Planning for Texas's Needs Using Highway Performance Monitoring System Analytical Process

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The Highway Performance Monitoring System (HPMS) analytical process was developed by FHWA to assess highway conditions and estimate national highway investment needs. It is structured to provide information about the effects of alternative standards, policy strategies, and program allocations on highway needs and performance. It is capable of revealing trends in highway capacity, condition, and service as well as trends in driver safety and environmental effects of airborne pollutants. The Texas Department of Transportation used HPMS to develop its 1989 Strategic Mobility Plan. This 20-year needs assessment for 1990 through 2009 pivoted around HPMS's ability to estimate backlog needs, project rehabilitation and reconstruction needs, and augment other information about new construction and right-of-way needs. To apply HPMS in Texas, changes were made to tailor the results to reflect Texas's standards and practices. The sample size was increased to facilitate use of the model at the district level. Highway improvement costs were factored to reflect differences between national average costs and those in Texas. Rural and urban traffic growth rates were adjusted downward to be more consistent with recent growth trends and default values for minimum tolerable conditions and design standards were modified. HPMS has minimized the employee hours required to identify funding needs, provided statewide consistency in assessing needs, prevented wish-list tendencies, and allowed for the "global" assessment of funding requirements. It is a tool that allows examination of diverse scenarios and alternative uses of funds.

The Texas Department of Transportation's (TxDOT's) use of the FHWA Highway Performance Monitoring System (HPMS) is perhaps better understood by looking first at the size and diversity of the state and at the department's historical approach to estimating needs. This overview highlights the complexities of and supports the department's shift to statistical sampling and computer modeling for needs estimation.

SIZE AND DIVERSITY

In area, Texas is the second-largest state in the union; it ranks third in population. Texas has 262,145 mi^2 of land and 16.8 million people. TxDOT's 12 tourist bureaus welcome more than 3 million visitors each year. Geographical and climatic variety encompass mountains and deserts in the west, snow and freeze-thaw cycles in the north, piney woods with abundant rain in the east, and Gulf Coast ocean and sand to the south. Eleven urban areas have populations over 200,000, and 19 smaller urban areas have populations over 50,000. More than 80 percent of the people live in urban areas. The state has 13.9 million registered vehicles and 11.4 million active licensed drivers, which log more than 107 billion vehicle-mi of travel a year. All of this occurs on an excess of 305,000 centerline-mi of roads, 46,000 bridges and culverts, 14,000 railroad crossings, 10 ferries, and 1 tunnel. With more than 30,000 bridges, Texas leads the nation in the number of bridges on a state highway system. The Interstate system has almost 3,200 centerline-mi; another 31,500 mi are U.S. or state highways; 41,400 mi make up the farm-to-market system; and about 1,000 mi are metropolitan highways.

TxDOT must address Texas's great socioeconomic, demographic, and geographical diversity in its responsibility for designing, constructing, and maintaining the roughly 77,000 centerline-mi of highways that have an estimated replacement value of $100 billion. To accomplish this, the department has an annual construction budget of about $1.5 billion and approximately 15,000 employees in 18 divisions and 18 field districts. There are 288 maintenance sections and 133 resident engineer offices around the state.

HISTORICAL APPROACH TO NEEDS DETERMINATION

Before the adoption of HPMS, TxDOT used committees to determine personnel, equipment, materials, and highway needs for its 20-year Strategic Mobility Plan (SMP). The information was obtained from the districts and divisions and involved historical data, a department computer model (RENU) that projected pavement maintenance and rehabilitation requirements, and the Project Development Plan (PDP). The PDP provides the basis for programming and scheduling individual construction projects. This process had significant shortcomings in that it was labor-intensive, it reflected the inconsistencies and biases of the many participants, and it was viewed by certain political figures as a wish-list. To improve the process, a decision was made to use the computer modeling and statistical projection capabilities of the HPMS analytical process to identify highway needs for TxDOT's 1989 SMP. HPMS-computed roadway-related needs amounted to approximately $33 billion, which is 40 percent of the department's total identified needs. It was used to forecast rehabilitation, reconstruction, additional capacity, new construction, and right-of-way (ROW) requirements. Needs for human resources, equip-

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ment, highway maintenance, bridges, loops and bypasses around cities, and new construction projects identified in the PDP were estimated outside HPMS to produce total fiscal requirements for TxDOT.

HPMS PARAMETER ADJUSTMENTS

To estimate more accurately highway infrastructure needs, HPMS was tailored for use at the state level (*1*). In 1987 the HPMS sample size was increased to enhance statistical validity at the district level. Highway improvements costs were factored to reflect differences between national average costs and those in Texas. Resurfacing costs for rural roads were also adjusted. Rural and urban traffic growth rates were adjusted downward to be more consistent with recent growth trends. Default values for minimum tolerable conditions (MTCs), present serviceability ratings (PSRs), and design standards were modified to be more consistent with standards and practices in Texas. The maximum number of lanes and ROW requirements were constrained for forecasting needs. Details of the tailoring follow.

Roadway Samples

From the inventory of 22,559 universe sections, the number of sample sections was increased from 2,363 to 5,702. Universe miles went from 72,749 to 77,244, and the corresponding sample miles were expanded from 8,810 to 17,771. These adjustments stemmed from a 3-year research project sponsored by FHWA and TxDOT and was conducted by the Texas Transportation Institute (TTI) of Texas A&M University (*2*). Because HPMS data were being collected and reported to FHWA on a yearly basis, it was believed that the number of samples could be expanded for effective use within the state. To further increase the validity of the sample, TxDOT conducts surveys of the HPMS sample sites. A TxDOT employee and a representative from FHWA visit one district each month to assess individual district input as well as uniformity of statewide input. This frequency results in an 18-month validation cycle and is believed to be adequate for gauging the quality of field input.

Costs

Adjustments were made to highway improvement costs used in the analytical package. National ROW and construction costs from FHWA were factored in the aggregate to reflect costs in Texas. Since the costs in the data base are in 1986 dollars, they were adjusted to 1988 constant dollars to coincide with the beginning year of the 20-year plan. A highway construction cost index (HCI), calculated annually by TxDOT, was used in making these adjustments. Table 1 presents the adjusted costs that were calculated using the dollar price index (DPI) program parameter (output control card). In addition, for rural roads receiving seal-coat treatment in lieu of rehabilitation, resurfacing costs were adjusted with a program parameter card linked to a program (input) control card to properly reflect this anomaly (*1*) (Table 2). Those costs not related to construction were adjusted from 1986 dollars to 1988 dollars by use of the state and local government index.

Traffic Growth Rates

During development of the SMP in 1988, the unadjusted average annual daily traffic (AADT) values in HPMS produced a statewide, 20-year compounded growth rate of 2.94 percent a year. At the same time, the low and high population growth rates projected by the Texas Water Development Board for these 20 years were 1.38 and 2.26 percent, respectively. In view of the uncertainty regarding the traffic growth for the 20 years and considering the state's declining growth rate of recent years, TxDOT adopted conservative, low-end growth projections for use in the SMP. To accomplish this, the AADT growth was adjusted by a program parameter card coupled with program control cards. The HPMS analytical model facilitated detailed projections of growth in Texas by allowing

TABLE 1 DPI Adjustments

Year	1986	1987	1988
TxDot HCI	1.233	1.071	1.079

DPI = (1.079/1.233) x .845 = .74

Note: Texas's 1988 costs = 0.845 of the 1988 national average costs.

TABLE 2 Rural Road Seal-Coat Costs Adjustments

	INT STATE			OTH P ART			MI ART			MAJ COL			MI COL		
Resurfing	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Fed Deflt	72	74	98	51	53	92	40	42	73	15	16	27	11	18	24
TX Costs	58	60	80	41	43	75	33	34	59	8	9	15	6	6	6

Legend: (Roadway Functional Classes: Int State - Interstate; Oth P Art - Other Principal Arterials; Mi Art -Minor Arterials; Maj Col - Major Collectors; Mi Col - Minor Collectors); (Resurfng - Resurfacing; F, R, M - Flat, Rolling, and Mountainous Terrains); (Fed Deflt - FHWA National Default Costs); (Tx Costs - Texas' Costs); NOTE: All costs are in thousands of dollars.

TABLE 3 Texas HPMS Defaults, Rural/Urban AADT Adjustment Factors

RURAL FACTORS:		INT	PRIN ART	MI ART	MAJ COL	MI COL
		0.75	0.75	0.75	0.75	0.75
URBANIZED FACTORS:		INT	OFE	OPA	MI ART	COL
Area Code	015	0.41	0.41	0.41	0.41	0.41
Area Code	028	0.48	0.48	0.48	0.48	0.48
Area Code	066	0.56	0.56	0.56	0.56	0.56
Area Code	090	0.61	0.61	0.61	0.61	0.61
Area Code	096	0.28	0.28	0.28	0.28	0.28
Area Code	120	0.24	0.24	0.24	0.24	0.24
Area Code	122	0.34	0.34	0.34	0.34	0.34
Area Code	135	0.01	0.01	0.01	0.01	0.01
Area Code	137	0.39	0.39	0.39	0.39	0.39
Area Code	139	0.01	0.01	0.01	0.01	0.01
Area Code	140	0.06	0.06	0.06	0.06	0.06
Area Code	151	0.50	0.50	0.50	0.50	0.50
Area Code	166	0.33	0.33	0.33	0.33	0.33
Area Code	174	0.21	0.21	0.21	0.21	0.21
Area Code	197	0.19	0.19	0.19	0.19	0.19
Area Code	201	0.64	0.64	0.64	0.64	0.64
Area Code	205	0.79	0.79	0.79	0.79	0.79
Area Code	208	0.14	0.14	0.14	0.14	0.14
Area Code	211	0.25	0.25	0.25	0.25	0.25
Area Code	213	0.57	0.57	0.57	0.57	0.57
Area Code	230	0.83	0.83	0.83	0.83	0.83
Area Code	232	0.20	0.20	0.20	0.20	0.20
Area Code	248	0.64	0.64	0.64	0.64	0.64
Area Code	249	0.52	0.52	0.52	0.52	0.52
Area Code	250	0.39	0.39	0.39	0.39	0.39
Area Code	277	0.69	0.69	0.69	0.69	0.69
Area Code	282	0.31	0.31	0.31	0.31	0.31
Area Code	361	0.22	0.22	0.22	0.22	0.22
Area Code	362	0.69	0.69	0.69	0.69	0.69
Area Code	363	0.33	0.33	0.33	0.33	0.33

Note: National Default AADT Adjustment Factor value is 1.00 for each area code. Texas values differ from National Defaults and are highlighted with shading.

Legend: INT - Interstate; PRIN ART - Principal Arterial; MI ART - Minor Arterial; MAJ COL - Major Collector; MI COL -Minor Collector; OFE - Other Freeway/Expressway; OPA - Other Principal Arterial; COL - Collector.

growth rates by functional class of road for both rural and 30 urban areas (*1*). The actual AADT adjustment values used in the analytical model are presented in Table 3.

Minimum Tolerable Conditions and Related Changes

Individual MTCs were changed in the model with a program parameter card tied to program control cards so that the decision threshold between rehabilitation and reconstruction would represent standard practice in Texas (*1*). Some rural and urban shoulder widths were changed, as were a few pavement condition ratings and surface type definitions. Also, some volume-capacity ratios were changed for the urban areas to represent the use of freeway control systems that optimize traffic flow. Additionally, certain rural lane widths and shoulder type definitions were changed. Finally, lower functional class rural and urban roadway PSRs were adjusted with program parameter cards to reflect reconstruction practices in Texas (*1*). Adjustments used are presented in Tables 4 through 11.

Design Standards

Design standards were changed by the use of a program parameter card connected to program control cards (*1*). This facilitated the change of some rural lane widths along with rural and urban surface type definitions. Changes were also made to a small number of urban shoulder widths and average highway speeds. These modifications are presented in Tables 12 through 15.

Number of Lanes

There is an upward limit to the number of highway lanes that are acceptable in existing locations. Therefore, a lane limit roughly 50 percent greater than the default values of 8/10 lanes in the HPMS analytical model was used (*3*). This 12-lane-limit philosophy embraced vertical and horizontal capacity expansion beyond the FHWA program default lanes. In Texas, capacity demand beyond 12 lanes must be met by parallel corridors or other transportation solutions. In view of environmental concerns and the high cost of urban ROW, it was determined that long-range solutions for the latent capacity demand will require the use of increased mass transit, travel demand management, and traffic systems management.

APPLICATION ASSESSMENT

In assessing the tailoring of HPMS for Texas, as well as reviewing activities related to data gathering and computer mod-

TABLE 4 National HPMS Defaults, Rural/Urban Options in Effect

ANALYSIS MODE: FUNDING PERIOD
BASE YEAR: 1989
LENGTH CYCLE: 1 YEAR(S)
DOLLAR PRICE INDEX: 1.00
ADJUST FUTURE ADT: NO
DESIGN ADT FOR RURAL FULL ACCESS CONTROL: 10000

TARGET YEAR: 2009
PAVEMENT CYCLE AHEAD: 5 YEARS
FUTURE ADT YEAR: 2009

	INT	PRIN ART	MI ART	MAJ COL	MI COL
Rural maximum number lanes:	10	10	10	8	8
Rural PSR to determine reconst:	2.0	2.0	1.5	1.1	0.8

	INT	OFE	OPA	MI ART	COL
Urban maximum number lanes:					
Built-up	8	8	8	8	8
Outlying	10	10	10	10	8
Urban PSR to determine reconst:	2.2	2.0	1.8	1.1	1.0

SURFACE TYPE:	H FLEX	H RGD	INTR	LOW
Rural Improved PSR for Reconstruction:	4.6	4.6	4.4	4.2
Rural factor added to existing PSR for resurf:	1.8	1.8	1.8	1.8
Rural maximum improved PSR for resurfacing	4.3	4.3	4.2	4.0
Urban improved PSR for reconstruction:	4.6	4.6	4.4	4.2
Urban factor added to existing PSR for resurf:	1.8	1.8	1.8	1.8
Urban maximum improved PSR for resurfacing:	4.3	4.3	4.2	4.0

Note: National Defaults are provided for reference.

Legend: INT - Interstate; PRIN ART - Principal Arterial; MI ART - Minor Arterial; MAJ COL - Major Collector; MI COL -Minor Collector; OFE - Other Freeway/Expressway; OPA - Other Principal Arterial; COL - Collector; H Flex - High Flexible; H RGD - High Rigid; INTR - Intermediate.

TABLE 5 Texas HPMS Defaults, Rural/Urban Options in Effect

ANALYSIS MODE: FUNDING PERIOD
BASE YEAR: 1989
LENGTH CYCLE: 1 YEAR(S)
DOLLAR PRICE INDEX: 0.74
ADJUST FUTURE ADT: YES
DESIGN ADT FOR RURAL FULL ACCESS CONTROL: 10000

TARGET YEAR: 2009
PAVEMENT CYCLE AHEAD: 5 YEARS
FUTURE ADT YEAR: 2009

	INT	PRIN ART	MI ART	MAJ COL	MI COL
Rural maximum number lanes:	12	12	12	12	12
Rural PSR to determine reconst:	2.0	2.0	1.5	1.5	1.5

	INT	OFE	OPA	MI ART	COL
Urban maximum number lanes:					
Built-up	12	12	12	12	12
Outlying	12	12	12	12	12
Urban PSR to determine reconst:	2.2	2.0	1.8	1.5	1.5

SURFACE TYPE:	H FLEX	H RGD	INTR	LOW
Rural Improved PSR for Reconstruction:	4.6	4.6	4.6	4.5
Rural factor added to existing PSR for resurf:	1.8	1.8	1.8	1.8
Rural maximum improved PSR for resurfacing	4.3	4.3	4.2	4.0
Urban improved PSR for reconstruction:	4.6	4.6	4.6	4.5
Urban factor added to existing PSR for resurf:	1.8	1.8	1.8	1.8
Urban maximum improved PSR for resurfacing:	4.3	4.3	4.2	4.0

Note: Texas values that differ from National Defaults are highlighted with shading.

Legend: INT - Interstate; PRIN ART - Principal Arterial; MI ART - Minor Arterial; MAJ COL - Major Collector; MI COL -Minor Collector; OFE - Other Freeway/Expressway; OPA - Other Principal Arterial; COL - Collector; H Flex - High Flexible; H RGD - High Rigid; INTR - Intermediate.

TABLE 6 National HPMS Defaults, Urban MTC

	INTERSTATE	OTH F/EXP	OTH P ART	MINOR ART	COLLECTOR
Volume-To-Capacity Ratio	0.95	0.95	0.95	0.95	0.95
Lane Width	12	11	10	8	8
Surface Type	2	2	2	3	4
Pavement Condition	3.2	3.0	2.8	2.4	2.0
Shoulder Type	1	1	2	3	3
Right Shoulder Width	8	8	6	6	6

Note: *Widths are in feet.*
National Defaults are provided for reference.

Legend: OTH F/EXP - Other Freeway/Expressway; OTH P ART - Other Principal Arterial; MINOR ART - Minor Arterial.

Shoulder Type Codes:	*Surface Type Codes:*
1 - Surfaced	*1 - High Flexible*
2 - Stabilized	*2 - High Rigid*
3 - Earth	*3 - Intermediate*
4 - Curbed	*4 - Low*
	5 - Gravel

TABLE 7 Texas HPMS Defaults, Urban MTC

	INTERSTATE	OTH F/EXP	OTH P ART	MINOR ART	COLLECTOR
Volume-To-Capacity Ratio	1.05	1.05	0.95	0.95	0.95
Lane Width	12	11	10	10	10
Surface Type	1	1	3	3	4
Pavement Condition	2.5	2.3	2.0	2.0	2.0
Shoulder Type	1	1	2	3	3
Right Shoulder Width	8	8	4	2	0

Note: Widths are in feet.
Texas values that differ from National Defaults are highlighted with shading.

Legend: OTH F/EXP - Other Freeway/Expressway; OTH P ART - Other Principal Arterial; MINOR ART - Minor Arterial.

Shoulder Type Codes:	*Surface Type Codes:*
1 - Surfaced	*1 - High Flexible*
2 - Stabilized	*2 - High Rigid*
3 - Earth	*3 - Intermediate*
4 - Curbed	*4 - Low*
	5 - Gravel

TABLE 8 National HPMS Defaults, Rural MTC (Interstates, Arterials)

	INTERSTATE			OTHER PRINCIPAL ARTERIALS						MINOR ARTERIALS					
ADT	ALL ADT			> 6000			< OR = 6000			> 2000			< OR = 2000		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Lane Width	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10
Rshld Width	8	8	6	8	8	6	8	8	6	6	6	4	6	6	4
Shld Type	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Pave Cond	3.0	3.0	3.0	3.0	3.0	3.0	2.8	2.8	2.8	2.4	2.4	2.4	2.4	2.4	2.4
V/C Ratio	0.75	0.90	0.95	0.75	0.85	0.95	0.75	0.85	0.95	0.75	0.85	0.95	0.75	0.85	0.95
Surf Type	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Horiz Align	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Vert Align	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Note: *Widths are in feet.*
National Defaults are provided for reference.

Legend: Terrain types F, R, M are Flat, Rolling, Mountainous.

Shoulder Type Codes:	*Surface Type Codes:*	*Horizontal/Vertical Alignment Codes:*
1 - Surfaced	*1 - High Flexible*	*1 - All curves/grades meet design standards*
2 - Stabilized	*2 - High Rigid*	*2 - Some curves/grades below design standards*
3 - Earth	*3 - Intermediate*	*3 - Curves/grades with reduced speed*
4 - Curbed	*4 - Low*	*4 - Several curves unsafe/significant reduction of speed on grade*
	5 - Gravel	

TABLE 9 National HPMS Defaults, Rural MTC (Major and Minor Collectors)

	MAJOR AND MINOR COLLECTORS								
ADT	> 1000			400 - 1000			< 400		
Terrain	F	R	M	F	R	M	F	R	M
Lane Width	10	10	10	8	8	8	16	16	16
Rshld Width	4	4	4	2	2	2	0	0	0
Shld Type	3	3	3	3	3	3	3	3	3
Pave Cond	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8
V/C Ratio	0.75	0.85	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Surf Type	3	3	3	4	4	4	5	5	5
Horiz Align	2	2	2	3	3	3	3	3	3
Vert Align	2	2	2	3	3	3	3	3	3

Note: Widths are in feet.
National Defaults are provided for reference.
MTC shown for lane width on collectors group 3 are for surface width.

Legend: Terrain types F, R, M are Flat, Rolling, Mountainous.

Shoulder Type Codes:	*Surface Type Codes:*
1 - Surfaced	*1 - High Flexible*
2 - Stabilized	*2 - High Rigid*
3 - Earth	*3 - Intermediate*
4 - Curbed	*4 - Low*
	5 - Gravel

Horizontal/Vertical Alignment Codes:
1 - All curves/grades meet design standards
2 - Some curves/grades below design standards
3 - Curves/grades with reduced speed
4 - Several curves unsafe/significant reduction of speed on grade

TABLE 10 Texas HPMS Defaults, Rural MTC (Interstates, Arterials)

	INTERSTATE			OTHER PRINCIPAL ARTERIALS						MINOR ARTERIALS					
ADT	ALL ADT			> 6000			< OR = 6000			> 2000			< OR = 2000		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Lane Width	12	12	12	11	11	11	11	11	11	11	11	11	10	10	10
Rshld Width	8	8	6	8	8	6	4	4	4	4	4	4	4	4	4
Shld Type	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Pave Cond	2.5	2.5	2.5	2.4	2.4	2.4	2.3	2.3	2.3	2.2	2.2	2.2	2.0	2.0	2.0
V/C Ratio	0.75	0.85	0.90	0.75	0.85	0.90	0.80	0.85	0.90	0.80	0.85	0.90	0.85	0.90	0.95
Surf Type	1	1	1	3	3	3	3	3	3	3	3	3	3	3	3
Horiz Align	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Vert Align	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3

Note: Widths are in feet.
Texas values that differ from National Defaults are highlighted with shading.

Legend: Terrain types F, R, M are Flat, Rolling, and Mountainous.

Shoulder Type Codes:	*Surface Type Codes:*	*Horizontal/Vertical Alignment Codes:*
1 - Surfaced	*1 - High Flexible*	*1 - All curves/grades meet design standards*
2 - Stabilized	*2 - High Rigid*	*2 - Some curves/grades below design standards*
3 - Earth	*3 - Intermediate*	*3 - Curves/grades with reduced speed*
4 - Curbed	*4 - Low*	*4 - Several curves unsafe/significant reduction of speed on grade*
	5 - Gravel	

eling of needs, Texas's use of HPMS has been found to be quite satisfactory. A private consulting firm, university research studies, a governmental agency study, and in-house studies have found our efforts to be on target in a number of areas, to require enhancements in a few areas, and to have the potential for use in other areas.

On Target

• Statistical analysis indicates that the error due to HPMS's being run on a sample of highway sections rather than on all highway sections is small when HPMS is used at the state level. Specifically, a 1991 analysis indicates that, at the state

TABLE 11 Texas HPMS Defaults, Rural MTC (Major and Minor Collectors)

	MAJOR AND MINOR COLLECTORS								
ADT	> 1000			400 - 1000			< 400		
Terrain	F	R	M	F	R	M	F	R	M
Lane Width	10	10	10	9	9	9	18	18	18
Rshld Width	4	4	4	2	2	2	0	0	0
Shld Type	2	2	2	3	3	3	3	3	3
Pave Cond	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8
V/C Ratio	0.85	0.90	0.95	1.00	1.00	1.00	1.00	1.00	1.00
Surf Type	3	3	3	4	4	4	4	4	4
Horiz Align	3	3	3	3	3	3	3	3	3
Vert Align	3	3	3	3	3	3	3	3	3

Note: *Widths are in feet.*
MTC shown for lane width on collectors group 3 are for surface width.
Texas values that differ from National Defaults are highlighted with shading.

Legend: Terrain types F, R, M are Flat, Rolling, and Mountainous.

Shoulder Type Codes:
1 - Surfaced
2 - Stabilized
3 - Earth
4 - Curbed

Surface Type Codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

Horizontal/Vertical Alignment Codes:
1 - All curves/grades meet design standards
2 - Some curves/grades below design standards
3 - Curves/grades with reduced speed
4 - Several curves unsafe/significant reduction of speed on grade

TABLE 12 National HPMS Defaults, Urban Design Standards

	FREEWAY/EXPRESSWAY		OTHER DIVIDED	
	BUILT-UP	OUTLYING	BUILT-UP	OUTLYING
Average Highway Speed	55	65	-	-
Median Width	16	24	-	-
Lane Width	12	12	12	12
Right Shoulder Width*	10	10	10	10
Left Shoulder Width*	6	6	6	6
Surface Type	2	2	2	2
	UNDIVIDED ARTERIALS		UNDIVIDED COLLECTORS	
	BUILT-UP	OUTLYING	BUILT-UP	OUTLYING
Average Highway Speed	-	-	-	-
Median Width	-	-	-	-
Lane Width	12	12	12	12
Right Shoulder Width*	8	10	6	10
Left Shoulder Width*	-	-	-	-
Surface Type	2	2	3	3

Note: *Widths are in feet.*
National Defaults are provided for reference.
Dash in table (-) indicates data not applicable.
Average Highway Speed is defined as the Weighted Average Design Speed in Miles per Hour.

Legend: * *For Facility Which Is Not Curbed*
Surface Type Codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

TABLE 13 Texas HPMS Defaults, Urban Design Standards

	FREEWAY/EXPRESSWAY		OTHER DIVIDED	
	BUILT-UP	OUTLYING	BUILT-UP	OUTLYING
Average Highway Speed	60	70	-	-
Median Width	16	24	-	-
Lane Width	12	12	12	12
Right Shoulder Width*	10	10	10	10
Left Shoulder Width*	4	4	4	4
Surface Type	1	1	1	1
	UNDIVIDED ARTERIALS		UNDIVIDED COLLECTORS	
	BUILT-UP	OUTLYING	BUILT-UP	OUTLYING
Average Highway Speed	-	-	-	-
Median Width	-	-	-	-
Lane Width	12	12	12	12
Right Shoulder Width*	8	10	4	8
Left Shoulder Width*	-	-	-	-
Surface Type	3	3	3	3

Note: *Widths are in feet.*
Dash in table (-) indicates data not applicable.
Texas values that differ from National Defaults are highlighted with shading.
Average Highway Speed is defined as the Weighted Average Design Speed in Miles per Hour.

*Legend: * For Facility Which Is Not Curbed*
Surface Type Codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

TABLE 14 National HPMS Defaults, Rural Design Standards

	INTERSTATE			OTHER PRINCIPAL ARTERIALS						MINOR ARTERIALS					
Design ADT	ALL ADT			> 6000			< OR = 6000			> 2000			< OR = 2000		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Shld Width	12	10	8	10	10	8	10	10	8	8	8	8	8	8	6
Surf Type	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Median Wdh	64	64	16	40	40	16	40	40	16	40	40	16	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Av Hwy Spd	70	70	55	70	65	55	70	65	55	70	60	50	65	55	45

	MAJOR AND MINOR COLLECTORS								
Design ADT	> 1000			400 - 1000			< 400		
Terrain	F	R	M	F	R	M	F	R	M
Shld Width	8	8	6	4	4	4	2	2	2
Surf Type	3	3	3	4	4	4	4	4	4
Median Wdh	0	0	0	0	0	0	0	0	0
Lane Width	12	12	11	11	11	11	10	10	10
Av Hwy Spd	65	55	45	60	50	40	50	40	30

Note: *Widths are in feet.*
National Defaults are provided for reference.
Av Hwy Spd: Average Highway Speed is defined as the Weighted Average Design Speed in Miles per Hour.

Legend: Terrain types F, R, M are Flat, Rolling, and Mountainous.
Surface type codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

TABLE 15 Texas HPMS Defaults, Rural Design Standards

	INTERSTATE			OTHER PRINCIPAL ARTERIALS						MINOR ARTERIALS					
Design ADT	ALL ADT			> 6000			< OR = 6000			> 2000			< OR = 2000		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Shld Width	12	10	8	10	10	8	10	10	8	8	8	8	8	8	6
Surf Type	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3
Median Wdh	64	64	16	40	40	16	40	40	16	40	40	16	0	0	0
Lane Width	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Av Hwy Spd	70	70	55	70	65	55	70	65	55	70	60	50	65	55	45

	MAJOR AND MINOR COLLECTORS								
Design ADT	> 1000			400 - 1000			< 400		
Terrain	F	R	M	F	R	M	F	R	M
Shld Width	8	8	6	4	4	4	2	2	2
Surf Type	3	3	3	4	4	4	4	4	4
Median Wdh	0	0	0	0	0	0	0	0	0
Lane Width	12	12	11	12	12	11	10	10	10
Av Hwy Spd	65	55	45	60	50	40	50	40	30

Note: *Widths are in feet.*
Av Hyw Spd: Average Highway speed is defined as the Weighted Average Design Speed in Miles per Hour

Legend: *Terrain types F, R, M are Flat, Rolling, and Mountainous.*
Surface type codes:
1 - High Flexible
2 - High Rigid
3 - Intermediate
4 - Low
5 - Gravel

level, highway needs estimated through the use of the HPMS sample will be within 10 percent of highway needs estimated for all sections 99 percent of the time (*4*).

• A 1991 review of Texas's controls over HPMS data collection found them to be reasonable, especially since FHWA's monitoring of state data gathering provides a further check on data quality (*4*). These findings were consistent with the findings of the U.S. General Accounting Office (GAO) review of HPMS use in six other states. In 1987 GAO affirmed HPMS to be statistically sound in representing the various types of highways at the national aggregate level (*5*).

• GAO found the analytical model to be a reasonable tool for presenting useful information on the condition and capital investment needs of the nation's highways (*5*). At the state level, the Texas State Auditor's office completed a study in 1991 and endorsed the use of HPMS as a useful planning tool for TxDOT.

• For those MTCs codified in the *Texas Highway Design Manual*, a 1991 study found that there is substantial agreement between HPMS inputs and the manual (*4*). However, because of restrictions on the availability of funds, the state has been unable to undertake many projects that meet its criteria for funding. As a result, the standards and practices represented in the input to HPMS are somewhat stricter than those currently used in the field.

• The procedure used by HPMS to identify highway improvements was found in a 1991 examination to produce generally reliable results with some minor exceptions noted (*4*).

Future Enhancements

One private consultant firm's review suggested the following improvements for the HPMS process (*4*):

• Vigilance in recording HPMS projections for new construction needs in the SMP so that there is no overlap with funding requirements identified in the PDP.

• Careful instruction of district staff in the coding of pavement items to prevent understatement of pavement-related needs that HPMS identifies for the state as a whole.

• Prudent coding of HPMS resurfacing costs and threshold values to prevent overstatement of some farm-to-market road needs.

Future Utilization of HPMS

• HPMS does not explicitly develop estimates of maintenance needs or take into account the effects of maintenance expenditure levels and policies. It may be possible to reflect the effects of increased (or decreased) maintenance expenditures on resurfacing and reconstruction needs by adjusting factors within the HPMS model that determine pavement deterioration rates (*4*).

• HPMS does not specifically consider the effects of changes in public transportation service levels and policies. If changes in transit levels or policies are contemplated, they can be represented in HPMS through ad hoc adjustments to traffic growth rates for specific urbanized areas or by temporary programming adjustments to sample data of specific locations (*4*).

• HPMS default AADT growth rates were adjusted from 3 to 1.4 percent a year for the 20-year planning period of the SMP. This rate was adopted intentionally to provide conservative, low-end estimates. Recent review of the default and adjusted growth rate values, along with the sensitivity of HPMS output to traffic growth rates, indicates that a number of growth rates should be used in future SMP evaluations. Use of several growth rates for future projections will be used to compensate for the high degree of uncertainty of traffic growth rates in the coming years.

• HPMS will be used for tracking the status of the highway system.

• The environmental effects of vehicle emissions, particularly in highly congested urban areas, will be evaluated.

• HPMS will be used to establish an approximation of needs for non-Interstate highways of national significance. This will be accomplished by using a TxDOT developed interface program that targets selected routes and corridors. This is accomplished by stripping all sample data not related to the selected route from the data base and by redefining appropriate expansion factors for the new universe.

• HPMS and the federally mandated Pavement Management System (PMS) currently under development address some overlapping areas: HPMS identifies rehabilitation, reconstruction, and some new construction needs, and PMS targets maintenance and reconstruction. Isolation of these overlapping areas as well as needs identified by the two different data bases will be devised so that each analytical package can enhance the other.

• Good correlation between the HPMS PSR scores and the Pavement Evaluation Scores used by PMS has been found through TxDOT and TTI research (T. Scullion and R. Smith, unpublished data). The department is currently moving toward one data collection effort that will satisfy HPMS and PMS requirements.

• As a result of deferred improvements because of lack of funds, HPMS will be used to evaluate increases in highway improvement costs.

• HPMS will be used to assess changes in pavement-related costs due to changes in truck volumes and truck weights.

• HPMS will be used to determine funds required to maintain the infrastructure. This will be accomplished by setting urban volume-capacity ratio thresholds so that the costs of construction and reconstruction for major widening and adding lanes are not simulated by the program.

• The 72nd Texas Legislature directed all state agencies to develop a 6-year strategic plan. HPMS will contribute significantly toward the development of this plan.

SUMMARY

The HPMS analytical process minimizes the employee hours required to estimate funding needs, provides statewide consistency in identifying needs, prevents wish-list tendencies, and minimizes political influence by globally assessing funding requirements in a non-project-specific manner. It can assess the highway infrastructure by estimating current and future deficiencies and improvement costs. HPMS is a policy planning tool that allows examination of a diversity of scenarios to best use available funds. It helps to position TxDOT to provide safe, dependable, and efficient movement of people and goods through effective and efficient use of funds.

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