses and homes, and (7) cooperation from local jurisdictions and the private sector can be obtained in protecting a corridor (AASHTO 1990).

In practice, coordination of roadways and land use depends on the voluntary commitment of the agencies involved. In San Antonio, Texas, for example, TxDOT staff has worked closely with city staff to coordinate access management strategies in rapidly developing areas such as the US 281/FM 1604 intersection (Lewis, Handy, and Goodwin 1999). In this example, TxDOT worked cooperatively with the city and the developer to limit the number of driveways and ensure on-site circulation across parcels through deed restrictions. To encourage similar and more formal efforts, the Florida Department of Transportation has published a brochure outlining possible access management strategies and has developed model access management regulations for cities (FDOT 1999; Williams et al. 1994).

Strategies Practiced in Texas

The 73rd Texas Legislature Committee on Transportation (1992) reviewed two policies related to right-of-way acquisition that assist in corridor preservation: the "enhanced-value" deduction and the early take procedure. Under an enhanced-value policy, the state subtracts any value added to the remaining portion of a parcel owing to highway construction from any amount awarded for the actual takings on the parcel before compensating for land takings. Currently, TxDOT is not allowed to compensate in this manner, but the federal government and twenty-four other states have laws that allow it (*Texas Performance Review* 1991, p. 55). Early take procedures would allow TxDOT to officially condemn land and begin construction while a property owner's compensation is undergoing review in a special commissioner's court after first placing the amount of the proposed purchase price in care of the court. If the court rules that a higher compensation is warranted, TxDOT would pay this difference at the time of the court's ruling, but projects would not be additionally delayed. Presently, TxDOT can use only five out twenty four corridor preservation techniques that are practiced in other states. These five strategies are as follows.

- fee simple purchase (acquiring full ownership of the property)
- negotiated agreements (a form of fee simple purchase where the purchase takes place through a contractual arrangement instead of eminent domain)
- protective buying (purchasing land in advance of final project approval when development threatens to obstruct the right-of-way)
- eminent domain (taking private property for public use by condemnation or regulation and compensating the prior owner)
- donations (owners voluntarily donate land to the state; the state can then use the fair market value of the property toward matching shares in federal aid highway projects).

1.6 EDUCATIONAL MATERIALS

Educational materials describing results and products of the frontage road project were created in both Word and PowerPoint format and sent to TxDOT for use by the Human Resources Division in training its engineers.

PowerPoint Document

The project team prepared a 16-slide PowerPoint document, in which the key results and products of the project were summarized to train engineers and developers and to inform the public. This document gives a background on frontage roads and the concerns associated with them. It then proceeds to summarize legal considerations, cost considerations, operations, safety, and land use impacts, and state/local impacts associated with these roads. Finally, it presents the flowchart developed on design policies and guidelines and actual cases studies done in Texas. Graphs and tables were included in this file to better convey information. More extensive illustrations of project results and products were provided in a Word document that accompanied the PowerPoint document.

Word Document

The project team prepared a short, educational Word document for use by TxDOT in training its engineers. The document begins with a background on frontage road history and their usage in designing roadways in Texas. Then, it continues with suggested alternatives to frontage roads that can be used to limit frontage road inclusion in design policies and improvement plans. It also suggests access management and corridor preservation techniques in addition to strategies that are practiced in Texas or elsewhere. Next, this document discusses the elements that should be considered in construction cost estimation with and without frontage roads. Furthermore, it describes the results of surveys performed for other states to ask their opinions on frontage roads. Finally, it discusses the frontage roads from the perspective of operation, safety, and legal issues. In general, this document provides the in-training engineers with a brief, but informative review of project results and products to aid in their design decisions.

1.7 CONCLUSION

In an earlier work, TxDOT Research Report # 0-1873-1, Kockelman et al. (2000) produced a comprehensive study and analysis of frontage road design policies including legal statutes, land development, traffic operations, safety, and cost perspectives. They found, for example, that freeway main lanes and arterial systems operate better in combination with frontage roads only in heavily developed areas, and the cost of building frontage road facilities is considerably higher than building facilities without frontage roads except in cases where high access-right values exist. Using such findings, and via Implementation Project 5-1873, they developed policies and procedures (Product 1) for both new limited-access roads and highway upgrade projects by applying findings of their earlier work. These procedures are as follows:

1. Identify prior agreements, commitments, or contracts that guarantee frontage road construction. In the case of highway upgrades, examine the current status of existing access to the facility or proposed right of way, and establish the cost of purchasing access rights from affected landowners.
2. Examine the proposed facility design and establish the interchange density (ID). Determine whether frontage road segments are needed to improve the safety and operations of the main lanes.
3. Examine any proposed frontage roads and examine the access density (AD) per edge mile of frontage road.

Examine the new facility, where it intersects the local road network, to evaluate any damage to the local network's integrity and connectivity; and determine if the lack of a frontage road would cause excessive route circuity in reaching an adjacent parcel.

They then implemented these policies in the assessment of frontage roads as an element of controlled-access facilities of several actual Texas corridors that are likely to be constructed as new facilities or upgraded to freeways in the near future (Product 2). The corridors selected for this purpose were US Highways 290, 281, and State Highway 71. The results of the formal assessment process conclude in favor of frontage road inclusion only for one of the three studied cases: US Highway 281.

The project team also examined the structural features of interstate highways I-10 and I-35 across the U.S. and compared sections within Texas to those in other states. They found network, ramp, and interchange densities to be generally higher in Texas than in other states; the nearest parallel roads and arterials to be closer; and, as expected, frontage roads to be far more common. Their analyses suggest that road networks around major highway facilities in Texas are more developed than those in other states, suggesting that network connectivity and access provision are less of an issue in Texas. Therefore, frontage roads may be less useful in Texas than elsewhere.

In the third stage of this Implementation project (Product 3), the research team described both potential and practiced access management and corridor preservation strategies that state highway departments can and do apply to improve safety and facilitate traffic flow across the U.S. and Canada. They highlighted issues of reasonable access, alternatives to frontage roads, corridor preservation, ramp location and spacing, merge lengths, and access-point densities. They concluded that a state's tendency to build frontage roads depends both on past access policies within the state, which tend to depend heavily on legislation and formal policy guidelines that specify the provisions under which a frontage road will be provided.

Finally, Product 4 documents all these design considerations and recommendations in both Word and PowerPoint documents for use by TxDOT Design Division, Human Resources Department, and district offices in the training of engineers and planners. Frontage road policy remains a controversial issue for the State, and the products of this Implementation Project are hoped to contribute to optimal design and access management policies.

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