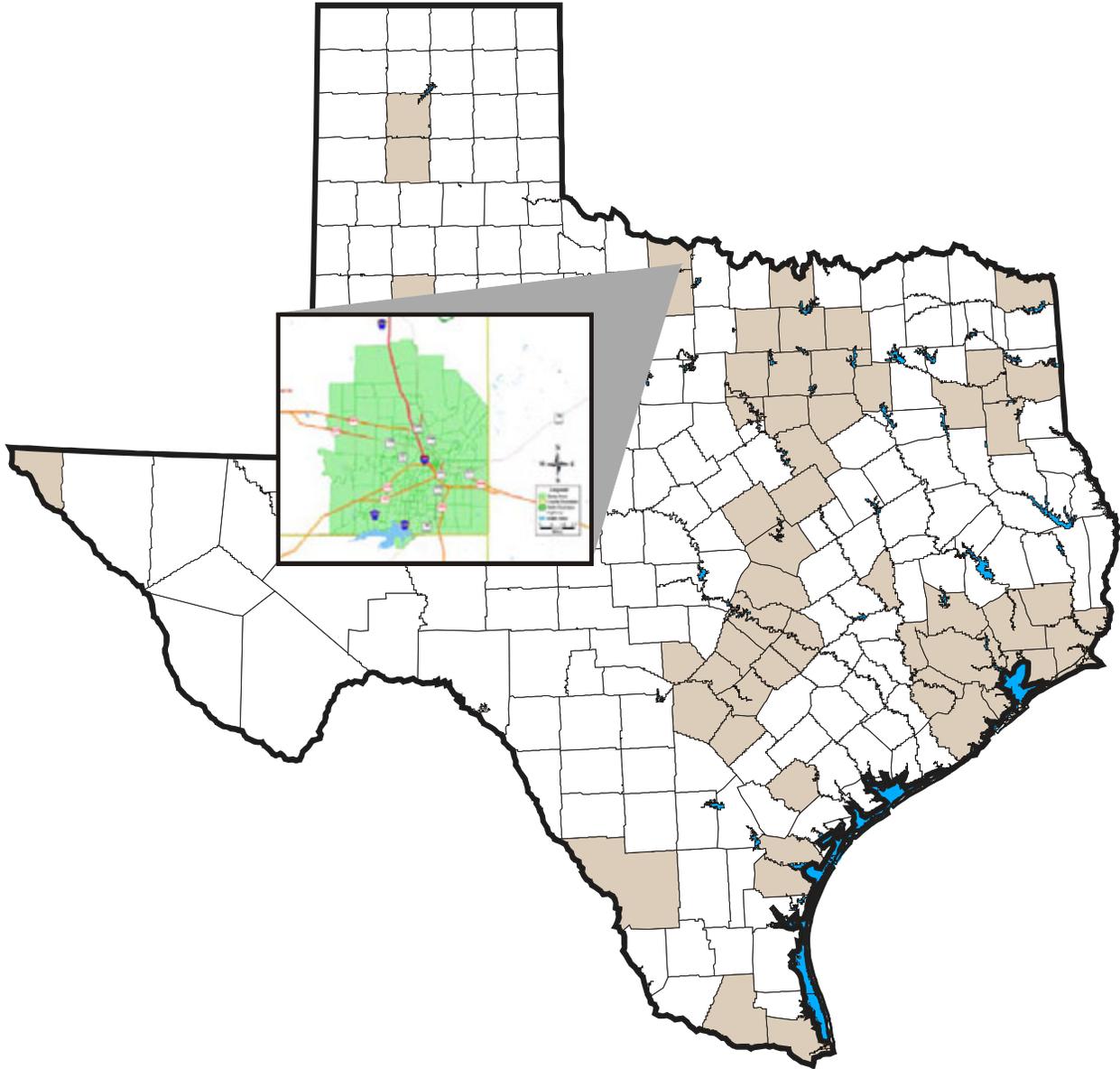


2010-2011 Wichita Falls Commercial Vehicle Survey Technical Summary



Prepared by the
Texas A&M Transportation Institute
November 2013

2010-2011 Wichita Falls Commercial Vehicle Survey

TECHNICAL SUMMARY

Texas Department of Transportation Travel Survey Program

Prepared by

Stephen Farnsworth
Associate Research Scientist

and

Lisa Larsen
Graduate Assistant Researcher

of the
Texas A&M Transportation Institute

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TEXAS A&M TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

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INTRODUCTION

In 2010 and 2011, the Texas Department of Transportation (TxDOT) funded a commercial vehicle survey in the Wichita Falls area. The purpose of this survey was to provide data that would enable TxDOT to forecast total commercial vehicle travel demand within the Wichita Falls urban area. The study area is located in north Texas near the Texas-Oklahoma border, as shown in Figure 1, and is located in Wichita County. The study area has a total population of approximately 131,500 people in 2010 (American Fact Finder).

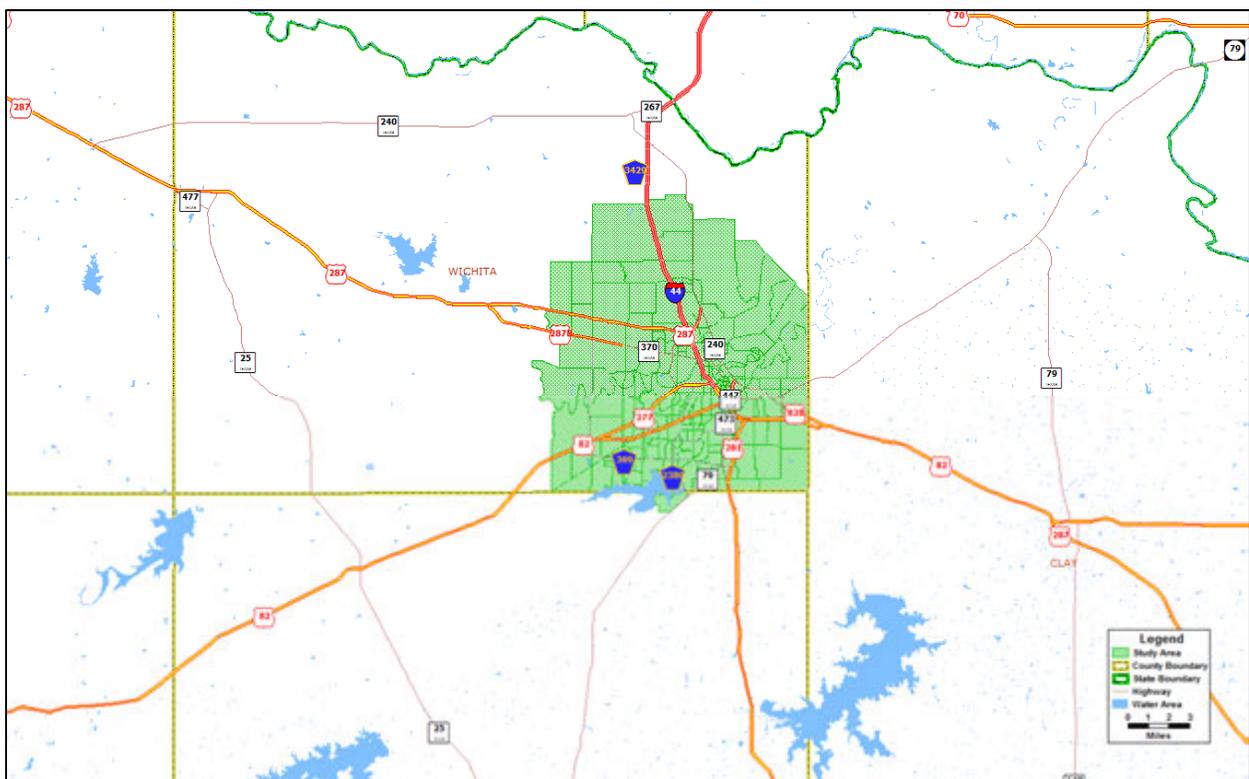


Figure 1. Wichita Falls Study Area.

This report presents a technical summary of the commercial vehicle travel survey conducted from 2010-2011 in the Wichita Falls region and documents the data collected and the analysis of results for the study area. The forms used in the survey are included in the Appendix of this report.

SURVEY METHODOLOGY

The commercial vehicle surveys for the Wichita Falls study area were conducted during the period between November 2010 and February 2011. ETC Institute was contracted by TxDOT to conduct the commercial vehicle surveys for the study area, with technical assistance from the Texas A&M Transportation Institute (TTI). Prior to these surveys, a pilot study was carried out which consisted of 25 commercial vehicles. A target number of 300 commercial vehicles (150 cargo vehicles and 150 service vehicles) was established for the Wichita Falls study area (ETC Institute 2011).

The survey sample was randomly selected from a listing of all business individuals, companies, and public agencies that own, operate, or lease commercial vehicles within the study area. This list was generated from the Texas Workforce Commission (TWC) employer that was provided by TxDOT in random order. Selected businesses were contacted and requested to participate in the survey. Those who agreed to participate were provided survey packets and instructions on how the survey forms should be filled out. The drivers of the commercial vehicles were asked to keep a 24-hour diary of the locations of all trips made by each vehicle.

As Table 1 shows, 486 businesses were contacted during the recruitment process. Contacts were tracked based on the following three categories:

- Agreed to Participate - The company or individual operated qualifying vehicles making trips within the study area, agreed to participate, and complete and return the survey materials.
- Refused to Participate - The company or individual operated qualifying vehicles making trips within the study area but refused to participate in the survey.
- Not Participating - The company or individual did not operate a qualifying vehicle making trips within the study area; or the company or individual did operate a qualifying vehicle that did not make trips within the study area.

Table 1. Survey Participation Rates.

Category	Contact Calls	
	Number	Percent of Total
Agreed to Participate	192	39.5
Refused to Participate	171	35.2
Not participating	123	25.3
Total	486	100.0

Source: 2010-2011 Commercial Vehicle Survey – Final Summary Report. ETC Institute.

Approximately 138 companies participated in the Wichita Falls commercial vehicle survey, from which a total of 341 commercial vehicle surveys were obtained (ETC Institute). Data editing and review processes were performed by TTI to ensure that the survey data collected were complete and followed the guidelines set forth in TxDOT’s bid specification for the project. A data check program was also utilized to examine the accuracy of geocoding of locations and logic of survey responses. The majority of data errors were expected to be corrected prior to final data submittals by the contractor (ETC Institute). However, it was not unusual to find errors during actual data processing and analysis. In this study, survey responses with irreconcilable data were not included in the survey analysis. Additionally, inconsistent trip records were dropped from the survey analysis.

The results presented in this technical summary are therefore based on data from 277 surveyed commercial vehicles.

SURVEY RESULTS

Vehicle Characteristics

This section presents the characteristics of registered trucks and surveyed commercial vehicles to provide an overview of the type and condition of commercial vehicles operating within the Wichita Falls study area. Information on registered trucks includes the number of diesel-fueled, gasoline-fueled and propane-fueled trucks by gross vehicle weight and by model year.

Information on surveyed commercial vehicles includes the vehicle's make, model and year, odometer reading, gross vehicle weight, vehicle classification, and fuel use.

Registered Commercial Vehicles

Based on TxDOT's vehicle registration data, there were nearly 2,000 trucks registered in the Wichita Falls study area in 2012. Table 2 shows the distribution of registered diesel trucks and gasoline trucks by gross vehicle weight. Over three-fourths (76 percent) of all trucks registered in the Wichita Falls study area are diesel-fueled vehicles. Sixty-one percent of all registered trucks had a gross vehicle weight of less than 10,000 pounds.

Table 2. Gross Vehicle Weight of Registered Trucks in Wichita Falls Study Area.

Gross Vehicle Weight	Diesel Trucks		Gasoline Trucks		Total	
	Number of Vehicles	% of Diesel Trucks	Number of Vehicles	% of Gasoline Trucks	Number of Vehicles	% of Total Trucks
< 10000	914	61.2	271	58.9	1,185	60.6
> 10000	151	10.1	93	20.2	244	12.5
> 14000	41	2.7	24	5.2	65	3.3
> 16000	44	3.0	24	5.2	68	3.5
> 19500	120	8.0	31	6.8	151	7.7
> 26000	71	4.8	8	1.7	79	4.1
> 33000	102	6.8	9	2.0	111	5.7
> 60000	51	3.4	0	0.0	51	2.6
Total	1,494	100.0	460	100.0	1,954	100.0

Source: TxDOT 2012.

Figure 2 shows the distribution of registered diesel trucks and gasoline trucks by model year. Registered gasoline trucks were older relative to the diesel trucks. The majority of the diesel trucks (73 percent) were less than ten years old, which was notably more than the 45 percent of gasoline trucks within that age range. Less than seven percent of the nearly 1,500 registered diesel trucks were older than 20 years, while 23 percent of registered gasoline trucks were older than 20 years.

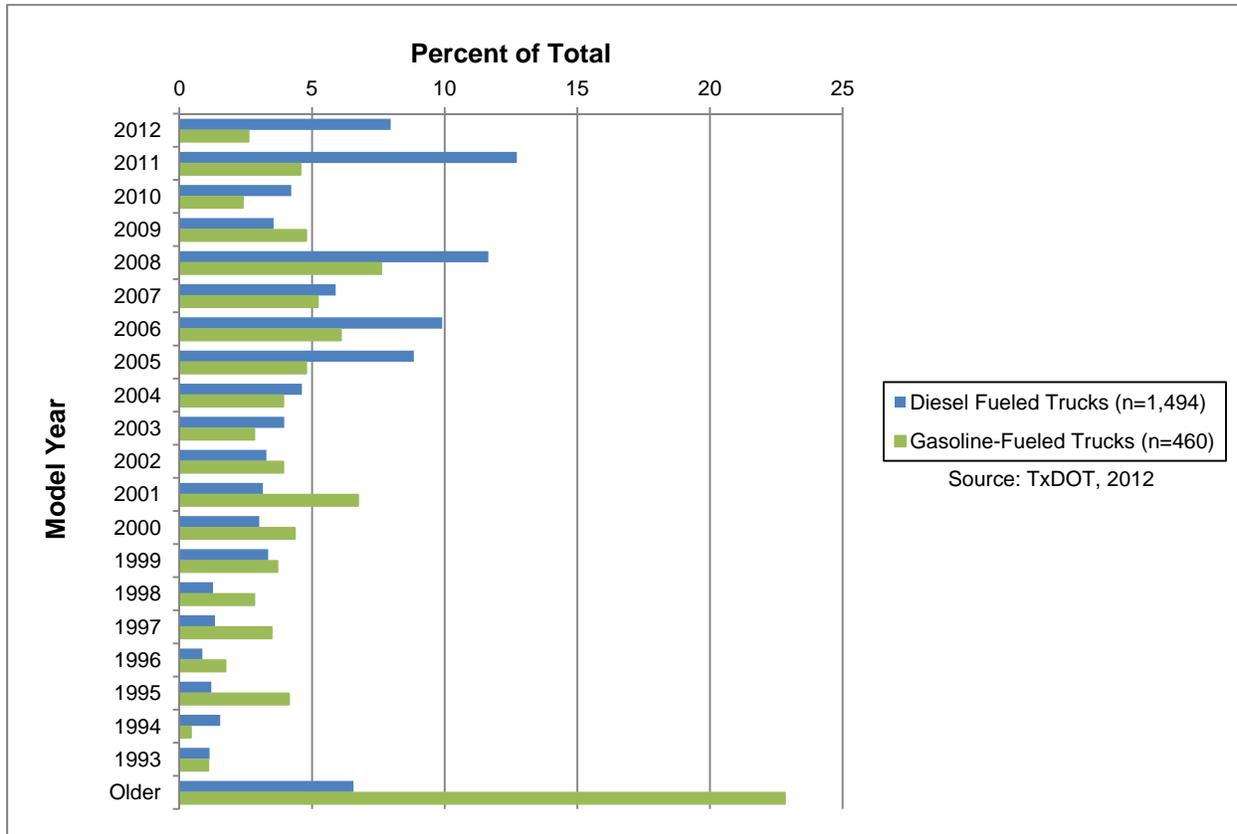


Figure 2. Model Year of Registered Trucks in the Wichita Falls Study Area.

Surveyed Commercial Vehicles

Commercial vehicles that participated in the Wichita Falls commercial vehicle survey were distinguished based on the ten classification types listed in Table 3. These were further categorized by commercial type as either major cargo/freight transport or local service vehicles, simply referred to in this report as cargo vehicles and service vehicles, respectively.

Cargo vehicles were defined as vehicles mainly used to transport cargo or freight which were typically bulk goods, materials, and cargo in large quantities for wholesale distribution. Service

vehicles were defined as vehicles mainly used to perform services such as those used by building contractors, plumbers, electricians, cable and telephone services/repairs, and delivery vans/vehicles used by local retailers. These also included company fleet vehicles or fleets and maintenance vehicles of public agencies such as TxDOT, city, county, or school district.

Table 3 shows the distribution of surveyed vehicles by vehicle classification type and commercial type. Out of the total 277 vehicles with survey responses, 117 were cargo vehicles and 160 were service vehicles. Among cargo vehicles, approximately 27 percent were pick-up trucks, 22 percent were single unit 2-axle trucks (6-wheelers), 19 percent were semi-tractor/trailer combinations, and 17 percent were vans. Among service vehicles, approximately 58 percent were pick-up trucks, 24 percent were vans, and nine percent were passenger cars. Vehicles classified as “other” were mostly buses which neither belonged in the van nor single unit 2-axle categories. There were some vehicles that were coded as “refused”, and several cases in which pick-up trucks were coded as cars or vans. These vehicles were re-classified in order to properly represent their characteristics.

Table 3. Vehicle Classification Type of Surveyed Commercial Vehicles.

Vehicle Classification	Cargo Vehicles		Service Vehicles		Total Vehicles	
	Number of Vehicles	Percent of Cargo	Number of Vehicles	Percent of Service	Number of Vehicles	Percent of Total
Passenger Car	2	1.7	14	8.8	16	5.8
Pickup Truck	32	27.4	92	57.5	124	44.8
Van (passenger or mini)	20	17.1	38	23.8	58	20.9
Sport Utility Vehicle	1	0.9	6	3.8	7	2.5
Single Unit 2-axle (6 wheels)	26	22.2	4	2.5	30	10.8
Single Unit 3-axle (10 wheels)	9	7.7	0	0.0	9	3.2
Single Unit 4-axle (14 wheels)	4	3.4	0	0.0	4	1.4
Semi (tractor-trailer)	22	18.8	2	1.3	24	8.7
Other	1	0.9	4	2.5	5	1.8
Total	117	100.0	160	100.0	277	100.0

Figure 3 shows the distribution of surveyed vehicles by fuel type. Approximately 43 percent of the surveyed vehicles used unleaded gasoline and 57 percent used diesel. Among cargo vehicles, 42 percent used gasoline and 58 percent used diesel. Among service vehicles, 94 percent used

gasoline and six percent used diesel. These reported percentages are based on those vehicles that were either ran on diesel or gasoline. The three vehicles who reported their fuel type as either hybrid or unknown were not included in the tables and figures used to present these results.

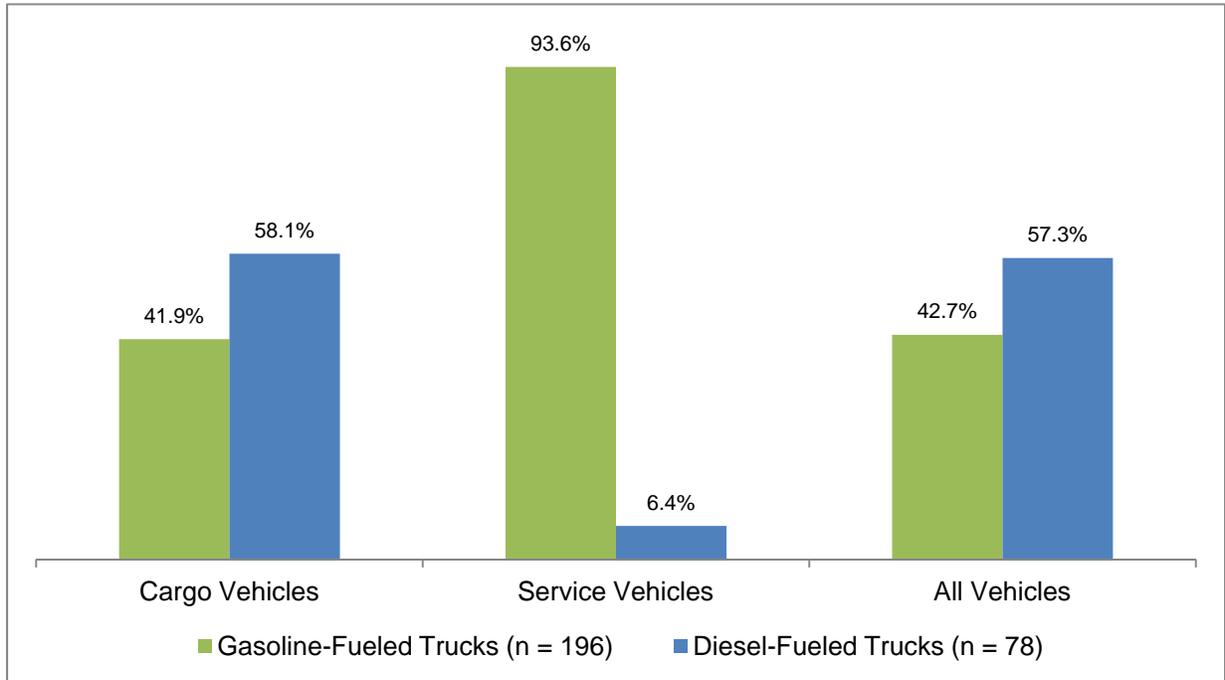


Figure 3. Type of Fuel Used by Surveyed Commercial Vehicles.

Table 4 shows the distribution of surveyed vehicles by gross vehicle weight. The survey included commercial vehicles with gross vehicle weight of less than 10,000 pounds. Approximately 93 percent of the service vehicles belonged to this category, while approximately 32 percent of the cargo vehicles weighed more than 19,500 pounds.

Table 4. Gross Vehicle Weight.

Gross Vehicle Weight (lbs.)	Cargo		Service		Total	
	Number of Vehicles	% of Cargo Vehicles	Number of Vehicles	% of Service Vehicles	Number of Vehicles	% of Total Vehicles
< 10,000	56	48.3	149	93.1	205	74.3
> 10,000	12	10.3	8	5.0	20	7.2
> 14,000	1	0.9	0	0.0	1	0.4
> 16,000	10	8.6	0	0.0	10	3.6
> 19,500	10	8.6	1	0.6	11	4.0
> 26,000	10	8.6	2	1.3	12	4.3
> 33,000	6	5.2	0	0.0	6	2.2
> 60,000	11	9.5	0	0.0	11	4.0
Total	116	100.0	160	100.0	276	100.0

Figure 4 shows the distribution of surveyed vehicles by model year. Note that although some of the commercial vehicles registered in the Wichita Falls study area had a model year of 2012, none of the surveyed vehicles fell into this category. Approximately 58 percent of cargo vehicles and 73 percent of service vehicles were less than 10 years old. The average age for cargo vehicles was 9.1 years, while the average age for service vehicles was 7.2 years (assuming 2012 as the base year).

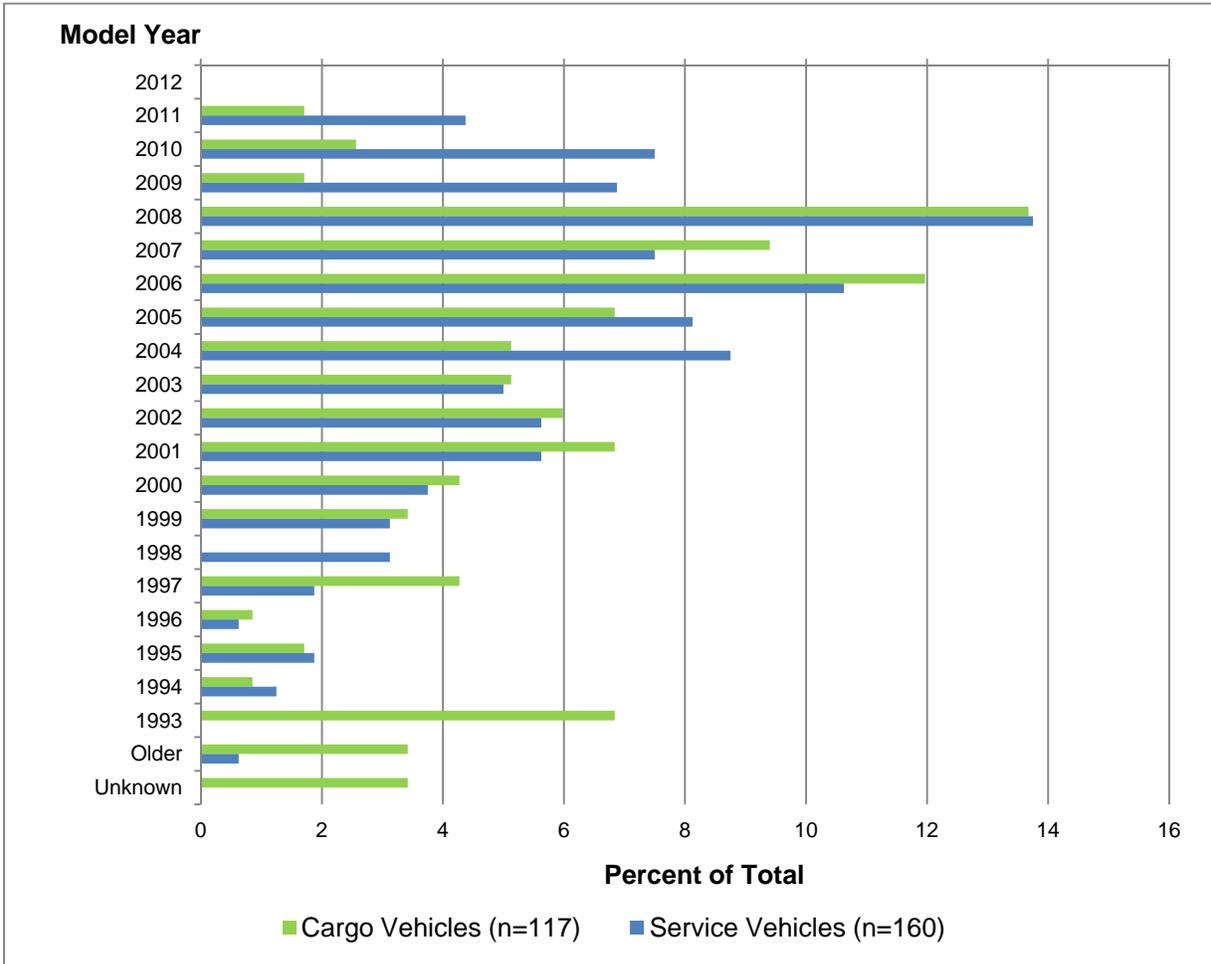


Figure 4. Vehicle Model Year.

Table 5 shows the average vehicle mileage by model year based on reported odometer readings from 250 surveyed vehicles at the beginning of their survey travel day. Cargo vehicles reported higher average odometer readings of nearly 194,000 miles compared to nearly 82,000 miles for service vehicles.

Table 5. Average of Reported Odometer Readings by Model Year.

Model Year	Cargo Vehicles		Service Vehicles		Total Vehicles	
	Number of Vehicles	Avg. Odometer Reading	Number of Vehicles	Avg. Odometer Reading	Number of Vehicles	Avg. Odometer Reading
2012	0	0	0	0	0	0
2011	2	20,689	6	6,879	8	10,331
2010	2	21,705	12	23,675	14	23,394
2009	2	117,581	9	49,743	11	62,077
2008	13	70,172	20	55,631	33	61,359
2007	9	105,008	11	72,153	20	86,938
2006	14	226,558	17	96,327	31	155,141
2005	8	144,464	10	86,404	18	112,208
2004	6	111,464	14	89,922	20	96,384
2003	5	154,844	8	91,200	13	115,678
2002	6	154,154	9	60,026	15	97,677
2001	8	149,743	9	140,809	17	145,013
2000	4	350,931	5	162,495	9	246,244
1999	3	160,024	5	125,974	8	138,743
1998	0	0	5	98,155	5	98,155
1997	3	279,721	3	194,937	6	237,329
1996	0	NA	1	31,011	1	31,011
1995	2	566,910	3	143,537	5	312,886
1994	1	163,772	2	69,318	3	100,802
1993	8	413,551	0	0	8	413,551
Older	2	74,933	1	168,140	3	106,002
Unknown	2	917,321	0	0	2	917,321
Total	100	193,841	150	81,755	250	126,590

Trip Frequency

The surveyed vehicles generated a total of 1,907 trips, of which 1,376 were internal trips and 531 were external trips. Internal trips were defined as those trips made within the Wichita Falls area. These trips were further distinguished by travel within or between zones. Inter-zonal trips were those trips made from one zone to another, while intra-zonal trips were made within the same zone. External trips were those trips made outside of the study area.

Figure 5 shows the distribution of inter-zonal, intra-zonal and external trips, while the breakdown of these trips is provided in Table 6. Cargo vehicles generated 804 trips, of which approximately 59 percent were inter-zonal trips, three percent were intra-zonal trips, and 38 percent were external trips. Service vehicles generated 1,103 trips, of which 70 percent were inter-zonal trips, nine percent were intra-zonal trips, and 21 percent were external trips.

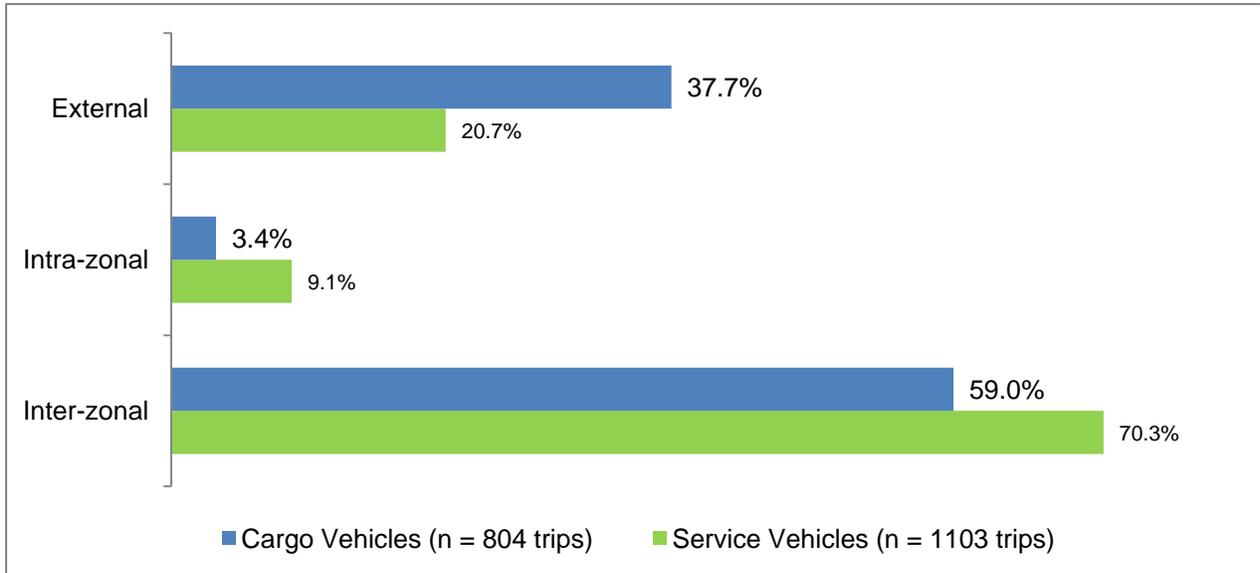


Figure 5. Inter-Zonal, Intra-Zonal, and External Trips.

Table 6. Total Internal and External Trips.

Vehicle Type Trip Type	Cargo Vehicles		Service Vehicles		Total Vehicles	
	Number	% of Total	Number	% of Total	Number	% of Total
Inter-zonal	474	59.0	775	70.3	1,249	65.5
Intra-zonal	27	3.4	100	9.1	127	6.7
Total Internal	501	62.3	875	79.3	1,376	72.2
External	303	37.7	228	20.7	531	27.8
Total	804	100.0	1,103	100.0	1,907	100.0

Figure 6 shows the distribution of total trips (internal and external trips) which varied from one trip to 28 trips per cargo vehicle and from one trip to 29 trips per service vehicle on their survey day. The average number of total trips per day was 7.0 trips for cargo vehicles and 6.9 trips for service vehicles.

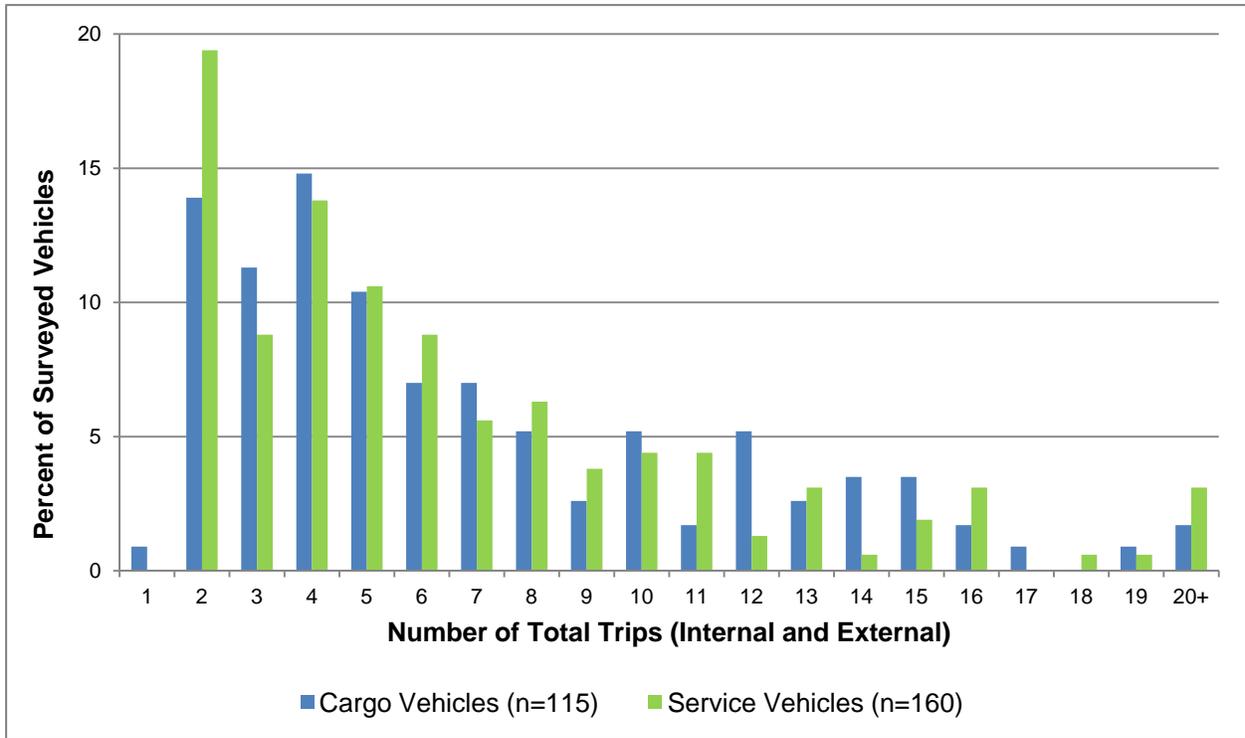


Figure 6. Total Trips per Vehicle.

Figure 7 shows the distribution of internal trips only. Approximately three percent of cargo vehicles made one internal trip per day, while only two percent of service vehicles reported making one internal trip per day. The average number of internal trips per day was 4.4 trips for cargo vehicles and 5.5 trips for service vehicles. Approximately 29 percent of cargo vehicles and 18 percent of service vehicles did not make any internal trips.

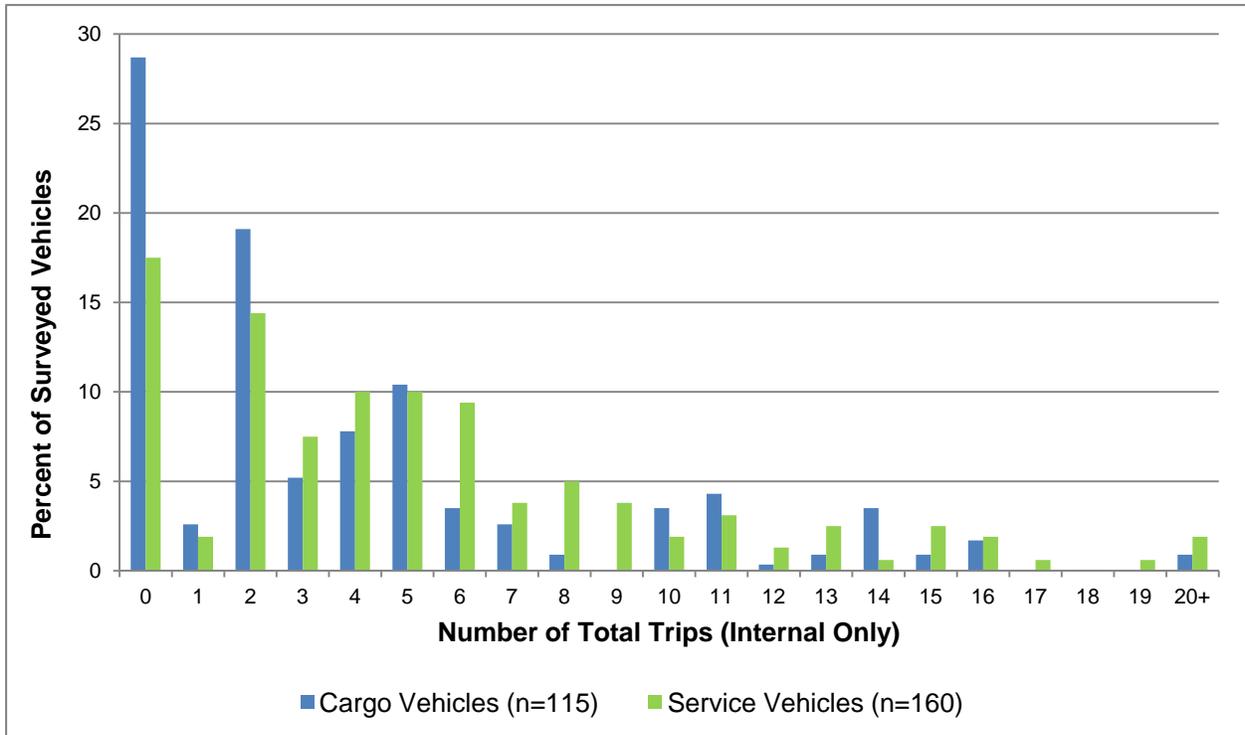


Figure 7. Total Internal Trips per Vehicle.

Trip Characteristics

Information on travel purpose and the type of land use activity where these trips occurred are important in estimating commercial vehicle trip patterns. The analysis of trips presented in this section is based solely on internal trips and does not include external trips.

Table 7 shows the distribution of internal trips by land use type at trip destinations. Approximately 34 percent of the trips made by cargo vehicles occurred at retail locations, followed by 13 percent to “other” locations, and 12 percent at residential locations. For service vehicles, nearly 27 percent of the trips took place at residential sites, followed by nearly 24 percent at locations classified as “other”, and 15 percent at office locations.

Table 7. Distribution of Internal Trips by Land Use Type at Trip Destinations.

Land Use	Cargo		Service	
	Number	Percent of Cargo	Number	Percent of Service
Office Building (Non-government)	53	6.6	170	15.4
Retail/Shopping	270	33.6	124	11.2
Industrial/Manufacturing	77	9.6	29	2.6
Medical/Hospital	66	8.2	35	3.2
Education (< 12th grade)	8	1.0	59	5.3
Education (College, Trade)	3	0.4	2	0.2
Government Office/Building	6	0.7	81	7.3
Residential	93	11.6	293	26.6
Airport	3	0.4	1	0.1
Intermodal Facility	0	0.0	0	0.0
Warehouse	61	7.6	22	2.0
Distribution Center	52	6.5	12	1.1
Construction Site	11	1.4	11	1.0
Other	101	12.6	264	23.9
Refused/Unknown	0	0.0	0	0.0
Total Trips	804	100.0	1,103	100.0

Table 8 shows the distribution of internal trips by trip purposes at trip destinations. Forty-six percent of the cargo vehicle internal trips were delivery, 26 percent were base, and 13 percent were classified as pick-up. For trips made by service vehicles, approximately 30 percent were classified as base, 23 percent were classified as service, and 15 percent were government.

Table 8. Trip Purposes at Destination Locations.

Trip Purpose	Cargo		Service	
	Number	Percent of Cargo	Number	Percent of Service
Base	130	25.9	265	30.3
Maintenance	13	2.6	9	1.0
Driver Needs	24	4.8	75	8.6
Delivery	228	45.5	1	0.1
Pick-up	66	13.2	6	0.7
Pick-up & Delivery	12	2.4	0	0.0
Government	2	0.4	130	14.9
Service	14	2.8	203	23.2
Sales	9	1.8	121	13.8
Other	3	0.6	65	7.4
Total Trips	501	100.0	875	100.0

Cargo Characteristics

Information on the type of cargo being delivered or picked up at each stop, the weight of cargo, and the type of land use where the cargo trip occurred was collected in the Wichita Falls commercial vehicle survey to examine the movement of commodities within and outside of the study area. The analyses presented in this section are for both internal and external trips made by surveyed cargo vehicles only, and do not include the trips made by service vehicles. The types of cargo in the survey were based on 22 classification types listed in Table 9.

The analysis of cargo trip data examined the types of cargo being transported at trip destinations, the trip purpose and land use activity at each stop, and the estimated net weight of the cargo being picked up and/or delivered for each trip. Several inconsistencies were observed during the processing and analysis of cargo trip data. There were some trips with full or partial cargo loads that did not report cargo weights but actually reported the type of cargo being transported. There were some trips that indicated delivery trip purpose but did not report any cargo weights at drop-off.

Table 9. Cargo Classification Types.

Cargo Type	Cargo Descriptions
1. Farm Products	Livestock, fertilizer, dirt, landscaping, etc.
2. Forest Products	Trees, sod, etc.
3. Marine Products	Fresh fish, seafood, etc.
4. Metals and Minerals	Crude petroleum, natural gas, propane, metals, gypsum, ores, etc.
5. Food, Health, and Beauty Products	Assorted food products, cosmetics, etc.
6. Tobacco Products	Cigarettes, cigars, and chewing tobacco
7. Textiles	Clothing, linens, etc.
8. Wood Products	Lumber, paper, cardboard, wood pulp, etc.
9. Printed Matter	Newspapers, magazines, books, etc.
10. Chemical Products	Soaps, paints, household or industrial chemicals, etc.
11. Refined Petroleum or Coal Products	Gasoline, etc.
12. Rubber, Plastic, and Styrofoam Products	Finished products of rubber, plastic, or Styrofoam
13. Clay, Concrete, Glass, or Stone	Finished products of clay, concrete, glass, or stone
14. Manufactured Goods/Equip.	Miscellaneous products (machinery, appliances, furniture, etc.)
15. Wastes	Waste products including scrap and recyclable materials
16. Miscellaneous Shipments	U.S. mail, U.P.S., Federal Express, and other mixed cargo
17. Hazardous Materials	Hazardous chemicals and substances
18. Transportation	Automobiles and other transport vehicles
19. Unclassified Cargo	Cargo not falling within one of the above categories
20. Driver Refused to Answer	Driver refused to answer
21. Unknown to Driver	Unknown to driver
22. Empty	Empty (including empty shipping containers)

Table 10 shows the distribution of trips by cargo type. Approximately 30 percent of the total cargo vehicle trips were transporting unclassified cargo types, followed by 15 percent transporting manufactured goods, about 10 percent transporting food, health, and beauty products, and about 10 percent transporting transportation cargo. Approximately one percent of the cargo trips reported an unknown cargo type and 14 percent were empty shipping containers.

Table 10. Distribution of Trips by Cargo Type at Destinations.

Cargo Type	Number of Trips	% of Total
Farm Products	12	1.5
Forest Products	27	3.4
Marine Products	0	0.0
Metals and Minerals	16	2.0
Food, Health, and Beauty Products	77	9.6
Tobacco Products	0	0.0
Textiles	15	1.9
Wood Products	10	1.2
Printed Matter	0	0.0
Chemical Products	11	1.4
Refined Petroleum or Coal Products	17	2.1
Rubber, Plastic, and Styrofoam Products	2	0.2
Clay, Concrete, Glass, or Stone	11	1.4
Manufactured Goods/Equipment	120	14.9
Wastes	2	0.2
Miscellaneous Shipments	1	0.1
Hazardous Materials	40	5.0
Transportation	77	9.6
Unclassified/Other Cargo	242	30.1
Driver Refused to Answer	0	0.0
Unknown to Driver	10	1.2
Total Trips with Cargo	690	85.8
Empty	114	14.2
Total Cargo Vehicle Trips	804	100.0

The commodity grouping scheme used by TxDOT in its Texas Statewide Analysis Model (SAM) was used to simplify the cargo types into ten commodity groups. The type of place option in the survey was categorized into seven land use categories. Table 11 shows the equivalency between SAM commodity groups and cargo classifications from the survey, while Table 12 shows the land use categories and their corresponding equivalents in the type of place options from the survey. Those items in italics did not have equivalents but were added or grouped together so as not to exclude any trips in the analysis.

Table 11. Equivalency between SAM Commodity Groups and Survey Classifications.

Commodity Group	Survey Cargo Classification
1. Agriculture	Farm Products, Forest Products, Marine Products
2. Raw Materials	Metals and Minerals, Chemical Products, Refined Petroleum or Coal Products
3. Food	Food, Health and Beauty Products, Tobacco Products
4. Textiles	Textiles, Rubber, Plastic, and Styrofoam Products
5. Wood	Wood Products, Printed Matter
6. Building Materials	Clay, Concrete, Glass or Stone Products
7. Machinery	Manufactured Goods/Equipment
8. Miscellaneous	Wastes, Miscellaneous Shipments
9. Secondary	Unclassified Cargo
10. Hazardous Materials	Hazardous Materials
--- <i>Transportation</i>	<i>Transportation</i>
--- <i>Empty</i>	<i>Empty</i>
--- <i>Unknown</i>	<i>Unknown to Driver/ Driver Refused to Answer</i>

Table 12. Equivalency between Land Use Category and Survey Type of Place.

Land Use Category	Type of Place
1. Office	Office Building
2. Retail	Retail/Shopping
3. Industrial	Industrial/Manufacturing
4. Medical	Medical/Hospital
5. Education	Educational (12th grade or less and college, trade, etc.)
6. Government	Government Office/Building
7. Residential	Residential
-- Other	Airport, Inter-modal Facility, Warehouse, Distribution Center, Construction Site, Other
-- Unknown	Land use category not provided, Omitted, Driver refused to answer

Table 13 shows the distribution of cargo trips by commodity group and land use type at trip destinations. Approximately 34 percent occurred at retail sites, and 10 percent of the trips occurred at industrial sites. Over 28 percent of the trips occurred at “Other” land use types,

which were mainly warehouses, distribution centers and construction sites. By commodity group, approximately 30 percent of the trips were transporting secondary materials, and about 15 percent were transporting machinery. Around 14 percent were not transporting cargo.

Table 13. Cargo Trips by Commodity Group and Land Use Destinations.

Commodity Group	Land Use								Total Trips	% of Total
	Office	Retail	Ind'l	Med	Edu	Gov't	Res	Othr		
Agriculture	1	29	0	1	0	0	2	6	39	4.9
Raw Materials	1	10	9	0	0	0	4	20	44	5.5
Food	1	61	0	0	0	0	0	15	77	9.6
Textiles	0	3	1	12	0	0	0	1	17	2.1
Wood	0	0	7	0	0	0	0	3	10	1.2
Building Materials	1	0	1	0	1	0	0	8	11	1.4
Machinery	5	28	19	12	3	5	11	37	120	14.9
Miscellaneous	0	1	0	0	0	0	0	2	3	0.4
Hazardous	0	1	2	0	0	0	3	34	40	5
Transportation	15	14	0	2	1	0	17	28	77	9.6
Secondary	14	90	28	37	6	1	31	35	242	30.1
Unknown	1	0	0	0	0	0	9	0	10	1.2
Empty	14	33	10	2	0	0	16	39	114	14.2
Total	53	270	77	66	11	6	93	228	804	100
Percent of Total	6.6	33.6	9.6	8.2	1.4	0.7	11.6	28.4	100	---

Figure 8 shows the distribution of trips at destination locations by trip purpose, while Table 14 shows a detailed summary of trips by commodity group and trip purpose. Approximately 47 percent of the total cargo vehicle trips were delivery, with secondary materials as the most common commodity group cited for surveyed trips. The trip purpose “pick-up” made up nearly 15 percent of the total cargo trips. However, these do not represent the actual portion of trips that picked up cargo because some of the trips coded as “base location” trip purpose were also the pick-up location for cargo.

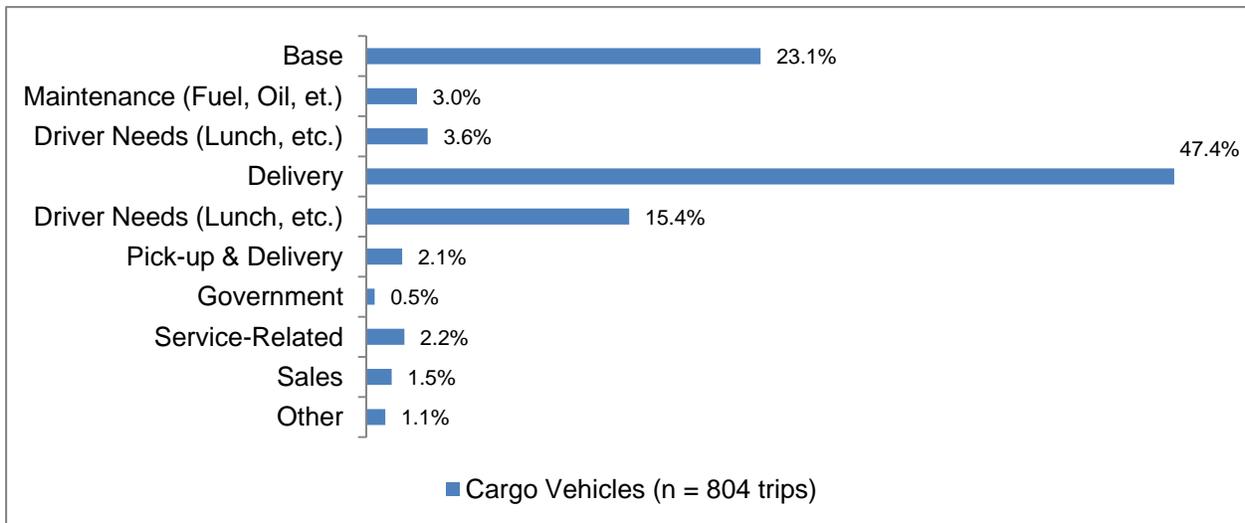


Figure 8. Cargo Trip Purposes at the Trip Destinations.

Table 14. Cargo Trips by Commodity Group and Trip Purpose at the Trip Destinations.

Commodity Group	Land Use										Total Trips	% of Total
	Base	Maint enance	Driver Need	Deliv	Pick-up	Pick-up & Deliv	Gov't	Serv	Sales	Oth		
Agriculture	7	0	1	29	2	0	0	0	0	0	39	4.9
Raw Materials	5	1	0	23	15	0	0	0	0	0	44	5.5
Food	10	0	0	66	0	0	1	0	0	0	77	9.6
Textiles	6	3	0	1	0	6	0	0	0	1	17	2.1
Wood	2	0	0	7	1	0	0	0	0	0	10	1.2
Building Materials	1	0	1	8	1	0	0	0	0	0	11	1.4
Machinery	31	7	3	53	24	0	0	1	1	0	120	14.9
Misc.	0	0	0	2	0	0	0	0	0	1	3	0.4
Hazardous	5	0	0	28	3	4	0	0	0	0	40	5.0
Transportation	12	0	1	23	41	0	0	0	0	0	77	9.6
Secondary	40	4	8	134	37	7	1	6	1	4	242	30.1
Unknown	1	0	0	7	0	0	2	0	0	0	10	1.2
Empty	66	9	15	0	0	0	0	11	10	3	114	14.2
Total	186	24	29	381	124	17	4	18	12	9	804	100
% of Total	23.1	3	3.6	47.4	15.4	2.1	0.5	2.2	1.5	1.1	100	---

The analysis of cargo weights by cargo type provides information on the volume and type of commodities being moved from the time the surveyed cargo vehicle left its base location, began its trip, continued making trips until it reached its destination(s), and returned to its base location. The net cargo weight for each trip was estimated based on the cargo weight being picked-up

and/or being dropped-off, consistent with the reported trip purpose for each stop. There were several cases when cargo types were changed between trips (i.e. reported as empty cargo or food type), even if the same cargo was being transported either for delivery or pick-up. The driver of the surveyed cargo vehicle reported a different trip purpose during a particular stop (i.e. driver needs - lunch, etc.), which indicated that no cargo was delivered and/or picked-up but the cargo remained in transit. In such cases, the cargo weight from the trip origin should be the net cargo weight at that particular stop or trip destination with its corresponding cargo type. If a delivery occurred during that particular stop, the cargo weight for that particular drop-off should be deducted from the current weight load, and if cargo was picked-up, the cargo weight should be added to the current weight load, thus resulting in an estimated net cargo weight for that particular trip.

Table 15 shows the distribution of average net cargo weight per trip by commodity group and land use type at destination locations and Table 16 shows the distribution by commodity group and trip purpose. Wood being transported to industrial sites has the highest average net cargo weight. Machinery was transported to all listed land use types. The trip purpose of delivery had the highest average net cargo weight for all listed commodity groups, excepting food, textiles, and empty.

Table 15. Average Net Cargo Weight by Commodity Group and Land Use at Trip Destinations.

Commodity Group	Land Use							
	Office	Retail	Ind'l	Med	Edu	Gov't	Res	Other
Agriculture	10,000	218	0	47	0	0	1,200	1,000
Raw Materials	0	29,406	22,403	0	0	0	21	5,067
Food	50	1,701	0	0	0	0	0	15
Textiles	0	0	400	2,283	0	0	0	0
Wood	0	0	70,406	0	0	0	0	6,667
Building Materials	0	0	0	0	57,250	0	0	16,906
Machinery	1	43	995	1,127	60	221	843	123
Miscellaneous	0	500	0	0	0	0	0	23,430
Hazardous	0	150	50,000	0	0	0	80	386
Transportation	2,062	1,695	0	3,750	0	0	194	1,405
Secondary	16	899	10,208	1	56	0	83	110
Unknown	0	0	0	0	0	0	26	0
Other	0	0	0	0	0	0	0	0

Table 16. Average Net Cargo Weight by Commodity Group and Trip Purpose at Trip Destinations.

Commodity Group	Trip Purpose					
	Base Location	Maintenance	Delivery	Pick-Up	Pickup & Delivery	Gov't
Agriculture	0	0	854	0	0	0
Raw Materials	0	0	25,962	0	0	0
Food	0	0	1,487	0	0	5,883
Textiles	0	0	400	0	4,567	0
Wood	0	0	73,263	0	0	0
Building Materials	0	0	24,063	0	0	0
Machinery	113	171	831	0	0	0
Miscellaneous	0	0	23,680	0	0	0
Hazardous Materials	0	0	4,350	116	0	0
Transportation	1,260	0	2,394	0	358	2
Secondary	0	0	3,971	0	583	0
Empty	0	0	19	0	0	48
Unknown	0	0	0	0	0	0

Table 17 shows the distribution of cargo trips and net cargo weights at trip destinations by commodity group. Overall, the average net cargo weight per trip was about 3,100 lbs. Of the classified commodity groups, wood showed the highest average net cargo weight of nearly

51,300 lbs. per trip. Transportation was the most frequently transported of the commodity groups, with average net cargo weights of over 1,500 lbs. per trip. A total of 10 trips were reported as not having a cargo yet provided cargo weights totaling 231 lbs.

Table 17. Cargo Trips and Net Cargo Weight by Commodity Group at Trip Destinations.

Commodity Group	Total Cargo Trips	Total Net Cargo Weight (lbs.)	Number of Trips*	Average Net Cargo Weight (lbs.)*
Agriculture	39	24,755	39	635
Raw Materials	44	597,122	44	13,571
Food	77	104,057	77	1,351
Textiles	17	27,800	17	1,635
Wood	10	512,840	10	51,284
Building Materials	11	192,500	11	17,500
Machinery	120	48,720	120	406
Miscellaneous	3	47,360	3	15,787
Hazardous	77	104,796	77	1,361
Transportation	242	373,724	242	1,544
Secondary	40	113,520	40	2,838
Unknown	114	0	0	0
Empty	10	231	10	23
Total	804	2,147,425	690	3,112

* Excluding trips with empty cargo.

Table 18 shows the number of trips and net cargo weights at trip destinations by land use type. Industrial land use sites showed the highest average net cargo weight of nearly 14,300 lbs. per trip, followed by education sites, with an average net cargo weight of over 5,250 lbs. per trip.

Table 18. Cargo Trips and Net Cargo Weights by Land Use at Trip Destinations.

Land Use	Total Cargo Trips	Total Net Cargo Weight (lbs.)	Number of Trips*	Average Net Cargo Weight (lbs.)*
Office	53	41,197	39	777
Retail	270	510,660	237	1,891
Industrial	77	1,099,584	67	14,280
Medical	66	48,508	64	735
Education	11	57,765	11	5,251
Government	6	1,104	6	184
Residential	93	18,085	77	194
Other	228	370,522	189	1,625
Total	804	2,147,425	690	3,112

* Excluding trips with empty cargo.

Table 19 shows the distribution of cargo trips and net cargo weights by trip purpose. Delivery trip purposes had the highest average net weight of nearly 5,400 lbs. per trip.

Table 19. Cargo Trips and Net Cargo Weights by Trip Purpose at Trip Destinations.

Land Use	Total Cargo Trips	Total Net Cargo Weight (lbs.)	Number of Trips*	Average Net Cargo Weight (lbs.)*
Base	186	53,900	120	449
Maintenance	24	1,200	15	80
Driver Needs	29	0	14	0
Delivery	381	2,049,372	381	5,379
Pick-up	124	4,740	124	38
Pick-up & Delivery	17	32,233	17	1,896
Government	4	5,980	4	1,495
Service	18	95	7	14
Sales	12	0	2	0
Other	9	0	6	0
Total	804	2,147,520	690	3,112

* Excluding trips with empty cargo.

Trip Length

Odometer readings at the beginning and end of the trip are useful in estimating travel distances for external and intra-zonal trips. The Wichita Falls commercial vehicle survey, however, only provided odometer mileage on each vehicle for the beginning of the trip and not for the end of the trip. Because this incomplete information makes odometer readings not particularly useful for trip length measurement in the analysis, network matrices available for the study area were used to estimate trip lengths. The network matrices provide travel distance and time estimates from one zone to all other zones in the Wichita Falls study area. Since each reported trip in the survey was coded with a traffic analysis zone (TAZ) number assigned to the study area, it was then possible to estimate the trip length based on the distance provided in the network matrix.

Figure 9 shows the TAZ boundary and base locations of surveyed vehicles within the Wichita Falls study area, while Figure 10 shows the origin and destination locations of trips made by the surveyed vehicles. Any trip that had at least one trip outside of the Wichita Falls study area was considered an external trip.

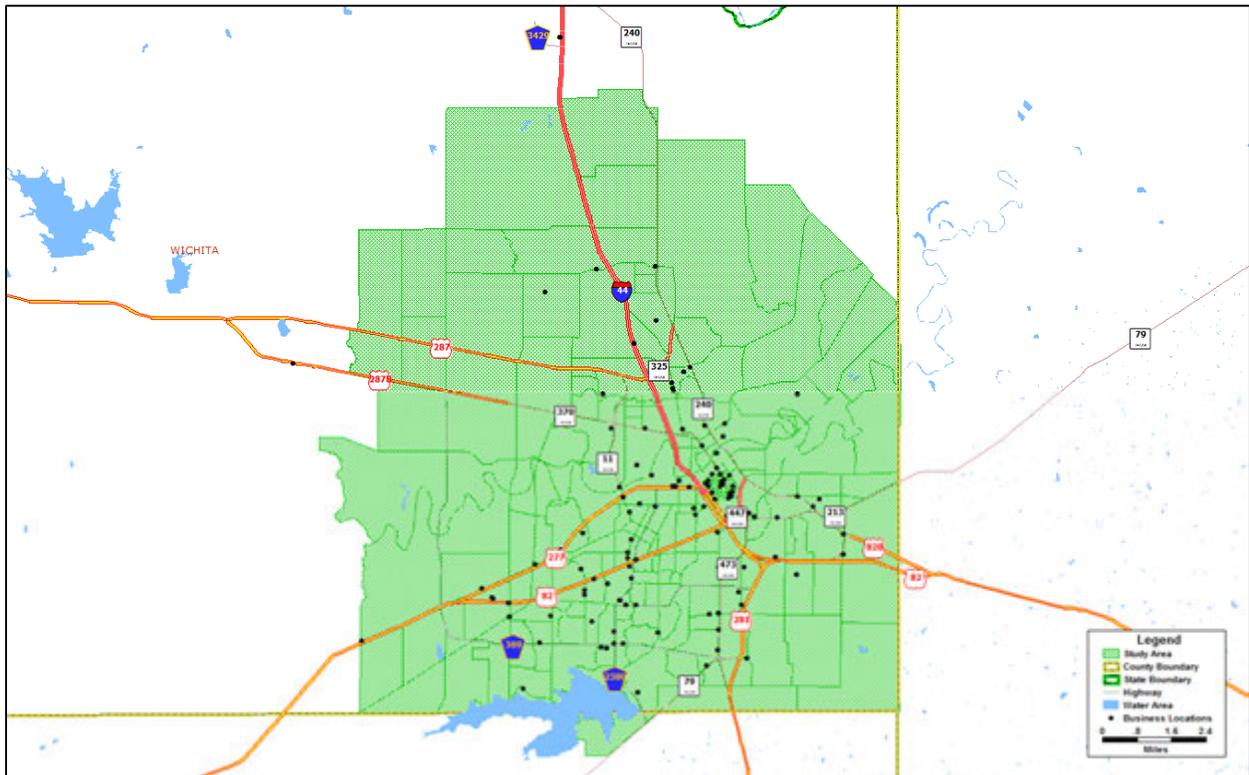


Figure 9. TAZ Boundary and Base Locations of Surveyed Commercial Vehicles.

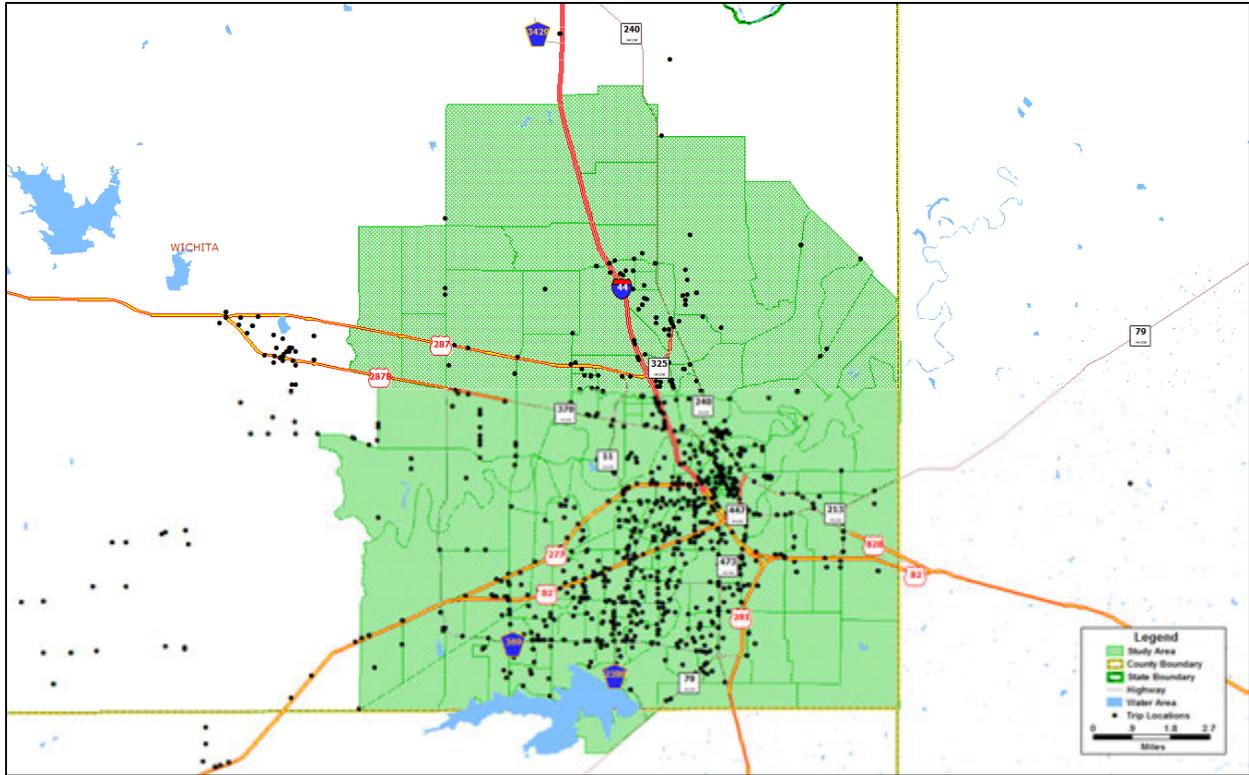


Figure 10. Trip Origins and Destinations of Surveyed Commercial Vehicles.

The results presented in this section pertain to trip length characteristics for 1,249 inter-zonal trips only. Table 20 shows the trip length frequency distribution (TLFD), grouped at five-mile intervals, while Table 21 show the ungrouped TLFD. Approximately 77 percent of both cargo and service vehicle trips had trip lengths less than five miles. Additionally, 21 percent of both cargo and service vehicle trips had trip lengths between six miles and ten miles. The longest trip lengths reported by cargo and service vehicles were 14 miles and 13 miles, respectively.

Table 20. Trip Length Frequency Distribution (Grouped Interval).

Trip Length (miles)	Cargo		Service		All Vehicles	
	# of Trips	% of Total	# of Trips	% of Total	# of Trips	% of Total
Less than 5	366	77.2	589	76.0	955	76.5
6 to 10	99	20.9	167	21.5	266	21.3
11 to 15	9	1.9	19	2.5	28	2.2
16 to 20	0	0.0	0	0.0	0	0.0
Total	474	100.0	775	100.0	1,249	100.0

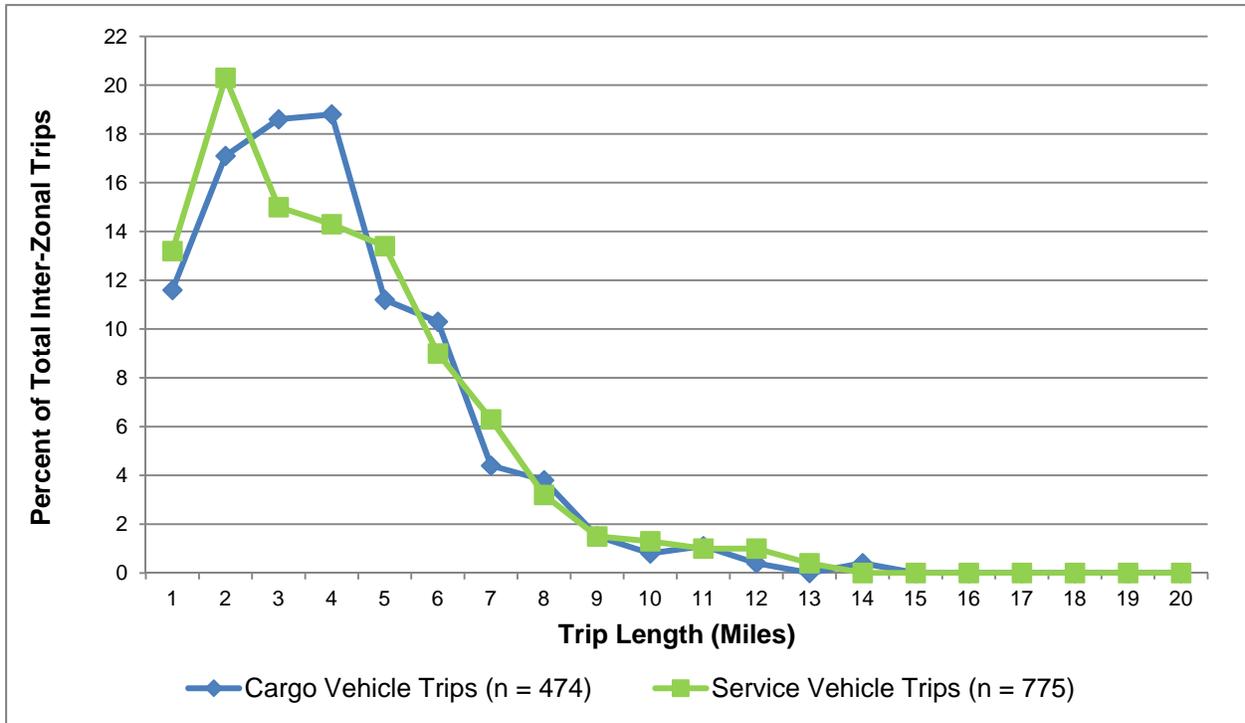


Figure 11. Surveyed Commercial Vehicle Trips TLFD.

Table 21. Trip Length Frequency Distribution (Ungrouped).

Trip Length (miles)	Cargo Vehicles		Service Vehicles		All Vehicles	
	# of Trips	% of Total	# of Trips	% of Total	# of Trips	% of Total
1	55	11.6	102	13.2	157	12.6
2	81	17.1	157	20.3	238	19.1
3	88	18.6	116	15.0	204	16.4
4	89	18.8	111	14.4	200	16.0
5	53	11.2	104	13.5	157	12.6
6	49	10.3	70	8.9	119	9.5
7	21	4.4	49	6.2	70	5.5
8	18	3.8	25	3.2	43	3.4
9	7	1.5	12	1.6	19	1.5
10	4	0.8	10	1.3	14	1.1
11	5	1.1	8	1.0	13	1.0
12	2	0.4	8	1.0	10	0.8
13	0	0.0	3	0.4	3	0.2
14	2	0.4	0	0.0	2	0.2
15	0	0.0	0	0.0	0	0.0
Total	474	100.0	775	100.0	1,249	100.0

Table 22 shows the average trip length to destinations by land use type for cargo and service vehicle trips. Overall, the average distance per trip traveled by the surveyed vehicles was 3.5

miles, with cargo vehicles and service vehicles both averaging 3.5 miles. The most number of trips by cargo vehicles occurred at retail land use types, with an average trip length of 3.0 miles, followed by “other” and medical sites with average trip lengths of 3.7 miles and 3.4 miles, respectively. For service vehicles, the highest frequency of trips occurred at residential land use types, with an average trip length of 3.6 miles. Over half (51 percent) of the trips made by service vehicles occurred at either residential or “other” land use sites.

Table 22. Average Trip Length to Destinations by Land Use Type.

Land Use	Cargo			Service			All Vehicles		
	Number of Trips	Total Trip Length (miles)	Avg. Trip Length (miles)	Number of Trips	Total Trip Length (miles)	Avg. Trip Length (miles)	Number of Trips	Total Trip Length (miles)	Avg. Trip Length (miles)
Office	40	158	4.0	145	530	3.7	185	689	3.7
Retail	158	472	3.0	90	313	3.5	248	784	3.2
Industrial	37	178	4.8	15	66	4.4	52	244	4.7
Medical	57	196	3.4	28	85	3.0	85	281	3.3
Education	9	30	3.3	47	147	3.1	56	177	3.2
Government	5	13	2.7	57	178	3.1	62	191	3.1
Residential	49	184	3.8	206	733	3.6	255	917	3.6
Other	119	439	3.7	187	693	3.7	306	1,133	3.7
Total	474	1,670	3.5	775	2,744	3.5	1,249	4,414	3.5

Table 23 shows the average trip length to destinations by commodity group for trips made by cargo vehicles only. Approximately 29 percent of the trips cited the commodity group “secondary”. The commodity group machinery was the next most frequently transported commodity group, with an average trip length of 3.7 miles per trip. The average trip length for vehicles with no cargo (empty) was 3.6 miles.

Table 23. Average Trip Length to Destinations by Commodity Group.

Commodity Group	Cargo		
	Number of Trips	Total Trip Length (miles)	Average Trip Length (miles)
Agriculture	15	36	2.4
Raw Materials	8	31	3.9
Food	69	161	2.3
Textiles	7	39	5.6
Wood	2	6	3.2
Building Materials	9	59	6.5
Machinery	77	285	3.7
Miscellaneous	1	4	4.1
Hazardous	14	56	4.0
Transportation	60	197	3.3
Secondary	138	531	3.8
Empty	74	266	3.6
Total	474	1,670	3.5

Travel Time and Speed

The Wichita Falls commercial vehicle survey provided travel logs on the arrival and departure times for each trip made by the surveyed commercial vehicles. The travel logs can be compared with the network travel time matrix table available for the study area. However, some of the reported travel logs had missing departure or arrival times, which rendered them unreliable in generating accurate estimates. Hence, as has been done in the estimation of trip lengths, travel time estimates were generated from the network travel time matrix table available for the Wichita Falls study area, and travel speed estimates were derived from the estimated trip lengths.

Table 24 shows the travel time frequency distribution of inter-zonal trips, grouped at five-mile intervals, while Figure 12 and Table 25 show the ungrouped TLF. Approximately 44 percent of the trips made by cargo vehicles were less than five minutes, 46 percent were between 6-and-10 minutes, and eight percent were between 11-and-15 minutes. For service vehicles, approximately 45 percent of the trips were less than five minutes, 43 percent were between 6-and-10 minutes, and 10 percent were between 11-and-15 minutes. The longest duration of travel time for cargo vehicles was 19 minutes, while the longest travel duration for service vehicles was 20 minutes.

Table 24. Travel Time Frequency Distribution (Grouped Interval).

Travel Time (minutes)	Cargo		Service		All Vehicles	
	# of Trips	% of Total	# of Trips	% of Total	# of Trips	% of Total
Less than 5	210	44.3	346	44.6	556	44.4
6 to 10	218	46.0	331	42.8	549	44.0
11 to 15	38	8.0	74	9.5	112	9.0
16 to 20	8	1.7	24	3.1	32	2.6
Total	474	100.0	775	100.0	1,249	100.0

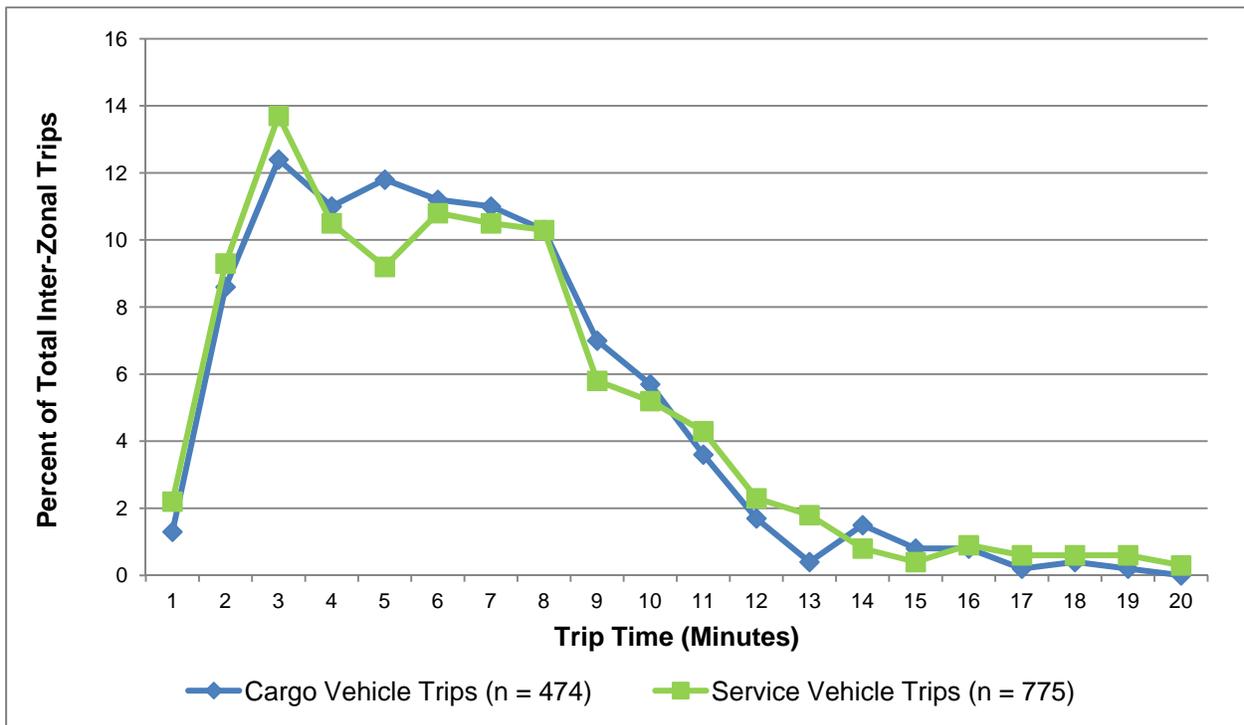


Figure 12. Surveyed Commercial Vehicle Trips Travel Time.

Table 25. Travel Time Frequency Distribution (Ungrouped).

Travel Time (minutes)	Cargo Vehicles		Service Vehicles		All Vehicles	
	# of Trips	% of Total	# of Trips	% of Total	# of Trips	% of Total
1	6	1.3	17	2.2	23	1.8
2	41	8.6	72	9.3	113	9.9
3	59	12.4	106	13.7	165	13.2
4	52	11.0	81	10.5	133	10.6
5	56	11.8	71	9.2	127	10.2
6	53	11.2	84	10.9	137	11.0
7	52	11.0	801	10.5	133	10.6
8	49	10.3	80	10.2	128	10.3
9	33	7.0	45	5.8	78	6.2
10	27	5.7	40	5.0	66	5.4
11	17	3.6	33	4.3	50	4.0
12	8	1.7	18	2.3	26	2.1
13	2	0.4	14	1.8	16	1.3
14	7	1.5	6	0.8	13	1.0
15	4	0.8	3	0.4	7	0.6
16	4	0.8	7	0.9	11	0.9
17	1	0.2	5	0.6	6	0.5
18	2	0.4	5	0.6	7	0.6
19	1	0.2	5	0.6	6	0.5
20	0	0.0	2	0.3	2	0.2
Total	474	100.0	775	100.0	1,249	100.0

Table 26 shows the average travel time and speed to destinations by land use for cargo and service vehicles. Overall, the average travel time for all surveyed vehicles was 5.9 minutes, with cargo vehicles averaging 5.8 minutes and service vehicles averaging 5.9 minutes. By land use types, trips made by cargo vehicles to industrial sites had the longest average travel duration of 7.3 minutes, with an average travel speed of 39.8 mph. For service vehicles, trips to industrial sites also had the highest average travel time of 7.0 minutes and an average travel speed of 37.5 mph.

Table 26. Average Travel Time and Speed to Destinations by Land Use Type.

Land Use	Cargo			Service			All Vehicles		
	Number of Trips	Avg. Travel Time (min)	Avg. Travel Speed (mph)	Number of Trips	Avg. Travel Time (min)	Avg. Travel Speed (mph)	Number of Trips	Avg. Travel Time (min)	Avg. Travel Speed (mph)
Office	40	6.5	36.3	145	6.1	35.8	185	6.2	35.9
Retail	158	5.1	35.2	90	5.8	35.7	248	5.4	35.4
Industrial	37	7.3	39.8	15	7.0	37.5	52	7.2	39.1
Medical	57	5.7	36.1	28	5.2	35.1	85	5.5	35.8
Education	9	5.4	37.0	47	5.4	34.9	56	5.4	35.2
Government	5	4.2	38.0	57	5.5	33.9	62	5.4	34.2
Residential	49	6.3	35.7	206	5.9	36.4	255	5.9	36.3
Other	119	6.0	36.7	187	6.2	35.8	306	6.1	36.2
Total	474	5.8	36.4	775	5.9	35.8	1,251	5.9	36.0

Table 27 shows the average travel time and speed to destinations by commodity group for trips made by cargo vehicles only. Trips transporting textiles had the longest average trip duration of 9.1 minutes, with an average travel speed of 36.6 mph. Secondary land use types had the highest number of trips, with an average travel time of 6.3 minutes and 36.8 mph.

Table 27. Average Travel Time and Speed to Destinations by Commodity Group.

Commodity Group	Cargo		
	Number of Trips	Average Travel Time (minutes)	Average Travel Speed (mph)
Agriculture	15	4.2	33.9
Raw Materials	8	6.3	37.2
Food	69	4.2	33.4
Textiles	7	9.1	36.6
Wood	2	5.5	35.1
Building Materials	9	9.6	40.7
Machinery	77	6.0	37.1
Miscellaneous	1	7.1	34.6
Hazardous	14	6.5	37.1
Transportation	60	5.6	35.4
Secondary	138	6.3	36.8
Empty	74	5.8	36.9
Total	474	5.8	36.4

Trip Tours

The analyses of trip tours show the amount of circuitous travel undertaken by commercial vehicles in the study area. Trip tours are defined as a combination (or chaining) of trips in which a vehicle leaves and returns to a common point, typically its base location. However, those cases where a vehicle did not report a base location (i.e., all of the reported trips were non-base) were considered on a case-by-case basis. In cases where the beginning and ending non-base zone were the same, a tour was considered to be made. In a handful of cases where only non-base trips were reported, the trip tour was determined to have an open start or end, with a trip tour happening as well.

To accurately analyze trip tours, external trips had to be included in the analysis. This is done because it is possible for trip tours to begin within the study area, then travel outside the study area, and then end or return to the study area. Therefore, to exclude external trips in the analysis could result in not capturing those trips that occur outside the study area that take place within the trip tour.

There were 1,907 trips observed in the Wichita Falls commercial vehicle survey. Each trip in the survey provided information on whether or not the origin of the trip was the vehicle's base location. This served as the basis for determining if the trip was a base trip or a non-base trip. A base trip was defined as when either trip ends (origin or destination) began or ended at the base location. If neither trip end was at the base location, then the trip was considered as a non-base trip. Such instances were treated separately from those vehicles with at least one trip involving a base, in determining whether the trip tour could be considered "all open," "completely closed," "before a closed tour," or "after a closed tour." Rather than simply labeling such trips as "all open," each case was considered individually. If the trips started or ended at the same zone number, the trips for this vehicle were classified as "completely closed." Similar logic was used in determining if a "trip before the tour" or a "trip after the tour" had occurred.

As Table 28 shows, approximately 54 percent of the total trips generated by cargo vehicles were non-base trips and 46 percent were base trips. For trips made by service vehicles, 49 percent were non-base trips and 51 percent were base trips.

Table 28. Base and Non-Base Trips.

Trip Type	Cargo Vehicles		Service Vehicles		All Vehicles	
	Number of Trips	Percent of Total	Number of Trips	Percent of Total	Number of Trips	Percent of Total
Base	371	46.1	560	50.8	931	48.8
Non-Base	433	53.9	543	49.2	976	51.2
Total	804	100.0	1,103	100.0	1,907	100.0

Table 29 shows the distribution of trip tours for cargo and service vehicles. There were 471 trip tours generated by 252 vehicles making at least one trip tour. Cargo vehicles made 204 tours and service vehicles produced 267 tours. The number of tours varied from 1-to-9 tours for cargo vehicles, and 1-to-6 tours for service vehicles. Approximately 58 percent of the cargo and service vehicles made only one trip tour (62 percent and 56 percent, respectively). For those cargo and service vehicles making only one trip tour, they averaged 5.9 trips and 4.3 trips within the tour, respectively. For all vehicles combined, the average number of tours per vehicle was 1.9 and the average number of trips per tour was 3.6.

Table 29. Trip Tours per Vehicle.

Cargo Vehicles				
Total Number of Trip Tours	Number of Vehicles	Number of Tours	Number of Trips	Average Trips per Tour
1	67	67	397	5.9
2	19	38	142	3.7
3	11	33	86	2.6
4	3	12	26	2.2
5	2	10	24	2.4
6	2	12	40	3.3
7	1	7	13	1.9
8	2	16	30	1.9
9	1	9	14	1.6
Cargo Total	108	204	772	3.8
Service Vehicles				
Total Number of Trip Tours	Number of Vehicles	Number of Tours	Number of Trips	Average Trips per Tour
1	80	80	347	4.3
2	32	64	267	4.2
3	15	45	138	3.1
4	10	40	102	2.6
5	4	20	42	2.1
6	3	18	35	1.9
Service Total	144	267	931	3.5
Grand Total	252	471	1,703	3.6

The analyses of trip tours also involved counting the number of non-base trips, external trips, inter-zonal trips and intra-zonal trips within trip tours to determine the total amount and types of travel that occur during the course of the tour. There were 1,703 trips observed within the total 471 trip tours. For all vehicles, 446 were external trips (26 percent), 1,156 were inter-zonal trips (68 percent), and 101 were intra-zonal trips (six percent). Table 30 shows the distribution of these trips for cargo and service vehicles.

Table 30. External, Inter-Zonal and Intra-Zonal Trips within Trip Tours.

No. of Trip Tours	External		Inter-Zonal		Intra-Zonal		Total Trips	
	Cargo Vehicles	Service Vehicles						
1	212	92	181	227	4	28	397	347
2	21	25	118	218	3	24	142	267
3	19	30	62	102	5	6	86	138
4	10	8	13	91	3	3	26	102
5	0	0	22	36	2	6	24	42
6	12	10	27	18	1	7	40	35
7	2	0	10	0	1	0	13	0
8	5	0	21	0	4	0	30	0
9	0	0	10	0	4	0	14	0
Total	281	165	464	692	27	74	772	931

Table 31 shows the number of non-base trips within trip tours separately since non-base trips are not mutually exclusive of the other trip types (i.e., a non-base trip may also be an inter-zonal or external trip).

Table 31. Non-Base Trips within Trip Tours.

No. of Trip Tours	Non-Base Trips within Trip Tours			Total Trips within Trip Tours					
	Cargo Vehicles	Service Vehicles	All Vehicles	Cargo Vehicles	Percent of Total	Service Vehicles	Percent of Total	All Vehicles	Percent of Total
1	271	199	470	397	51.4	347	37.3	744	43.7
2	66	152	218	142	18.4	267	28.7	409	24.0
3	41	57	98	86	11.1	138	14.8	224	13.2
4	18	30	48	26	3.4	102	11.0	128	7.5
5	5	6	11	24	3.1	42	4.5	66	3.9
6	16	17	33	40	5.2	35	3.8	75	4.4
7	0	0	0	13	1.7	0	0.0	13	0.8
8	2	0	2	30	3.9	0	0.0	30	1.8
9	0	0	0	14	1.8	0	0.0	14	0.8
Total	419	461	880	772	100.0	931	100.0	1,703	100.0

Figure 13 and Figure 14 show the percentage distribution of non-base trips, external trips, inter-zonal trips, and intra-zonal trips within trip tours for cargo vehicles and service vehicles, respectively.

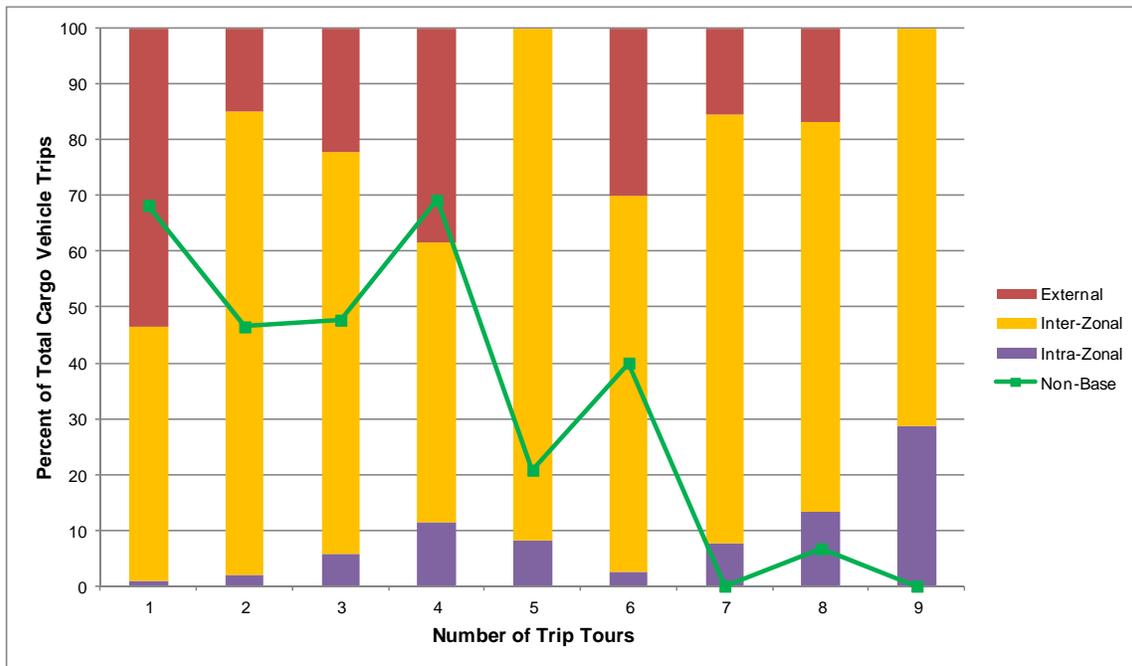


Figure 13. Cargo Vehicle Trips within Trip Tours by Trip Type.

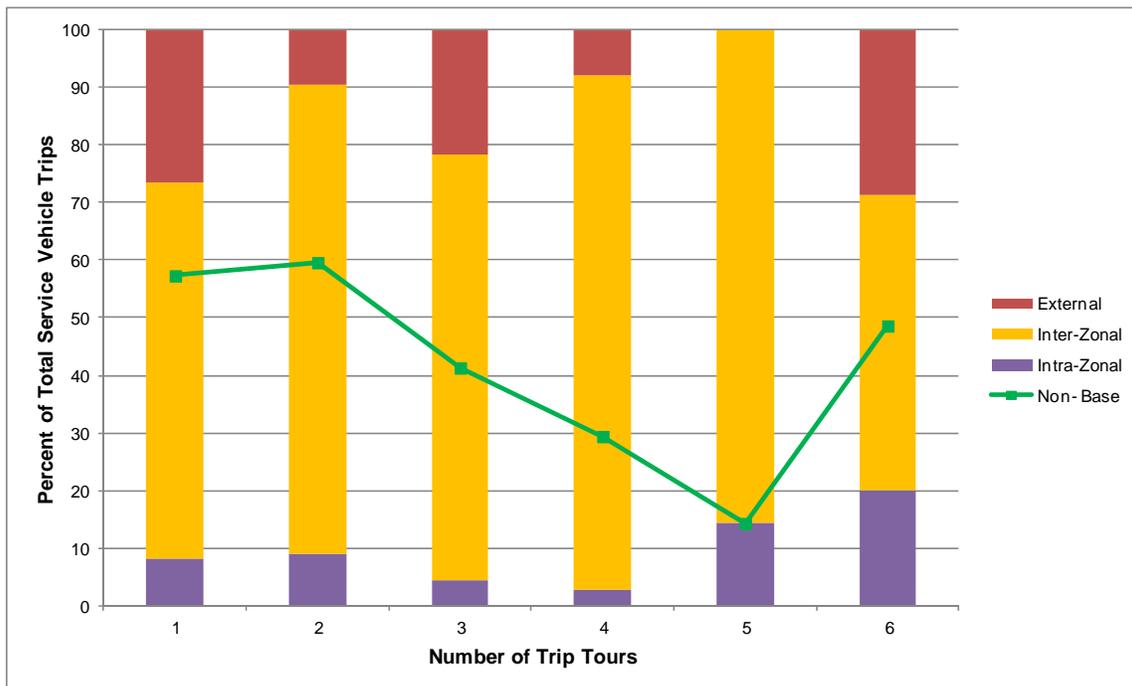


Figure 14. Service Vehicle Trips within Trip Tours by Trip Type.

The analyses of trip tours involved counting all the trips that began at the base location until the vehicle returned to its base location. Those trip chains that did not start and/or end at their base location, as well as those that only went to the base one time on the survey day, were considered open tours (except in the case of all non-base trips). In the case of non-base trips, if the trips were determined to contain completely closed tours under the criteria described earlier. They were labeled as completely closed tours. Due to the number of trips that were made in open tours, a review of when these trips occurred was performed. Table 32 provides an overview of when trips that are not part of tours were made relative to trip tours. Just over four percent of the trips made by cargo and service vehicles combined, within tours not considered to be complete, were before the first trip tour or after the last completed trip tour. A total of 3 vehicles (two cargo and one service) defined to be within an open tour were not associated with any tours.

Table 32. Summary of Open Tour Trips.

Trip Type	Cargo		Service		All Vehicles	
	# of Trips	% of Total	# of Trips	% of Total	# of Trips	% of Total
Before start of first tour	7	0.9	31	2.8	38	2.0
After end of last tour	8	1.0	32	2.9	40	2.1
Only Open	4	0.5	2	0.2	6	0.3
Within Closed	785	97.6	1,038	94.1	1,823	95.6
Total	804	100.0	1,103	100.0	1,907	100.0
No Tours	2	NA	1	NA	3	NA

*Total does not include the “No Tours” category; NA: Not Applicable.

Survey Expansion

The expansion of commercial vehicle survey data is conducted in an indirect manner. In typical travel surveys, an estimate of the population being sampled is known and data are then expanded to represent that population. In the case of commercial vehicle surveys, the population of vehicles operating in the study area is unknown. Vehicle registration data are not considered a viable basis to estimate the number of commercial vehicles in the study area because other vehicles operating in the area may be registered in neighboring counties. However, in the Wichita Falls commercial vehicle survey analysis, information on registered trucks has been included to show how the survey data compare with existing vehicle registration data.

The methodology currently used to expand commercial vehicle survey data is based on vehicle miles of travel (VMT) estimates from the Highway Performance Monitoring System (HPMS), and vehicle classification counts by functional classification for the study area. In essence, an estimate of the commercial VMT is developed from the HPMS data and is then used to expand the VMT observed from sampled commercial vehicles. HPMS data contain annual average daily traffic (AADT) estimates of the total VMT by functionally classified facilities such as freeways, arterials, collectors, and local roadways. Since AADT includes weekend traffic, a correction factor is applied to the data to obtain average weekday VMT by functional classification. Table 33 provides the adjusted 2011 HPMS VMT estimates for the Wichita Falls study area.

Table 33. 2011 HPMS Estimates of Weekday VMT in the Wichita Falls Study Area.

Functional Classification	Total Weekday VMT
Freeway	971,636
Arterial	1,118,606
Collector	440,044
Local	164,463
Total	2,694,750

The percentages of commercial and non-commercial vehicles by functional classification were determined by utilizing vehicle classification counts for the Wichita Falls area that were obtained from TxDOT. The percentage of commercial vehicles for internal sites for each functional classification were combined with the corresponding percentage for external sites based on the percentage of regional VMT estimated as external travel.

Table 34 provides the internal, external, and weighted percentages of commercial and non-commercial vehicles by functional classification. The weighted percentages were applied to the HPMS estimated weekday VMT shown in Table 33 to estimate the total commercial and non-commercial VMT. Table 35 shows the estimated VMT for commercial and non-commercial vehicles. There were no count data for local roadways at external sites, and as a result the percentages obtained at internal locations were utilized for that road classification.

Table 34. Percentage of Commercial and Non-Commercial Vehicles by Functional Classification.

Functional Classification	Percent of Commercial Vehicles			Percent of Non-Commercial Vehicles		
	Internal Sites (50%)	External Sites (50%)	Weighted Average	Internal Sites (50%)	External Sites (50%)	Weighted Average
Freeway	12	11	12	88	89	88
Arterial	9	16	12	91	84	88
Collector	8	11	9	92	89	91
Local	4	N/A	4	96	N/A	96

Table 35. Estimated VMT for Commercial and Non-Commercial Vehicles.

Functional Classification	Commercial VMT	Non-Commercial VMT	Total VMT
Freeway	113,302	858,334	971,636
Arterial	139,567	979,038	1,118,606
Collector	41,781	398,263	440,044
Local	6,579	157,885	164,463
Total	301,229	2,393,521	2,694,750

The total commercial VMT of 301,229 miles represents all commercial vehicles that traveled within the Wichita Falls study area. To properly expand the survey data and determine the total internal commercial vehicle trips generated in the study area, external VMT estimates had to be subtracted from the total commercial VMT. The external commercial VMT was estimated to be 63,294 miles. Therefore, the internal commercial VMT estimate was 237,935 miles.

The total internal VMT observed from the commercial vehicle survey was 4,372 miles, of which 1,659 miles were cargo VMT and 2,713 miles were service VMT. This estimate was based on 1,249 inter-zonal trips (474 cargo vehicle trips and 775 service vehicle trips), multiplied by the average trip length (3.5 miles for both cargo and service vehicles). The total internal commercial VMT (237,935 miles) represented all commercial vehicles and is not distinguished by cargo or service vehicles. Based on the vehicle classification counts conducted in the study area, approximately 31 percent of the commercial vehicles belonged to Class 5 (two-axle six-tire single unit trailers) through Class 13 (seven or more axle multi-trailers) and were assumed as cargo transport vehicles. Approximately 69 percent of the commercial vehicles belonged to Class 3 (pick-up, van, or two-axle four-tire single unit trailers) and Class 4 (buses) and were assumed as service vehicles. Therefore, to establish the VMT estimates by commercial cargo and service

types, it was deemed reasonable to apply these percentages to the total internal commercial VMT. The resulting VMT estimates were 73,760 miles for cargo vehicles and 164,175 miles for service vehicles.

An expansion factor was derived based on the quotient between total internal VMT and observed internal VMT (from the survey) for each commercial vehicle type. The expansion factors (44.46 for cargo vehicles and 60.53 for service vehicles) were then multiplied by the observed number of inter-zonal trips to estimate the total vehicle trips. The resulting inter-zonal trip estimates were approximately 21,074 cargo vehicle trips and 46,907 service vehicle trips. Additionally, 7,253 intra-zonal trips were made, bringing the total number of internal commercial vehicle trips (inter-zonal and intra-zonal combined) to 75,234. Based on the average number of inter-zonal trips per day of 4.3 trips for cargo vehicles and 5.5 trips for service vehicles, 14,886 commercial vehicles (5,202 cargo vehicles and 9,684 service vehicles) were estimated to be operating within the Wichita Falls study area on a daily basis. This estimate is 7.6 times more than the approximate 1,955 trucks registered in the study area in 2011. Table 36 provides a summary of key results from the Wichita Falls commercial vehicle survey and data expansion.

Table 36. Key Survey Results and Expanded Trip and VMT Data.

Indicator	Cargo Vehicles	Service Vehicles	All Vehicles
Sample Size	117	160	277
Total Inter-Zonal Trips	474	775	1,249
Total Intra-Zonal Trips	27	100	127
Total Internal Trips	501	875	1,376
Total External Trips	303	228	531
Total Internal and External Trips	804	1,103	1,907
Average Total Trips per Vehicle	6.87	6.89	6.88
Average Total Internal Trips per Vehicle*	4.28	5.47	4.97
Average Trip Length	3.5	3.5	3.5
Observed Internal VMT	1,659	2,713	4,372
Total Internal Commercial VMT	73,760	164,175	237,935
Survey Expansion Factor	44.46	60.53	54.43
Total Expanded Inter-Zonal Commercial Vehicle Trips	21,074	46,907	67,982
Total Expanded Intra-Zonal Commercial Vehicle Trips	1,200	6,053	7,253
Total Expanded Commercial Vehicle Trips	22,275	52,960	75,234
Number of Commercial Vehicles Operating on a Daily Basis	5,202	9,684	14,886
Attraction Rate to Households	--	--	0.381

*Based on internal trips of 277 surveyed commercial vehicles (117 cargo vehicles and 160 service vehicles).

One final calculation was the determination of the commercial vehicle attraction rate to households. In the survey, approximately 20 percent of the trips went to residential land use types. This percentage was applied to the total, expanded commercial vehicle trips within the study area to obtain an estimated 15,228 trips to residential locations. The residential trip estimate was divided by the estimated number of households in the Wichita Falls area (40,020) to obtain an attraction rate of 0.381.

SURVEY SUMMARY

This section provides a summary of vehicle and trip characteristics of 277 commercial vehicles that participated in the 2010-2011 Wichita Falls commercial vehicle survey. Based on the results from the survey, significant differences as well as similarities on travel characteristics were observed between cargo vehicles and service vehicles.

The average vehicle age for cargo vehicles was 9.1 years compared to 7.2 years for service vehicles. The odometer readings reported by cargo vehicles indicated an average mileage of 194,000 miles, which was nearly double the reported average mileage of 82,000 miles by service vehicles. In terms of fuel use, around 58 percent of cargo vehicles used diesel and 42 percent used unleaded gasoline, while 94 percent of service vehicles used unleaded gasoline and six percent used diesel.

The analyses of trip characteristics included in-depth examination of trip frequency, trip type, average trip length, trip purpose, and land use activity at trip destinations by commercial vehicle type. Surveyed cargo vehicles made an average of 7.0 total trips per day, compared to 6.9 trips per day for service vehicles. Excluding the trips made outside of the study area (external trips), cargo vehicles produced 4.4 internal trips per day, with average travel distance of 3.5 miles, compared to service vehicles which made 5.5 internal trips per day, with average trip length of 3.5 miles. The average travel time per trip for cargo vehicles was 5.8 minutes and for service vehicles the average travel time per trip was 5.9 minutes.

In terms of trip purpose at trip destinations, approximately 46 percent of the cargo vehicle trips were delivery, 26 percent were base related, and 13 percent were pick-up. For trips made by service vehicles, approximately 30 percent were base related, 23 percent were service related, and 15 percent were government related.

In terms of land use activity, approximately 34 percent of the trips made by cargo vehicles occurred at retail locations, followed by 13 percent to 'other', and 12 percent to residential locations. For service vehicles, over 27 percent of the trips took place at residential sites, followed by 24 percent at locations classified as 'other', and 15 percent at office locations.

The analyses of cargo characteristics were exclusive to trips made by cargo vehicles only and involved examining the types of cargo/commodities being transported at trip destinations, the trip purposes and land use activity at each stop, and the net weight of cargo being picked-up and/or dropped off for each trip. Overall, the average net cargo weight per trip was around 3,100 pounds. Wood products showed the highest average net cargo weight of around 51,000 pounds per trip, but the most frequently transported commodity was transportation products with an average net cargo weight of 1,550 pounds per trip. The land use "industrial" showed the highest

average net cargo weight of around 14,300 pounds per trip, but the retail land use had the most number of trips and an average cargo weight of approximately 1,900 pounds per trip. Delivery trip purpose had the highest average net cargo weight of around 5,400 pounds per trip.

The analyses of trip tours involved examining the amount of circuitous travel performed by the commercial vehicles in the study area. It also involved counting the number of non-base trips, external trips, inter-zonal trips, and intra-zonal trips within trip tours to determine the total amount and types of travel that occur during the course of the tour. A total of 471 trip tours were generated by the surveyed vehicles, with cargo vehicles making 204 tours and service vehicles producing 267 tours. The number of trip tours per vehicle varied from one to nine tours for cargo vehicles and one to six tours for service vehicles. The average number of trips tours for all vehicles was 1.9 and the average number of trips per tour was 3.6. Trips made as part of trip tours accounted for 1,703 trips (772 trips by cargo vehicles and 931 trips by service vehicles). Within the trip tours, approximately 68 percent were inter-zonal trips, six percent were intra-zonal trips and the remaining 26 percent were external trips. Non-base trips (which were not mutually-exclusive of the other trip types) made up approximately 52 percent of the trips within the tours.

Lastly, the expansion of commercial vehicle survey data were based on vehicle miles of travel (VMT) estimates and vehicle classification counts for the Wichita Falls study area. The commercial VMT estimates represented all commercial vehicles and do not distinguish by cargo and service vehicle types. Therefore, the estimation of VMT and volume of cargo and service vehicles operating within the study area were mainly based on key findings from the survey, such as the total number of internal cargo and service vehicle trips, the average number of trips per cargo and service vehicle, and the average trip lengths per cargo and service vehicle. Based on these findings, approximately 14,900 commercial vehicles (5,200 cargo vehicles and 9,700 service vehicles) were estimated to be operating within the Wichita Falls study area on a daily basis, roughly 7.6 times the volume of trucks registered in the study area in 2011.

APPENDIX

**COMMERCIAL VEHICLE SURVEY
PART 1: VEHICLE INFORMATION**

(If you have participated in prior surveys, please fill out this form anyway.)

Vehicle ID #: _____ Vehicle License #: _____

Survey Location (zone): _____ SIC Code: _____

Travel Day: _____
Month / Day

Company or Name of Owner (name on registration):

Address of location where vehicle was based at beginning of travel day:

(Street Address or Nearest Intersection)

City _____ State _____ ZIP _____

Type of Place vehicle was based at on beginning of travel day. (SEE BELOW) _____

Vehicle Info: Make _____; Model: _____; Year: _____

Vehicle Type 1) Cargo / Freight Transport Vehicle
 2) Service Vehicle (vehicle is not used to transport cargo or freight)

Vehicle Fuel: 1) Unleaded Gas 2) Diesel 3) Propane 4) Hybrid
 5) Other _____(Specify)

Vehicle Classification:

- | | |
|---|---|
| 1) <input type="checkbox"/> Passenger Car | 5) <input type="checkbox"/> Single Unit 2-axle (6 wheels) |
| 2) <input type="checkbox"/> Pick-up | 6) <input type="checkbox"/> Single Unit 3-axle (10 wheels) |
| 3) <input type="checkbox"/> Van (Cargo or Mini) | 7) <input type="checkbox"/> Single Unit 4-axle (14 wheels) |
| 4) <input type="checkbox"/> Sport Utility Vehicle (SUV) | 8) <input type="checkbox"/> Semi (all Tractor-Trailer combinations) |
| 9) <input type="checkbox"/> Other _____ | |

Gross Vehicle Weight: _____ pounds

Beginning Odometer Reading: _____ **Number of Trips Total:** _____

Type of Place Codes		
(1) Office Building	(6) Educational (College, Trade, etc.)	(11) Warehouse
(2) Retail / Shopping	(7) Government Office/Building	(12) Distribution Center
(3) Industrial/Manufacturing	(8) Residential	(13) Construction Site
(4) Medical / Hospital	(9) Airport	(14) Other (specify)
(5) Educational (12 th grade or less)	(10) Intermodal Facility	(99) Refused/Unknown

**Commercial Vehicle Survey
PART 2: Travel Log**

VEHICLE LICENSE #: _____

THE PLACE MY TRAVEL BEGAN TODAY WAS:

Work / Base Location Other Location (Please describe) _____

Type of Place (Specify Type of Place 1-14 or 99, see codes below) _____

(Street address or nearest intersection for place travel began)

TRAVEL DATE _____ Month / Day

(City, state, zip code)

DEPARTURE TIME: _____ a.m./p.m.

When you left the above location was your vehicle: Fully Loaded Partially Loaded Empty Not Applicable (Service Vehicle)

If loaded, what is the total weight in pounds of the cargo being transported? (Please provide an estimate if unsure of exact weight) _____

RECORD EVERY PLACE YOU GO, INCLUDING QUICK STOPS

RECORD the following information about each place		What time did you arrive and depart this location? (record exact times)	Activity What are you doing at this Location (see options below)	What type of place is this? (see options below)	Is this the work / base location for this vehicle? <input type="checkbox"/> - Yes <input type="checkbox"/> - No	Type of Cargo What is it?	Cargo Weight (in Pounds)
<i>NAME of Place:</i>	<i>Address including city, state, and zip OR Nearest street intersection or Landmark</i>						
PLACE 1	Arrive: _____ am/pm						Delivery _____
	Depart: _____ am/pm						Picked Up _____
PLACE 2	Arrive: _____ am/pm						Delivery _____
	Depart: _____ am/pm						Picked Up _____
PLACE 3	Arrive: _____ am/pm						Delivery _____
	Depart: _____ am/pm						Picked Up _____

ACTIVITY OPTIONS		TYPE OF PLACE OPTIONS		
(1) Base Location / Return to Base Location	(5) Maintenance (fuel, oil, etc.)	(1) Office Building (Non-Government)	(6) Education (college, trade)	(11) Warehouse
(2) Delivery	(6) Driver Needs (lunch, etc.)	(2) Retail / Shopping	(7) Government Office / Building	(12) Distribution Center
(3) Pick-up	(7) Service related business	(3) Industrial/Manufacturing	(8) Residential	(13) Construction Site
(4) Pick-up and Delivery	(8) Other (Please specify)	(4) Medical / Hospital	(9) Airport	(14) Other (specify)
		(5) Education (12 th grade or less)	(10) Intermodal Facility	(99) Refused / Unknown

Record Type 21

Commercial Vehicle Survey Travel (continued)

VEHICLE LICENSE #: _____

RECORD the following information about each place		What time did you arrive and depart this location? (record exact times)	Activity What are you doing at this location? (see options below)	What type of place is this? (see options below)	Is this the work / base location for this vehicle?	Type of Cargo What is it?	Cargo Weight (in Pounds)
NAME of Place:	Address including city, state, and zip OR nearest street intersection or Landmark						
PLACE 4 PLACE 5 PLACE 6 PLACE 7 PLACE 8 PLACE 9		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up

ACTIVITY OPTIONS	TYPE OF PLACE OPTIONS
(1) Base Location / Return to Base Location (2) Delivery (3) Pick-up (4) Pick-up and Delivery (5) Maintenance (fuel, oil, etc.) (6) Driver Needs (lunch, etc.) (7) Service related business (8) Other (Please specify)	(1) Office Building (Non-Government) (2) Retail / Shopping (3) Industrial/Manufacturing (4) Medical / Hospital (5) Education (12 th grade or less) (6) Education (college, trade) (7) Government Office / Building (8) Residential (9) Airport (10) Intermodal Facility (11) Warehouse (12) Distribution Center (13) Construction Site (14) Other (specify) (99) Refused / Unknown

Commercial Vehicle Survey Travel (continued)

VEHICLE LICENSE #: _____

RECORD the following information about each place		What time did you arrive and depart this location? (record exact times)	Activity What are you doing at this location? (see options below)	What type of place is this? (see options below)	Is this the work / base location for this vehicle?	Type of Cargo What is it?	Cargo Weight (in Pounds)
NAME of Place:	Address including city, state, and zip OR Nearest street intersection or Landmark						
PLACE 10 PLACE 11 PLACE 12 PLACE 13 PLACE 14		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		Delivery Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		Delivery Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		Delivery Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		Delivery Picked Up
		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		Delivery Picked Up

ACTIVITY OPTIONS		TYPE OF PLACE OPTIONS		
(1) Base Location / Return to Base Location (2) Delivery (3) Pick-up (4) Pick-up and Delivery	(5) Maintenance (fuel, oil, etc.) (6) Driver Needs (lunch, etc.) (7) Service related business (8) Other (Please specify)	(1) Office Building (Non-Government) (2) Retail / Shopping (3) Industrial/Manufacturing (4) Medical / Hospital (5) Education (12 th grade or less)	(6) Education (college, trade) (7) Government Office / Building (8) Residential (9) Airport (10) Intermodal Facility	(11) Warehouse (12) Distribution Center (13) Construction Site (14) Other (specify) (99) Refused / Unknown

Record Type 21

Commercial Vehicle Survey (continued)

VEHICLE LICENSE #: _____

	RECORD the following information about each place NAME of Place: Address including city, state, and zip OR Nearest street intersection or Landmark	What time did you arrive and depart this location? (record exact times)	Activity What are you doing at this location? (see options below)	What type of place is this? (see options below)	Is this the work / base location for this vehicle? <input type="checkbox"/> - Yes <input type="checkbox"/> - No	Type of Cargo What is it?	Cargo Weight (in Pounds)
PLACE 15		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
PLACE 16		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
PLACE 17		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
PLACE 18		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up
PLACE 19		Arrive: _____ am/pm Depart: _____ am/pm			<input type="checkbox"/> - Yes <input type="checkbox"/> - No		_____ Delivery _____ Picked Up

ACTIVITY OPTIONS	TYPE OF PLACE OPTIONS
(1) Base Location / Return to Base Location (2) Delivery (3) Pick-up (4) Pick-up and Delivery (5) Maintenance (fuel, oil, etc.) (6) Driver Needs (lunch, etc.) (7) Service related business (8) Other (Please specify)	(1) Office Building (Non-Government) (2) Retail / Shopping (3) Industrial/Manufacturing (4) Medical / Hospital (5) Education (12 th grade or less) (6) Education (college, trade) (7) Government Office / Building (8) Residential (9) Airport (10) Intermodal Facility (11) Warehouse (12) Distribution Center (13) Construction Site (14) Other (specify) (99) Refused / Unknown