Trip Generation for Special-Use Truck Traffic

DAN R. MIDDLETON, JOHN M. MASON, JR., AND T. CHIRA-CHAVALA

Special-use truck traffic is the traffic associated with the processing and transporting of timber, grain, beef cattle, cotton, produce, sand and gravel, and limestone. Industry and vehicle characteristics for each of these six commodities were determined. The impact of each special-use activity center was assessed in terms of trip generation. Specific activity centers were selected for each industry. Number of trips generated, radius of influence, loads, vehicle configuration, and seasonal variations were determined for each selected activity center through agency and industry contacts and field studies.

The term "special-use" has been coined to designate truck traffic that has atypical travel patterns, trip lengths, truck configurations, and axle loads. The travel patterns of these vehicles tend to be cyclic in nature; in some cases the trip is made several times in a typical day. Trip lengths are relatively short, usually less than 100 mi. The origin and destination may remain the same month after month, but eventually either the origin or the destination will change. Axle loads, although generally not well documented, are in many cases greater than normally expected. Trips generated by these special-use activity centers pose problems for the planning, design, and maintenance of the highways that serve their needs.

To determine the definitive elements of these isolated traffic demands, the Texas State Department of Highways and Public Transportation (SDHPT) initiated a 4-year study to evaluate the impact of special-use truck traffic. The predecessor to this study was a comprehensive evaluation of the effects of oil field development on roadways in the state of Texas *(1)*.

The special users identified in this study fall into the two broad categories of agriculture and surface mining. A list of specific commodities was refined as industry characteristics were determined; the selected commodities are

Agriculture	*Surface Mining*
Timber	Sand and gravel
Grain	Crushed stone
Beef cattle	
Cotton	
Produce	

METHODOLOGY

Four basic steps were followed to accomplish the objectives of the study:

1. Select special-use industries,
2. Determine industry characteristics,
3. Determine vehicle characteristics of selected industries, and
4. Determine trip-making characteristics.

D. R. Middleton and T. Chira-Chavala, Texas Transportation Institute, Texas A&M University System, College Station, Tex. 77843-3135. J. M. Mason, Jr., Post, Buckley, Schuh & Jernigan, Inc., 5405 Cypress Center Drive, Suite 200, Tampa, Fla. 33609-1066.

Select Special-Use Industries

Selection of special-use industries began with the identification of industries whose specific commodities and activity centers uniquely affected the highway system in Texas. The activities surrounding oil field development and production were studied initially; agricultural product movement and quarrying and mining remain as unique special-use generators.

The list of specific commodities selected for study was refined as industry characteristics were determined. Some commodities were found to be more significant than others. Evaluation of the impacts of activity centers for special-use commodities such as uranium ore and poultry showed a relatively small number of trips generated in comparison with other commodities. In addition, poultry was not a weight-intensive (high-density) commodity.

Determine Industry Characteristics

Several public agencies were contacted to acquire available information about the selected commodities. For the timber industry, for example, the Texas Forest Service and the Forest Service provided printed information, maps, and names of private firms.

Site visits to various activity centers, which included interviews with key industry personnel, were conducted. Activity centers are defined as points where commodities are processed or handled. These centers often served as focal points for mode transfer.

The processing-activity phase of special-use commodities usually had more than one activity center that could be chosen for evaluation. Therefore a selection process involving the following criteria was established to identify the appropriate activity center.

1. The site must be a "primary" operation in total processing of the commodity,
2. A "significant" number of trips must be generated by the commodity, and
3. The commodity must represent a fairly widespread problem in the state.

Although these criteria were not easy to quantify, they were suitable for establishing the primary processing point of the identified commodity. The selected activity centers for the chosen commodities are as follows:

Commodity	*Activity Center*
Timber	Mills
Grain	Elevator
Beef cattle	Feedlot
Produce	Distributor
Cotton	Gin
Sand and gravel	Pit
Crushed stone	Quarry

Telephone interviews were also used to supplement on-site interviews. These interviews often yielded a range of answers to a standard set of questions depending on the specific industry's size, differing climates, differing harvesting or mining techniques, effects of rail, and economic conditions during the life of each company.

The disparity of information received verbally indicated that field surveys were necessary to supplement the on-site office and telephone interviews. A comprehensive data collection plan was developed for this purpose. State maps similar to Figure 1 were used to depict the location of activity centers and the intensity of activity for a particular commodity. These exhibits were supplemented by site-specific maps from the Texas Forest Service *(2)* or lists of activity centers *(3)*, which provide the following information for each county: name of firm, mailing address, telephone number, and in many cases an indication of size.

Determine Vehicle Characteristics Associated with Selected Industries

Methods used to acquire information about vehicles used in the special-use industries were telephone requests for literature from Texas truck and trailer dealerships, office and field interviews of industry personnel, vehicle classification counts at activity centers, information from other ongoing truck-related research, and information from state departments such as the Texas Department of Public Safety (DPS), License and Weight Division. The vehicular information gathered included AASHTO classification, vehicle dimensions, engine and drive train characteristics, load-carrying capacities, typical axle loads, and percentage vehicle distribution. Table 1 gives vehicle dimensions, vehicle descriptions, and carrying capacities for selected commodities.

A sample of axle weights was collected as part of another

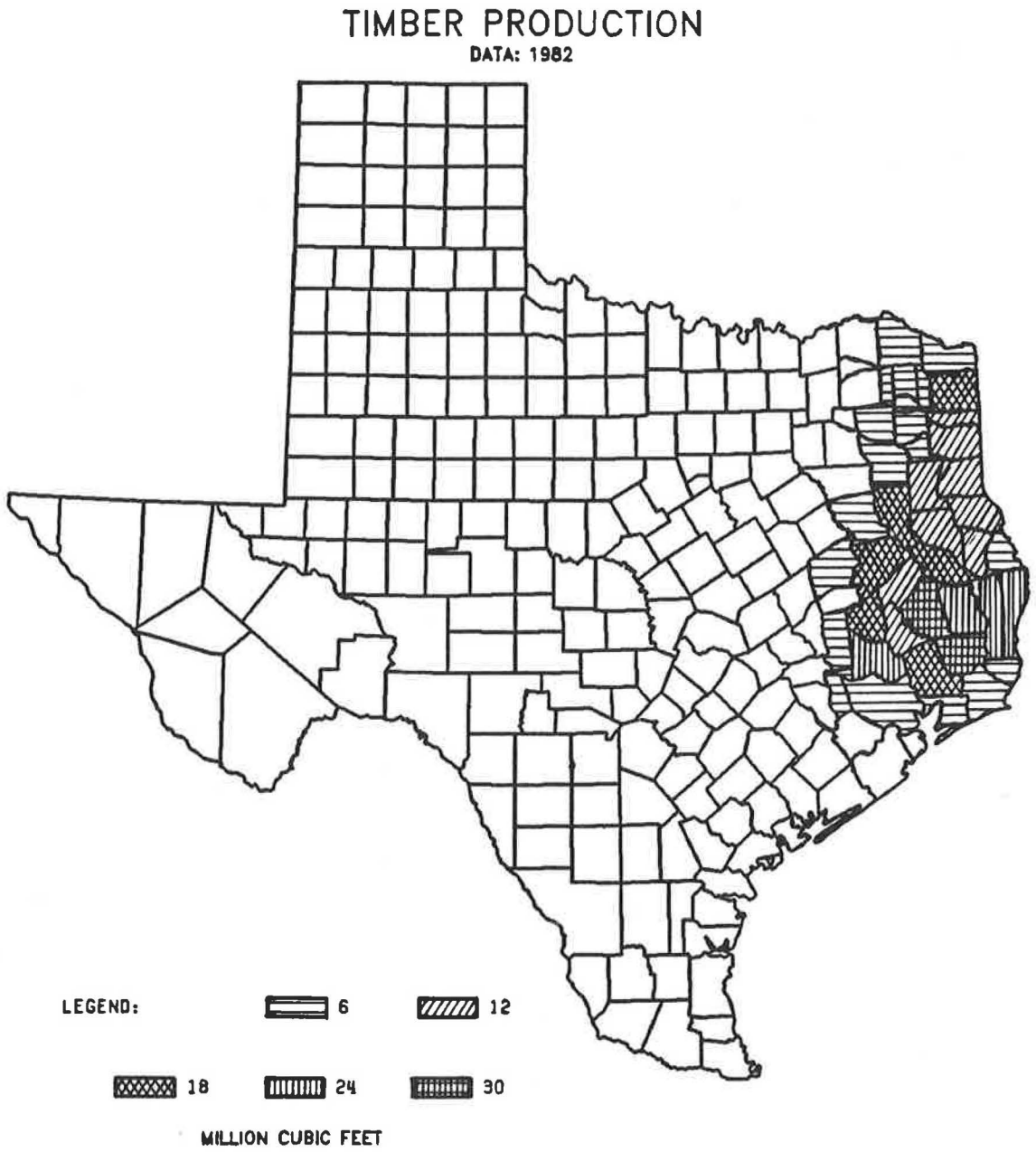

FIGURE 1 Location and intensity of timber operations.

TABLE 1 TYPICAL TRAILER AND TRUCK BED DIMENSIONS

Commodity	Vehicle Description	Width (ft)	Length (ft)	Overall Height (ft)
Timber	3-S2 fold-up	8.0	35–45	—[a]
	3-S2 pulpwood	8.0	35–40	—
	3-S2 (chip) van	8.0	38–40	12.8
	3-S2 flatbed	8.0	32–45	4.7[b]
	SU-1	8.0	8–10	9.6
	SU-2	8.0	10–14	9.6
Grain	SU-1	8.0	8–10	9.6
	SU-2	8.0	10-14	9.6
	3-S2 grain	8.0	39–42	9.6
Beef cattle	3-S2 possum belly	8.0	44–50	13.5
	3-S2 grain	8.0	39–42	9.6
	SU-2 grain	8.0	10–14	9.6
Produce	SU-2	8.0	10–14	9.6
	Tractor/field trailer	7.0	10–12	8.0
	3-S2 reefer	8.0	30–50	12.5–13.5
Cotton	SU-2 module	8.0	37.5	13
	Field trailer	7.0	—	—
	3-S2 flatbed	8.0	32–45	4.7[b]
	3-S2 van	8.0	38–50	12.8
Sand and gravel	SU-2 with pup	8.0	24–28	8
	3-S2 dump	8.0	24.3–35	8.9–9.7
Crushed stone	SU-2 with pup	8.0	24–28	8
	3-S2 dump	8.0	24.3–35	8.9–9.7

[a]Data unavailable.

[b]For flatbeds, the height is the floor level.

research project that evaluated truck tire pressures on Texas highways *(4)*. The procedure involved project staff working with DPS License and Weight personnel at weigh strips or other acceptable locations and using semiportable scales in an ongoing enforcement effort. Typical weights of special-use vehicles determined during a 2-year period in areas near the special-use activity centers are given in Table 2.

Determine Trip-Making Characteristics

Specific information sought was radius of influence and trip generation rates. Radius of influence represented the maximum distance from an activity center at which vehicular traffic is generated. For trucks, it is usually thought of as the haul distance from the loading site (timber cutting site) to the load destination or unloading site (timber mill).

A range of values for both radius of influence and trip generation rates was gathered from several on-site office interviews. These trip generation figures were supplemented by manual and machine traffic classification counts at selected activity centers. Trip-making characteristics as well as typical vehicle weights determined by office interviews are given in Table 2. A summary of vehicle classification information acquired through office and field interviews is given in Table 3.

To determine which activity centers to study throughout the state, a random selection procedure was used. This involved

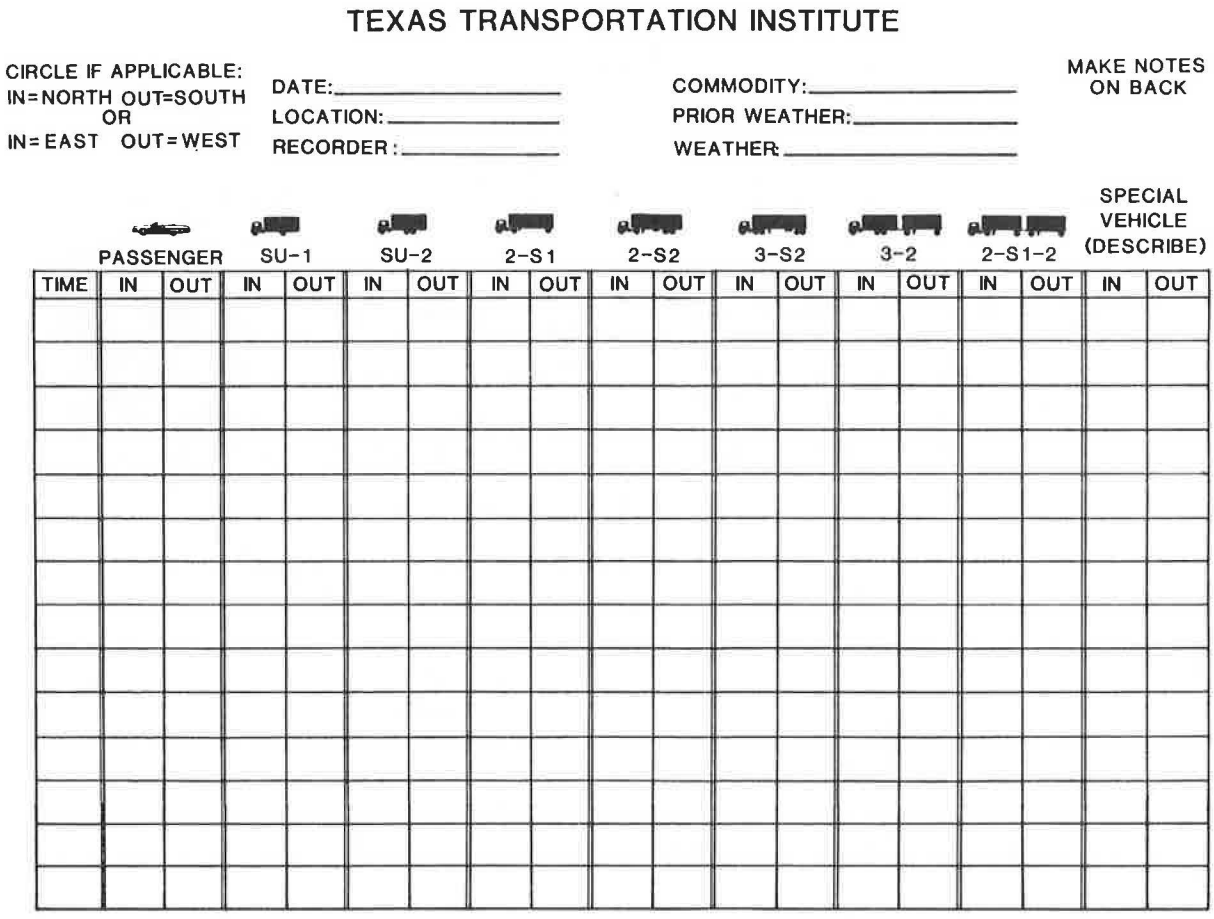

FIGURE 2 Standard manual count form.

TABLE 2 SPECIAL-USE COMMODITY SUMMARY FROM OFFICE INTERVIEWS

COMMODITY (Activity Center)	COMMON TRUCK SILHOUETTES	AVG. DAILY TRUCK TRIPS(a)		TYPICAL RADIUS OF INFLUENCE (MILES)	TYPICAL WEIGHT RANGE (1000 lb) (b)		PEAK SEASON
		AVG	LG		TANDEM AXLE	GROSS VEHICLE	
TIMBER MILLS							
- Paper		350	550(c)	50	32-38	74-86	Mar.-Nov.
- Plywood		150	350	50	32-38	74-86	Mar.-Nov.
- Particle Board		150	300	50	32-38	74-86	Mar.-Nov.
- Sawmill		150	250	50	32-38	74-86	Mar.-Nov.
GRAIN Elevator		200	400(c)	20	32-40	76-90	May-July
BEEF CATTLE - Feedlot		60	90	600	32-35	76-82	Yr. Round
PRODUCE - Distributor		200	500	20	32-36	72-80	Mar.-Apr.
COTTON - Gin		40	110	20	30-36	72-82	Sep.-Dec.
SAND/GRAVEL - Pit		600	1,100(c)	60	32-36	70-80	Mar.-Nov.
LIMESTONE - Quarry		1,400	2,800(c)	120	32-36	70-80	Mar.-Nov.

(a) One-way trips, i.e. one origin, one destination
(b) Based on experience, conversation, limited weight information, other research projects.
(c) Truck trip generation depends on percent rail. Rail is assumed to have negligible influence at these activity centers.

developing sample plans for the commodities of interest in such a way that the truck trip generation factors obtained would represent the entire state and activity centers of varying sizes. In most cases, a two-stage process was used to select activity centers for manual and machine counts. The first step involved random selection of counties in which the commodity was produced. The second stage involved a random selection of activity centers from the selected counties.

The number of activity centers selected throughout the state was

Commodity	*No. of Sites*
Timber	13 (mills)
Grain	12 (elevators)
Beef cattle	10 (feedlots)
Cotton	12 (gins)
Produce	6 (distributors)
Sand and gravel	15 (pits)
Limestone	15 (quarries)

Of a total of several hundred possible activity centers statewide, 83 were selected for observation. A manual count procedure was used almost exclusively because of the difficulty of finding automated count stations that would clearly represent only traffic generated by the activity center.

The standard manual count form is shown in Figure 2. Information recorded included date, time, and number of vehicles entering and exiting the site by AASHTO classification. Other information recorded during the count was location, name of recorder, weather on count day and 2 days before, and additional information gathered through interviews of industry personnel.

For each site selected, a vehicle classification count was made using 15-min intervals for all traffic entering and leaving the facility during a total time period of 1 day. This meant on-site observation at any given site for from 8 to 18 hr. Typical AASHTO vehicle classifications used were PC (passenger car); SU-1 (single-unit truck with two axles); SU-2 (single-unit truck with three axles); SU-2 with pup (SU-2 pulling two-axle trailer, surface mining applications); 2-S1 (two-axle tractor, one-axle semitrailer); 2-S2 (two-axle tractor, two-axle semitrailer); 3-S2 (three-axle tractor, two-axle semitrailer); 3-2 (three-axle truck, two-axle trailer); and 2-S1-2 (two-axle tractor, one-axle semitrailer, two-axle trailer).

TABLE 3 SPECIAL-USE TRIP GENERATION FROM INTERVIEWS (peak season)

Location (activity center)	No. of Passenger Cars per Day	Percentage of One-Way Truck Trips per Day			Maximum Daily Truck Trips[a]
		Single Unit	3-S2	Other Trucks	
Timber mills					
Pulpwood	1,800	21	75	4	550
Plywood mill	650	5	90	5	325
Particle board	650	12	84	4	300
Large sawmill	—[b]	4	80	16	250
Average sawmill	240	7	80	13	150
Grain elevator	8–10	88	12	0	400
Beef cattle					
Large feedlot	110–140	11	89	—	90
Average feedlot	50–60	16	84	—	50
Produce					
Large distributor	400–500	40	40	20	500
Average distributor	120	23	59	18	220
Cotton gin	—	65	13	22	110
Sand and gravel					
Large pit	140	5	95	—	1,000
Average pit	—	5	95	—	550
Limestone					
Large quarry	800	5	95	—	2,000
Average quarry	300	5	95	—	1,000

[a]One-way trips (i.e., one origin and one destination).
[b]Data unavailable.

TABLE 4 MANUAL CLASSIFICATION TRAFFIC COUNTS

Activity Center	Size	Average Percentage of Combination Trucks	Average Percentage of Single-Unit Trucks	Total Truck Trips[a]
Timber mills				
Pulpwood mill	Large	83	17	291–435
Plywood mill	Average	80	20	64
	Large	92	8	196–281
Particle board mill	Large	83	17	305–362
Sawmill	Small	54	46	65
	Average	77	23	82
	Large	79	21	161–264
Grain elevator	Average	24	76	133–313
	Large	58	42	349–570
Produce distributor	Small	24	76	23–34
	Average	69	31	125
	Large	44	56	340–379
Sand and gravel pit	Small	25	75	58–128
	Average	92	8	97–137
	Large	85	15	240–775
Limestone quarry	Small	64	36	42–63
	Average	12	88	122–194
	Large	60	40	147–474

Note: Based on preliminary survey data, subject to change.
[a]One-way trips—one origin and one destination (entering plus exiting).

Results of these classification counts are given in Table 4. The reported values are initial counts for 1 day at fewer than the total number of selected sites. Differences between the values quoted in interviews and the actual field counts were expected. Additional site-specific classification counts will be conducted in future years. However, several factors must be recognized in dealing with special-use commodities. Inclement weather such as heavy rain often slows processing of such commodities. Fluctuations in the demand for a commodity such as crushed stone in a particular geographic area also affect production rates. Another noteworthy point is that interview information was not meant to be precise; an approximate range of values was sought for comparison.

SUMMARY AND CONCLUSIONS

Special-use truck traffic as considered herein involves the traffic associated with the transporting of timber, grain, beef cattle, cotton, produce, sand and gravel, and limestone. This traffic is likely to be unique in vehicle distribution, axle configuration, axle loads, and seasonal fluctuations. Trips generated by special-use activity centers pose problems in the planning, design, and maintenance of the highways that serve their needs.

The impact of the various special-use activity centers must be evaluated in terms of automobile and truck trips generated per unit time, radius of influence, and seasonal fluctuation. Trip generation rates in the range of from 100 to 400 trips per day were found at many activity centers. The radius of influence or the haul distance of these trucks is usually in the range of from 20 to 100 mi. The peak period of haul in the state of Texas for most of these commodities is March through November.

Vehicle classifications by interview and field counts indicated that the predominant AASHTO classification was 3-S2. 3-S2s were usually more than 80 percent of the total truck traffic generated by the activity centers surveyed. Single-unit trucks were also found in all commodity movements evaluated, and in larger numbers at grain elevators, produce distributors, and cotton gins.

Trip generation rates are currently lacking at industrial sites. Site-specific, special-use truck traffic information is so scarce as to be practically nonexistent. The vehicle classification, traffic count, and commodity movement information provided in this paper begins to fill the void in current trip generation data. At least 2 more years of field counts are planned at the selected activity centers. Annual and seasonal variations are anticipated; economic shifts may also alter the initial findings substantially. The results nonetheless provide guidance for estimating the magnitude of the impact of the identified special-use traffic generators.

ACKNOWLEDGMENT

Information presented in this paper represents the initial efforts of an ongoing study. The methodology and findings reflect the characteristics of the particular commodities found in Texas.

This phase of the project was sponsored by the Texas State Department of Highways and Public Transportation and the Federal Highway Administration. The views, interpretations, analyses, and conclusions expressed or implied in this paper are those of the authors. They are not necessarily those of the sponsors.

REFERENCES

1. J. M. Mason, B. E. Stampley, and H. C. Petersen. *The Effects of Oil Field Development on Flexible Pavement Networks*. Research Report 299–6. Texas Transportation Institute, Texas A&M University, College Station, Aug. 1984.
2. D. J. Skove. *Harvest Trends 1983*. Publication 134. Texas Forest Service, Texas A&M University, College Station, 1982.
3. *Texas Forest Industries Directory 1982*. Texas Forest Service, Texas A&M University, College Station, 1982.
4. F. L. Roberts, J. T. Tielking, D. Middleton, R. L. Lytton, and K. Tseng. *Effect of Tire Pressures on Flexible Pavements*. Research Report 372–1F. Texas Transportation Institute, Texas A&M University, College Station, Dec. 1985.