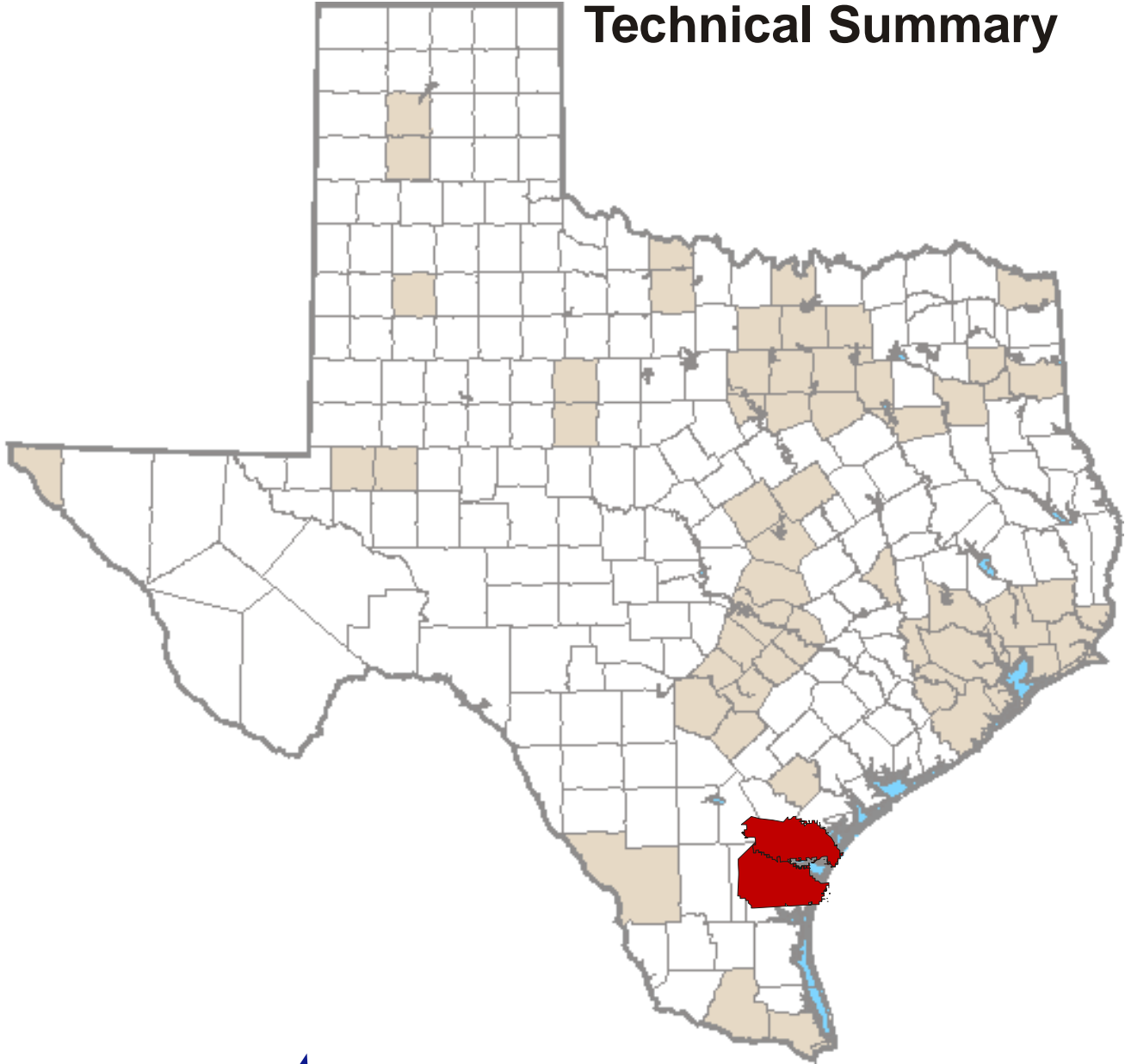


2010 Corpus Christi Commercial Vehicle Survey Technical Summary



Prepared by the
Texas A&M Transportation Institute
August 2012

**2010 Corpus Christi Urban Transportation Study
(CCUTS)
Commercial Vehicle Survey
TECHNICAL SUMMARY**

Texas Department of Transportation Travel Survey Program

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INTRODUCTION

In 2010, the Texas Department of Transportation (TxDOT) funded a commercial vehicle survey in the Corpus Christi Urban Transportation Study (CCUTS) area. The purpose of this survey was to provide data that would enable TxDOT to forecast total commercial vehicle travel demand within the Corpus Christi urban area.

The study area is located along the Gulf coast of Texas and, as shown in Figure 1, comprises the entirety of Nueces and San Patricio counties. The two-county study area had an approximate total combined population of 405,000 in 2010.

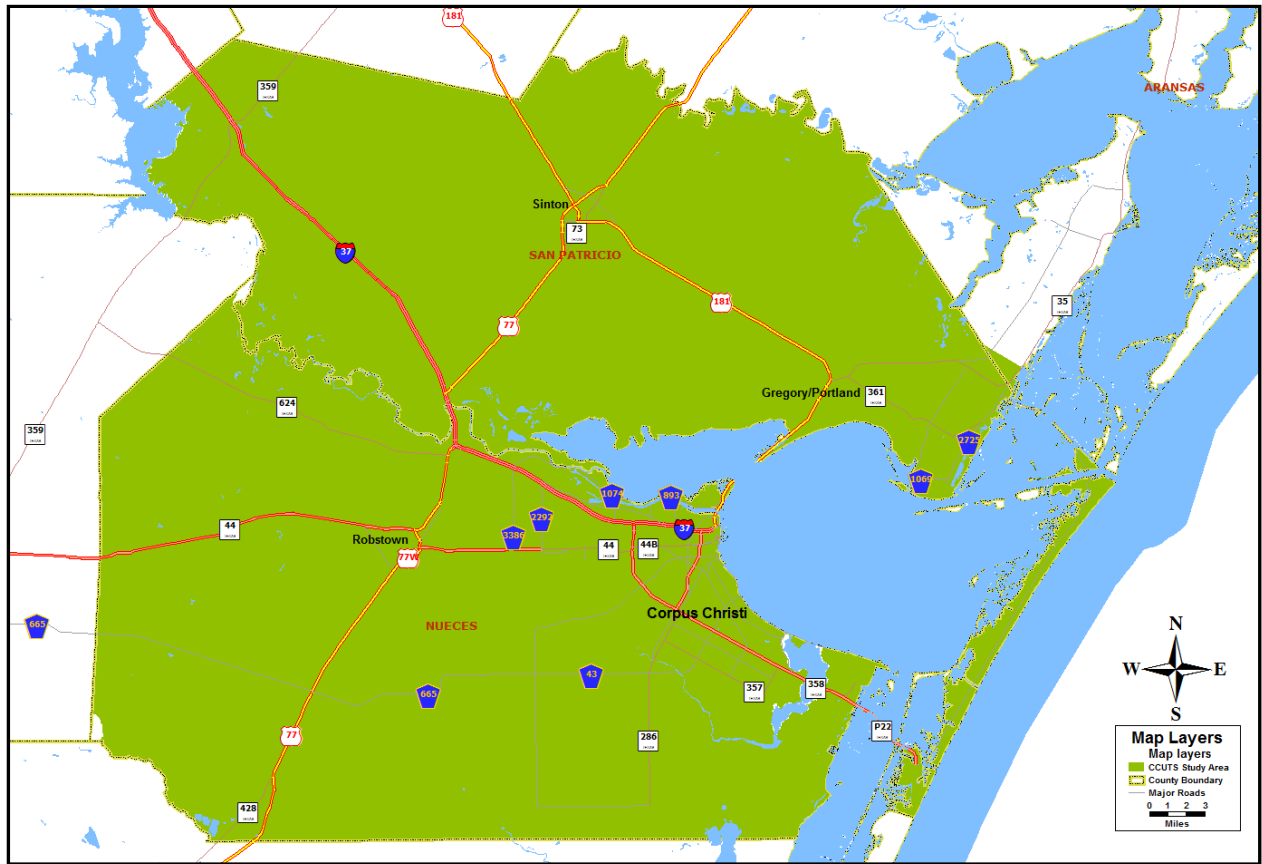


Figure 1. CCUTS Study Area.

This report presents a technical summary of the commercial vehicle travel survey conducted in 2010 in the Corpus Christi 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 survey for the CCUTS study area was conducted during the period between September and December 2010. 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 of 25 commercial vehicles that were owned, leased, or operated by recruited workplaces was carried out. The over-sample rate was established and a target number of 419 businesses was established for the CCUTS survey area.¹

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 areas. This list was generated from the Texas Workforce Commission (TWC) employer database 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, more than 400 companies/individuals 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.

¹ Corpus Christi Transportation Study 2010-11 Commercial Vehicle Survey – Final Summary Report. ETC Institute. October 2011.

Table 1. Survey Participation Rates.

Category	Contact Calls	
	Number	Percent of Total
Agreed to Participate	162	38.6
Refused to Participate	179	42.7
Not Participating	78	18.7
Total	419	100.0

Source: Corpus Christi Transportation Study 2010-11 Commercial Vehicle Survey – Final Summary Report. ETC Institute.

A total of 104 companies participated in the CCUTS commercial vehicle survey, from which a total of 344 commercial vehicle surveys were obtained. 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 and are noted accordingly in the report.

The results presented in this technical summary are therefore based on data from 344 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 CCUTS study area. Information on registered trucks include the number of diesel-fueled, gasoline-fueled, propane-fueled, and other-fueled trucks by gross vehicle weight and by model year. Information on surveyed commercial vehicles include 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 over 6,900 trucks registered in the CCUTS study area in 2010. Table 2 shows the distribution of registered diesel trucks and gasoline trucks by gross vehicle weight. Approximately 76 percent of all trucks registered in the CCUTS study area are diesel-fueled vehicles. Over half (53 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 the CCUTS 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
< 10,000	2,728	51.5	972	58.9	3,700	53.3
> 10,000	548	10.3	304	18.4	852	12.3
> 14,000	233	4.4	94	5.7	327	4.7
> 16,000	224	4.2	51	3.1	275	4.0
> 19,500	463	8.7	122	7.4	585	8.4
> 26,000	369	7.0	52	3.2	421	6.1
> 33,000	610	11.5	50	3.0	660	9.5
> 60,000	121	2.3	4	0.2	125	1.8
Total	5,296	100.0	1,649	100.0	6,945	100.0

Source: TxDOT 2010

Figure 2 shows the distribution of registered diesel trucks and gasoline trucks by model year. Registered diesel trucks were slightly newer relative to the gasoline trucks. The majority of the diesel trucks (77 percent) were less than ten years old, which was more than the 65 percent of gasoline trucks within that age range. Approximately three percent of the nearly 5,300 registered diesel trucks were older than 20 years, while slightly more than eight percent of registered gasoline trucks were older than 20 years.

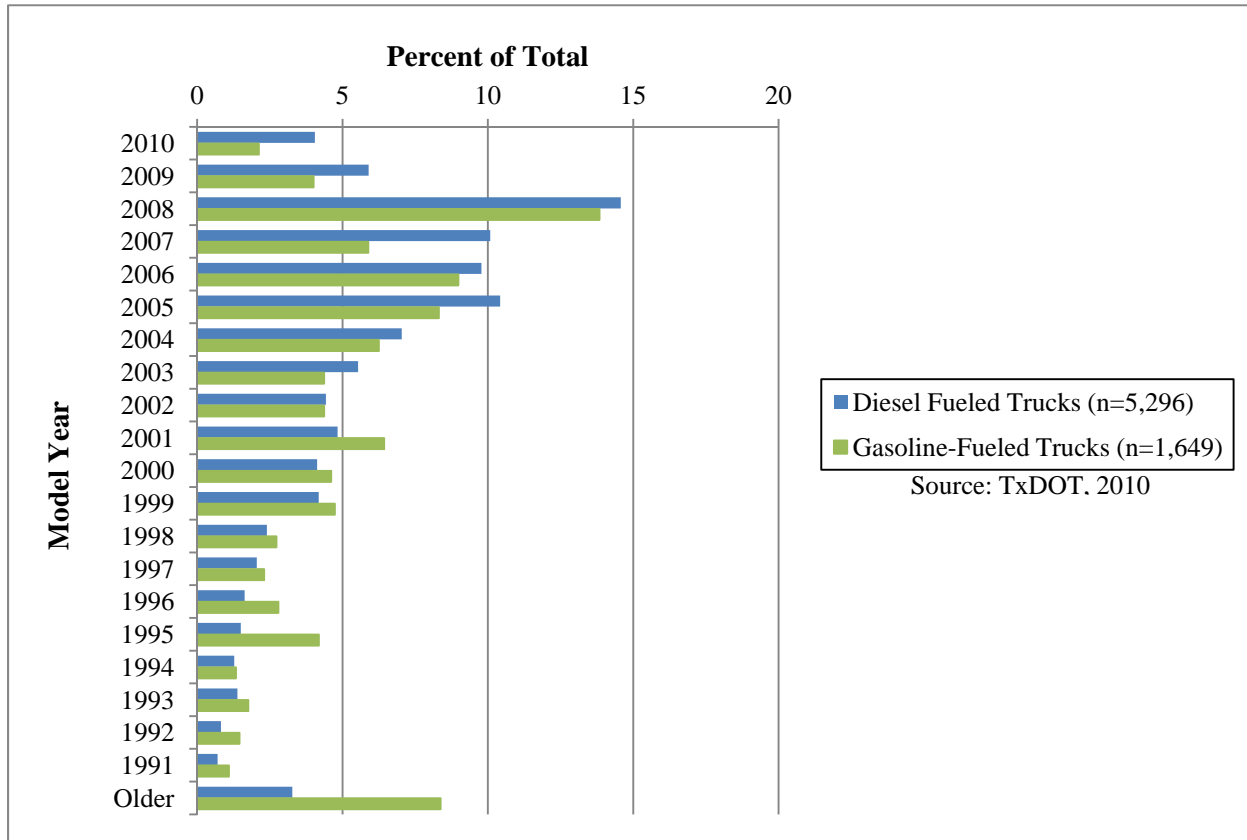


Figure 2. Model Year of Registered Trucks in the CCUTS Study Area.

Surveyed Commercial Vehicles

Commercial vehicles that participated in the CCUTS commercial vehicle survey were distinguished based on the 10 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.

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 344 vehicles surveyed, 168 were cargo vehicles and 176 were

service vehicles. Among cargo vehicles, approximately 45 percent were pick-up trucks, 20 percent were single unit 2-axle trucks (6-wheelers), 16 percent were semi-tractor/trailer combinations, and 16 percent were vans. Among service vehicles, approximately 67 percent were pick-up trucks, 13 percent were vans, and seven percent were passenger cars.

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	0	0.0	13	7.4	13	3.8
Pick-Up Truck	76	45.2	118	67.0	194	56.4
Van (passenger or minivan)	26	15.5	22	12.5	48	14.0
Sport Utility Vehicle	3	1.8	12	6.8	15	4.4
Single Unit 2-axle (6 wheels)	33	19.6	11	6.3	44	12.8
Single Unit 3-axle (10 wheels)	4	2.4	0	0.0	4	1.2
Single Unit 4-axle (14 wheels)	0	0.0	0	0.0	0	0.0
Semi (Tractor-Trailer)	26	15.5	0	0.0	26	7.6
Other	0	0.0	0	0.0	0	0.0
Total	168	100.0	176	100.0	344	100.0

Figure 3 shows the distribution of surveyed vehicles by fuel type. Approximately 68 percent of the surveyed vehicles used unleaded gasoline and 32 percent used diesel. Among cargo vehicles, 53 percent used gasoline and 47 percent used diesel. Among service vehicles, 83 percent used gasoline and 17 percent used diesel.

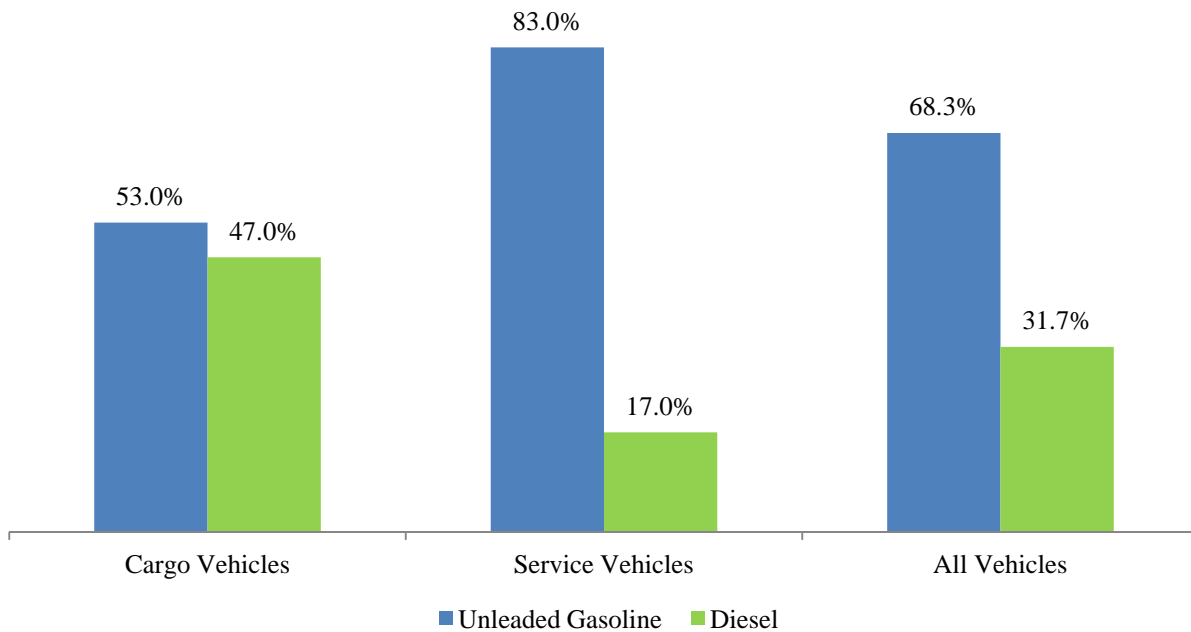


Figure 3. Type of Fuel Used by Surveyed Commercial Vehicles.

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 95 percent of the service vehicles belonged to this category, while approximately 65 percent of the cargo vehicles weighed less than 10,000 pounds.

Table 4. Gross Vehicle Weight.

Gross Vehicle Weight (lbs.) Min / Max	Cargo		Service		Total	
	Number of Vehicles	% of Cargo Vehicles	Number of Vehicles	% of Service Vehicles	Number of Vehicles	% of Total Vehicles
0 / 10,000	109	64.9	167	94.9	276	80.2
10,001 / 14,000	4	2.4	5	2.8	9	2.6
14,001 / 16,000	5	3.0	1	0.6	6	1.7
16,001 / 19,500	3	1.8	0	0.0	3	0.9
19,501 / 26,000	15	8.9	0	0.0	15	4.4
26,001 / 33,000	7	4.2	2	1.1	9	2.6
33,001 / 60,000	10	6.0	0	0.0	10	2.9
> 60,001	12	7.1	0	0.0	12	3.5
Unknown	3	1.8	1	0.6	4	1.2
Total	168	100.0	176	100.0	344	100.0

Figure 4 shows the distribution of surveyed vehicles by model year. Approximately 73 percent of service vehicles and 71 percent of cargo vehicles were less than 10 years old. The average age for cargo vehicles was 6.4 years, while the average age for service vehicles was 6.5 years.

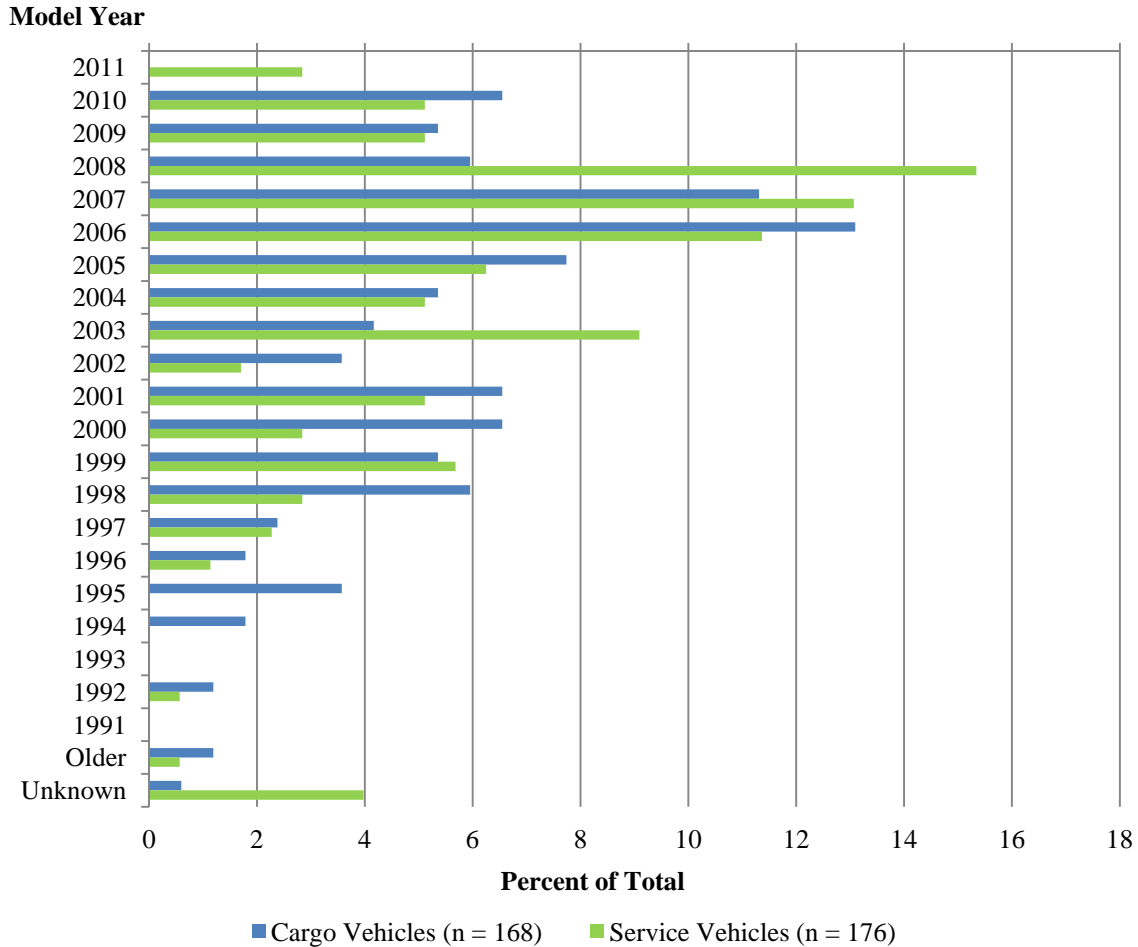


Figure 4. Vehicle Model Year.

Table 5 shows the average vehicle mileage by model year based on reported odometer readings from 344 surveyed vehicles at the beginning of their survey travel day. Cargo vehicles reported higher average odometer readings of about 144,500 miles compared to just over 94,100 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
2011	0	0	5	10,334	5	10,334
2010	11	22,388	9	16,657	20	19,809
2009	9	31,660	9	24,905	18	28,283
2008	10	73,320	27	59,728	37	63,401
2007	19	101,705	23	81,782	42	90,795
2006	22	109,970	20	92,808	42	101,797
2005	13	229,125	11	90,547	24	165,610
2004	9	143,373	9	85,660	18	114,517
2003	7	267,986	16	133,558	23	174,471
2002	6	150,390	3	117,770	9	139,517
2001	11	151,644	9	185,567	20	166,910
2000	11	130,187	5	158,301	16	138,973
1999	9	212,775	10	178,698	19	194,839
1998	10	200,318	5	126,346	15	175,661
1997	4	150,565	4	173,305	8	161,935
1996	3	116,084	2	85,286	5	103,764
1995	6	410,842	0	0	6	410,842
1994	3	244,272	0	0	3	244,272
1993	0	0	0	0	0	0
1992	2	49,218	1	106,144	3	68,193
1991	0	0	0	0	0	0
Older	2	119,225	1	125,948	3	121,466
Unknown	1	115,320	7	80,181	8	84,573
Total	168	144,537	176	94,149	344	118,757

Trip Frequency

The surveyed vehicles generated a total of 1,482 trips, of which 1,355 were internal trips and 127 were external trips. Internal trips were defined as those trips made within the CCUTS area. These trips were further distinguished by determining whether travel occurred within or between zones. Trips made from one zone to another are referred to as inter-zonal trips, and those trips made within the same zone are referred to as intra-zonal trips. External trips were those trips made where one or both of the trip ends were outside of the study area.

Figure 5 shows the distribution of inter-zonal, intra-zonal and external trips, while Table 6 provides a breakdown of these trips. Cargo vehicles generated 662 trips, of which approximately 82 percent were inter-zonal trips, nine percent were intra-zonal trips, and nine percent were external trips. Service vehicles generated 820 trips, of which around 87 percent were inter-zonal trips, five percent were intra-zonal trips, and eight percent were external trips.

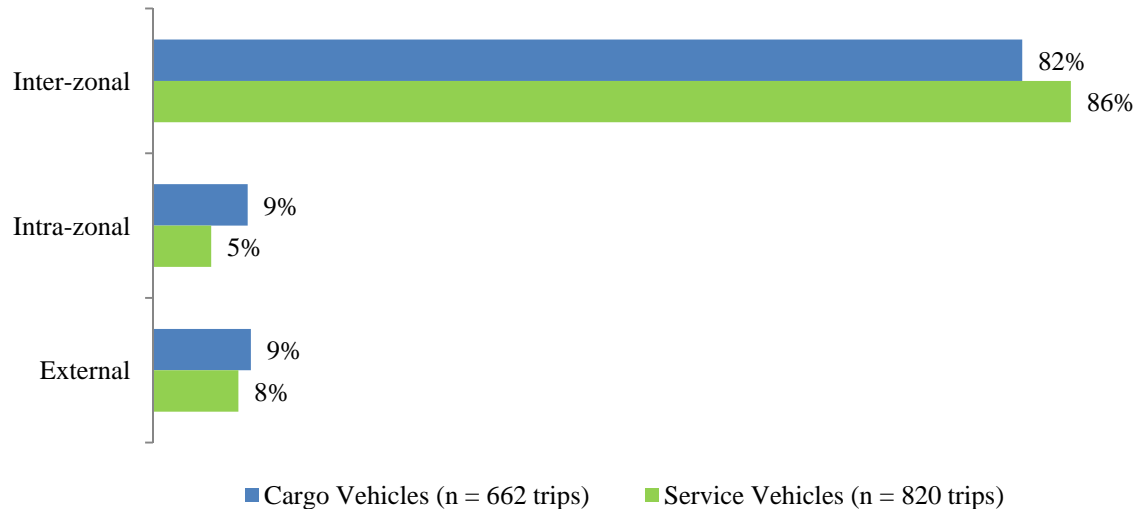


Figure 5. Inter-Zonal, Intra-Zonal, and External Trips.

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	542	81.9	709	86.5	1,251	84.4
Intra-Zonal	59	8.9	45	5.5	104	7.0
Total Internal	601	90.8	754	92.0	1,355	91.4
External	61	9.2	66	8.0	127	8.6
Total	662	100.0	820	100.0	1,482	100.0

Figure 6 shows the distribution of total trips (internal and external trips) which varied from one trip to 29 trips per cargo and service vehicle. There were only two vehicles that made more than 20 trips on their survey day. However, these additional trips were not recorded in their travel diary due to lack of space. Additionally, there were 81 vehicles (48 cargo and 33 service) that made no trips on their respective survey days. For those vehicles that made at least one trip on

the survey day, the average number of total trips per day was 5.5 trips for cargo vehicles and 5.7 trips for service vehicles.

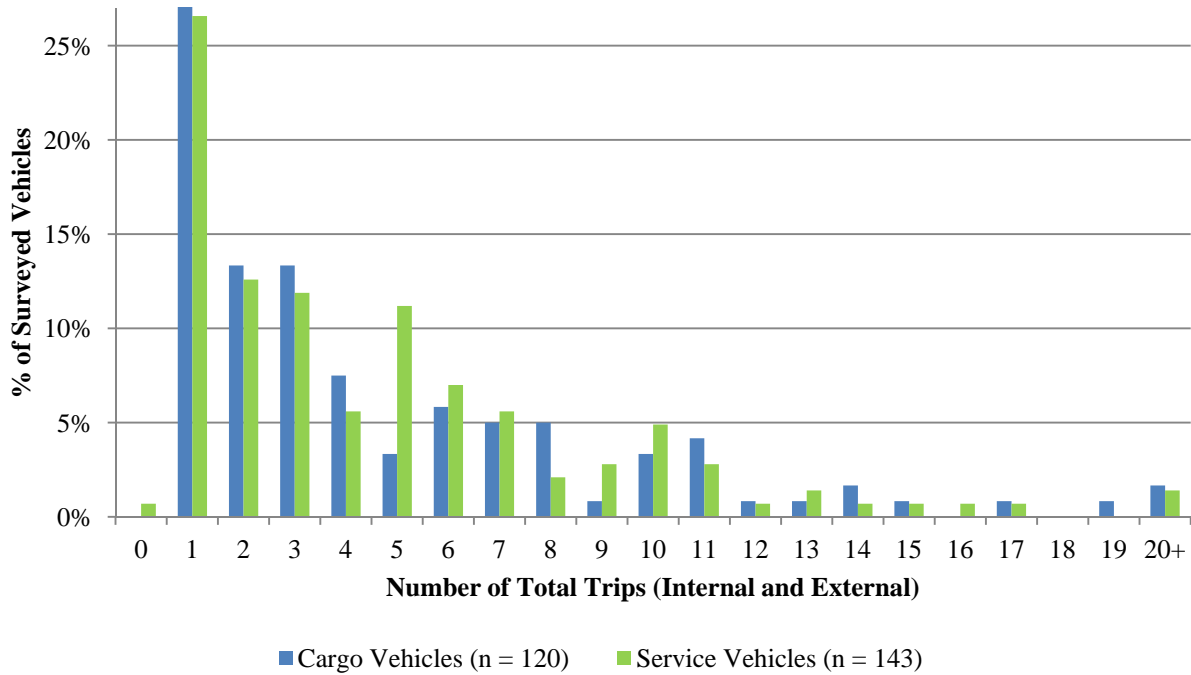


Figure 6. Total Trips per Vehicle.

Figure 7 shows the distribution of internal trips only. Approximately two percent of both cargo vehicles and service vehicles made one internal trip per day. Nearly 23 percent of cargo vehicles and 22 percent of service vehicles made two internal trips per day. The average number of internal trips per day was 5.0 trips for cargo vehicles and 5.3 trips for service vehicles.

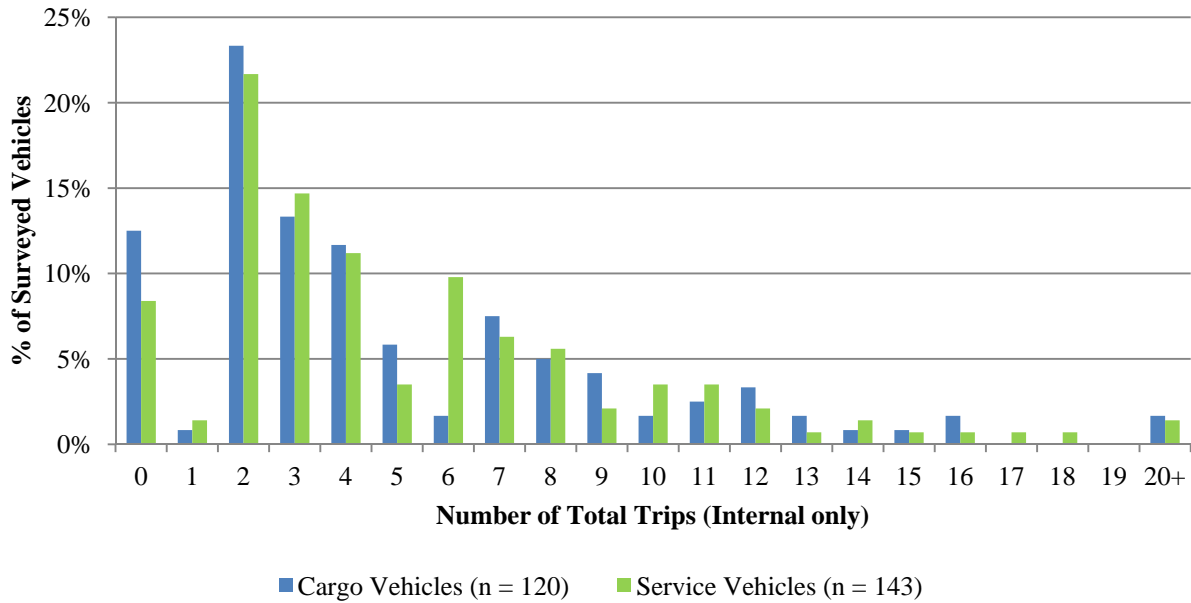


Figure 7. Total Internal Trips per Vehicle.

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 24 percent of the trips made by cargo vehicles were to retail locations, followed by 21 percent to residential locations, and 12 percent to warehouse locations. For service vehicles, nearly 34 percent of the trips took place at residential sites, followed by 15 percent to retail locations and 14 percent at non-government office buildings.

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

Frequency	Cargo		Service	
	Number	Percent of Cargo	Number	Percent of Service
Office Building (Non-Government)	66	11.0	97	14.3
Retail/Shopping	141	23.5	101	14.9
Industrial/Manufacturing	68	11.3	66	9.7
Medical/Hospital	18	3.0	40	5.9
Education (< 12th Grade)	15	2.5	0	0.0
Education (College, Trade)	4	0.7	0	0.0
Government Office/Building	11	1.8	52	7.7
Residential	126	21.0	235	34.7
Airport	0	0.0	0	0.0
Intermodal Facility	0	0.0	0	0.0
Warehouse	73	12.1	0	0.0
Distribution Center	17	2.8	0	0.0
Construction Site	22	3.7	0	0.0
Other	40	6.7	86	12.7
Refused/Unknown	0	0.0	0	0.0
Total Trips	601	100.0	677	100.0

Table 8 shows the distribution of internal trips by trip purposes at trip destinations. Slightly over 29 percent of the cargo vehicle internal trips were delivery, 28 percent were returning to base, and 17 percent were pick-up. For trips made by service vehicles, approximately 47 percent were service-related, 28 percent were returning to base, and 11 percent were “other.”

Table 8. Trip Purposes at Destination Locations.

Trip Purpose	Cargo		Service	
	Number	Percent of Cargo	Number	Percent of Service
Return to Base Location	169	28.1	213	28.2
Delivery	176	29.3	19	2.5
Pick-Up	102	17.0	25	3.3
Pick-Up and Delivery	19	3.2	4	0.5
Maintenance (Fuel, Oil, Etc.)	26	4.3	14	1.9
Driver Needs (Lunch, Etc.)	17	2.8	38	5.0
Service-Related	86	14.3	357	47.3
Other	6	1.0	84	11.1
Refused/Unknown	0	0.0	0	0.0
Total Trips	601	100.0	754	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 CCUTS commercial vehicle survey to examine the movement of commodities within and outside of the study area. The analyses presented in this section is for both internal and external trips made by surveyed cargo vehicles only, and do not include the trips made by service vehicles.

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. Additionally, there were some trips that reported cargo weights at pick-up but the weights that were reported were not consistent at drop-off. Such inconsistencies generated errors in the estimation of net weight of cargo for that particular trip. Therefore, it was necessary to manually process the cargo trip data and to make assumptions regarding cargo weights. The types of cargo in the survey were based on 22 classification types listed in Table 9.

Table 9. Cargo Classification Types.

Cargo Classifications	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 provides the distribution of trips by cargo type. Approximately 25 percent of the total cargo vehicle trips were transporting manufactured goods, followed by 11 percent transporting unclassified materials, and nearly seven percent carrying wood products. Approximately one-third (33 percent) of the cargo trips were reported as empty, including empty shipping containers.

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

Cargo Type	Number of Trips	% of Total
Farm Products	13	2.0
Forest Products	6	0.9
Marine Products	7	1.1
Metals and Minerals	13	2.0
Food, Health, and Beauty Products	27	4.1
Tobacco Products	0	0.0
Textiles	1	0.2
Wood Products	46	6.9
Printed Matter	3	0.5
Chemical Products	1	0.2
Refined Petroleum or Coal Products	5	0.8
Rubber, Plastic, and Styrofoam Products	9	1.4
Clay, Concrete, Glass, or Stone	7	1.1
Manufactured Goods/Equipment.	168	25.4
Wastes	37	5.6
Miscellaneous Shipments	1	0.2
Hazardous Materials	21	3.2
Transportation	3	0.5
Unclassified/Other Cargo	71	10.7
Driver Refused to Answer	4	0.6
Unknown to Driver	2	0.3
Total Trips with Cargo	445	67.2
Empty	217	32.8
Total Cargo Vehicle Trips	662	100.0

The commodity grouping scheme used by TxDOT in the Texas Statewide Analysis Model (SAM) was used to simplify the cargo types into 10 commodity groups. The types of place option in the survey were 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, Intermodal 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. Nearly 26 percent of the trips occurred at “Other” land use types, which were mainly warehouses, distribution centers and construction sites. Approximately 24 percent of the

trips occurred at retail sites, and 20 percent occurred at residential sites. By commodity group, approximately 33 percent of the trips were not transporting goods, 25 percent were transporting machinery, and eleven percent were transporting secondary 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	Other		
Agriculture	1	1	6	0	6	1	0	11	26	3.9
Raw Materials	0	2	6	0	0	0	0	11	19	2.9
Food	1	17	2	0	0	0	0	7	27	4.1
Textiles	1	7	0	0	0	0	0	2	10	1.5
Wood	12	8	1	11	1	2	0	14	49	7.4
Building Materials	2	1	0	0	0	0	0	4	7	1.1
Miscellaneous	0	0	8	1	0	0	28	1	38	5.7
Machinery	12	59	12	3	1	2	48	31	168	25.4
Secondary	8	18	8	2	0	2	16	17	71	10.7
Hazardous Materials	2	1	8	1	0	0	5	4	21	3.2
Transportation	0	2	0	0	0	0	0	1	3	0.5
Empty	33	39	26	1	11	5	33	69	217	32.8
Unknown	0	3	0	0	0	0	2	1	6	0.9
Total	72	158	77	19	19	12	132	173	662	100.0
Percent of Total	10.9	23.9	11.6	2.9	2.9	1.8	19.9	26.1	100.0	--

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 31 percent of the total cargo vehicle trips were delivery, with machinery and secondary cargo as the most frequent delivered among the commodity groups. These same groups were also the two most frequently picked-up commodities. The trip purpose “pick-up” made up nearly 16 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.

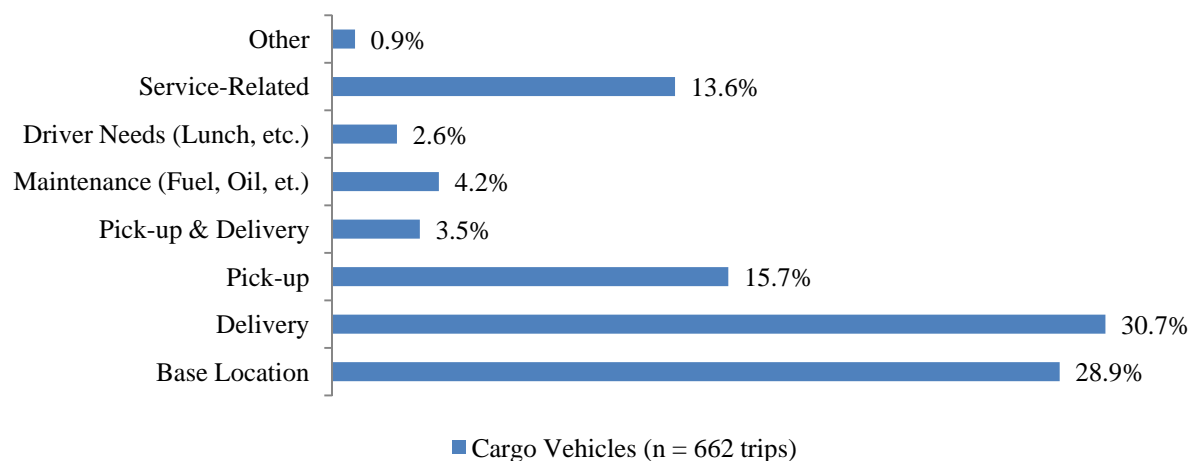


Figure 8. Cargo Trip Purposes at the Trip Destinations.

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

Commodity Group	Trip Purpose								Total Trips	% of Total
	Base Location	Delivery	Pick-Up	Pick-Up & Delivery	Maintenance	Driver Needs	Service	Other		
Agriculture	8	8	6	2	0	0	2	0	26	3.9
Raw Materials	7	9	0	2	1	0	0	0	19	2.9
Food	8	12	4	3	0	0	0	0	27	4.1
Textiles	2	2	4	0	2	0	0	0	10	1.5
Wood	8	12	23	3	1	2	0	0	49	7.4
Building Materials	1	1	3	0	0	0	2	0	7	1.1
Miscellaneous	0	5	32	0	1	0	0	0	38	5.7
Machinery	30	96	21	9	6	2	4	0	168	25.4
Secondary	14	44	6	0	4	3	0	0	71	10.7
Hazardous	6	11	1	3	0	0	0	0	21	3.2
Transport.	0	1	2	0	0	0	0	0	3	0.5
Empty	105	1	2	1	13	9	80	6	217	32.8
Unknown	2	1	0	0	0	1	2	0	6	0.9
Total	191	203	104	23	28	17	90	6	662	100.0
Percent of Total	28.9	30.7	15.7	3.5	4.2	2.6	13.6	0.9	100.0	--

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 either 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 to 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. Miscellaneous materials being transported to industrial sites showed the highest average net cargo weight, followed by secondary materials being delivered to industrial land use sites. Miscellaneous cargo for the trip purpose “maintenance” had the highest average net cargo weight, followed by secondary cargo at the trip purpose “pick-up.”

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

Commodity Group	Land Use							
	Office	Retail	Ind'l	Med	Edu	Gov't	Res	Other
Agriculture	0	0	3,445	0	19	0	0	10,722
Raw Materials	0	1,332	6,372	0	0	0	0	1,244
Food	40	399	55	0	0	0	0	50
Textiles	0	627	0	0	0	0	0	2,565
Wood	4	22	344	0	0	231	0	1,722
Building Materials	45	0	0	0	0	0	0	4,850
Miscellaneous	0	0	17,058	249	0	0	0	0
Machinery	63	280	25	41	218	2,146	62	1,310
Secondary	29	445	14,005	4	0	3	2	1,417
Hazardous Materials	0	20	1,738	0	0	0	20	15
Transportation	0	875	0	0	0	0	0	0
Empty	0	0	0	0	0	0	0	0
Unknown	0	103	0	0	0	0	0	0

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

Commodity Group	Trip Purpose							
	Base Location	Delivery	Pick-Up	Pick-Up & Delivery	Maintenance	Driver Needs	Service	Other
Agriculture	17,336	1	0	0	0	0	0	0
Raw Materials	5,793	1,280	0	1,250	0	0	0	0
Food	739	114	0	0	0	0	0	0
Textiles	2,565	2,195	0	0	0	0	0	0
Wood	2,988	100	0	10	0	0	0	0
Building Materials	30	0	6,467	0	0	0	30	0
Miscellaneous	0	50	3,577	0	22,000	0	0	0
Machinery	1,693	112	156	2	156	0	4	0
Secondary	1,771	6	18,558	0	2,003	0	0	0
Hazardous Material	683	7	1,400	2,833	0	0	0	0
Transportation	0	1,750	0	0	0	0	0	0
Empty	0	0	0	0	0	0	0	0
Unknown	0	308	0	0	0	0	0	0

Table 17 shows the distribution of cargo trips and average net cargo weights at trip destinations by commodity group. Overall, the average net cargo weight per trip was about 1,400 lbs. Of the classified commodity groups, agriculture showed the highest average net cargo weight at approximately 5,300 lbs. per trip. However, machinery and secondary materials were the most frequently transported commodity groups, with average net cargo weights of about 400 lbs. and 2,000 lbs. per trip, respectively.

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 Trips¹	Average Net Cargo Weight (lbs.)¹
Agriculture	26	138,723	26	5,336
Raw Materials	19	54,573	19	2,872
Food	27	7,284	27	270
Textiles	10	9,519	10	952
Wood	49	25,143	49	513
Building Materials	7	19,490	7	2,784
Miscellaneous	38	136,709	38	3,598
Machinery	168	65,783	168	392
Secondary	71	144,421	71	2,034
Hazardous Materials	21	14,080	21	670
Transportation	3	1,750	3	583
Empty	217	0	0	0
Unknown	6	308	6	51
Total	662	617,783	445	1,388

¹ 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 approximately 5,800 lbs. per trip. Cargo trips to “Other” locations showed the next highest average net cargo weight at nearly 2,600 lbs. per trip.

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

Land Use	Total Cargo Trips	Total Net Cargo Weight (lbs.)	Number of Trips ¹	Average Net Cargo Weight (lbs.) ¹
Office	72	1,162	39	30
Retail	158	41,142	119	346
Industrial	77	297,969	51	5,843
Medical	19	382	18	21
Education	19	313	8	39
Government	12	4,757	7	680
Residential	132	2,605	99	26
Other	173	269,453	104	2,591
Refused/Unknown	0	0	0	0
Total	662	617,783	445	1,388

¹ Excluding trips with empty cargo.

Table 19 shows the distribution of cargo trips and net cargo weights by trip purpose. The trip purpose “Delivery” had the highest average net weight at 2,700 lbs. per trip as well as the most number of trips.

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

Trip Purpose	Total Cargo Trips	Total Net Cargo Weight (lbs.)	Number of Trips ¹	Average Net Cargo Weight (lbs.) ¹
Return to Base Location	191	24,804	86	288
Delivery	203	541,817	202	2,682
Pick-Up	104	80	102	1
Pick-Up and Delivery	23	50,987	22	2,318
Maintenance (Fuel, Oil, Etc.)	28	5	15	0
Driver Needs (Lunch, Etc.)	17	0	8	0
Service-Related	90	90	10	9
Other	6	0	0	0
Unknown	0	0	0	0
Total	662	617,783	445	1,388

¹ 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 Corpus Christi 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 normally provide travel distance and time estimates from one zone to all other zones in the respective study area. However, for the CCUTS area, there was not a travel time matrix available, so only trip length summary information was analyzed. 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.

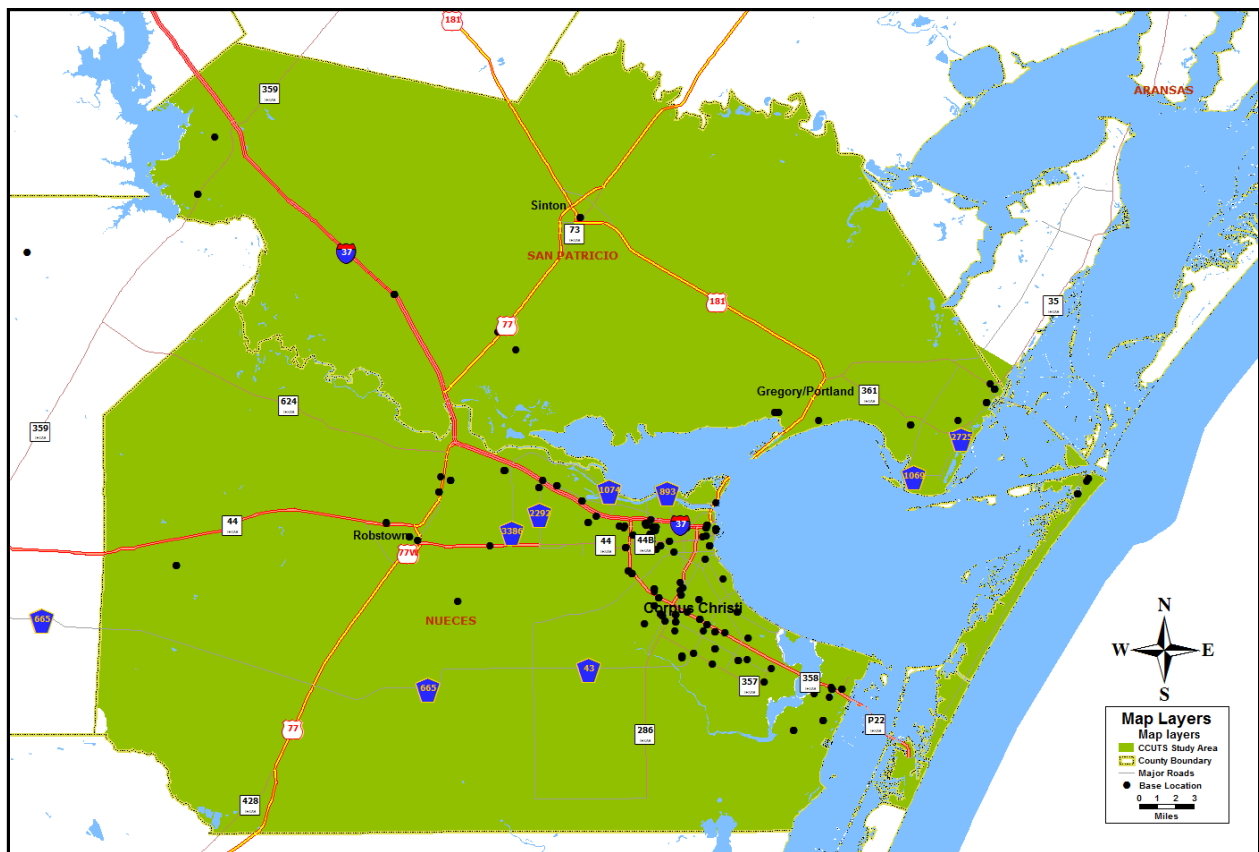


Figure 9. TAZ Boundary and Base Locations of Surveyed Commercial Vehicles.

Figure 9 shows the TAZ boundary and base locations of surveyed vehicles within the Corpus Christi 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 end outside of the CCUTS study area was considered an external trip.

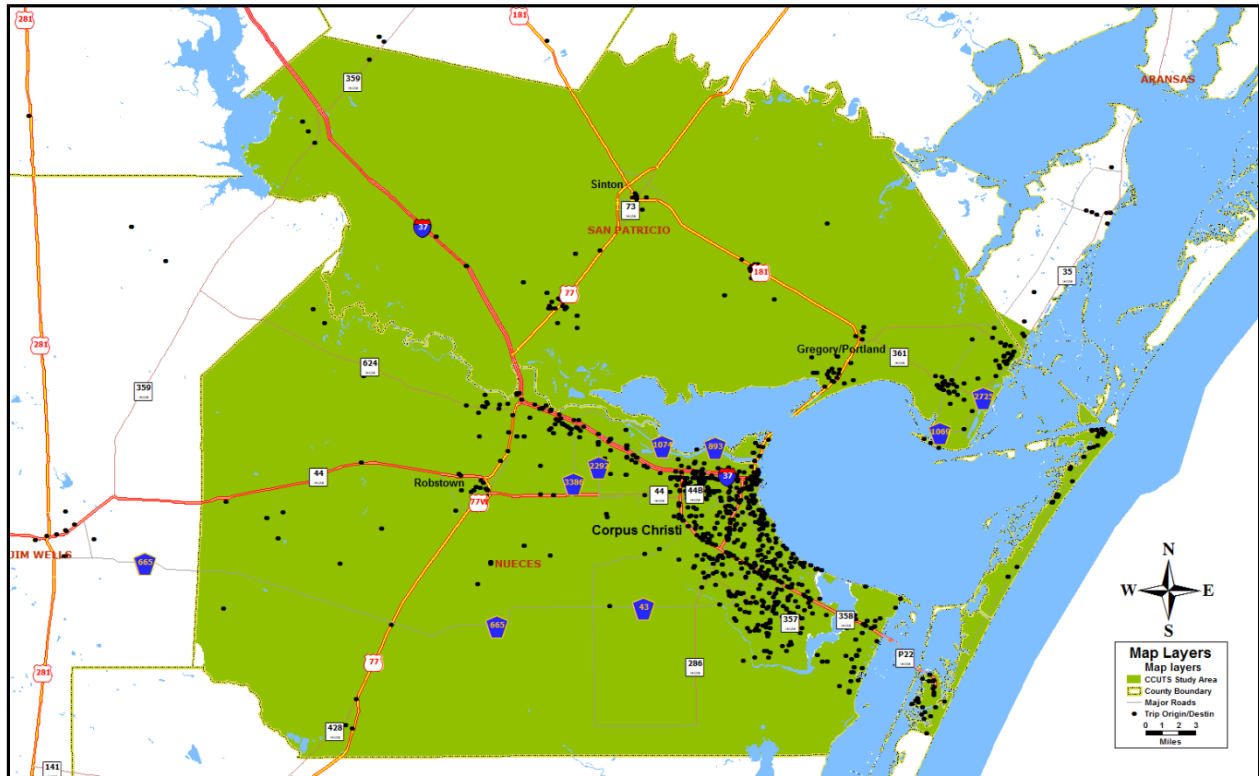


Figure 10. Trip Origins and Destinations of Surveyed Commercial Vehicles.

The results presented in this section pertain to trip length characteristics for 1,251 inter-zonal trips only. Table 20 shows the trip length frequency distribution (TLFD), grouped at five-mile intervals, while Figure 11 and Table 21 show the ungrouped TLFD. Approximately 53 percent of the cargo and 45 percent of the service vehicle trips had trip lengths less than five miles, and 23 percent of the cargo vehicle trips and 28 percent of the service vehicles had trip lengths between six miles and ten miles. The longest trip lengths reported by cargo and service vehicles were 36 and 40 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	287	53.0	317	44.7	604	48.3
6 to 10	125	23.1	201	28.3	326	26.1
11 to 15	56	10.3	82	11.6	138	11.0
16 to 20	31	5.7	56	7.9	87	7.0
21 to 25	20	3.7	31	4.4	51	4.1
26 to 30	13	2.4	15	2.1	28	2.2
31 to 35	9	1.7	4	0.6	13	1.0
36 to 40	1	0.2	3	0.4	4	0.3
41 to 45	0	0.0	0	0.0	0	0.0
Over 45	0	0.0	0	0.0	0	0.0
Total	542	100.0	709	100.0	1,251	100.0

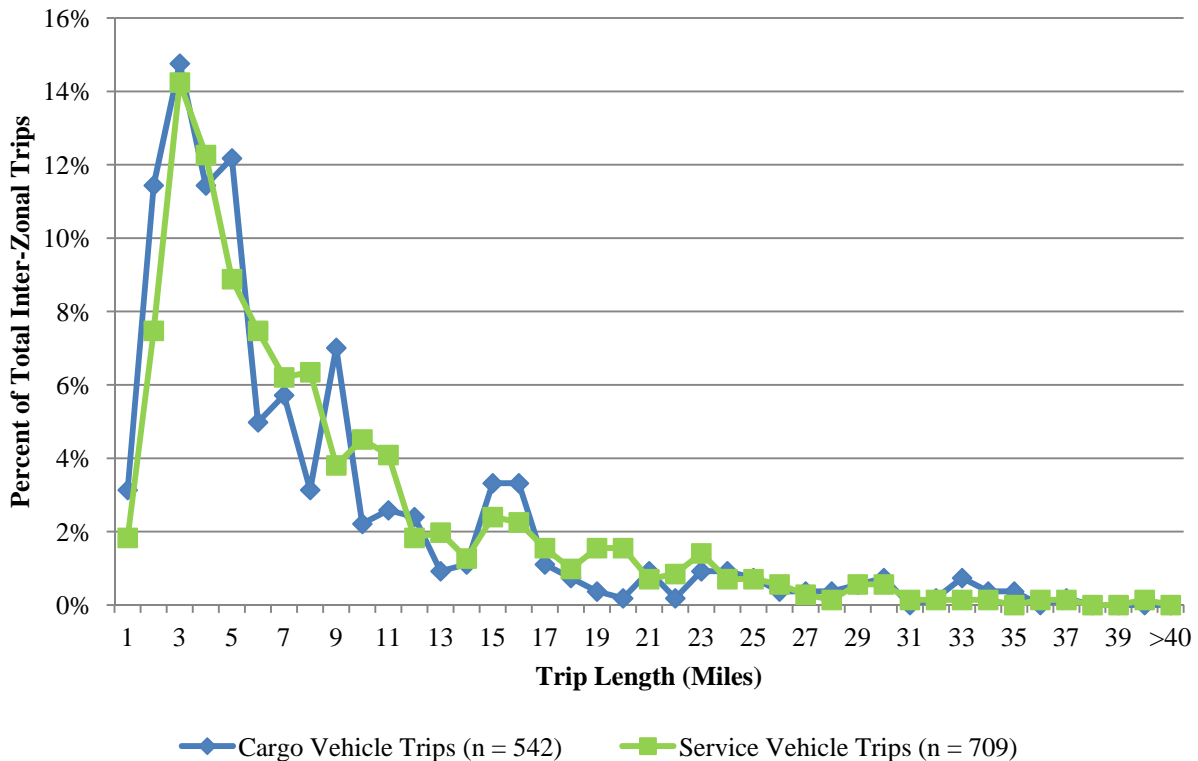


Figure 11. Surveyed Commercial Vehicle Trips TLFD.

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	17	3.1	13	1.8	30	2.4
2	62	11.4	53	7.5	115	9.2
3	80	14.8	101	14.2	181	14.5
4	62	11.4	87	12.3	149	11.9
5	66	12.2	63	8.9	129	10.3
6	27	5.0	53	7.5	80	6.4
7	31	5.7	44	6.2	75	6.0
8	17	3.1	45	6.3	62	5.0
9	38	7.0	27	3.8	65	5.2
10	12	2.2	32	4.5	44	3.5
11	14	2.6	29	4.1	43	3.4
12	13	2.4	13	1.8	26	2.1
13	5	0.9	14	2.0	19	1.5
14	6	1.1	9	1.3	15	1.2
15	18	3.3	17	2.4	35	2.8
16	18	3.3	16	2.3	34	2.7
17	6	1.1	11	1.6	17	1.4
18	4	0.7	7	1.0	11	0.9
19	2	0.4	11	1.6	13	1.0
20	1	0.2	11	1.6	12	1.0
21	5	0.9	5	0.7	10	0.8
22	1	0.2	6	0.8	7	0.6
23	5	0.9	10	1.4	15	1.2
24	5	0.9	5	0.7	10	0.8
25	4	0.7	5	0.7	9	0.7
26	2	0.4	4	0.6	6	0.5
27	2	0.4	2	0.3	4	0.3
28	2	0.4	1	0.1	3	0.2
29	3	0.6	4	0.6	7	0.6
30	4	0.7	4	0.6	8	0.6
31	0	0.0	1	0.1	1	0.1
32	1	0.2	1	0.1	2	0.2
33	4	0.7	1	0.1	5	0.4
34	2	0.4	1	0.1	3	0.2
35	2	0.4	0	0.0	2	0.2
36	0	0.0	1	0.1	1	0.1
37	1	0.2	1	0.1	2	0.2
38	0	0.0	0	0.0	0	0.0
39	0	0.0	0	0.0	0	0.0
40	0	0.0	1	0.1	1	0.1
> 40	0	0.0	0	0.0	0	0.0
Total	542	100.0	709	100.0	1,251	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 7.8 miles, with cargo vehicles averaging 7.6 miles and service vehicles averaging 8.0 miles. The most number of trips by cargo vehicles occurred at “other” land use types, with an average trip length of 7.8 miles, followed by retail and residential sites with average trip lengths of 7.0 and 8.3 miles, respectively. For service vehicles, the highest frequency of trips occurred at residential land use types, with an average trip length of 8.7 miles. Over half of the trips made by service vehicles (57 percent) occurred at residential, retail, and office 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)	Average Trip Length (miles)	Number of Trips	Total Trip Length (miles)	Average Trip Length (miles)	Number of Trips	Total Trip Length (miles)	Average Trip Length (miles)
Office	63	550	8.7	96	567	5.9	159	1,116	7.0
Retail	134	935	7.0	99	840	8.5	233	1,775	7.6
Industrial	62	512	8.3	62	688	11.1	124	1,200	9.7
Medical	17	80	4.7	34	204	6.0	51	283	5.6
Education	17	67	3.9	75	363	4.8	92	430	4.7
Government	11	48	4.3	51	397	7.8	62	445	7.2
Residential	90	751	8.3	207	1,809	8.7	297	2,560	8.6
Other	148	1,151	7.8	85	825	9.7	233	1,976	8.5
Total	542	4,094	7.6	709	5,693	8.0	1,251	9,785	7.8

Table 23 shows the average trip length to destinations by commodity group for trips made by cargo vehicles only. Machinery was the most frequently transported commodity group, with an average trip length of 7.4 miles per trip. Trips transporting miscellaneous materials showed the longest average trip length of 12.8 miles per trip. The average trip length for trips with empty cargo was 8.4 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	16	162	10.2
Raw Materials	11	23	2.1
Food	14	94	6.7
Textiles	10	29	2.9
Wood	48	302	6.3
Building Materials	7	57	8.1
Machinery	146	1,078	7.4
Miscellaneous	11	141	12.8
Transportation	3	25	8.3
Hazardous Materials	17	176	10.4
Secondary	59	344	5.8
Unknown	6	29	4.8
Empty	194	1,633	8.4
Total	542	4,093	7.6

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. 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 1,482 trips observed in the CCUTS 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.

As Table 24 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, 60 percent were non-base trips and 40 percent were base trips.

Table 24. 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	305	46.1	331	40.4	636	42.9
Non-Base	357	53.9	489	59.6	846	57.1
Total	662	100.0	820	100.0	1,482	100.0

Table 25 shows the distribution of trip tours for cargo and service vehicles. There were 286 trip tours generated by 192 vehicles making at least one trip tour. Cargo vehicles made 145 tours and service vehicles produced 141 tours. The number of tours varied from one-to-nine tours for cargo vehicles, and one-to-five tours for service vehicles. The majority of cargo and service vehicles made only one trip tour (73 percent and 70 percent, respectively). For those cargo and service vehicles making only one trip tour, they averaged 4.4 and 5.1 trips within the tour, respectively. For all vehicles combined, the average number of tours per vehicle was 1.5 and the average number of trips per tour was 3.9.

Table 25. 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	69	69	301	4.4
2	13	26	98	3.8
3	9	27	77	2.9
4	2	8	24	3.0
5	0	0	0	0.0
6	1	6	18	3.0
7	0	0	0	0.0
8	0	0	0	0.0
9	1	9	20	2.2
Cargo Total	95	145	538	3.7
Service Vehicles				
Total Number of Trip Tours	Number of Vehicles	Number of Tours	Number of Trips	Average Trips per Tour
1	68	68	349	5.1
2	21	42	131	3.1
3	4	12	47	3.9
4	1	4	27	6.8
5	3	15	35	2.3
6	0	0	0	0.0
7	0	0	0	0.0
8	0	0	0	0.0
9	0	0	0	0.0
Service Total	97	141	589	4.2
Grand Total	192	286	1,127	3.9

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 1,127 trips observed within the total 286 trip tours. For all vehicles, 85 were external trips (7 percent), 954 were inter-zonal trips (85 percent), and 88 were intra-zonal trips (8 percent).

Table 26 shows the distribution of these trips for cargo and service vehicles. Table 27 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 26. 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	Cargo Vehicles	Service Vehicles	Cargo Vehicles	Service Vehicles	Cargo Vehicles	Service Vehicles
1	37	32	225	297	39	20	301	349
2	8	4	86	124	4	3	98	131
3	0	2	69	42	8	3	77	47
4	0	0	20	21	4	6	24	27
5	0	0	0	34	0	1	0	35
6	2	0	16	0	0	0	18	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	20	0	0	0	20	0
Total	47	38	436	518	55	33	538	589

Table 27. 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	163	213	376	301	55.9	349	59.3	650	57.7
2	46	48	94	98	18.2	131	22.2	229	20.3
3	23	23	46	77	14.3	47	8.0	124	11.0
4	8	19	27	24	4.5	27	4.6	51	4.5
5	0	5	5	0	0.0	35	5.9	35	3.1
6	6	0	6	18	3.3	0	0.0	18	1.6
7	0	0	0	0	0.0	0	0.0	0	0.0
8	0	0	0	0	0.0	0	0.0	0	0.0
9	2	0	2	20	3.7	0	0.0	20	1.8
Total	248	308	556	538	100.0	589	100.0	1,127	100.0

Figure 12 and Figure 13 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. The cargo vehicle that completed nine tours made only inter-zonal trips.

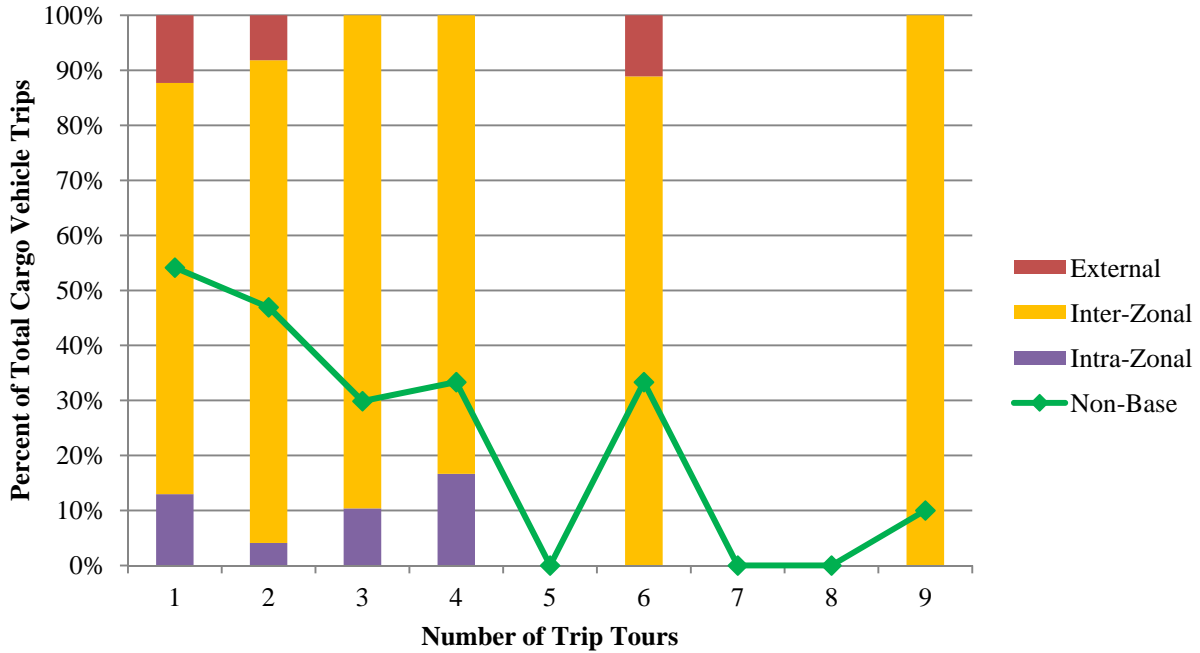


Figure 12. Cargo Vehicle Trips within Trip Tours by Trip Type.

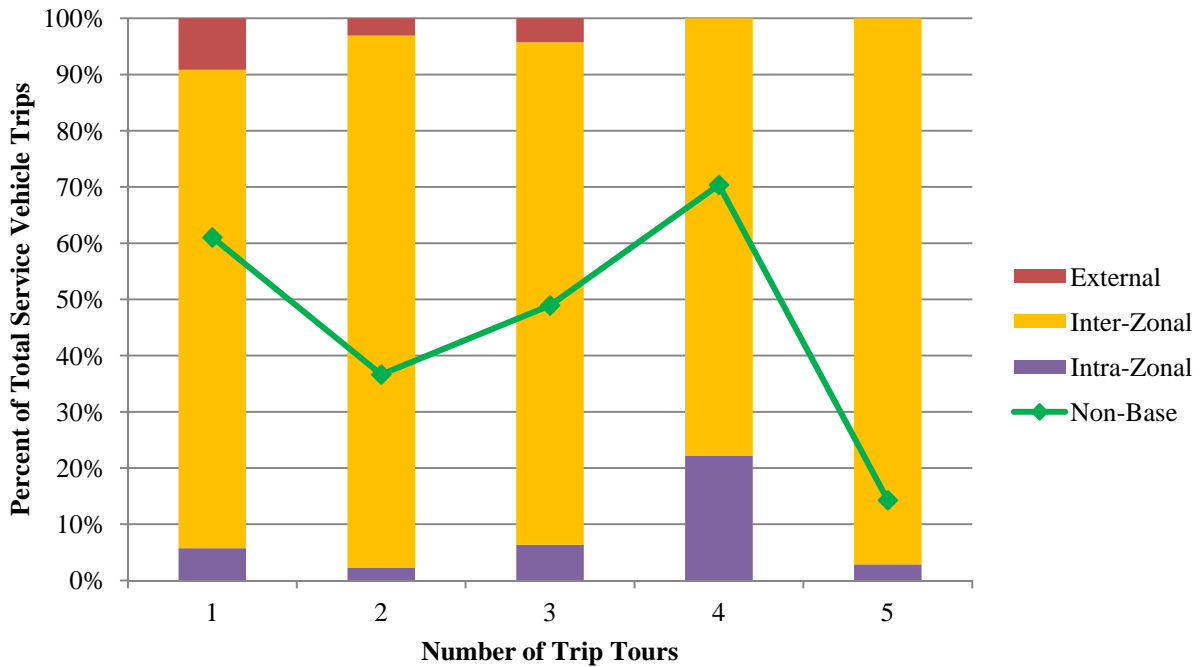


Figure 13. Service Vehicle Trips within Trip Tours by Trip Type.

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. Due to the number of trips that were made in open tours, a review of when these trips occurred was performed. Table 28 provides an overview of when trips that are not part of tours were made relative to trip tours. Nearly four percent of the trips made by cargo and service vehicles combined were before the first trip tour or after the last completed trip tours. However, nearly 20 percent of the trips were made by surveyed vehicles that did not have any trip tours. A total of 71 vehicles (25 cargo and 46 service) did not make a trip tour on the survey day.

Table 28. 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	6	0.91	16	1.95	22	1.48
After end of last tour	5	0.76	29	3.54	34	2.29
No tour (base only once)	113	17.07	186	22.68	299	20.18
Total (non-tour trips)	124	18.73	231	28.17	355	23.95
Within a tour	538	81.27	589	71.83	1,127	76.05
Total (all trips)	662	100.00	820	100.00	1,482	100.00

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 CCUTS 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 contains 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 29 provides the adjusted 2008 HPMS VMT estimates for the CCUTS study area.

Table 29. 2008 HPMS Estimates of Weekday VMT in the CCUTS Study Area.

Functional Classification	Total Weekday VMT
Freeway	3,911,839
Arterial	5,294,722
Collector	1,342,202
Local	2,069,070
Total	12,617,833

The percentage of commercial and non-commercial vehicles by functional classification are generally determined by utilizing vehicle classification counts obtained during the conduct of an external survey and vehicle classification counts conducted at randomly selected locations within the study area. However, there has not been a recently conducted external survey in the CCUTS area, so external count data from another study area was utilized for a portion of the expansion. After reviewing data from several study areas, it was determined that the Killeen/Temple (KTUT) study area had external count data that exhibited similar characteristics to the internal count data obtained for the CCUTS area.

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. As mentioned previously, there has been no recent external survey conducted for the CCUTS area, so the percent of external related VMT (as derived from the total HPMS VMT) for the KTUT study area was utilized. Based on the 2006 KTUT external survey, external VMT for the study area amounted to 26 percent of the total VMT. Therefore, it was reasonable to assume that 74 percent of the total VMT was internal

travel. These percentages were applied to obtain the weighted average for each functional classification.

Table 30 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 29 to estimate the total commercial and non-commercial VMT. Table 31 shows the estimated VMT for commercial and non-commercial vehicles.

Table 30. Percentage of Commercial and Non-Commercial Vehicles by Functional Classification.

Functional Classification	Percent of Commercial Vehicles			Percent of Non-Commercial Vehicles		
	Internal Sites (74%)	External Sites (26%)	Weighted Average	Internal Sites (74%)	External Sites (26%)	Weighted Average
Freeway	12	24	15	88	76	85
Arterial	17	12	15	83	88	85
Collector	8	7	8	92	93	92
Local	N/A	4	4	N/A	96	96

Table 31. Estimated VMT for Commercial and Non-Commercial Vehicles.

Functional Classification	Commercial VMT	Non-Commercial VMT	Total VMT
Freeway	588,987	3,322,852	3,911,839
Arterial	812,375	4,482,347	5,294,722
Collector	108,230	1,233,972	1,342,202
Local	82,763	1,986,307	2,069,070
Total	1,592,355	11,025,478	12,617,833

The total commercial VMT of 1,592,355 miles represented all commercial vehicles that traveled within and to the boundary of the CCUTS study area. To properly expand the survey data and determine the total internal commercial vehicle trips generated in the study area, commercial external VMT estimates had to be subtracted from the total commercial VMT. Using the KTUT external VMT estimate of 20 percent that was derived from the external trip tables, the total internal commercial VMT was determined to be 1,276,012 miles.

The total internal VMT observed from the commercial vehicle survey was 9,791 miles, of which 4,119 miles were cargo VMT and 5,672 were service VMT. This estimate was based on 1,251

inter-zonal trips (542 cargo vehicle trips and 709 service vehicle trips), multiplied by the average trip length (7.6 miles for cargo and 8.0 miles for service vehicles).

The total internal commercial VMT (1,276,012 miles) represented all commercial vehicles and is not distinguished by cargo or service vehicles. It was assumed that the distribution of cargo and service vehicle types operating in the CCUTS study area was consistent with the distribution observed in the survey sample. In the survey, 42.1 percent of the observed commercial vehicle VMT was attributable to cargo vehicles and 57.9 percent was attributable to 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 536,824 miles for cargo vehicles and 739,188 miles for service vehicles.

Expansion factors were derived based on the quotient between total internal VMT and observed internal VMT (from the survey) for each commercial vehicle type. The expansion factor (130.32) was then multiplied by the observed number of inter-zonal and intra-zonal trips to estimate the total vehicle trips. The resulting trip estimates were approximately 78,324 cargo vehicle trips and 98,263 service vehicle trips. Based on the average number of internal trips per day of 5.0 trips for cargo vehicles and 5.3 trips for service vehicles, 34,205 commercial vehicles (15,665 cargo vehicles and 18,540 service vehicles) were estimated to be operating within the CCUTS study area on a daily basis. This estimate is nearly five times the 6,945 trucks registered in the study area in 2010. Table 32 provides a summary of key results from the CCUTS commercial vehicle survey and data expansion.

Table 32. Key Survey Results and Expanded Trip and VMT Data.

Indicator	Cargo Vehicles	Service Vehicles	All Vehicles
Sample Size	168	176	344
Total Inter-Zonal Trips	542	709	1,251
Total Intra-Zonal Trips	59	45	104
Total Internal Trips	601	754	1,355
Total External Trips	61	66	127
Total Internal and External Trips	662	820	1,482
Average Total Trips per Vehicle	5.5	5.7	5.6
Average Total Internal Trips per Vehicle ¹	5.0	5.3	5.2
Average Trip Length	7.6	8.0	7.8
Observed Internal VMT (miles)	4,119	5,672	9,791
Total Internal Commercial VMT (miles)	536,824	739,188	1,276,012
Survey Expansion Factor	130.32	130.32	130.32
Total Expanded Inter-Zonal Commercial Vehicle Trips	70,635	92,399	163,034
Total Expanded Intra-Zonal Commercial Vehicle Trips	7,689	5,865	13,554
Total Expanded Commercial Vehicle Trips	78,324	98,263	176,587
Number of Commercial Vehicles Operating on a Daily Basis	15,665	18,540	34,205
Attraction Rate to Households	--	--	0.333

¹ Based on internal trips of 344 surveyed commercial vehicles (168 cargo vehicles and 176 service vehicles).

One final calculation was the determination of the commercial vehicle attraction rate to households. In the survey, approximately 27 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 47,046 trips to residential locations. The residential trip estimate was divided by the estimated number of households in the CCUTS area (141,300) to obtain an attraction rate of 0.333.

SURVEY SUMMARY

This section provides a summary of vehicle and trip characteristics of 344 commercial vehicles that participated in the 2010 CCUTS 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 6.4 years compared to 6.5 years for service vehicles. The odometer readings reported by cargo vehicles indicated an average mileage of

144,500 miles, which was nearly 50 percent more than the reported average mileage of 94,100 miles by service vehicles. In terms of fuel use, around 53 percent of cargo vehicles used unleaded gasoline and 47 percent used diesel, while 68 percent of service vehicles used unleaded gasoline and 32 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 5.5 total trips per day, compared to 5.7 trips per day for service vehicles. Excluding the trips made outside of the study area (external trips), cargo vehicles produced 5.0 internal trips per day, with average travel distance of 7.6 miles, compared to service vehicles which made 5.3 internal trips per day, with average trip length of 8.0 miles.

In terms of trip purpose at trip destinations, approximately 29 percent of the cargo vehicle trips were delivery, 28 percent were base related, and 17 percent were picking-up cargo. For trips made by service vehicles, approximately 47 percent were service-related trip purpose, 28 percent were base related, and 11 percent were for “other.”

In terms of land use activity, approximately 25 percent of the trips made by cargo vehicles occurred at “other” land use types, 24 percent occurred at retail sites, and 21 percent occurred at residential locations. For service vehicles, nearly 31 percent of the trips took place at residential sites, 13 percent occurred at retail sites, and another 13 percent occurred at office buildings.

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 1,400 pounds. Agricultural materials showed the highest average net cargo weight of around 5,300 pounds per trip, but the most frequently transported commodity was machinery with a net cargo weight of 400 pounds per trip. Industrial land use showed the highest average net cargo weight of around 3,900 pounds per trip, but more trips occurred at retail sites with net cargo weight averaging nearly 300 pounds per trip. The delivery base trip purpose had the highest average net

cargo weight of around 2,700 pounds per trip, and it also had the highest number of trip occurrences.

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 286 trip tours were generated by the surveyed vehicles, with cargo vehicles making 145 tours and service vehicles producing 141 tours. The number of trip tours per vehicle varied from one to nine tours for cargo vehicles, and one to five tours for service vehicles. The average number of trips tours for all vehicles was 1.5 and the average number of trips per tour was 3.9. Trips made as part of trip tours accounted for 1,127 trips (538 trips by cargo vehicles and 589 trips by service vehicles). Within the trip tours, approximately 84 percent were inter-zonal trips, eight percent were external trips and the remaining eight percent were intra-zonal trips. Non-base trips (which were not mutually-exclusive of the other trip types) made up approximately 57 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 CCUTS 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 34,200 commercial vehicles (15,650 cargo vehicles and 18,550 service vehicles) were estimated to be operating within the CCUTS study area on a daily basis, roughly five times the volume of trucks registered in the study area in 2010.

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: _____ am/pm

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)
NAME of Place:	Address including city, state, and zip OR Nearest street intersection or Landmark						
PLACE 1		Arrive: _____ am/pm Depart: _____ am/pm					Delivery Picked-Up
PLACE 2		Arrive: _____ am/pm Depart: _____ am/pm					Delivery Picked-Up
PLACE 3		Arrive: _____ am/pm Depart: _____ am/pm					Delivery Picked-Up

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

Commercial Vehicle Survey Travel (continued)

	RECORD the following information about each place <i>NAME of Place:</i> _____ <i>Address including city, state, and zip</i> OR <i>Nearest street intersection or Landmark</i> _____	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 10		Arrive: _____ am/pm Depart: _____ am/pm					Delivery <hr/> Picked-Up
PLACE 11		Arrive: _____ am/pm Depart: _____ am/pm					Delivery <hr/> Picked-Up
PLACE 12		Arrive: _____ am/pm Depart: _____ am/pm					Delivery <hr/> Picked-Up
PLACE 13		Arrive: _____ am/pm Depart: _____ am/pm					Delivery <hr/> Picked-Up
PLACE 14		Arrive: _____ am/pm Depart: _____ am/pm					Delivery <hr/> 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 (continued)

	RECORD the following information about each place <i>NAME of Place:</i> _____ <i>Address including city, state, and zip</i> <i>OR</i> <i>Nearest street intersection or Landmark</i> _____	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					_____ Delivery _____ Picked-Up
PLACE 16		Arrive: _____ am/pm Depart: _____ am/pm					_____ Delivery _____ Picked-Up
PLACE 17		Arrive: _____ am/pm Depart: _____ am/pm					_____ Delivery _____ Picked-Up
PLACE 18		Arrive: _____ am/pm Depart: _____ am/pm					_____ Delivery _____ Picked-Up
PLACE 19		Arrive: _____ am/pm Depart: _____ am/pm					_____ 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

