HOUSTON, TEXAS

BRIEF: HOV TRANSITWAY SYSTEM

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HOUSTON, TEXAS (USA)
HOV Transitway System

CITY CONTEXT

The Houston urbanized area has a population of approximately 3 million people, of which about 1.8 million live in the city. The central business district (CBD) employs (1999) approximately 150,000. About 28% of the CBD employees use public transport during peak periods.

The Metropolitan Transit Authority of Harris County (METRO) has a bus fleet of about 1,400 vehicles. System-wide average weekday ridership (July, 2001) is about 330,000.

The metropolitan area is characterized by the low-density development that is typical of most southwestern cities. The area has flat terrain, and there are relatively few barriers to travel. An extensive radial-circumferential ferry system has been developed and progressively improved over the years. In response to peak-period traffic congestion on the freeway system, and right-of-way restrictions in many corridors, a system of high occupancy vehicle (HOV) lanes, with peak-period express bus service has been implemented over the last two decades. A contra flow lane on the North Freeway was placed in service in 1979. Following its success, median-barrier one-directional HOV lanes were provided on radial freeways.

The system was developed cooperatively by the Texas Department of Transportation and METRO. The Texas Transportation Institute (TTI) has aided both agencies, especially in evaluating system performance.

SYSTEM DESCRIPTION

The Houston High Occupancy Vehicle (HOV) lanes are used by buses, carpools, vanpools, and motorcyclists. Houston has the longest barrier-separated HOV lane system in the United States.

METRO operates HOV lanes on six freeways: the Gulf (I-45 South), Southwest (US-59 South), North (I-45 North), KATY (I-10 West), Eastex (US 59 North), and Northwest (US 290 West). (See Figure 1.) Extensions to the Southwest, KATY, Northwest, and Eastex HOV facilities are in design or under construction. By the year 2003, the HOV lane network is programmed to expand from its current 98 miles to 111 miles. [158 – 179 km] (See Table 1).

The HOV lanes operate weekdays in the inbound direction between 5 AM and 11 AM and in the outbound direction from 2 PM to 8 PM. Because of past problems with congestion on the HOV lanes, carpools are limited to 3+ occupants (rather than the typical 2+ occupants) during the 6:45–8:00 AM and 5:00–6:00 PM, “peak of the peak period” on the KATY Freeway HOV lane. A similar restriction is applied to the Northwest Freeway HOV lanes during the peak of the peak AM period. Most express bus service operates only during the peak periods.

DESIGN FEATURES

The Houston HOV lanes are typically one-lane, barrier-separated, reversible facilities. The lanes are about 20.5 feet wide [6 m] to allow passing of disabled vehicles. Figure 2 shows a typical view. The exception is a 6.6-mile [10.6-km] stretch of concurrent flow HOV lane on the western end of the KATY Freeway facility. Figure 3 shows a typical cross section for the KATY Freeway before and after its initial reconstruction to provide the one-way reversible HOV lanes.

RAMPS

The HOV lanes are accessed through the following types of ramps:

- Slip ramps to connect with the freeway main lanes,
- "Wishbone" ramps to connect with freeway frontage roads,
- "T-ramps" to connect with park-and-ride lots,
- Standard ramps to connect with surface streets, and
- Special bus/HOV ramps to connect with downtown streets.

Figure 4 gives an example of a reversible bus/HOV lane.

BUS LANES

Curb bus lanes are provided on Louisiana and Travis Streets to expedite bus flow.

SUPPORT FACILITIES

The HOV lanes are supported by an extensive system of park-and-ride lots and transit centers. Four transit centers have been established with direct access to five HOV lanes. The number of park-and-ride lots supporting each HOV facility varies between three and eight. All transit centers and 10 of the 32 park-and-ride lots have direct, grade-separated connectors to an HOV lane.

TranStar, a high-tech traffic and emergency management center, which is a state, county, city, and METRO joint facility (Figure 5), controls the HOV lanes through a series of variable message signs. TranStar is linked by fiber optic cable to closed circuit television cameras (CCTV) monitoring the freeways for traffic flow, as well as being linked to the computerized traffic signals on arterial roadways and freeway feeder streets. METRO's buses feed traffic information to TranStar, while getting congestion updates in return.

BUS OPERATIONS

The express bus services, like the HOV lanes, have evolved over the years. They are mainly oriented in a radial direction with downtown Houston as the main destination and the Texas Medical Center as the secondary destination. A 1987 study reported 2,245 of 2,370 morning peak-period bus passengers had destinations in downtown Houston. The other passengers were going to the Texas Medical Center and other locations[1]. Most bus routes start at the park-and-ride lots located adjacent to the HOV lanes, but some neighborhood express routes are also provided. Frequent peak-period service is operated out of most lots, with 5-minute peak-hour

headways from some of the larger facilities. Over-the-road coaches are used on many routes. Limited or no off-peak service is provided.

The express buses currently serve major activity centers such as the Texas Medical Center (TMC), Greenway Plaza, and the Post Oak/Galleria area (Uptown). More recently, reverse commute services have been added in some corridors, taking advantage of buses deadheading back to park-and-ride lots.

The 295 Uptown Route, for example, operated 22 daily trips in 1999 during the morning and evening peak periods, with slightly more than 400 daily riders.

VEHICLES

Many express bus routes use 45-foot, 57-seat, over-the-road coaches, as shown in Figure 6. These coaches provide a high degree of comfort. Single-door operation and on-board fare collection slows passenger boarding in downtown Houston during the evening peak period, however. AM peak-hour speeds on Louisiana Street bus lanes approximate 5 to 6 miles per hour.

FARES

The cash fare for local bus passengers is $1.00, whereas the express bus fares are set on a zonal basis with cash fares ranging from $1.50 to $3.50. As with local buses, there are a variety of fare discounts. (See Table 2).

TRAVEL TIMES

The HOV lanes have substantially reduced travel times for buses, carpools, and vanpools. While freeway travel averages 24 miles per hour during most morning and evening rush hours, HOV lane traffic operates between 50 miles per hour and 55 miles per hour, saving those who use the lane anywhere from 12 to 22 minutes per trip.

Buses using the different HOV lanes save 2 to 23 minutes over traveling in the general travel freeway lanes. On average, peak-hour bus operating speeds for the freeway/HOV trip segment have almost doubled because of the HOV lanes, increasing from 26 mph to 54 mph. This increase in bus operating speeds resulted in significant reductions in bus schedule time.

The schedule time to downtown Houston for the 288 Addicks Park-and-Ride Express on the KATY (I-10 West) HOV lane was reduced from 45 to 24 minutes, the Edgebrook Park-and-Ride Express on the Gulf (I-45 South) HOV lane was reduced from 40 to 25 minutes, and the 214 Northwest Park-and-Ride Express on the Northwest (US 290) HOV lane was reduced from 50 to 30 minutes. A 1 ½-mile eastern extension of the KATY (I-10 West) HOV lane is reported to have reduced revenue bus hours by 31,000 hours annually.

USAGE AND RIDERSHIP

Usage of the HOV lanes is summarized in Table 3. The HOV lanes serve over 100,000 person trips each weekday, serving almost 35,000 automobile trips that would otherwise travel main freeway lanes. During rush hours, METRO's six HOV lanes move the same volume of people as 19 freeway main lanes.

Bus Riders

Table 4 gives peak-hour and peak-period bus and bus passenger volumes for each freeway HOV lane. Overall, almost 50,000 bus passengers use six HOV lanes during the peak period (25,000/ AM and 25,000/PM) and over 10,000 during each peak-hour. One-way bus volumes range up to 70 buses per hour on individual lanes, and peak-hour passenger volumes range from about 1500 to 2000 persons [2].

Salient characteristics of bus passengers are given in Table 5. About 90% of the riders have an automobile available for the trip, suggesting that the express bus service attracts "choice" riders. Some 18%–30% of the riders did not make the trip before, suggesting that the lanes have "induced" travel. The availability of time to "do other things" is reported as the main reason for riding the express buses. Most riders arrive at bus terminal park-and-ride lots by automobile for the inbound trip, and almost all are going to work.

Park-and-Ride Lots

In March 2001, 32 park-and-ride lots contained almost 32,000 spaces (see Table 6). There were over 17,000 parkers, resulting in an overall utilization rate of 55%. However, facilities along the KATY, Gulf, and Northwest Freeways had occupancies of over 60%. Several individual facilities, (e.g., the Addides Park-and-Ride lots) operated over capacity [3]. Figure 7 shows a map of park-and-ride facilities that connect to commuter buses.

Costs

Costs for developing the HOV lanes were obtained from several sources. A 1987 study set forth costs of $525 million for 71 miles of HOV lanes along the North, KATY, Gulf, Northwest, and Southwest Freeways, about $7.4 million per mile [4]. A 1995 study gave costs for 91 miles of Transitway in all corridors of $643 million in 1990 dollars, about $7 million per mile [5]. About 70% of costs were for the HOV lanes and ramps. A 2001 report by the General Accounting Office reported actual construction costs of $455 million for the KATY, North, Northwest, and Gulf Freeways; when expressed in constant 2000 dollars, costs were $643 million, or $10 million per mile [6].

Related Projects

An 8-mile, $350-million light rail line is under construction along Main Street connecting downtown Houston with the Texas Medical Center and the Astrodome. Operations are forecast to begin in 2004. METRO is working with the city of Houston, the Downtown Management District, and the Federal Transit Administration (FTA) in a transit streets improvement project in midtown and downtown Houston. The plans call for rebuilt streets, widened sidewalks, and improved drainage. The plan also includes distinctive new bus shelters and other passenger amenities such as lighting, information kiosks, and landscaping. Some of the improvements are being made along streets where the express buses run.

Assessment

Houston's freeway HOV lane system has substantially improved travel speeds, benefiting bus passengers and reducing operating costs. Built at a cost of about $10 million per mile, including

support facilities, the HOV land systems have attracted motorists and generated new trips—attributes normally associated with rail transit.

More importantly, the HOV land systems have provided a timely and cost-effective solution to commuting in the Houston area. The HOV lane systems are in many respects a rubber-tired, commuter rail-like service; their speeds are high, and they focus on the city center. The passengers carried are comparable to those carried by commuter-rail lines in several communities (e.g., Miami and Virginia).

The express bus service mainly operates in one direction and runs only during peak periods. For the future, there is a need to look toward two-directional HOV lanes that can permit all-day service and enhance the transit identity in major corridors. This is one of the concepts that is being explored for expansion of the KATY (I-10) corridor.

REFERENCES

1. Christiansen, D.L. "The Effectiveness of the KATY Freeway (I-10) Transitway." *Proceedings of the Second National Conference on High Occupancy Vehicle Lanes and Transitways*. Houston, Texas; October 21-28, 1987. Lancaster, A. and Lomax, T., Editors.

2. Stockton, B., Daniels, G., Hall, K., and Christiansen, D. *An Evaluation of High-Occupancy Vehicle Lanes in Texas.* Texas Transportation Institute (1997).

3. Metropolitan Transit Authority of Harris County. *HOV Quarterly*, Utilization Report. Prepared by Texas.

4. MacLennon, Robert. "Houston Transitway Projects." *Proceedings of the Second National Conference on High Occupancy Vehicle Lanes and Transitways*, October 25-26, 1987. Lancaster, A. and Lomax, T., Editors.

5. Kain, J. F., and Liv, Z. "Secrets of Success, How Houston and San Diego Transit Providers Achieved Large Increases in Transit Ridership." Prepared by the Federal Transit Administration, May 1995.

6. *Bus Rapid Transit Shows Promise*. General Accounting Office, September 2001.

Table 1: HOV Lane System Status (October 2001)

HOV Lane Facility	Status (miles)				
	In Generation	Under Construction	Engineering Design	Proposed	Total at Connection
KATY (I-10 West)	21.9	-	-		21.9
North (I-45 North)	19.9	-	-		19.9
Gulf (I-45 South)	15.5	-	-		15.5
Southwest (US 59 South)	12.2	0.6	1.5		14.3
Northwest (US 290)	13.5	-	-	5.9	19.4
Eastex (US 59 North)	14.7	5.5			20.2
Total	**97.7**	**6.1**	**1.5**		**111.2**

Source: Metropolitan Transit Authority of Harris County

Table 2: Commuter Route Fares (October, 2001)

	Fare type	Zone 1	Zone 2	Zone 3	Zone 4
Regular Fares	Adult Cash	$1.50	$2.50	$3.00	$3.50
	30 Day	$50.00	$78.00	$94.00	$110.00
	365 Day	$459.00	$702.00	$846.00	$990.00
Commuter Discount Fares (Senior, disabled, and student)	Cash	$.60	$1.10	$1.25	$1.45
	30 Day	$21.15	$36.95	$42.85	$48.70
	365 Day	$52.00	$52.00	$52.00	$52.00
Commuter Youth Fares (Ages 5-11)	Cash	$.35	$.65	$.75	$.85
	30 Day	$12.65	$22.15	$25.70	$29.20
	365 Day	$52.00	$52.00	$52.00	$52.00

Note: Cash Local $US Fare is $1.00
Source: Metropolitan Transit Authority of Harris County

Table 3: Summary of Houston High Occupancy Vehicle Lane Operations

March 2001

Measure	Katy HOV Lane		North HOV Lane		Gulf HOV Lane		Northwest HOV Lane		Southwest HOV Lane		Eastex HOV Lane		Total HOV Lanes	
	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons	Vehicles	Persons
AM Peak Hour														
Buses	43	1,955	48	2,555	34	1,530	21	1,155	52	2,285	22	1,150	220	10,630
Vanpools	9	72	4	32	17	103	17	103	8	52	5	46	60	408
Carpools	1,055	2,339	1,368	2,858	1,384	2,877	1,014	2,082	1,563	3,149	236	505	6,620	13,810
Motorcycles	14	14	13	13	8	8	8	8	4	4	2	2	49	49
Total	1,121	4,380	1,433	5,458	1,443	4,518	1,060	3,348	1,627	5,490	265	1,703	6,949	24,897
AM Peak Period														
Buses	99	3,930	112	5,470	76	3,210	48	2,355	113	4,710	45	2,285	493	21,960
Vanpools	36	218	33	198	32	184	30	168	22	119	17	130	170	1,017
Carpools	3,169	6,784	2,987	6,196	2,609	5,376	2,498	5,100	3,127	6,308	461	960	14,851	30,724
Motorcycles	46	46	32	32	22	22	33	33	6	6	3	3	142	142
Total	3,350	10,978	3,164	11,896	2,739	8,792	2,609	7,656	3,268	11,143	526	3,378	15,656	53,843
PM Peak Hour														
Buses	34	1,405	54	2,595	38	1,745	24	1,350	40	1,640	27	1,120	217	9,855
Vanpools	22	140	11	67	23	208	7	65	12	69	1	11	76	560
Carpools	1,145	2,427	1,065	2,186	912	1,948	1,267	2,601	955	2,016	232	475	5,576	11,653
Motorcycles	9	9	1	1	8	8	5	5	0	0	0	0	23	23
Total	1,210	3,981	1,131	4,849	981	3,909	1,303	4,021	1,007	3,725	260	1,606	5,892	22,091
PM Peak Period														
Buses	100	4,185	107	5,080	86	3,475	49	2,515	105	3,795	53	2,230	500	21,280
Vanpools	36	224	34	215	27	222	31	250	26	160	13	91	167	1,162
Carpools	3,283	7,019	2,587	5,291	2,155	4,580	2,790	5,733	2,338	4,910	548	1,131	13,701	28,664
Motorcycles	29	29	6	6	20	20	12	12	2	2	5	5	74	74
Total	3,448	11,457	2,734	10,592	2,288	8,297	2,882	8,510	2,471	8,867	619	3,457	14,442	51,180
Total Daily														
Buses	199	8,115	219	10,550	162	6,685	97	4,870	218	8,505	98	4,515	993	43,240
Vanpools	72	442	67	413	59	406	61	418	48	279	30	221	337	2,179
Carpools	7,926	16,751	6,389	13,117	5,113	10,654	5,999	12,255	6,149	12,586	1,259	2,591	32,835	67,954
Motorcycles	75	75	38	38	42	42	45	45	8	8	8	8	216	216
Total	8,272	25,383	6,713	24,118	5,376	17,787	6,202	17,588	6,423	21,378	1,395	7,335	34,381	113,589

Source: Metropolitan Transit Authority of Harris County. HOV Quarterly Utilization Report. Prepared by Texas Transportation Institute, March 2000.

Table 4: Peak Period Bus and Passenger Ridership – Houston HOV System

March 2001

Freeway	AM				PM			
	Peak Hour		Peak Period		Peak Hour		Peak Period	
	Buses	Passengers	Buses	Passengers	Buses	Passengers	Buses	Passengers
KATY (I-10 West)	43	1955	99	3930	34	1405	100	4185
Non Metro	(5)	(190)	(13)	(410)	(2)	(60)	(15)	(590)
North (I-45)	48	2555	112	5470	54	2595	107	5080
Non Metro	(15)	(750)	(34)	(1680)	(16)	(740)	(39)	(1740)
Gulf (I-45)	34	1530	76	3210	38	1745	86	3475
Northwest (US 290)	21	1155	48	2355	24	1350	49	2515
Southwest (US 59)	52	2285	113	4710	40	1640	105	3795
Non Metro	(2)	(90)	(7)	(280)	(1)	(50)	(4)	(130)
Eastex (US 59)	22	1150	45	2285	27	1120	53	2230
Total	220	10630	493	21960	217	9855	500	21280
Non Metro	(22)	(1010)	(54)	(2320)	(19)	(850)	(58)	(2460)
Grand Total	**242**	**11640**	**547**	**24280**	**236**	**10705**	**558**	**23740**

Source: *HOV Lane Utilization Quarterly Report*. Prepared for Metropolitan Transit Authority by Texas Transportation Institute. March, 2001.

Table 5: Characteristics of Bus Passengers

Item		KATY (I-10)	North (I-45)	Gulf	Northwest (US 290)
1. Automobile Availability		91%	95%	89%	92%
2. Prior Mode	Drove Alone	46%	39%	38%	43%
	Carpooled	8%	9%	8%	12%
	Vanpooled	8%	8%	6%	8%
	Bus	3%	15%	30%	3%
	Did not make Trip	30%	28%	18%	25%
	Other	5%	1%	0%	9%
3. Reasons for Using Express Bus Service	Cheaper than Driving	46%			52%
	Part of Fare	48%			57%
	Saves Time	39%			26%
	Time to Do Things	75%			94%
	No Car	5%			-
4. Access Mode	Walk	1%			1%
	Bus	-			-
	Auto Driver	88%			88%
	Carpooled	9%			8%
	Dropped Off	1%			1%
	Other	1%			1%
5. Trip Purpose	Work	99%			99%
	School	0.4%			0.6%
	Personal Business (Including Medical)				
	Other	0.6%			0.4%

Source: Adapted from Pratt, R. H. “Busways and Express Bus Services, Draft, 2000.

Table 6: Park-and-Ride-and-Pool Lot Utilization, March 2001

Freeway	Number of Facilities	Lot Capacity in Spaces	Daily Parked Vehicles	Percent of Lot Capacity
KATY (I-10 West)	6	5649	3512	62.2%
North (I-45)	5	7313	4009	54.8%
Gulf (I-45)	5	3581	2505	70%
Northwest (US 290)	4	3990	2618	65.6%
Southwest (US 59)	8	7363	3360	45.6%
Eastex (US 59)	4	3798	1495	39.4%
Total	32	31694	17499	55.2%

Source: HOV Lane Utilization Quarterly Report. Prepared by Texas Transportation Institute for Metropolitan Transit Authority of Harris County. March 2001.

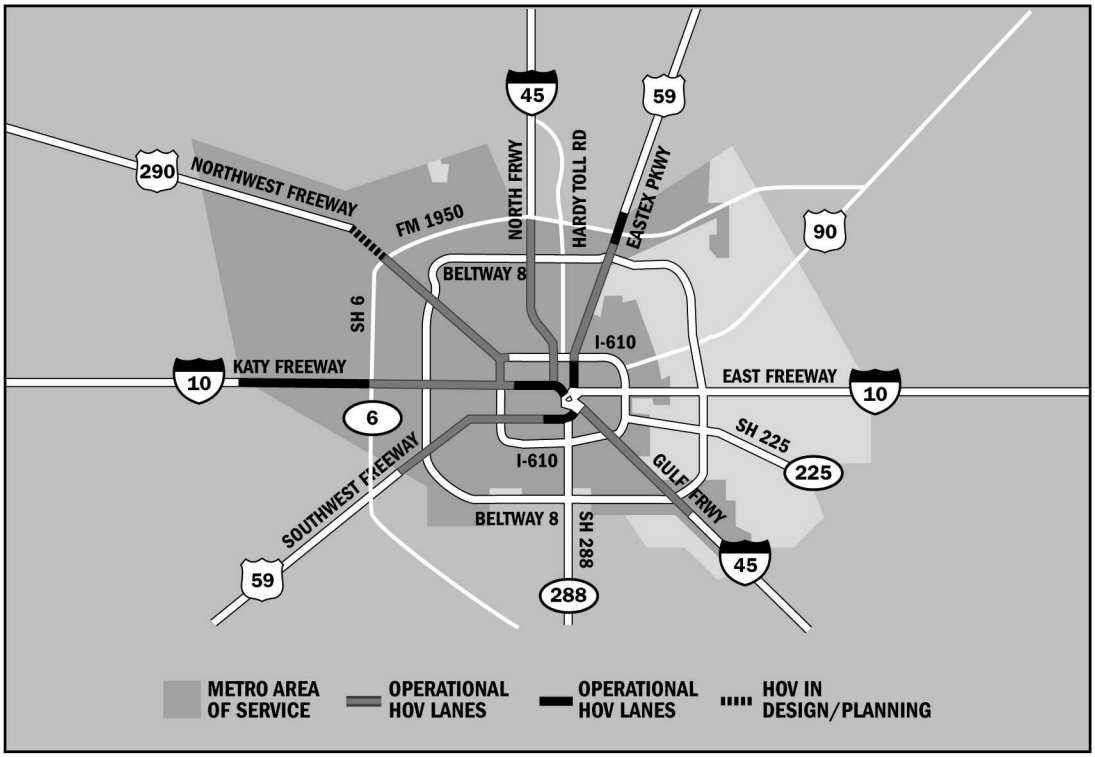
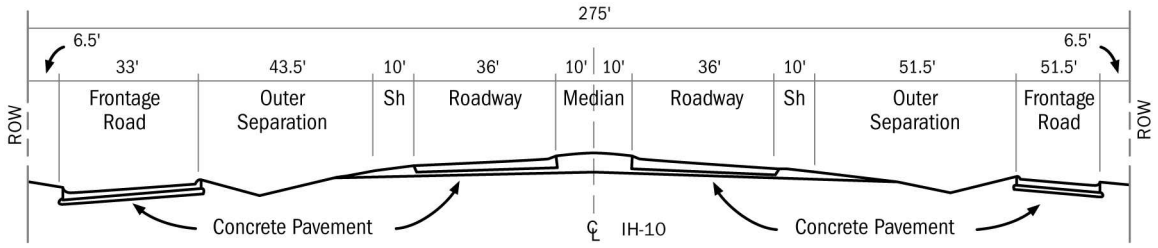
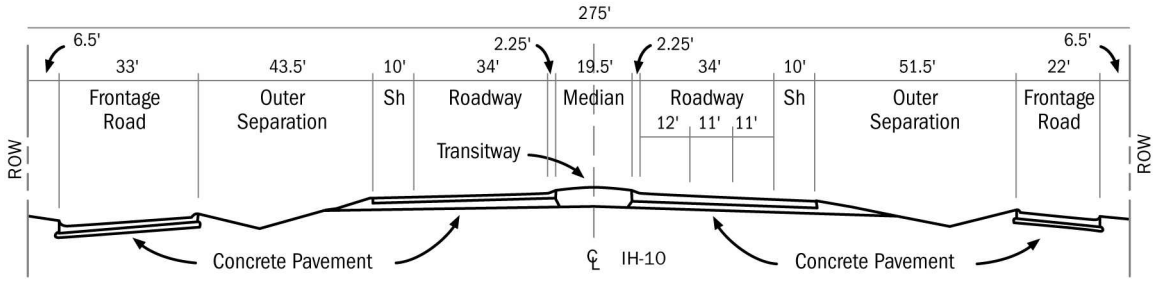


Figure 1: HOV System Map

Figure 2: Typical View of HOV Lane



Typical Section Before Transitway Construction



Typical Section After Transitway Construction

Figure 3: Typical Section Before and After Transitway Construction

Figure 4: Reversible Bus/HOV Lane

Figure 5: TranStar Control Room

Figure 6: Vehicle Used for BRT Service

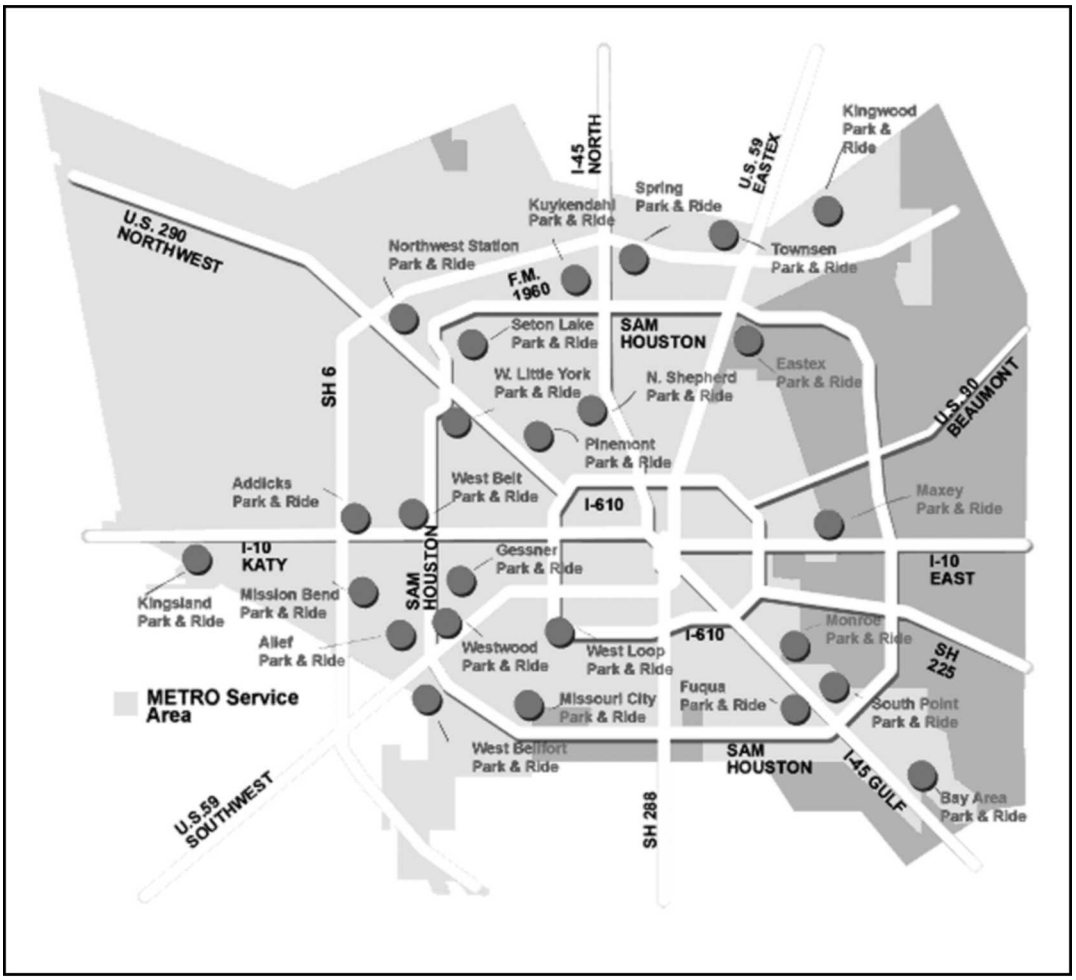


Figure 7: Map of Park-and-Ride Locations