SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS

CHAPTER 7 - HEAVY DUTY TRUCK MODEL

Contents

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Introduction

As part of the Regional Model Update, SCAG commissioned a team to develop improvements and enhancements to the Heavy Duty Truck (HDT) Model. This Chapter provides the technical approach used to implement various model improvements. A key element of this model development effort was the collection and analysis of HDT trip data. A report documenting this data collection effort is available from SCAG[2] This Chapter addresses the various elements of the Heavy Duty Truck Model, including internal and external HDT trips, Port HDT trips and Intermodal HDT trips.

HDT Model Structure

Figure 7-1 provides a flow chart of the overall structure of the HDT model. The model forecasts trips for three HDT weight classes: light-heavy (8,500 to 14,000 lbs. gross vehicle weight (GVW); medium-heavy (14,001 to 33,000 lbs. GVW); and heavy-heavy (>33,000 lbs. GVW). The key components of the new HDT Model are the following:

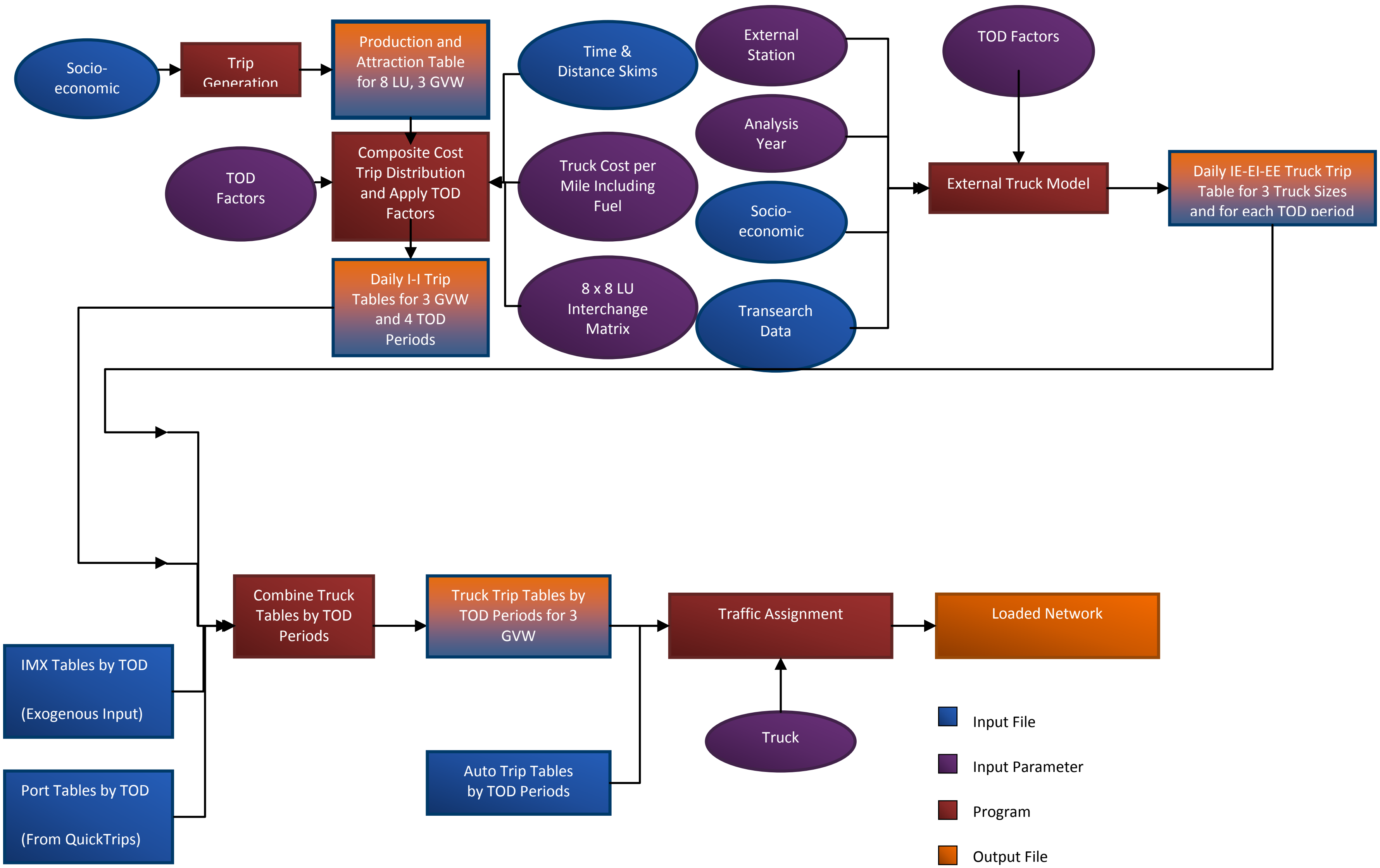
- ***External Trip Generation and Distribution Model.*** This component estimates the trip table for all interregional truck trips based on commodity flow patterns that link Southern California with the rest of the nation. The previous model used a commodity flow database obtained from outside sources, and included procedures for converting annual tonnage flows at the county level to daily truck trips at the TAZ level. The updated model replaces the older Caltrans Intermodal Transportation Management System (ITMS) commodity flow database with a new TRANSEARCH database from IHS/Global Insight. Adjustments were made to the TransCAD scripts that convert annual tonnage flows into daily truck trip tables. These modifications are a result of differences in data formats between TRANSEARCH and ITMS.

- ***Internal Trip Generation and Distribution Models.*** This component of the HDT Model estimates trip tables for intraregional trips. Trip generation is based on trip rates (number of trips per employee or household) for different land uses/industry sectors at the trip ends. This basic structure was retained, although all of the current trip rates were updated with new survey data. Other trip generation specifications (e.g., trip rates as a function of size of firm or more detailed industry/land use classifications) were reviewed, but it was determined that these specifications were not supported by currently available forecast data from SCAG.

  The trip distribution process was modified by developing a matrix of factors that indicate the trip interchange relationships among different land use types (i.e., what fraction of trips originating at a land use such as manufacturing sites go to warehouses vs. other manufacturing sites, etc.). The GPS survey data was used to develop a series of gravity models for each truck class. This offers some of the benefits of tour-based models by directing trips from zone to zone based on logical relationships amongst land use types without the extensive data requirements (typically difficult to collect from trip diary surveys) that are required to support development of a full tour-based model.

[2] Cambridge Systematics, Inc., *SCAG Task 4 Data Verification and Analysis – Final Report*, October 2010.

Figure 7-1: Final HDT Model Structure



- ***Special Generator Trip Generation and Distribution Models.*** These models include the port model and the intermodal rail model. All of the input parameters to the port trip generation model were updated to reflect current port capacity improvements and throughput forecasts. This model update also implements a procedure to incorporate secondary port truck trips. These are cargo trips from intermediate handling locations (container staging areas, transshipment sites, etc.) to final destinations. Additionally there are secondary (empty) movements of trucks associated with port truck trips, for purposes of truck repositioning. Both cargo and empty truck secondary trips are allocated to other destination in the regions using the gravity model distribution.

- ***Trip Assignment.*** The model incorporates a multiclass assignment combining the truck trip tables with the passenger trip tables. Prior to assignment, the truck trip tables are converted to PCEs. The PCE factors were adapted from the TRB Highway Capacity Manual[3], and are a function of the percent truck volume and length and steepness of grades. Five time periods are used to assign truck trips, consistent with the auto trip assignment. Updated time-of-day factors were developed using data from permanent classification count stations, weigh-in-motion (WIM), and vehicle classification counts.

Internal HDT Model

Internal HDT Trip Generation Model

The internal truck trip generation model is land use-based, where trip rates are multiplied by employment by industry sector to obtain internal truck trip productions and attractions. All the internal truck travel in the region is associated with eight broad but distinct land uses, namely, households, agriculture/mining/construction, retail, government, manufacturing, transportation/utility, wholesale, and other (service). The trip rates (i.e., truck trips per employee) for every land use were updated based on recent data collection efforts –establishment surveys and third-party truck GPS data.

Land Use and Socioeconomic Data

The socioeconomic data used by the Internal HDT Model is consistent with those data used by the passenger model, except that the employment data are stratified into more employment categories. The 22 two-digit NAICS categories of employment were mapped to 10 final categories to account for truck trip generation similarities. This employment category mapping is shown in Table 7-1. These stratified employment types, plus households, support eight land use purposes for the HDT trip generation models: Households, Agriculture/Mining/Construction, Retail, Governments, Manufacturing, Transportation and Utility, Wholesale, and Other (service).

[3] Highway Capacity Manual. Volume 2: Uninterrupted Flow. Transportation Research Board: Washington D.C., 2010.

Table 7-1: Aggregated Two-Digit NAICS Categories

	Two-Digit	Two-Digit Description		Aggregate Categories for Trip Generation Models
1	11	Agriculture, Forestry, Fishing, and Hunting	1	Agriculture, Forestry, Fishing, and Hunting
2	21	Mining	2	Mining
3	22	Utilities	3	Utilities
4	23	Construction	4	Construction
5	31	Manufacturing	5	Manufacturing
6	42	Wholesale Trade	6	Wholesale Trade
7	44	Retail Trade	7	Retail Trade
8	45	Retail Trade	7	Retail Trade
9	48	Transportation and Warehousing	8	Transportation and Warehousing
10	49	Transportation and Warehousing	8	Transportation and Warehousing
11	51	Information Services	9	FIRES
12	52	Finance and Insurance	9	FIRES
13	53	Real Estates, and Rental and Leasing	9	FIRES
14	54	Professional, Scientific, and Technical Services	9	FIRES
15	55	Management of Companies and Enterprises	9	FIRES
16	56	Administrative and Support, and Waste Management and Remediation Services	9	FIRES
17	61	Educational Services	10	EDU
18	62	Health Care, and Social Assistance	9	FIRES
19	71	Arts, Entertainment, and Recreation	9	FIRES
20	72	Accommodation, and Food Services	9	FIRES
21	81	Other Services (Except Public Administration)	9	FIRES
22	92	Public Administration	11	GOVT

Internal HDT Trip Rates

Trip rates derived from establishment surveys and GPS data for each truck type and land use are shown in Table 7-2.

Table 7-2: Internal HDT Trip Rates

Category	Light HDT Trip Rate	Medium HDT Trip Rate	Heavy HDT Trip Rate
Households	0.0147	0.0046	0.0072
Agriculture/Mining/Construction	0.0804	0.0778	0.0715
Retail	0.0663	0.0662	0.0703
Government	0.0296	0.0150	0.0148
Manufacturing	0.0613	0.0655	0.0924
Transportation/Utility/Warehousing	0.1583	0.1819	0.3206
Wholesale	0.0916	0.0968	0.1316
Other (Service)	0.0095	0.0111	0.0151

Table 7-3 shows the 2008 HDT trip generation estimates. As expected, households in the region generate a high number of trip ends. This is mostly due to the fact that land uses such as transportation and warehousing, utilities, service and retail deliver goods and provide services to residential neighborhoods. The largest HDT trip generator is the transportation and utility land use that includes trucks involved in power generation, water supply and sewage treatment, all kinds of transportation (trucking industry, taxi, and chartered services), and postal and courier services. The second highest generators of HDT trips are retail and manufacturing land uses, which account for a major share of employment in the region and serve the vast area and population of the six-county SCAG region.

Table 7-3: 2008 Internal HDT Trip Generation Estimates

Land Use	Light HDT Trip Ends	Medium HDT Trip Ends	Heavy HDT Trip Ends	Total Trip Ends	Percent of Total Trip Ends
Households	85,194	26,692	42,031	153,917	15%
Ag/Mining/Construction	39,080	37,833	34,784	111,698	11%
Retail	55,607	55,527	58,953	170,087	17%
Governments	7,339	3,733	3,670	14,742	1%
Manufacturing	46,715	49,902	70,471	167,087	17%
Transportation/Utility/ Warehousing	57,057	65,584	115,586	238,227	24%
Wholesale	36,468	38,549	52,395	127,412	13%
Other	2,937	3,422	4,664	11,023	1%
Total	**330,398**	**281,242**	**382,553**	**994,194**	

Internal HDT Trip Distribution Model

The trip distribution process was modified by developing a matrix of factors that indicate the trip interchange relationships among different land use types (i.e., what fraction of trips originating at a land use such as manufacturing sites go to warehouses vs. other manufacturing sites, etc.). The internal HDT trip distribution model uses a gravity formulation, stratified by land use type at both the production and the attraction end of the trip. This results in a total of 64 gravity models for each truck type (LHDT, MHDT and HHDT). After trip distribution, the 64 different trip matrices are combined into a single matrix for each truck type, so that only three matrices are passed on to time-of-day factoring and trip assignment.

Truck trips are distributed using composite cost impedances that accounts for time and distance-based monetary costs in addition to travel time. Based on a review of the literature, the appropriate distance-based costs for the SCAG model are identified in a report commissioned by the Minnesota DOT[4]. These costs account for fuel, tires, maintenance and repair, and depreciation.

The link composite cost is calculated as shown in the equation below. The corresponding unit costs are shown in Table 7-4.

Composite Cost = *Cost per hour * Congested time +*
*[Fuel Price / Fuel efficiency + Cost per mile (excluding fuel)] * Distance*

[4] Levinson, David Matthew, Corbett, Michael J. and Hashami, Maryam, *Operating Costs for Trucks*, (2005) http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID1736159_code807532.pdf?abstractid=1736159&mirid=1.

Table 7-4: Composite Truck Unit Costs

Truck Type	Cost per Hour	Fuel Efficiency (MPG)	Cost per Mile (excluding fuel)	Fuel Price per Gallon
LHDT	$13.84	8.5	$0.14	$3.13 (a)
MHDT	$19.21	7.0	$0.23	$3.15 (b)
HHDT	$19.21	6.0	$0.26	$3.15 (b)

(a) Assumes a fleet mix of 60% gasoline and 50% diesel powered trucks.
(b) Average price of diesel fuel in California between 2006 and 2011.

The GPS survey of truck trips provided the data to calibrate the model friction factors. These data were used to build observed truck trip flow matrices, stratified by truck type (LHDT, MHDT and HHDT). The TransCAD gravity model calibration utility was used to calibrate the fraction factors that best matched the observed truck flow matrices, given the composite cost impedances and land-use based trip productions and attractions. Figures 7-2 to 7-4 show the trip length calibration, respectively for each truck class.

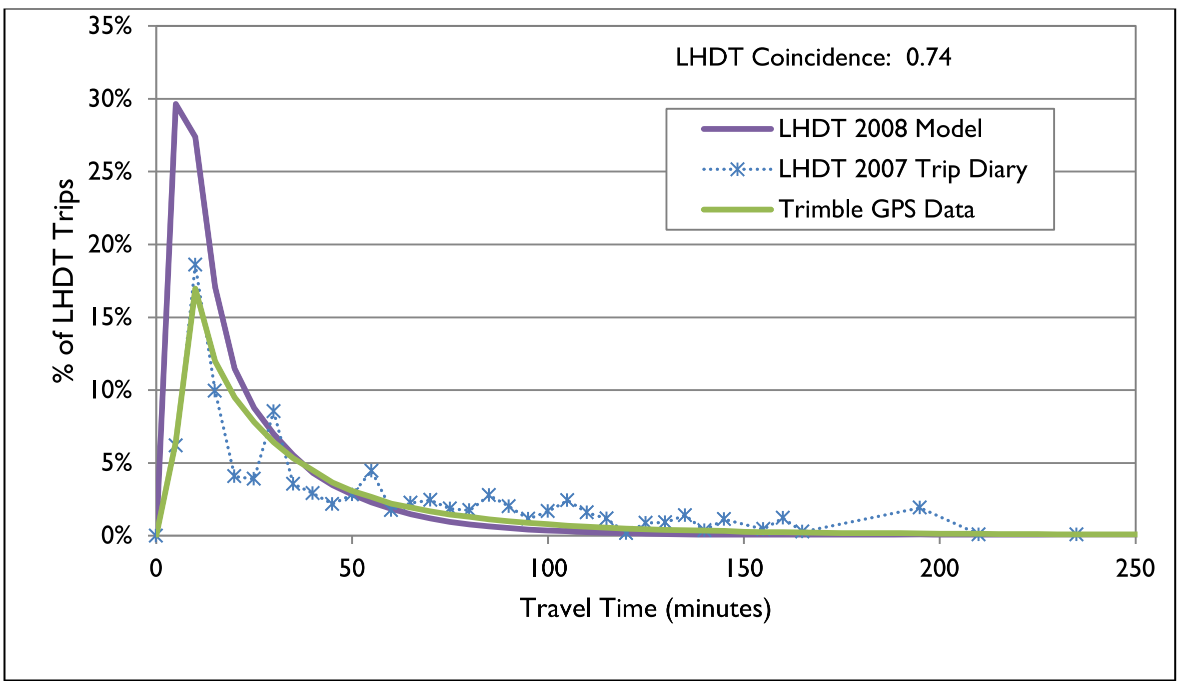


Figure 7-2 LHDT Internal Truck Trip Length Calibration

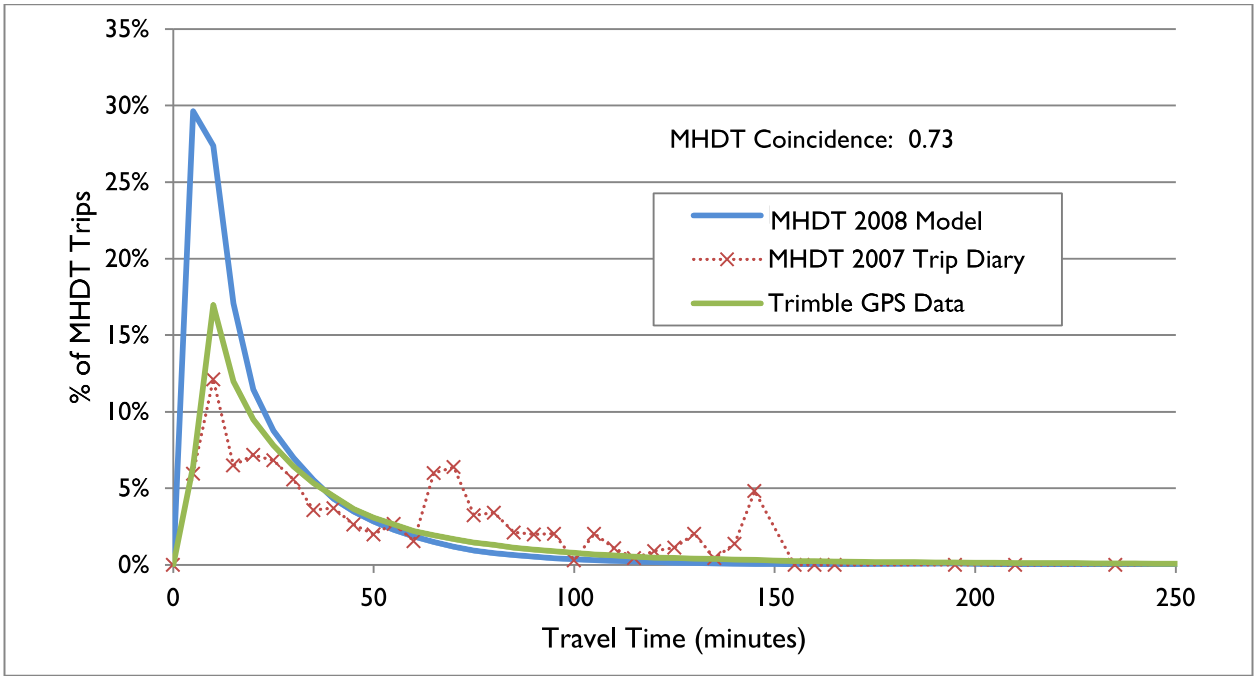


Figure 7-3 MHDT Internal Truck Trip Length Calibration

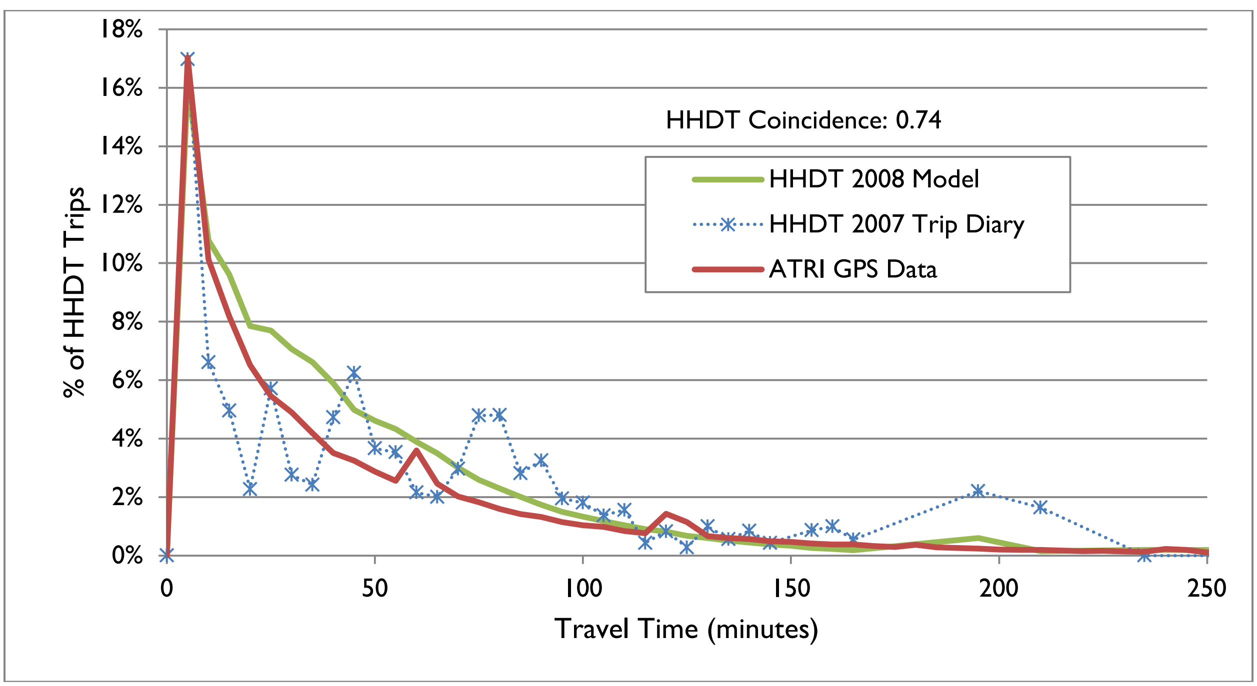


Figure 7-4 HHDT Internal Truck Trip Length Calibration

External HDT Model

The external HDT Model consists of internal-external & external-internal trips (IE/EI), and external-external truck trips (EE). The IE/EI HDT trips are generated and distributed using a combination of commodity flow data at the county level and 2-digit NAICS employment data for allocating county data to TAZs. Growth factors developed using the commodity flow data at a county level and external cordon are used to forecast future year external HDT trips from the base year trip flow matrices.

The external HDT Model is based on the 2007 TRANSEARCH commodity flow table. The TRANSEARCH data are provided as annual flows in tons and are converted to daily weekday flows using an annualization factor of 306 (6 days per week for 51 weeks) for all commodities. The flows are converted from tons to trucks using the payload factors shown in Table 7-5. These payload factors were developed using data from the 2002 Vehicle Inventory and Use Survey (VIUS).

The methodology that converts commodity flows to annual HDT trips at the TAZ level is described below for various direction, commodity and shipment type combinations.

Outbound Truck Load and Private Carrier Shipments

The external trip end of the outbound commodity flows are allocated to external cordon stations using survey data from the SCAG region. The internal trip end of the outbound commodity flows is disaggregated from counties to TAZs based on shares of employment in the manufacturing, agricultural, mining industries, or warehousing land use acreage, depending on the type of commodity.

Inbound Truck Load and Private Carrier Shipments

The external trip end of the inbound commodity flows are allocated to cordon stations as described above for outbound flows. To establish the internal TAZ trip end, flows of each commodity destined to warehouses are estimated using Reebie data, and then disaggregated to TAZs based on the share of warehousing land use acreage. The remaining non-warehouse destination flows are assumed to be destined directly to manufacturing facilities. To disaggregate these flows, the fraction of each commodity consumed by different industries is determined using an Input-Output table, and then disaggregated to TAZs based on shares of employment in the corresponding industry.

Less than Truck Load (TL) Shipments

SCAG inbound and outbound LTL shipments typically move through LTL terminals at the origin and destination so the same methodology is used for both directions. Also, since LTL shipments could carry any commodity, the approach is the same for all commodities. Truck load payload factors are used because payloads for LTL shipments cannot be determined (each LTL shipment carries many commodities with varying payloads). The external trip end of the LTL commodity flow is allocated to cordon stations as described above for truck load shipments. The internal trip end is disaggregated from county to TAZ based on the share of LTL trucking employment.

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Table 7-5: External HDT Commodity Payload Factors

Commodity		Payload Factors (Tons per Truck)		
STCC	Description	LHDT	MHDT	HHDT
1	Farm Products	1	2	16
8	Forest Products	3	6	14
9	Fresh Fish or Other Marine Products	2	2	10
10	Metallic Ores	3	3	24
11	Coal	3	3	18
13	Crude Petroleum, Natural Gas, or Gasoline	3	6	15
14	Non-metallic Minerals	4	5	16
19	Ordinance or Accessories	2	5	14
20	Food or Kindred Products	3	4	15
21	Tobacco Products, excluding Insecticides	3	6	15
22	Textile Mill Products	1	4	11
23	Apparel or Other Finished Textile Products	5	6	9
24	Lumber or Wood Products, excluding Furniture	4	6	16
25	Furniture or Fixtures	2	3	9
26	Pulp, Paper, or Allied Products	2	7	13
27	Printed Matter	2	7	15
28	Chemicals or Allied Products	2	5	14
29	Petroleum or Coal Products	3	6	11
30	Rubber or Miscellaneous Plastics Products	3	5	12
31	Leather or Leather Products	3	6	13
32	Clay, Concrete, Glass, or Stone Products	3	7	14
33	Primary Metal Products	5	6	15
34	Fabricated Metal Products	5	5	11
35	Machinery, excluding Electrical	2	3	9
36	Electrical Machinery, Equipment, or Supplies	2	5	8
37	Transportation Equipment	2	7	11
38	Instruments, Photographic Goods, Optical Goods, Watches, or Clocks	2	4	10
39	Miscellaneous Products of Manufacturing	2	6	8
40	Waste or Scrap Materials	2	3	14
43	Mail	3	4	14
44	Freight Forwarder Traffic	3	1	7
45	Shipper Association or Similar Traffic	3	6	9
46	Freight All Kinds	3	5	12
47	Small Packages, LTC or LTL	3	6	10
48	Waste Hazardous Materials or Waste Hazardous Substances	3	6	15

External – External HDT Trips

The 2007 TRANSEARCH data identify EE truck freight flows passing through the SCAG region. To assign the cordon station to each EE trip end, a method similar to the one used for the external end of the IE/EI trips was used.

Empty Truck Trips

To account for all external truck trips in the SCAG region, empty truck are added to the loaded truck trips estimated from the commodity flows. Empty truck trip percentages at each external cordon location were generated from survey data. Assuming the empty truck fractions to be the same for all O-D pairs for an external cordon, empty truck trips are added to the loaded truck trips between SCAG TAZs and external TAZs.

Port HDT Model

Ports TAZ Development

The SCAG Tier 1 Zone System consists of 4,192 TAZs, including 40 TAZs that represent the Ports areas. The Port HDT Model was updated to use a more refined set of port TAZs, developed by the Port of Long Beach. This zone system, called Port TAM, includes a total of 85 Ports area TAZs, for a total of 4,251 Tier 1 TAZs. Table 7-6 below provides a summary breakdown of the 4,251 TAZ system.

Table 7-6: Port TAM 4,251 TAZ System

from Zone ID	To Zone ID	Zone Type	Total
1	4109	Internal zones	4,109
4110	4149	External zones	40
4150	4161	Airport zones	12
4162	4246	Port zones	85
4247	4251	Extra zones	5
Total Zones			**4,251**

Terminal Gate Surveys

Origin-destination (OD) truck surveys were conducted in early 2010 at the Ports of Los Angeles and Long Beach Marine Terminals. The marine terminals are distribution points where international cargo is loaded onto trucks and rail. The survey was conducted to obtain OD pattern information by truck type. Surveys were conducted at six Port of Long Beach terminals (ITS, PCT, LBCT, CUT, SSA, and HANJIN) and six Port of Los Angeles terminals (YTI, MAERSK, EVERGREEN, TRAPAC, YANG MING, and APL).

A total of 23,030 survey sheets were distributed and 3,559 were returned. From the returned surveys, 2,981 origin trips were fully completed and geo-coded, and another 2,593 destination trips were also fully completed and geo-coded for a total of 5,574 trips. Tables 7-7 and 7-8 present the survey sample origins and destinations by container type.

The marine terminal truck trips exhibited the following OD patterns:

- 12% traveled to the Ports areas & nearby locations
- 30% traveled to Gateway cities locations
- 20% traveled to off-dock yards
- 33% traveled to locations within the rest of the SCAG region
- Less than 5% traveled to out of state locations
- 98% of the off-dock intermodal yard traffic went to the four main intermodal yards (ICTF, Hobart, East LA, and LATC). Almost no traffic was recorded from yards at Industry and San Bernardino.

Table 7-7: Survey Sample Origins

Terminal	Bobtails	Chassis	Containers	Total
ITS	121	45	259	**425**
PCT	98	33	215	**346**
LBCT	165	14	282	**461**
CUT	94	45	151	**290**
SSA	75	26	73	**174**
HANJIN	142	13	198	**353**
YTI	9	3	21	**33**
MAERSK	107	31	80	**218**
EVERGREEN	59	21	104	**184**
TRAPAC	163	13	166	**342**
YANG MING	48	10	69	**127**
APL	13	1	14	**28**
Total	**1,094**	**255**	**1,632**	**2,981**

Table 7-8: Survey Sample Destinations

Terminal	Bobtails	Chassis	Containers	Total
ITS	116	22	246	**384**
PCT	77	22	173	**272**
LBCT	115	15	258	**388**
CUT	89	18	141	**248**
SSA	30	14	94	**138**
HANJIN	85	31	187	**303**
YTI	15	1	16	**32**
MAERSK	35	31	140	**206**
EVERGREEN	55	6	103	**164**
TRAPAC	86	14	213	**313**
YANG MING	23	10	81	**114**
APL	10	3	18	**31**
Total	**736**	**187**	**1670**	**2,593**

Port Truck Trip Generation

The port trip generation model was developed in 2008 based on a detailed port area zone system and specialized trip generation rates for autos and trucks by type (Bobtail, Chassis, and Containers). Port truck trip generation has two components: 1) container terminal truck trips, and 2) non-container terminal truck trips.

Container Terminal Truck Trip Generation

The container terminal truck trip generation model for the ports is referred to as the QuickTrip Model. QuickTrip was originally developed for the Ports of Los Angeles and Long Beach. The Model includes detailed input variables such as mode split (rail versus truck moves), time-of-day factoring, weekend moves, empty return factors, and other characteristics that affect the number of trucks entering and exiting through the terminal gates. The relevant input data for each container terminal include the following:

- Peak monthly Twenty-Foot Equivalent Units (TEU) throughput.
- TEU-to-lift conversion factor: factor determining the average number of TEUs associated with each lift at the terminal.
- TEU land-side throughput distributions: percent of TEU throughput associated with on-dock intermodal imports, on-dock intermodal exports, off-dock intermodal imports, off-dock intermodal exports, local imports, local exports, empties, and trans-shipments across the wharf.
- Number of operating days during the week.
- Percent of throughput moved during each terminal operating shift (for the day, second and hoot shifts).

QuickTrip produces the following truck trip outputs for each terminal:

- Monthly gate transactions
- Peak week truck trip volume
- Daily truck trips, and truck trips by each hour of the day by type of truck trip (bobtail, chassis, container, empty), and direction (arrival at and departure from the terminal)

QuickTrip can be used to generate base as well as future year truck trips by truck type and direction for each terminal, using the model inputs described earlier for each specific year. The inputs that are particularly expected to change for different years include the peak monthly TEU throughput, and the TEU land-side throughput distributions (based on expected increase in on-dock intermodal capacity at the port terminals in the future). Additionally, the model has the capability to analyze the impacts of other port truck trip reduction strategies such as virtual container yards and off-peak truck diversions, using specific inputs associated with these strategies.

The Model was enhanced to allow the user to assess whether the estimated capacity of each rail yard has been exceeded. If so, traffic is iteratively re-allocated to other yards that are not over capacity. The enhanced model also allows the user to choose different efficiency factors, such as "percent double cycle trucks," for different off-dock yards. In the original version, the user had to use the same variables for the entire off-dock market.

Non-Container Terminal Truck Trip Generation

Non-container terminal truck trip generation estimates were also developed for the Ports as part of the Port truck trip generation process. This includes trips to and from all of the other types of marine terminals (automobile terminals, dry bulk terminals, liquid bulk terminals and break-bulk terminals). In addition, there are many non-terminal land uses located throughout the ports (e.g., administrative offices, recreation, commercial, government buildings) that potentially generate truck traffic.

Existing non-container terminal truck trips were developed by conducting a series of driveway and midblock truck counts throughout the Ports. A number of specific terminals were counted at their driveways, while other terminals and miscellaneous land use activities were reflected via the use of downstream roadway truck counts. In some cases, a roadway truck count was used to represent the trip generation of a group of non-container terminals and other land uses.

Port Trip Table Distribution

The zone to zone distribution of port truck trips is based on a fixed OD matrix. A detailed and comprehensive truck driver survey was undertaken by the ports at the marine container terminals. The survey was used to develop detailed origin-destination "trip tables" for use in the Port area travel demand model. The stated trip OD from every valid survey was correlated with the travel demand model TAZ system. The survey results were then used to develop port truck OD matrices by truck type for use in the model. Distribution patterns were developed separately for arrival trips and departure trips for each terminal. A total of 15 Port Truck Trip Tables were developed (5 time periods by 3 vehicle classes): AM, MD, PM, EV and NT time periods, and Bobtails, Chassis and Container truck trips. The time periods are consistent with those used by the passenger model. Empty container and loaded container truck types are combined into one truck type called container truck type.

For terminals with few or no observations (Pier C, YTI and APL) an average distribution of all surveyed records was used. Before creating survey frequency distribution vectors, survey sample trips were adjusted to exclude trips that have both OD within the same terminal.

Base Year Port Trip Tables Summary

Summaries of 2008 Port truck trips are shown in Tables 7-9 and 7-10.

Table 7-9: 2008 Port HDT Trips by Truck Type

Time Period	Bobtails	Chassis	Containers	Total
AM	1,339	415	1,858	3,612
MD	7,756	2,439	11,037	21,232
PM	3,669	1,159	5,248	10,076
EV	1,888	596	2,696	5,180
NT	2,832	895	4,045	7,772
Daily	**17,484**	**5,504**	**24,884**	**47,872**

Table 7-10: 2008 Port HDT Trips by Time Period and County

County	Time Period					
	AM	MD	PM	EV	NT	Total
Imperial						**0**
Los Angeles	3,276	19,752	9,430	4,846	7,269	**44,573**
Orange	108	475	206	106	159	**1,055**
Riverside	46	204	89	46	69	**455**
San Bernardino	153	675	295	153	230	**1,506**
Ventura	6	26	12	7	10	**62**
External Stations	23	100	44	23	34	**224**
Total	**3,612**	**21,233**	**10,076**	**5,182**	**7,772**	**47,875**
% of Daily Trips	**7.5%**	**44.4%**	**21.0%**	**10.8%**	**16.2%**	

Intermodal HDT Trips

Intermodal Trip Tables

Intermodal (IMX) trucks trips are heavy HDT movements generated at the six regional intermodal facilities in the SCAG region. These intermodal facilities are shown in Figure 7-5. The intermodal (IMX) trip tables were developed from the IMX surveys conducted for LACMTA in 2005[5]. These surveys collected the following data on truck movements at these facilities: total inbound and outbound trains by month, including origin, destination, and number of containers by type; weekly train schedule; number of "lifts" (loading/unloading rail cars) by month split by containers versus trailers; and gate transactions by day by type (inbound, outbound, loaded, empty and bobtail).

The data obtained from the six IMX terminals were used to put together matrices of annual shipment flows at the zip code level. Trips to or from the ports were excluded, as they will be modeled by the Port HDT Model. Four customer data matrices were developed: TL inbound, TL outbound, LTL inbound, and LTL outbound. A summary of these truck movements is shown in Table 7-11. These truck trips were all assumed to be HHDTs. The daily truck trips were developed assuming an annualization factor of 306. A summary of the IMX daily trip tables by terminal and county, as derived from the 2005 IMX surveys, is presented in Table 7-12.

[5] Cambridge Systematics, Inc. LACMTA Cube Cargo Model Development. 2005.

Figure 7-5: Intermodal Facilities in the SCAG Region

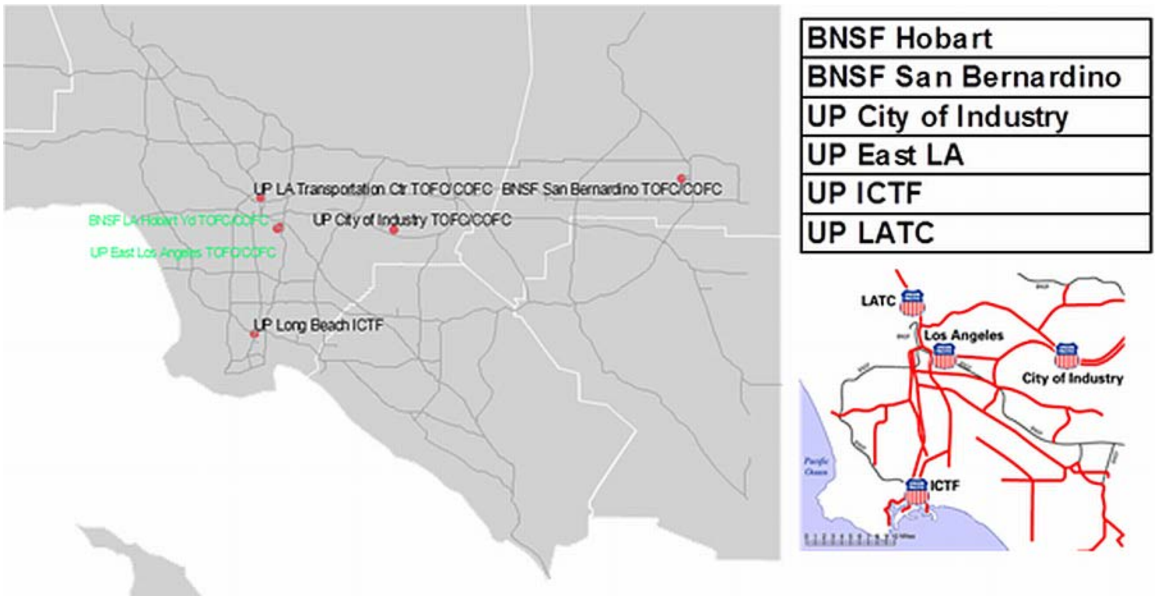

Table 7-11: 2005 Domestic IMX (Non-Port) Annual Truck Trips

Domestic	BNSF Hobart	BNSF San Bernardino	UP City of Industry	UP East LA	UP ICTF	UP LATC	Total
Inbound	444,204	433,333	93,789	96,757	2,463	21,812	1,092,357
TL/IMC	273,495	300,654	81,789	85,567	2,276	18,781	762,562
LTL	170,708	132,679	12,000	11,190	187	3,031	329,795
Outbound	445,011	458,677	78,431	69,837	662	21,353	1,073,970
TL/IMC	280,997	331,201	66,901	59,086	482	18,441	757,108
LTL	164,014	127,476	11,530	10,751	180	2,912	316,862
Total	889,214	892,009	172,220	166,594	3,125	43,165	2,166,327
TL/IMC	554,492	631,855	148,690	144,653	2,758	37,222	1,519,670
LTL	334,722	260,154	23,530	21,941	367	5,943	646,657

Table 7-12: 2008 Intermodal HHDT Trips by Terminal and County

IMX Terminal	IMX Terminal TAZ	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	Grand Total	Share by Terminal
UP ICTF	1,360	0	9	1	1	1	0	**13**	**0%**
UP LATC	1,591	0	84	22	24	15	1	**147**	**2%**
BNSF Hobart	1,679	10	1,722	280	327	532	36	**2,905**	**40%**
UP East LA	1,702	2	322	110	78	73	4	**589**	**8%**
UP City of Industry	2,304	6	283	152	112	49	3	**606**	**8%**
BNSF San Bernardino	3,773	19	516	1,687	687	50	2	**2,961**	**41%**
Grand Total		**37**	**2,937**	**2,252**	**1,228**	**720**	**47**	**7,221**	
Share by County		**1%**	**41%**	**31%**	**17%**	**10%**	**1%**		

Secondary HDT Trips

The truck trip table calculated from the Port and IMX models comprises only the portion of the trip between those facilities and locations, primarily wholesale land uses, elsewhere in the SCAG region. These trips give rise to additional, "secondary" trips from these locations. That is, the first leg of this HDT trip chain is from Port or IMX to wholesale, while the second leg is from that wholesale land use to any internal TAZ in the six-county SCAG region.

These trips should be represented as wholesale land use truck trips in the internal HDT Model. The Port and IMX implied secondary truck production and attractions were added to the internal trucks prior to trip distribution. Table 7-13 presents a summary of the total wholesale HHDT trips in the region that are computed from three models – internal HDT, Port and IMX.

Table 7-13: 2008 Wholesale HDT Trips

Truck Type/PA	Internal HDT	Port Model HHDT	IMX HHDT Trips	Total Wholesale HHDT
LHDT Productions	35,129	n/a		
LHDT Attractions	35,129			
MHDT Productions	37,133			
MHDT Attractions	37,133			
HHDT Productions	50,470	12,885	3,405	66,760
HHDT Attractions	50,470	12,254	3,570	66,294

HDT Time-of-Day Factoring & Assignment

The HDT Model uses fixed time-of-day factors derived from observed truck counts. The HDT time of time periods are consistent with the passenger model periods, namely:

- AM Peak: 6:00 AM – 9:00 AM
- Mid-day: 9:00 AM - 3:00 PM
- PM Peak: 3:00 PM - 7:00 PM
- Evening: 7:00 PM – 9:00 PM
- Night: 9:00 PM – 6:00 AM

The HDT diurnal factors were derived from the 2007 Vehicle Travel Information System (VTRIS)[6] database. VTRIS is maintained by the FHWA Office of Highway Policy Information to track traffic trends, vehicle distributions and weight of vehicles to meet data needs specified in highway legislation. The VTRIS database contains truck classification counts spanning nearly half a year at many locations on SCAG interstate and state highways. The HDT time of day factors are shown in Table 7-14.

[6] http://www.fhwa.dot.gov/ohim/ohimvtis.cfm

Table 7-14: HDT Time-of-Day Factors

Time Period	Diurnal Factors		
	LHDT	MHDT	HHDT
AM Peak (6 AM - 9AM)	18.8%	18.0%	13.9%
Midday (9 AM-3PM)	42.9%	46.5%	35.3%
PM Peak (3 PM- 7PM)	20.3%	15.5%	16.7%
Evening (7 PM - 9 PM)	4.8%	3.5%	7.2%
Night (9 PM - 6AM)	13.2%	16.5%	26.9%

HDT trips are assigned simultaneously with the auto trips as part of a user equilibrium multiclass assignment. The assignment methodology is described in detail in Chapter 8 – Trip Assignment. Truck volumes are converted to PCEs following the procedures recommended in the 2010 Highway Capacity Manual. The PCE factors are a function of grade, length of the climb segment, and percent of truck volume, and vary by truck type (LHDT, MHDT and HHDT). These factors are shown in Table 7-15.

Table 7-15: HDT Passenger Car Equivalent Factors

Percent Trucks	Length of Grade in miles	Light -Heavy				Medium-Heavy				Heavy-Heavy			
		% Grade				% Grade				% Grade			
		< 2	2 - 4	4 - 6	> 6	< 2	2 - 4	4 - 6	> 6	< 2	2 - 4	4 - 6	> 6
0-5%	< 1	1.3	1.5	3.0	4.0	1.5	2.0	3.5	5.0	2.5	2.5	4.5	6.0
	1 - 2	1.3	2.5	4.0	5.0	1.5	3.5	5.0	6.5	2.5	5.0	7.5	12.5
	> 1	1.3	2.5	4.0	5.0	1.5	3.5	5.0	6.5	2.5	5.0	7.5	12.5
5-10%	< 1	1.3	1.5	2.5	3.0	1.5	2.0	3.0	4.0	2.5	2.5	4.5	5.5
	1 - 2	1.3	2.0	3.5	4.0	1.5	3.0	4.0	5.5	2.5	4.0	8.0	11.5
	> 1	1.3	2.0	3.5	4.0	1.5	3.0	4.0	5.5	2.5	4.0	8.0	11.5
>10%	< 1	1.3	1.5	2.0	2.5	1.5	2.0	2.5	3.0	2.5	2.5	4.0	4.0
	1 - 2	1.3	2.0	3.0	3.5	1.5	2.5	3.5	4.0	2.5	3.5	6.0	9.0
	> 1	1.3	2.0	3.0	3.5	1.5	2.5	3.5	4.0	2.5	3.5	6.0	9.0