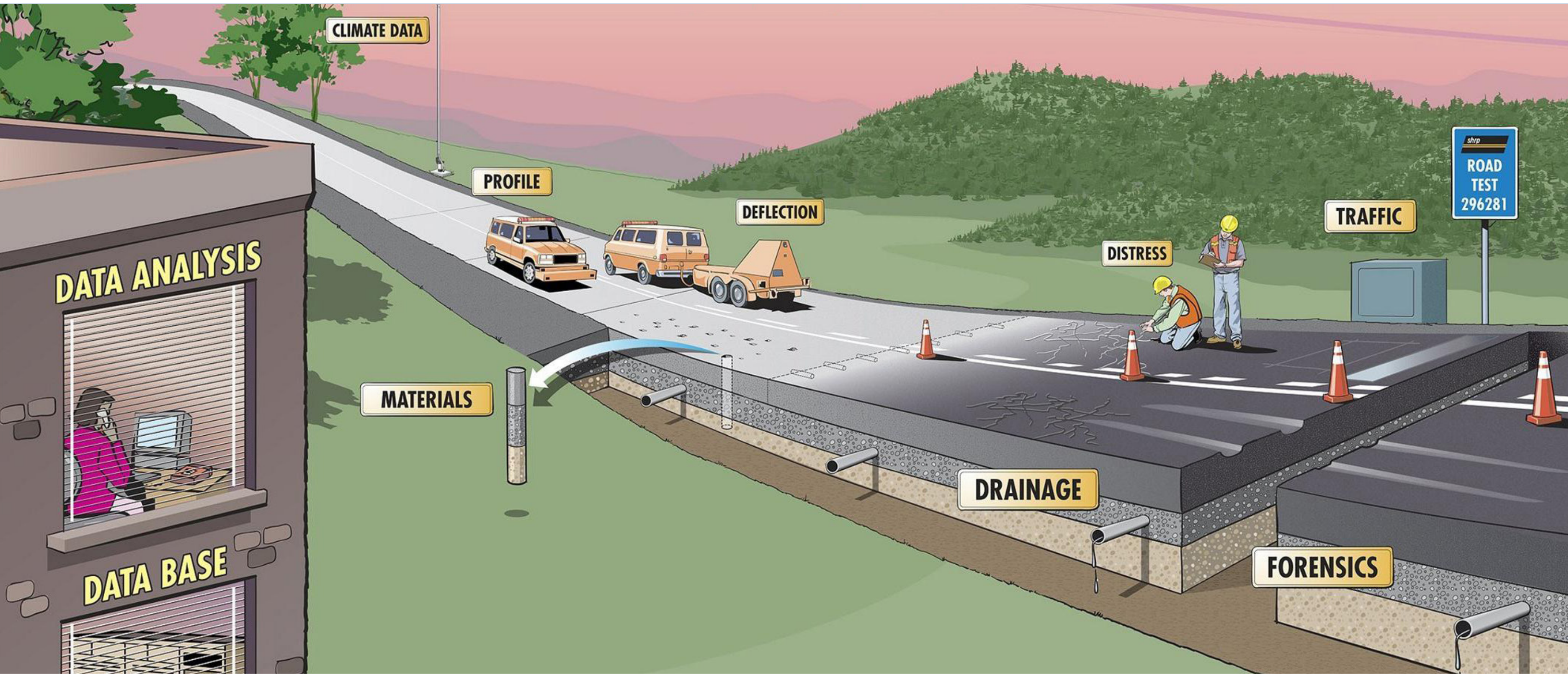
Guide to Select Long-Term Pavement Performance Traffic Data for Multiple Uses

PUBLICATION NO. FHWA-HRT-24-062 MARCH 2024



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Federal Highway Administration

Research, Development, and Technology
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LTPP™

FOREWORD

This Guide is designed to help users of the Long-Term Pavement Performance (LTPP) database navigate the available traffic data and computed parameters in the LTPP InfoPave™ web portal. The Guide identifies traffic parameters suitable for different pavement analyses and details how to use InfoPave to extract the desired data.

The Guide consists of two parts. Part 1 describes traffic parameters available through LTPP program sources and provides details about the methods used to collect traffic data and compute traffic parameters. It also contains recommendations for the most applicable traffic parameters for different types of pavement analyses. Part 2 provides practical examples and details on how to use InfoPave to identify and extract various traffic parameters for LTPP sites.

The methodologies presented in this report can be applied beyond the LTPP program to assist highway agencies in the computation of traffic statistics necessary to support pavement design, research, management, and forensic investigations. Contractors, researchers, and consultants can also benefit from this research.

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Research and Development

Cover Graphic
Source: FHWA.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA-HRT-24-062	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Guide to Select Long-Term Pavement Performance Traffic Data for Multiple Uses		5. Report Date March 2024
		6. Performing Organization Code
7. Author(s) O.I. Selezneva and M.E. Hallenbeck (ORCID: 0000-0002-2298-0666)		8. Performing Organization Report No.
9. Performing Organization Name and Address Applied Research Associates, Inc. 7184 Troy Hill Drive, Suite N Elkridge, MD 21075-7056		10. Work Unit No.
		11. Contract or Grant No. DTFH6114C00018
12. Sponsoring Agency Name and Address Office of Infrastructure Research and Development Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296		13. Type of Report and Period Covered July 2014—September 2023; Final Report
		14. Sponsoring Agency Code HRDI-30

15. Supplementary Notes
Deborah Walker (ORCID: 0000-0002-3684-5190; HRDI-30) served as the contracting officer's representative.

16. Abstract
The purpose of this Guide is to help Long-Term Pavement Performance (LTPP) data users determine traffic parameters suitable for their analyses and identify LTPP tables containing such parameters. This Guide describes available tools and specific procedures for extracting these parameters from the LTPP database and provides practical examples with step-by-step instructions for identifying and extracting traffic parameters for different types of LTPP and other research analyses. This Guide consists of two parts. Part 1 includes a description of traffic data and parameters available through LTPP program sources and provides recommendations on what traffic parameters are most applicable for different types of pavement analyses. Part 1 also provides information about methods used to collect traffic data and compute traffic parameters. Part 2 contains practical examples of how to identify and extract different traffic data and parameters from the LTPP database using the InfoPave™ web portal. In summary, this Guide is designed to help LTPP users maximize use of LTPP traffic data for achieving their pavement analysis objectives.

17. Key Words	18. Distribution Statement
Traffic data, traffic loading, pavement design, Long-Term Pavement Performance, MEPDG, WIM, vehicle class, truck volume, axle weight	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. https://www.ntis.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	160	N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1,000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT	annual average daily traffic
AADTT	annual average daily truck traffic
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
AIMS	Ancillary Information Management System
ALDF	axle load distribution factors
APT	axles per truck
ATL	annual total truck load
ATR	automatic traffic recorder
AVC	automatic vehicle classifier
CTL	cumulative total truck load
CTV	cumulative truck volume
DOW	day of the week
ESAL	equivalent single-axle load
FHWA	Federal Highway Administration
GESAL	general equivalent single-axle load
GPS	General Pavement Study
GVW	gross vehicle weight
HDF	hourly distribution factors
ID	identification
IMS	Information Management System
IMS Guide	*Information Management System User Guide*
IVR	individual vehicle record
JPCP	jointed plain concrete pavement
LEF	load-equivalency factor
LTAS	Long-Term Pavement Performance Traffic Analysis Software
LTPP	Long-Term Pavement Performance
MAF	monthly adjustment factor
MEPDG	*Mechanistic-Empirical Pavement Design Guide*
NALS	normalized axle load spectra
NCHRP	National Cooperative Highway Research Program
PCC	portland cement concrete
PLUG	*Pavement Loading User Guide*
QC	quality control
RPPIF	Relative Pavement Performance Impact Factor
SDR	Standard Data Release
SN	structural number
SPS	Specific Pavement Study
SQL	Structured Query Language
TMG	*Traffic Monitoring Guide*
TPF	Transportation Pooled-Fund Study
VCD	vehicle class distribution
WIM	weigh-in-motion

PART 1. LTPP TRAFFIC DATA AND PARAMETERS: DATA SOURCES, METHODS, TOOLS, AND RECOMMENDATIONS FOR USE

This Guide consists of two parts. Part 1 helps Long-Term Pavement Performance (LTPP)[1] users make informed decisions about selecting traffic parameters suitable for their pavement analysis goal(s) and includes the following:

- Overview (chapter 1).
- Description of the traffic data and parameters available through LTPP program sources (chapter 2).
- Description of methods used by the LTPP program to collect traffic data and compute traffic parameters (chapter 3).
- Recommendations on what traffic parameters are most applicable for different types of pavement analyses (chapter 4).
- Information on where to get the LTPP traffic data (chapter 5).

In summary, part 1 of this Guide provides detailed descriptions of the traffic parameters available from LTPP sources and their applicability for different types of pavement analyses.[2,3]

CHAPTER 1. INTRODUCTION

BACKGROUND

Traffic data support LTPP program[(1)] experiments and data analysis studies by providing a measure of traffic loads applied to individual LTPP pavement test sections being studied. Most LTPP test sites are located on the existing highways that have accumulated traffic loads prior to the installation of traffic monitoring equipment. The exceptions are selected Specific Pavement Study (SPS)[(1)] test sites for new flexible and rigid pavements that had traffic monitoring equipment installed from the beginning of the pavement's service life. Over the years, a large quantity of traffic data have been collected at LTPP test sites. Most data were collected by U.S. State and Canadian Provincial transportation agencies and submitted to the LTPP program. These data were collected using a variety of equipment and data collection methods. As a result, both data quantity and quality vary among the LTPP test sites. Over the years, based on the collected data, many traffic parameters have been developed and stored in different LTPP database tables[(2,3,4)] The format, location, and contents of these tables have been modified over time to make the traffic data easier to access. Currently, these tables are accessible through the InfoPave™ web portal.[(3)] However, users not familiar with the history and evolution of the LTPP traffic data collection effort often face challenges identifying relevant data tables and reliable data suitable for their analyses. This document will remedy those challenges.

PURPOSE

The purpose of this *Guide to Select Long-Term Pavement Performance Traffic Data for Multiple Uses* (herein referred to as the "Guide") is to help LTPP users identify traffic parameters for their analyses and identify LTPP database tables containing such parameters. The Guide contains information about methods used to collect traffic data and compute traffic parameters. The Guide also describes how to extract these parameters using the InfoPave web portal and provides practical examples with step-by-step instructions for different types of LTPP and other pavement analyses.[(3)] In summary, the Guide is designed to help LTPP users maximize use of LTPP traffic data for achieving their pavement analysis objectives.

GUIDE OVERVIEW

This Guide consists of two parts. Part 1 describes traffic parameters available through LTPP program sources and provides recommendations about what traffic parameters are most applicable for different types of pavement analyses. It also provides details about methods used to collect traffic data and compute the traffic parameters. Part 2 contains practical examples of how to identify and obtain different traffic data and parameters using the InfoPave web portal.[(3)] For parameters not available through the web portal, examples of computational procedures are provided showing how available LTPP traffic data could be used to compute the desired parameter. For traffic parameters that cannot be computed using available LTPP traffic data, references to available default values and alternative data sources are provided.

Part 1 of the Guide includes the following chapters:

- Chapter 1 describes the purpose, scope, and organization of the Guide.
- Chapter 2 describes the traffic data and computed parameters with references to the LTPP database tables containing these parameters.
- Chapter 3 describes the sources of LTPP traffic data and methods used to collect the data, as well as provides references to the methods used to compute the traffic parameters. It describes indices and codes available in LTPP traffic tables that could be used to identify data sources and computational methods and how to use this information as an aid in traffic data and parameter selection.
- Chapter 4 provides recommendations about types of traffic data and parameters most suitable for common pavement analyses, including references to traffic parameter names and LTPP traffic tables containing these parameters.
- Chapter 5 describes the methods for obtaining LTPP traffic data and parameters using the InfoPave web portal or by contacting the LTPP Customer Support Service Center.

Part 2 of the Guide includes the following traffic data selection scenarios:

- Scenario 1 shows how to obtain traffic volume information.
- Scenario 2 shows how to obtain vehicle classification information.
- Scenario 3 shows how to obtain detailed axle or truck loading information.
- Scenario 4 shows how to obtain summary traffic loading information.
- Scenario 5 shows how to obtain traffic inputs for use in the AASHTOWare® Pavement ME Design™ software.(5)

In summary, part 1 helps LTPP users make informed decisions about selecting traffic parameters suitable for their pavement analysis goal(s), and part 2 provides detailed instructions on how to obtain these parameters from LTPP sources.(3)

CHAPTER 2. LTPP TRAFFIC DATA AND SOURCES

The *LTPP Information Management System* [IMS] *User Guide* (IMS Guide) is a comprehensive resource that describes various databases maintained by LTPP program.(2) Chapter 12 and chapter 16 of the IMS Guide contain descriptions of the traffic tables included in the LTPP program's annual Standard Data Release (SDR).(6) The SDR contains data and information for researchers, highway agency personnel, and others interested in pavement performance-related research and is downloadable through the LTPP InfoPave web portal.(3) This chapter provides information from the IMS Guide pertinent to using LTPP traffic data and parameters.

LTPP TRAFFIC DATABASES

The LTPP traffic tables are updated annually and available for download from the InfoPave web portal.(3) The LTPP traffic data tables come from the two LTPP data sources described in the following subsections.

Traffic Databases Included in the SDR

LTPP traffic data and parameters used for most pavement analyses are included in the Traffic module of the Pavement Performance section of the SDR.(6) The contents of the Traffic module are described in chapter 12 of the IMS Guide.(2) The Traffic module contains several tables with annual estimates of traffic volume, vehicle classification, and axle loading in the LTPP lane. In addition to traffic parameters commonly used in transportation engineering and planning, traffic input parameters formatted for use with the Mechanistic-Empirical Design Guide (MEPDG) method are included in the Traffic module, as well as traditional equivalent single-axle load (ESAL) parameter used in pavement design prior to the development of the MEPDG method.(2,7,8) These tables support pavement analyses based on empirical methods, as well as mechanistic–empirical analyses.

The Pavement Performance section of the SDR(6) contains the following traffic databases, which are available in Microsoft® Access® format:

- Traffic: This database contains all SDR traffic tables, excluding the TRF_MEPDG_AX_DIST table, which stores MEPDG axle load distributions.
- TRF_MEPDG_AX_DIST_*: This series of databases, organized by State code (each database name has the State's two-letter abbreviation instead of "*"). Each database contains the TRF_MEPDG_AX_DIST table detailing axle load distributions binned in MEPDG-compatible format. The data in this table are stored by LTPP section identification (ID) (including STATE_CODE and SHRP_ID), year, vehicle class, and axle group for years with at least 210 days of accepted traffic loading data for the LTPP lane.

Traffic Databases Associated with LTPP Traffic Analysis Software

Another source of LTPP traffic data includes databases associated with the LTPP Traffic Analysis Software (LTAS) database.(2) LTAS data are mostly used by traffic researchers interested in the analysis of traffic characteristics and their changes over time on a more granular, disaggregated level. Chapter 16 of the IMS Guide contains detailed descriptions of the LTAS database's structure and tables.(2) The LTAS databases contain daily and monthly traffic data used for computing annual traffic estimates stored in the pavement performance database. LTAS data also contain information on the locations of traffic monitoring equipment, statistical summaries used in the quality review of traffic data, information about identified data errors, and other information used in the traffic data review and analysis. In addition, traffic data from adjacent or non-LTPP lanes are stored in LTAS databases. States may provide traffic data from additional lanes adjacent to the LTPP test section or lane. These data are stored but not processed.

Starting in 2017, LTAS data also include normalized axle load spectra (NALS) at monthly and annual levels and the Relative Pavement Performance Impact Factor (RPPIF). Due to size limitations, LTAS tables may be in either Microsoft Access or Microsoft Structured Query Language (SQL) Server database format.

LTAS data in Microsoft Access format include the following traffic databases (two-letter State name abbreviation is used instead of "*" in database names).(2)

- Annual_Traffic_*: Series of databases, organized by State code containing summarized count data and annual traffic estimates for the LTPP test sections.
- Daily_Count_ERR_*: Series of databases, organized by State code containing daily vehicle classification, weight, and volume counts along with the associated error counts for class and weight data for the LTPP test sections. Traffic data purges and the record status of the traffic data are also included.
- Hourly_Class_Counts: Contains volume of trucks by hour table for SPS sites with a weigh-in-motion (WIM) system that has been field validated by the LTPP program.
- LTAS_Administration: Contains LTAS-specific database metadata and other control tables used by the LTPP program.
- Monthly_Axle_*: Series of databases, organized by State code, containing monthly axle load distributions and supporting information for the LTPP test sections. The database may contain LTPP sections for a part of a State, a single State, or multiple States, depending on the size limitations of Microsoft Access.
- Monthly_Count: Contains monthly vehicle count data by month for the LTPP test sections.
- Monthly_GVW_*: Series of databases, organized by State code, containing monthly gross vehicle weight (GVW) data for the LTPP test sections by year, month, lane, direction, vehicle classification, and day of the week (DOW). Number of days of data in the month for that DOW is also included.

LTAS data available in SQL Server format include the following databases:[2]

- Daily_Axles_*: Series of databases, organized by State code containing daily data on the number of axles by axle load bin, vehicle class, and axle group for the LTPP test sections.
- Daily_GVW_*: Series of databases, organized by State code, containing daily data on GVWs aggregated by weight bin and vehicle class for the LTPP test sections.

LTPP TRAFFIC DATA TABLES AND PARAMETERS

A detailed description of the structures and contents of LTPP traffic data tables can be found using LTPP Table Navigator, accessible through the InfoPave web portal (select LTPP Table Navigator option on the Data menu, then select the LTPP traffic table name of interest under the Traffic subsection and click on the "Export to Excel" button).[3] The following sections summarize traffic tables available in the pavement performance database. Discussion of specific LTPP traffic parameters recommended for different LTPP analyses, with references to appropriate LTPP traffic data tables, is included in chapter 4. Traffic data and parameters are reported in LTPP traffic data tables for individual LTPP General Pavement Study (GPS) or SPS test sections.

Traffic Tables Associated with the Pavement Performance Database

Table Naming Convention

Names of tables[3] were developed to help users recognize the source of data or identify datasets developed for a specific application, such as the MEPDG.[7] The "*" character used in the following table names means that more than one table name has the prefix shown before the "*" character.

TRF_HIST Tables*

Tables[3] starting with the prefix TRF_HIST include traffic information provided to the LTPP program by State and Provincial highway agencies for the years prior to the installation of traffic monitoring equipment and for the years when traffic monitoring equipment was not collecting data. Most GPS test sections are existing highways that have accumulated traffic loads prior to the installation of traffic monitoring equipment. For pavement research, knowledge of these historical loadings is important. Whenever available, the methodologies that State highway agencies use to derive historical estimates have been documented by the agencies and provided to LTPP (as metadata). In some cases, little data were available, and histories are "best guess" estimates. Historical data include annual estimates of total and truck volumes and the total ESALs.

TRF_MON or TRF_MONITOR* Tables*

Tables[3] starting with prefixes TRF_MON or TRF_MONITOR include traffic information based on traffic monitoring data collected at LTPP sites. This traffic information consists of two types. The first type includes simple statistical summaries of actual measurements from automatic traffic recorders (ATRs), automatic vehicle classifiers (AVCs), and WIM equipment. The second type is computed values or annualized estimates based on the traffic monitoring data, including annual estimates of total and truck volumes, vehicle class distributions (VCDs), axle loading distributions, and total ESALs calculated using American Association of State Highway and Transportation Officials (AASHTO) methodology.

TRF_MEPDG Tables*

Tables(3) starting with the prefix TRF_MEPDG include traffic parameters that are computed to be used with the MEPDG method. TRF_MEPDG parameters are computed for the LTPP lane only for years with at least 210 days of accepted traffic loading data. The data included in TRF_MEPDG* tables require additional manipulation to develop representative values for use in the AASHTOWare Pavement ME Design software.(5) TRF_MEPDG traffic parameters include annual average daily truck traffic (AADTT), vehicle class and axle loading distributions, hourly truck volume adjustment factors, monthly truck volume adjustment factors, and the number of axles per vehicle class.

MEPDG Tables*

Tables(3) starting with the prefix MEPDG include traffic parameters that are computed for use in AASHTOWare Pavement ME Design.(5) MEPDG traffic parameters include base year (the first year the LTPP site opened to traffic) AADTT, representative VCD, truck traffic growth parameters by vehicle class, representative axle load distribution factors (ALDF), and the representative number of axles per vehicle class.

TRF_ESAL Tables*

Tables(3) starting with the prefix TRF_ESAL include annual ESAL estimates computed by the LTPP program using the methodology in the 1993 edition of the AASHTO *Guide for Design of Pavement Structures*.(8) The estimates are based on section-specific pavement structures. These estimates are available for each year that has accepted monitored axle-loading information for a section.

NALS and RPPIF* Tables*

Tables(3) starting with prefixes NALS or RPPIF(4) resulted from LTPP research that produced the *Long-Term Pavement Performance Pavement Loading Users Guide* (PLUG)(9) and LTPP traffic loading defaults(10) for AASHTOWare Pavement ME Design software. NALS tables contain normalized axle-load spectra by vehicle class and axle group. RPPIF tables contain traffic loading summary statistics used to group LTPP sites and vehicle classes with similar loading per axle.

Traffic Volume Table

The TRF_HIST_VOLUME_COUNT table(3) contains results of vehicle volume counts that were taken by State and Provincial highway agencies prior to the start of LTPP program traffic monitoring and were used to estimate traffic volumes at a given site. These counts were not necessarily taken at the sites.

Vehicle Classification Tables

The vehicle classification data can be found in the following tables accessible through InfoPave:(3)

- TRF_HIST_CLASS_DATA: This table contains results of vehicle classification counts that were taken by the State and Provincial highway agencies prior to the start of LTPP program traffic monitoring and were used to estimate vehicle distributions at a given site. These counts were not necessarily taken at the sites.

- TRF_MONITOR_LTPP_LN: This table contains information on the amount of traffic monitoring data collection, which occurred at each site for each year for each vehicle class. This table also includes the estimated annual volume of trucks by class and the estimated number of axles associated with those truck volumes. Values are reported only for the LTPP lane.

Traffic Loading Summary Tables

The traffic loading data can be found in the following tables accessible through InfoPave:(3)

- TRF_HIST_EST_ESAL: This table contains estimates of ESALs at the LTPP section level for each year from the date of that test section's construction (or 1965, whichever is later) until its inclusion in the LTPP program (or 1989, whichever is earlier).

- TRF_MON_EST_ESAL: This table contains annual estimates of the number of ESALs in the LTPP lane and estimates of truck and total vehicle volumes supplied by participating highway agencies. Data in this table are from 1990 (or when the LTPP lane became open to traffic, whichever is later) until the test section was instrumented with traffic monitoring equipment or for any year in which the traffic monitoring equipment was not operational.

- TRF_ESAL_COMPUTED: This table contains estimates of annual ESAL calculations for LTPP lanes. These ESAL estimates are provided only for sites that have acceptable samples of axle load measurements contained in the LTPP database in the indicated year. The axle load sample is expanded to an annual estimate using a time-based multiplier. Estimates are contained in the KESAL_YEAR field with units of kESAL/year or 1,000 ESAL/year. Thus, a value of 1 in this field should be interpreted as 1,000 ESAL/year in the LTPP lane.

- TRF_MONITOR_AXLE_DISTRIB: This table contains the annualized number of axles in each weight range (i.e., weight bin) for each axle group (i.e., single, tandem, triple, quad, and quad+ (more than four axles)). This information is obtained using the data collected by WIM equipment installed at or near LTPP test sections. Note that steering-axle weight distributions are not recorded separately from other single axles in this table. The WEIGHT_BIN_SIZE field contains the size of the weight bins used to describe the weight distribution by axle type. This distribution is for the LTPP lane only.

Tables Used for ESAL Computation

The data used for ESAL computation can be found in the following tables accessible through InfoPave:[3]

- TRF_ESAL_INPUTS_SUMMARY: This table contains a summary of all of the input data used for the annual ESAL estimate, including pavement type, structural number (SN) for asphalt concrete (AC) pavements, effective thickness for portland cement concrete (PCC) pavements, terminal service index value, functional road classification, climate characterizations such as annual average precipitation and freeze index, LTPP experimental climate region, and start and end dates associated with the construction number to which these values apply.

- TRF_ESAL_AC_THICK: This table contains values used to compute SNs for AC-surfaced test sections. It includes the thickness, type of layer, layer coefficient, average resilient modulus, and drainage layer coefficient for base and subbase layers. This table also includes start and end dates to which these values apply.

- TRF_ESAL_PCC_COMP_THICK: This table contains values used to compute values of the effective thickness of PCC layers used in the ESAL calculation. This table includes information on the thickness of multiple PCC layers and whether they are bonded.

MEPDG Traffic Inputs Tables

The MEPDG traffic input parameters can be found in the following tables accessible through InfoPave:[3]

- TRF_MEPDG_AADTT_LTPP_LN: This table contains estimates of AADTT in LTPP test lane computed by three alternate computation methods based on a combination of classification and weight data, only classification, or only weight data. Estimates are provided by year.

- TRF_MEPDG_VEH_CLASS_DIST: This table contains percentages of trucks by vehicle class within truck population (See Federal Highway Administration (FHWA) *Traffic Monitoring Guide* for definition of FHWA vehicle classes 4–13) in LTPP lane.[11] Each estimate is based on classification counts, weight data, or a combination of both classification and weight data as indicated by the code contained in the TRF_DATA_TYPE field. Estimates are provided by year.

- TRF_MEPDG_MONTH_ADJ_FACTR: This table contains adjustment factors for average daily truck traffic by month for each truck class based on either vehicle classification or weight data, as indicated by the code contained in the TRF_DATA_TYPE field. Estimates are provided by year.

- TRF_MEPDG_HOURLY_DIST: This table contains data describing the annual average hourly distribution of trucks by each hour of the day in LTPP lane, based on available classification data. Computations are performed using the MEPDG algorithm.[7] This table contains data for sites with at least 210 days of classification data in a calendar year.

- TRF_MEPDG_AX_DIST_ANL: This table contains the annual normalized axle load distributions by class and axle group for LTPP sites that satisfy data availability and data review criteria. Records in this table are generated from the LTPP TRF_MONITOR_AXLE_DISTRIB table where matching records in the TRF_MONITOR_LTPP_LN table have a RECORD_STATUS equal to D or E. Per site, at least 2 years with more than 210 days of WIM data must exist in the TRF_MONITOR_LTPP_LN table for data to be present in this table.

- TRF_MEPDG_AX_DIST_ANL_VAR: This table contains means and variances of the elements of the normalized axle load distributions by vehicle class and axle type for all years of available site-specific monitoring data. Per site, at least 2 years with more than 210 days of WIM data must exist for data to be present in this table.

- TRF_MEPDG_AX_DIST: This table contains normalized axle load distributions by month, truck class, and axle group for each LTPP site and year with more than 210 days of WIM data in the TRF_MONITOR_LTPP_LN table. This table is provided in multiple databases due to its large size, organized by State or Provincial code.

- TRF_MEPDG_AX_PER_TRUCK: This table contains the annual average number of axles by vehicle class and axle type by year for LTPP sites. These data are computed from axles weighed as summed in the TRF_MONITOR_LTPP_LN table. Estimates are provided by year.

AASHTOWare Pavement ME Design Input Tables

The AASHTOWare Pavement ME design input parameters can be found in the following tables accessible through InfoPave:[3]

- MEPDG_TRUCK_VOL_PARAMETERS: This table contains input parameters used in AASHTOWare Pavement ME Design software[5] to estimate traffic volumes of FHWA vehicle classes 4–13[11] for pavement analyses or design periods, including the following for each LTPP site and experiment: LTPP lane AADTT for the first year the site was opened to traffic, percentile VCD factors, and truck volume growth information (fitting either a linear or compound growth function). The table is designed to resemble the AASHTOWare Pavement ME Design software input table to facilitate data entry using a copy–paste operation.

- MEPDG_AXLE_LOAD_DIST_FACTOR: This table contains ALDF for use with AASHTOWare Pavement ME Design. One set of values is provided for each LTPP site, including the source of the data or method used to develop the ALDF. This table is designed to resemble the AASHTOWare Pavement ME Design input table to facilitate data entry using a copy–paste operation.

- MEPDG_AXLE_PER_TRUCK: This table contains the representative number of axles per truck (APT) for vehicles in FHWA vehicle classes 4–13 for use with AASHTOWare Pavement ME Design software. It includes the source of the data or method used to develop the APT. This table is designed to resemble the AASHTOWare Pavement ME Design input table to facilitate data entry using a copy–paste operation.

Analysis-Ready Traffic Summary Parameters

The analysis-ready traffic summary parameters can be found in the following tables accessible through InfoPave:(3)

- TRF_TREND: This table contains annual truck volume estimates for LTPP lanes by vehicle classification and year for each test site for each in-service and in-experiment year. The table also includes estimates of AADTT (computed for FHWA vehicle classes 4–13(11) combined), cumulative truck volumes (CTVs), cumulative FHWA vehicle class 9 truck volumes, ESAL, general equivalent single-axle load (GESAL), and total annual load estimates for each year from the time each test section opened for traffic. These values are calculated based on data consolidated from the multiple traffic data sources described in this chapter; missing values are estimated. The source of the data or estimation method for each year is also provided in this table.

- TRF_REP: This table contains representative AADTT values for LTPP sites, as well as the percentage of AADTT value corresponding to each FHWA vehicle class 4–13. The table also includes representative loading parameters for each truck class. One set of values is provided per LTPP site and experiment combination. Metadata describing the confidence associated with the traffic parameters included in TRF_REP table are also included.

Traffic Metadata Tables

The traffic metadata data can be found in the following tables accessible through InfoPave:(3)

- TRF_BASIC_INFO: This table contains basic information on the location of the LTPP test sites.

- TRF_CALIBRATION_AVC: This table contains information on the calibration activities associated with AVC equipment used to collect vehicle classification data at LTPP test sites.

- TRF_CALIBRATION_WIM: This table contains information on the calibration activities associated with equipment used to collect WIM data at LTPP test sites.

- TRF_EQUIPMENT_MASTER: This table contains information on both AVC and WIM equipment during calibration events.

- TRF_HIST_WEIGHT_MASTER: This table contains all available general information on the roadways and equipment used for historical truck weighing sessions.

- TRF_HIST_CLASS_MASTER: This table contains information on classification counts that furnished data for the TRF_HIST_CLASS_DATA table. This table also contains the total volumes recorded during each count.

Traffic Tables From LTAS Databases

LTAS database tables that containing detailed traffic count data at various levels of data aggregation are detailed in the following sections. The following LTAS tables are accessible through InfoPave web portal.[3]

Vehicle Classification and Traffic Volume Count Data Tables

The following LTAS vehicle classification and traffic volume count data tables can be found on InfoPave:[3]

- YY_CT: This table contains count data by site, year, lane, direction, DOW, and data source for each year for which classification and/or weight data were accepted for estimating volumes. The number of days of data in the year for a specific DOW is also included. This table is created by summing, for each data type, the number of days and counts for each DOW in a month using data from the MM_CT table. Included in the table is the number of vehicles observed during the count, but these data could not be classified.

- MM_CT: This table contains count data by site, year, month, lane, direction, DOW, and data source for each month for which classification and/or weight data were accepted for estimating volumes. This table is created by summing, for each data type, the number of days and counts for each DOW in a month using data from the relevant DD_CT table. The vehicle classes are converted from a State or Provincial agency-specified method into the FHWA vehicle classes. (See FHWA TMG for description of 13 FHWA vehicle classes.[11]) This table also includes the number of unclassified vehicles.

- DD_CL_CT: This table summarizes the number of vehicles by class for each day based on classification records. This table contains count data by site, year, month, day, lane, and direction for each day for which classification data were accepted for estimating volumes. This table is created by summing, for each day, the counts over all hours in a defined day.

- DD_VOL: This table summarizes the number of vehicles by site, year, month, day, lane and direction.

- DD_WT_CT: This table summarizes the number of vehicles by class based on weight records. This table contains count data by site, year, month, day, lane, and direction for each day for which weight data exist for estimating loads.

- HH_CL_CT: This table stores the hourly volumes by vehicle class in the input method for classification data for selected sites. These data are used to generate inputs to the TRF_MEPDG_HOURLY_DIST table.

Traffic Loading Data Tables

The following LTAS traffic loading data tables can be found on InfoPave:[3]

- YY_AX: This table contains the number of axle counts by LTPP site, year, lane, direction, vehicle class, DOW, and load bin. The number of days of data in the year for a specific DOW is also included. This table is created by summing the number of days and the number of axles in each load bin by axle group for each DOW and each year using data from the MM_AX table. Only vehicles in FHWA vehicle classes 4–13[11] are included.

- MM_AX: This table contains the number of axle counts by LTPP site, year, month, lane, direction, vehicle classification, axle group, DOW, and load bin. This table is created by summing the number of days and the number of axles in each load bin by axle group for each DOW, each month, and each year using data from the DD_AX table. Only vehicles in FHWA vehicle classes 4–13 are included. Data provided to LTPP in a State or Provincial agency-specific vehicle classification method are converted into 13 FHWA vehicle classes.

- DD_AX: This table contains the number of axle counts by LTPP site, year, month, day, lane, direction, vehicle class, axle group, and load bin. Each record in this table is created by summing the number of axle counts for all hours in a calendar day for each load bin, axle group, and vehicle class. All vehicle classes, including passenger vehicles, may be in this table. Data are presented in vehicle classes that follow a State or Provincial agency-specified vehicle classification method.

- YY_GVW: This table contains GVW data by LTPP site, year, lane, direction, vehicle classification, DOW, and weight bin. The number of days of data in the year for a specific DOW is also included. This table is created by summing the number of days and GVW data by weight bin for the DOWs for a year using data from the MM_GVW table. Only vehicles in FHWA vehicle classes 4–13 are included.

- MM_GVW: This table contains GVW data by LTPP site, year, month, lane, direction, vehicle classification, DOW, and weight bin. This table is created by summing the number of days and GVW data by weight bin for the DOWs for each month and each year using data from the DD_GVW table. Only vehicles in FHWA vehicle classes 4–13 are included. Data provided to LTPP in a State or Provincial agency-specific vehicle classification method are converted into the 13 FHWA vehicle classes.

- DD_GVW: This table contains GVW data by LTPP site, year, month, day, lane, direction, vehicle class, and weight bin. This table is created by summing GVW data by weight bin over all hours in a calendar day for each vehicle class. All vehicle classes, including passenger vehicles, may be in this table. Data are presented in vehicle classes that follow a State or Provincial agency-specified vehicle classification method.

Axle and Vehicle Loading Characterization Tables

The following LTAS axle and vehicle loading characterization tables can be found on InfoPave:(3)

- NALS_ANNUAL_DISTRIB: This table contains NALS data by LTPP site, year, lane, direction, vehicle class, and axle group. This table is created by averaging values from the NALS_MONTHLY_DISTRIB table. This table is limited to FHWA vehicle classes 4–13.(11)

- NALS_ANNUAL_EVAL: This table contains record status values by LTPP site, year, lane, direction, vehicle class, and axle group for each associated NALS in the NALS_ANNUAL_DISTRIB table. Record status values are based on the size of the NALS distribution tails.

- NALS_MONTHLY_DISTRIB: This table contains percentile NALS values by LTPP site, year, month, lane, direction, vehicle class, axle group, and load bin. This table is created by normalizing values from the MM_AX table. This table is limited to FHWA vehicle classes 4–13.

- NALS_MONTHLY_EVAL: This table contains record status values by LTPP site, year, month, lane, direction, vehicle class, and axle group for each associated NALS in the NALS_ANNUAL_DISTRIB table. Record status values are based on the size of the NALS distribution tails.

- RPPIF_NALS_ANNUAL: This table contains the RPPIF by LTPP site, year, lane, direction, vehicle class, and axle group. This table is created by applying values from the RPPIF_WIJ_FACTOR table to the annual NALS distribution.

- RPPIF_NALS_MONTHLY: This table contains the RPPIF by LTPP site, year, month, lane, direction, vehicle class, and axle group. This table is created by applying values from the RPPIF_WIJ_FACTOR table to the monthly NALS distribution.

- RPPIF_WIJ_FACTOR: This table contains axle groups, weight bins (defined by the low weight bin boundary), and the factor values for each weight bin. Factors were developed to support grouping similar NALS using RPPIF values.

- RPPIF_VEHICLE_CLASS_ANNUAL: This table contains the RPPIF per vehicle class values by LTPP site, year, lane, direction, and FHWA vehicle classes 4–13. These values are created using data from RPPIF_NALS_ANNUAL and VEHICLE_CLASS_AVG_AX_ANL tables.

- RPPIF_VEHICLE_CLASS_MONTHLY: This table contains the RPPIF per vehicle class values by LTPP site, year, month, lane, direction, and vehicle class. These values are created using data from RPPIF_NALS_MONTHLY and VEHICLE_CLASS_AVG_AX_MONTH tables.

- RPPIF_ANNUAL_AVG_TRUCK: This table contains the RPPIF for a representative truck by LTPP site, year, lane, and direction. The value is created using data from RPPIF_VEHICLE_CLASS_ANNUAL and VEHICLE_CLASS_ADT_ANNUAL tables.

- RPPIF_MONTHLY_AVG_TRUCK: This table contains the RPPIF value for a representative truck by LTPP site, year, month, lane, and direction. These values are created using data from RPPIF_VEHICLE_CLASS_MONTHLY and VEHICLE_CLASS_ADT_MONTH tables.

Axle Per Truck Tables

The following LTAS axle per truck tables can be found on InfoPave:[3]

- VEHICLE_CLASS_AVG_AX_ANL: This table contains the average number of axles by LTPP site, year, lane, direction, vehicle class, and axle group. These values are created using data from VEHICLE_CLASS_AVG_AX_MONTH table.

- VEHICLE_CLASS_AVG_AX_MONTH: This table contains the average number of axles by LTPP site, year, month, lane, direction, vehicle class, and axle group. These values are created using data from are VEHICLE_CLASS_TOTAL_AXLE and VEHICLE_CLASS_TOTAL_COUNT tables.

- VEHICLE_CLASS_TOTAL_AXLES: This table contains the total number of axles by LTPP site, year, month, lane, direction, vehicle class, and axle group. These values are created using data from MM_AX table.

Traffic Metadata Tables

The following LTAS traffic metadata tables can be found on InfoPave:[3]

- TRAFFIC_CLASS_CONVERT_MASTER: This table indicates which classification scheme is used by an agency or a specific site.

- TRAFFIC_CLASS_CONVERT_DATA: This table contains information on matching a State or Provincial highway agency's classification method to the 13 FHWA vehicle classes.[11]

- SITE_EQUIPMENT_INFO: This table identifies types of equipment installed and classification schemes used with that equipment.

ANCILLARY LTPP TRAFFIC DATA AND INFORMATION

Additional sources of information about data and parameters included in LTPP traffic tables can be found in the following tables included in the Administrative module of the IMS Guide:[(2)]

- CODES: This table contains codes and associated descriptions for coded values in the IMS.
- CODETYPES: This table contains definitions and sources of information for all code tables stored in the LTPP IMS.

Additional traffic data and information is available in the LTPP Ancillary Information Management System (AIMS) archives.[(12)] Chapter 17 of the IMS Guide provides information about available ancillary LTPP traffic data and information.[(2)] Ancillary LTPP traffic data include traffic output files from LTAS and those created by legacy LTPP Traffic Quality Control software and files from the iANALYZE® software.[(2)] LTAS-related ancillary traffic data files are in the FHWA TMG file format.[(11)]

In addition, AIMS archives contain electronic images of scanned hardcopy data forms used to report basic traffic information, traffic scale calibration, historical traffic, and traffic estimates produced by agencies when no onsite measurements were performed. This information also includes images of vehicles at selected WIM sites with corresponding vehicle classification results.

Most of the ancillary information from AIMS archives can be obtained through InfoPave. Image files (and other data not found through InfoPave) can be obtained by contacting the LTPP Customer Support Service Center at ltppinfo@dot.gov or by calling 202–493–3035.

CHAPTER 3. LTPP TRAFFIC METADATA

This chapter describes sources of LTPP traffic data. It also provides references to methods used to collect traffic data and compute traffic parameters and describes codes available in LTPP traffic data tables[3] to identify data sources and computational methods. Information in this chapter will help users' understanding of the data and methods used in the traffic data collection and computation of LTPP traffic parameters, as well as limitations associated with the data sources and methods.

METHODS OF TRAFFIC DATA COLLECTION

LTPP Traffic Data Sources

Sources of LTPP traffic data include the following:

- Historical data provided by States and Provinces.
- Monitoring data collected by States and Provinces for the LTPP program.[13]
- Monitoring data collected by the program through the LTPP SPS Traffic Data Collection Pooled-Fund Study, TPF-5(004) [14] and the LTPP warm-mix asphalt overlay experiment.
- LTPP vehicle classification data collection effort.

The *Guide to LTPP Traffic Data Collection and Processing* provides a detailed description of the LTPP traffic data collection and processing methods and procedures.[13] The following sections provide a brief summary of LTPP traffic data sources and data collection methods, updated with information about recent efforts of LTPP traffic data collection.

Data Collected by State and Provincial Agencies Prior to the LTPP Program

Traffic data or estimates of traffic collected for each LTPP test site prior to its participation in the LTPP experiment are referenced within LTPP data sources as historical data. Historical estimates and supporting data were submitted by local agencies to the LTPP program via a series of forms referred to as LTPP Traffic Data Sheets (available under the Ancillary Data Selection and Download section of InfoPave.[3]) Historical estimates include annual average daily traffic (AADT) values for the entire roadway and test lane broken out for all vehicles as well as trucks only. ESAL estimates for the test section lane were also obtained.

Data Collected by State and Provincial Agencies as Part of the LTPP Program

After a test site becomes part of the LTPP experiment, an effort is made to collect site-specific traffic data at or near each site. States and Provinces collect data using automated traffic data collection equipment, such as ATRs, AVCs, and WIM systems. Equipment can be permanently installed at LTPP sites, or portable equipment can be used to take short-duration counts. Equipment from different manufacturers can be used.

States and Provinces follow procedures in the FHWA TMG[11] for collecting and reporting traffic data, and they submit the data (i.e., traffic volume, vehicle classification, and axle loading) to the LTPP program for further processing. The program processes and quality checks the data before making the data available on the InfoPave web portal.[3] Due to differences in methods and equipment States and Provinces use to collect these data, the quality and quantity of available traffic data vary among LTPP sites.

Data From Select LTPP SPS WIM Sites

Since 2003, 26 LTPP SPS WIM sites[14] have been installed as part of the LTPP SPS Traffic Data Collection Pooled-Fund Study TPF-5(004). These sites have been installed to collect research-quality traffic loading data at select SPS-1, -2, -5, and -6 sites.[15] From 2016 to 2018, the LTPP program expanded the number of LTPP SPS WIM sites to include the new SPS-10 sites.

To meet the study's research-quality standards, data of known calibration, meeting LTPP's WIM data accuracy requirements—for steering and tandem axles, GVW, bumper-to-bumper vehicle length, vehicle speed, and axle spacing—must be collected for 210 days within a year. Details about LTPP SPS WIM equipment, installation, calibration, and accuracy requirements are documented in the *LTPP Field Operations Guide for SPS WIM Sites*.[16] Table 1 shows criteria used to evaluate if errors observed in WIM data collected during field validations meet the accuracy criteria of research-quality data.

Table 1. LTPP WIM data accuracy criteria for research-quality data.

Parameter	95-Percent Confidence Limit of Error
Steering axles	+20 percent
Tandem axles	+15 percent
GVW	+10 percent
Vehicle length	±3 percent (or 2.2 ft)
Axle length	+0.5 ft

Vehicle Classification Data Collected by LTPP Program

To provide at least a sample of classification data for all pavement sections that remained in study in 2005, the LTPP program acquired a week's worth of classification data from approximately 140 sites. Data were collected during 2005–2006 from agencies and LTPP program contractors using the 13 FHWA vehicle classes.[11]

Data Shared by LTPP Traffic Sites

For some LTPP sites, no traffic data are provided in LTPP traffic tables because one set of traffic data is used for multiple sites. The record of shared data is maintained in SHRP_INFO and SPS_GPS_LINK tables.[3] To identify reference traffic sites for an LTPP site that is not included in LTPP traffic tables, the following fields should be used in the SHRP_INFO table for sites that are not part of the SPS-3 or -4 experiments:

- The CLASS_SITE field identifies the reference LTPP site for vehicle classification and volume information.

- The WIM_SITE field identifies the reference LTPP site for axle loading and truck weight information.

For sites that are part of the SPS-3 or -4 experiments, the related GPS section, found using SPS_GPS_LINK, is used as the traffic data source. For some LTPP sites, the source of classification or weight data changes over time, with data coming from one location for some years and a different location for other years. Similarly, classification data may come from one site while weight data may come from another.

INFORMATION ON TRAFFIC DATA COLLECTION EQUIPMENT

The SITE_EQUIPMENT_INFO table (accessible through InfoPave web portal) contains information about traffic monitoring equipment used at LTPP sites.(3) This table identifies the types of data being collected (i.e., volume, classification, and weight), types of sensors being used, and vehicle classification schemes being used. The table does not provide information on the installation, maintenance, validation, or calibration of that equipment. However, some of this information is available in TRF_CALIBRATION_AVC, TRF_CALIBRATION_WIM, and TRF_EQUIPMENT_MASTER tables. Equipment installation and maintenance information are available in LTPP Traffic Data Sheets 14 and 15 under the Ancillary Data Selection and Download section of InfoPave.(3)

TRAFFIC DATA ACCURACY

The following two LTPP tables (accessible through InfoPave(3)) contain information about calibration efforts performed on traffic monitoring equipment used at some LTPP sites:

- The TRF_CALIBRATION_AVC table contains calibrations of automated vehicle classifiers.

- The TRF_CALIBRATION_WIM table contains calibrations of WIM devices.

These tables include statistics quantifying measurement errors observed from calibration test truck runs, including mean measurement errors and standard deviations of errors for WIM sites. This information could be used to infer measurement accuracy of traffic monitoring equipment. In addition, LTPP Traffic Data Sheet 11, available from the LTPP AIMS, contains information about the calibration of traffic volume counters.(12)

Not all LTPP WIM sites have information in the TRF_CALIBRATION_WIM table, and the available information does not always cover all data collection periods. Due to the variety of data collection equipment and systems being used, along with the limited availability of supporting data (such as WIM equipment performance parameters, calibration records and criteria, and WIM performance characteristics measured after calibration), the accuracy of most LTPP traffic loading data submitted by State and Provincial agencies is unknown.

TRAFFIC DATA AVAILABILITY

Information on traffic data availability allows a researcher to quickly identify LTPP sites with detailed traffic data that could be used in a pavement performance analysis. Information about the number of days for which traffic data were collected and accepted at each site can be obtained from the following fields in the LTPP TRF_MONITOR_LTPP_LN table using InfoPave web portal:(3)

- The COUNT_DAYS field shows the number of days with vehicle classification data per year for each LTPP site.
- The WEIGHT_DAYS field shows number of days with vehicle and/or axle weight data per year for each LTPP site.

The TRF_MONITOR_LTPP_LN table contains only LTPP sites with traffic monitoring data. Additional information may be available in TRF_HIST_VOLUME_COUNT and TRF_HIST_CLASS_DATA tables for the years when historical data were provided by participating State and Provincial highway agencies.

METHODS USED TO COMPUTE TRAFFIC PARAMETERS

Table 2 details reference sources that describe methods used to develop different LTPP traffic parameters.

Table 2. Reference sources describing methods used to develop different traffic parameters.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
AADT LTPP lane historical count (prior to 1990)	Estimated AADT for the LTPP lane from count data	COUNT_AADT_LTPP_LN	TRF_HIS_VOLUME_ COUNT	Values are computed by State and Provincial agencies prior to the start of LTPP monitoring (before 1990); values are based on traffic-volume count data; procedures are State specific, and methods are not documented.
AADT two-way historical count (prior to 1990)	Estimated two-way AADT in all lanes from count data	COUNT_AADT	TRF_HIST_VOLUME_ COUNT	Values are computed by State and Provincial agencies prior to the start of LTPP monitoring (before 1990); values are based on traffic-volume count data; procedures are State specific, and methods are not documented.
AADT LTPP lane historical estimate (prior to 1990)	Estimated AADT for the LTPP lane	AADT_ALL_VEHIC	TRF_HIST_EST_ESAL	See METH_EST_AADT_LTPP code in the TRF_HIST_EST_ESAL table.(3)
AADT two-way historical estimate from local State or Provincial agency (prior to 1990)	Estimated AADT in all lanes, two-way	AADT_ALL_VEHIC_ 2WAY	TRF_HIST_EST_ESAL	See METH_EST_AADT_TOT code in the TRF_HIST_EST_ESAL table.
AADT LTPP lane during LTPP experiment (1990 or later); estimate from local State or Provincial agency	Estimated AADT for the LTPP lane	AADT_ALL_VEHIC	TRF_MON_EST_ESAL	See METH_EST_AADT_LTPP code in the TRF_MON_EST_ESAL table.
AADT two-way during LTPP experiment (1990 or later); estimate from local State or Provincial agency	Estimated two-way AADT in all lanes	AADT_ALL_VEHIC_ 2WAY	TRF_MON_EST_ESAL	See METH_EST_AADT_TOT code in the TRF_MON_EST_ESAL table.
AADTT LTPP lane during LTPP experiment (1990 or later); estimate from local State or Provincial agency	Estimated AADTT in the LTPP lane	AADT_TRUCK_COMBO	TRF_MON_EST_ESAL	See METH_EST_TRK_LTPP code in the TRF_MON_EST_ESAL table.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
AADTT two-way during LTPP experiment (1990 or later); estimate from local State or Provincial agency	Estimated two-way AADTT in all lanes	AADT_TRUCK_COMBO_2WAY	TRF_MON_EST_ESAL	See METH_EST_TRK_TOT code in the TRF_MON_EST_ESAL table.
AADTT LTPP lane historical estimate from local State or Provincial agency (prior to 1990)	Estimated AADTT in the LTPP lane	AADT_TRUCK_COMBO	TRF_HIST_EST_ESAL	See METH_EST_TRK_LTPP code in the TRF_HIST_EST_ESAL table.
AADTT two-way historical estimate from local State or Provincial agency (prior to 1990)	Estimated two-way AADTT in all lanes	AADT_TRUCK_COMBO_2WAY	TRF_HIST_EST_ESAL	See METH_EST_TRK_TOT code in the TRF_HIST_EST_ESAL table.
AADTT in the LTPP lane; estimated for all years	Estimated AADTT for the LTPP lane for each in-service year up to the end of site participation in the LTPP experiment	AADTT_ALL_TRUCKS_TREND	TRF_TREND	See AADTT_SOURCE code in the TRF_TREND table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.[4]
Annual total truck volume trend; estimated for all years	Estimated total annual truck volume for each year of participation in the LTPP experiment	ANNUAL_TRUCK_VOLUME_TREND	TRF_TREND	See AADTT_SOURCE code in the TRF_TREND table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
AADTT by vehicle class trend for FHWA vehicle classes 4–13;[11] estimated for all years	AADTT by vehicle class for FHWA classes 4–13 estimated for each site for each in-service year of participation in the LTPP experiment	AADTT_VEH_CLASS_*_TREND	TRF_TREND	See VEH_CLASS_SOURCE code in the TRF_TREND table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Cumulative FHWA vehicle class 9 truck volume since site opened to traffic; estimated annually	Estimated cumulative FHWA vehicle class 9 truck volume to have crossed this test section since it opened to traffic through the end of the year indicated	CUMULATUVE_VOLUME_VEH_CLASS_9_TREND	TRF_TREND	See VEH_CLASS_SOURCE code in the TRF_TREND table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Cumulative heavy truck volume since site opened to traffic; estimated annually	Estimated cumulative volume for FHWA vehicle classes 4 and 6–13 to have crossed the test section since it opened to traffic through the end of the year indicated	CUMULATUVE_VOLUME_ HEAVYTRUCKS_TREND	TRF_TREND	See VEH_CLASS_SOURCE code in the TRF_TREND table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Representative AADTT value for each LTPP site	Single AADTT value useful for identifying test sites with truck traffic volumes falling within selected ranges	REP_AADTT	TRF_REP	See REP_AADTT_CLASS_USE_ RATING code in the TRF_REP table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Representative vehicle classification percentage	Estimated percentage of total daily truck traffic that occurs within the specified FHWA truck class at this site over the course of its participation in the LTPP experiment	REP_PERCENT_VEH_ CLASS_#	TRF_REP	See REP_VEH_CLASS_USE _RATING code in the TRF_REP table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Annual estimate of total truck volume for years with monitoring data (1990 or later)	Annual estimate of trucks in the LTPP lane	TRUCKS_LTPP_LN	TRF_MONITOR_LTPP_L N	See *LTAS Volume 4, Functional Specifications*.[1]
Annual estimate of the total number of axles for years with monitoring data (1990 or later)	Annual estimate of the number of single, tandem, tridem, and quad+ axles	SINGLE_AX_EST, TANDEM_AX_EST, TRIDEM_AX_EST, QUADPLUS_AX_EST	TRF_MONITOR_LTPP_L N	See *LTAS Volume 4, Functional Specifications*.
Annualized axle load distribution for years with WIM data (1990 or later)	Annual estimate of the number of axles measured in each weight range for each axle group (i.e., single, tandem, triple, and quad+) and each FHWA vehicle class 4–13	AX_CT_01, …AX_CT_40	TRF_MONITOR_AXLE_ DISTRIB	See *LTAS Volume 4, Functional Specifications.*

[1]A copy of LTAS volume 4 can be requested by contacting LTPP Customer Support Services Center at ltppinfo@dot.gov.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Axle load distribution summarized by DOW, month, and year for each month with weight data	Axle load summaries by load range, year, month, DOW, lane, direction, FHWA vehicle classes 4–13, axle group, and site for each month with load data	AX_CT_01, …AX_CT_40	MM_AX	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*
GVW distribution summarized by DOW, month, and year for each month with weight data	GVW summaries by load range, year, month, DOW, lane, direction, vehicle class, axle group, and site for each month with load data	BIN01, …BIN50	MM_GVW	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*
VCD summarized by DOW, month, and year for each month with classification and/or weight data	Vehicle count summaries by site, year, month, DOW, lane, direction, and data source for each month with classification and/or weight data	CT_SUM_01, …CT_SUM_15	MM_CT	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*
Axle load distribution summarized by DOW and year for each year with weight data	Axle load summaries by load range, year, DOW, lane, direction, vehicle class, axle group, and site for each year with load data	AX_CT_01, …AX_CT_40	YY_AX	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*
GVW distribution summarized by DOW and year for each year with weight data	GVW summaries by load range, year, DOW, lane, direction, vehicle class, axle group, and site for each year with load data	BIN01, …BIN50	YY_GVW	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*
VCD summarized by DOW and year for each year with classification and/or weight data	Vehicle count summaries by site, year, month, DOW, lane, direction, and data source for each year with classification and/or weight data	CT_SUM_01, …CT_SUM_15	YY_CT	This table is from LTAS software database. See *LTAS Volume 4, Functional Specifications.*

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Annual normalized axle load distribution for years with at least 210 days of WIM data for computing MEPDG ALDF	Annual normalized axle distribution by FHWA vehicle classes 4–13 and axle group for sites that have at least 2 years with more than 210 days of WIM data in the TRF_MONITOR_ LTPP_LN table	PERCENT_AXLES	TRF_MEPDG_AX_DIST_ ANL	See SQL scripts and procedures for TRF_MEPDG tables.
Monthly normalized axle load distribution for years with at least 210 days of WIM data for computing MEPDG ALDF	Normalized axle load distribution by month, FHWA vehicle classes 4–13, and axle group for years with at least 210 days of WIM data	PERCENT_AXLES	TRF_MEPDG_AX_DIST	Values are computed from weight data in MM_AX LTAS table. The process is documented in SQL scripts and procedures for TRF_MEPDG tables.[2]
MEPDG ALDF	ALDF in MEPDG format representing the percentage of total axle applications within each load interval for a specific axle type (i.e., single, tandem, tridem, and quad+) and FHWA vehicle classes 4–13; one set of factors represents each LTPP site	MEPDG_LG01, …MEPDG_LG39	MEPDG_AXLE_LOAD_ DIST_FACTOR	See field ALDF_USE_RATING for quality assessment and source. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
AADTT LTPP lane for years with 210 days or more of weight or count data for computing MEPDG first year AADTT	AADTT based on FHWA vehicle classes 4–13 for the LTPP lane for years with 210 days or more of weight or count data	AADTT	TRF_MEPDG_AADTT_ LTPP_LN	See field TRF_DATA_TYPE for data source; the computational method is based on the NCHRP 1-37A Report (MEPDG).(7)
MEPDG first year AADTT LTPP lane	Estimated AADTT for the first year when the pavement at the LTPP site location was opened to traffic	AADTT_FIRST_YEAR_ LTPP_LANE	MEPDG_TRUCK_VOL_ PARAMETERS	See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.

[2]A copy of the SQL scripts and procedures can be requested by contacting LTPP Customer Support Service Center at ltppinfo@dot.gov.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Vehicle class volume distribution by year for computing MEPDG vehicle class volume distribution	Percentage of trucks by FHWA vehicle classes 4–13 within the truck population (in the LTPP lane reported for years with 210 days or more of weight or count data	PERCENT_OF_TRUCKS	TRF_MEPDG_VEH_ CLASS_DIST	See SQL scripts and procedures for TRF_MEPDG tables.
MEPDG vehicle class volume distribution	Representative percentage of trucks in each FHWA vehicle class 4–13; one set of factors represents each LTPP site	VEH_CLASS_DIST_ PERCENT	MEPDG_TRUCK_VOL_ PARAMETERS	See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
MEPDG truck growth function and growth rate by FHWA vehicle classes 4–13	Linear or compound truck traffic growth rate for FHWA vehicle classes 4–13, expressed as a percentage, from the first year when the pavement at LTPP site location was opened to traffic until the end of site participation in the LTPP experiment	VEH_CLASS_GROWTH_ FUNCTION VEH_CLASS_GROWTH_ RATE	MEPDG_TRUCK_VOL_ PARAMETERS	See the codes in VEH_CLASS_ GROWTH_USE_RATING field in the MEPDG_TRUCK_ VOL_PARAMETERS table and computational procedure in the *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
MAFs by year for computing MEPDG MAFs	Adjustment factors for AADTT for each FHWA vehicle class 4–13 by month reported for years with 210 days or more of weight or count data	MONTHLY_RATIO	TRF_MEPDG_MONTH_ ADJ_FACTR	See SQL scripts and procedures for TRF_MEPDG tables; additional data manipulations are needed to compute representative values for use in AASHTOWare Pavement ME Design software.[5]
HDF by year for computing MEPDG HDF	Adjustment factors for annual average hourly distribution of trucks by hour in the LTPP lane	PCT_HOURLY	TRF_MEPDG_HOURLY_ DIST	Computational method is based on NCHRP 1-37A Report (MEPDG);[7] additional data manipulations are needed to compute representative values for use in AASHTOWare Pavement ME Design software.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Axles per truck by year for computing MEPDG APT	Average number of axles in each axle group for a vehicle in FHWA vehicle classes 4–13 reported for each year with 210 days or more of weight or count data	AXLES_TRUCK	TRF_MEPDG_AX_PER_ TRUCK	Values are computed from the axles summed in the TRF_MONITOR_ LTPP_LN LTPP table; SQL scripts and procedures for TRF_MEPDG tables.
MEPDG APT	Representative number of axles for each truck class (i.e., FHWA vehicle classes 4–13) for each axle type (i.e., single, tandem, tridem, and quad); one set of factors represents per LTPP site	SINGLE_AXLES, TANDEM_AXLES, TRIDEM_AXLES, and QUAD_AXLES	MEPDG_AXLE_PER_ TRUCK	See the APT_USE_RATING field of the MEPDG_AXLE_PER_ TRUCK table. See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
ESAL historical estimate (prior to 1990)	Annual ESALs in thousands in the LTPP lane for years prior 1990	ANL_KESAL_LTPP_LN_ YR	TRF_HIST_EST_ESAL	From State or Provincial agency. Method unknown.
ESAL monitored (1990 or later)	Annual ESALs in thousands in the LTPP lane for 1990 or later	ANL_KESAL_LTPP_LN_ YR	TRF_MON_EST_ESAL	From State or Provincial agency. Method unknown.
Annual ESAL for years with acceptable WIM data	Annual ESALs in thousands in the LTPP lane for sites with an acceptable sample of axle load measurements in a given year	KESAL_YEAR	TRF_ESAL_COMPUTED	See methodology from 1993 AASHTO *Guide for Design of Pavement Structures*.(8)
Annual ESAL trend estimated for all years	Annual ESAL estimate for each in-service year up to the end of site participation in the LTPP experiment	ANNUAL_ESAL_TREND	TRF_TREND	See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Annual GESAL trend	Annual GESAL estimate for each in-service year up to the end of site participation in the LTPP experiment	ANNUAL_GESAL_TREND	TRF_TREND	See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Annual total load trend estimated for all years	Annual total load estimate for each in-service year up to the end of site participation in the LTPP experiment	ANNUAL_TOTAL_LOAD_TREND	TRF_TREND	See *Facilitating Analysts' Use of Traffic Data from the Long-Term Pavement Performance (LTPP) Program* final report.
Representative GESAL per APT	Representative number of GESAL per APT	REP_GESAL_SINGLE_AXLE, REP_GESAL_TANDEM_AXLE, REP_GESAL_TRIDEM_AXLE, REP_GESAL_QUAD_AXLE	TRF_REP	See *LTPP IMS, Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019 (version 27), Working Draft Database Specifications.[3]
Representative GESAL per vehicle class	Representative number of GESAL per vehicle class for FHWA vehicle classes 4–13	REP_GESAL_PER_VEH_CLASS_4, REP_GESAL_PER_VEH_CLASS_13	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Representative GESAL per truck	Representative number of GESAL per truck	REP_GESAL_PER_TRUCK	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Representative ESAL per APT	Representative number of ESAL per APT	REP_ESAL_SINGLE_AXLE, REP_ESAL_TANDEM_AXLE, REP_ESAL_TRIDEM_AXLE, REP_ESAL_QUAD_AXLE	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Representative ESAL per vehicle class	Representative number of ESAL per vehicle class for FHWA vehicle classes 4–13	REP_ESAL_PER_VEH_CLASS_4, …REP_ESAL_PER_VEH_CLASS_13	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Representative ESAL per truck	Representative number of ESAL per truck	REP_ESAL_PER_TRUCK	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Representative GVW per truck	Representative GVW per truck	REP_GVW_TRUCK	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.

[3]A copy of *LTPP IMS, Database Schema for Analysis Ready Traffic Computed Parameters*, can be requested by contacting LTPP Customer Support Service Center at ltppinfo@dot.gov.

Parameter Name	Parameter Description	LTPP Field Name	LTPP Table	Reference Source
Representative GVW per vehicle class	Representative GVW per vehicle class for FHWA vehicle classes 4–13	REP_GVW_VEH_CLASS_4, …REP_GVW_VEH_CLASS_13	TRF_REP	See *LTPP IMS Database Schema for Analysis Ready Traffic Computed Parameters*, February 2019.
Average monthly RPPIF per axle per vehicle class	Monthly average RPPIF per APT	RPPIF	RPPIF_NALS_MONTHLY	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016 (version 6), Working Draft Database Specification.[4]
Annual average RPPIF per axle per vehicle class	Annual average RPPIF per APT	ANNUAL_RPPIF	RPPIF_NALS_ANNUAL	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016.
Average monthly RPPIF per vehicle class	Monthly average RPPIF by vehicle class	VEHICLE_CLASS_RPPIF	RPPIF_VEHICLE_CLASS_MONTHLY	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016.
Annual average RPPIF per vehicle class	Annual average RPPIF by vehicle class	VEHICLE_CLASS_RPPIF_ANL	RPPIF_VEHICLE_CLASS_ANNUAL	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016.
Monthly average RPPIF per truck	Monthly average RPPIF per truck	TRUCK_RPPIF	RPPIF_MONTHLY_AVG_TRUCK	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016.
Annual average RPPIF per truck	Annual average RPPIF per truck	ANNUAL_TRUCK_RPPIF	RPPIF_ANNUAL_AVG_TRUCK	See *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters*, August 2016.

MAFs = monthly adjustment factors; HDF = hourly distribution factors; NCHRP = National Cooperative Highway Research Program.

[4]A copy of *LTPP IMS—LTAS Database Schema for NALS Tables and Derivative Computed Parameters* can be requested by contacting LTPP Customer Support Service Center at ltppinfo@dot.gov.

CODES DESCRIBING DATA AND METHODS USED FOR PARAMETER COMPUTATION AND PARAMETER USABILITY

To provide LTPP users with some means of assessing accuracy and applicability of available analysis-ready traffic parameters, a set of codes is included in each table containing analysis-ready traffic parameters. Table 3 through table 14 provide descriptions of codes associated with different parameters. Using these codes, LTPP researchers could identify LTPP sites that have traffic parameters that meet the analysis criteria based on the data source and data quality information. These codes can be downloaded from the InfoPave web portal[(3)] by selecting the following InfoPave options:

1. Select Data option from the main InfoPave menu.
2. Select LTPP Table Navigator option from the Data menu.
3. Select Codes (CODES) from the list of tables.
4. Click on "Export to Excel" button located at the bottom of the screen.

Table 3. Fields describing sources and usability of traffic parameters included in analysis-ready tables.

LTPP Field	LTPP Table
AADTT_SOURCE	TRF_TREND
VEH_CLASS_SOURCE	TRF_TREND
ESAL_SOURCE	TRF_TREND
GESAL_SOURCE	TRF_TREND
GVW_SOURCE	TRF_TREND
REP_AADTT_USE_RATING	TRF_REP
REP_VEH_CLASS_USE_RATING	TRF_REP
REP_LOAD_USE_RATING	TRF_REP
VEH_CLASS_GROWTH_USE_RATING	MEPDG_TRUCK_VOL_PARAMETERS
ALDF_USE_RATING	MEPDG_AXLE_LOAD_DIST_FACTOR
APT_USE_RATING	MEPDG_AXLE_PER_TRUCK

Table 4. Codes for AADTT_SOURCE fields.

Code	Description
E	Estimated value
EC	AADTT calculated using compound growth function
EL	AADTT calculated using linear growth function
H	Historical AADTT value
M	Monitored AADTT value
MC	Monitored AADTT value calculated from monitored class data (when available)
N	No data; site not open to traffic
S	State-provided AADTT value
WA	Derived from publicly available AADT data on agency website
WC	Derived from publicly available AADT and vehicle classification data on agency website

Table 5. Codes for VEH_CLASS_SOURCE fields.

Code	Description
A	AADTT: Based on classification volumes calculated using AADTT and median class percentages.
D	Default: Based on an external source.
EC	Estimated compound: Estimated based on other years of data at that site to fill in the gaps in data coverage using a best fit compound growth equation.
EL	Estimated linear: Estimated based on other years of data at that site to fill in the gaps in data coverage using a best fit linear growth equation.
H	Historical: AADTT value supplied by the State department of transportation.
M	Monitored: AADTT value submitted in monitoring data.
MC	Monitored calculated: AADTT value computed from vehicle classification data obtained from the monitoring data collection program.
N	Not open to traffic: This site has not yet opened to traffic.
S	State-supplied: Based on State-supplied historical record data collection efforts prior to the LTPP traffic monitoring program.

Table 6. Codes for the ESAL_SOURCE field.

Code	Description
0	No annual ESAL is provided for the virtual SPS site (*00) or any site that has no pavement structure information.
1	Annual ESAL is computed by LTPP based on site- and year-specific WIM data.
2	Annual ESAL is computed based on the average ESAL-per-truck values computed using selected years of site-specific WIM data and site- and year-specific annual truck volume from the TRF_TREND table.
3	Agency-supplied annual ESAL is for years during LTPP monitoring program.
4	Agency-supplied annual ESAL is for years prior to LTPP monitoring program.
5	Annual ESAL is estimated based on the representative ESAL-per-truck value from the TRF_REP table and the site- and year-specific annual truck volume by vehicle class from the TRF_TREND table.
6	Annual ESAL is 0 due to zero truck volume.

Table 7. Codes for the GESAL_SOURCE field.

Code	Description
1	Annual GESAL is computed by LTPP based on site- and year-specific WIM data.
5	Annual GESAL is estimated based on the representative GESAL-per-vehicle-class value from the TRF_REP table and the site- and year-specific AADTT by vehicle class from the TRF_TREND table.
6	Annual GESAL is 0 due to zero truck volume.

Table 8. Codes for the GVW_SOURCE field.

Code	Description
1	Annual total GVW is computed by LTPP based on site- and year-specific WIM data.
5	Annual total GVW is estimated based on the representative GVW per truck value from the TRF_REP table and the site and year-specific annual truck volume from TRF_TREND table.
6	Annual total GVW is 0 due to zero truck volume.

Table 9. Codes for the REP_AADTT_USE_RATING field.

Code	Description
1	Best: >75 percent of AADTT estimates used have an AADTT_SOURCE of M, and no years during that period experience a year-to-year change in AADTT >25 percent and > 50 trucks.
2	Better: >75 percent of the AADTT estimates used have an AADTT_SOURCE of either M or S, and no years during that period experience a year-to-year change in AADTT >25 and percent >50 trucks.
3	Good: >50 percent of the AADTT estimates used have an AADTT_SOURCE of M, but <75 percent are M or S; no years have a year-to-year change in AADTT >25 percent and >50 trucks.
4	Fair: >25 percent of the AADTT estimates used have an AADTT_SOURCE of M, but < 50 percent are either M or S or have large year-over-year AADTT changes.
5	Poor: <25 percent of the AADTT estimates used have an AADTT_SOURCE of either M or S.

Table 10. Codes for REP_VEH_CLASS_USE_RATING.

Code	Description Long
1	Best: >75 percent of years used are monitored vehicle class data, *and* no year-to-year percentage any class changes by more than 15 percent in the period.
2	Better: >50 percent of years used are monitored vehicle class data, *and* no year-to-year percentage change in any class >15 percent *and* no years have a large year-to-year change in AADTT.
3	Good: >50 percent but <75 percent of years used are monitored vehicle class data *and* no year-to-year change in any class >15 percent *but* at least one large year-to-year AADTT change.
4	Fair: >25 percent but <50 percent of years used are monitored vehicle class data *or* at least one year-to-year change in any truck class >15 percent.
5	Poor: <25 percent of the years used are monitored vehicle class data.
6	No monitoring data were present.

Table 11. Codes for ALDF_USE_RATING fields.

Code	Description
1	Best: Based on WIM data that satisfy accuracy requirements for ASTM E1318-09[17] Type I WIM systems passing data reasonableness checks. Data include at least one of each DOW in each month.
2	Better: Based on WIM data that satisfies accuracy requirements for ASTM E1318-09 Type I WIM systems passing data reasonableness checks. Data available for at least 1 year, not necessarily all months.
3	Good: Based on WIM data collected by the equipment that does not have a calibration record. Data quality cannot be quantified. Values based on annual data summaries passing QC checks.
4	Fair: Based on WIM data collected by the equipment that does not have a calibration record. Data quality cannot be quantified. Values based on selected annual data summaries passing QC checks.
5	Default-State pattern: Available WIM data are of unknown quality and did not pass study descriptive checks for acceptable precision and bias.
6	Default-PLUG pattern: Available WIM data are of unknown quality and did not pass study descriptive checks for acceptable precision and bias. Loading pattern used to identify LTPP PLUG defaults.
7	Default-no pattern PLUG: No WIM or information about loading pattern and/or weights is available. LTPP PLUG default values were assigned using information other than site-specific weight data.
8	Default-no pattern State: No WIM or information about loading pattern and/or weights is available. Default values based on the data from the other WIM sites in the same State.
10	Agency ESAL based: No directly usable annual axle distribution. Agency ESAL estimate more reasonable than ESALs computed from annual distribution and used as basis for selecting loading distribution.
11	ESALCalc based: No directly usable annual axle distribution. ESALCalc estimate more reasonable than agency ESAL estimate and used as basis for selecting loading distribution.
12	Quantitative acceptance: Single available annual axle distribution quantitatively screened and accepted for direct use. No better than "fair" quality.
13	Location based: No axle data or agency provided ESAL estimates. Loading distributions selected based on location information only.
20	Multiple years of unknown data quality, with typical distribution accepted as representative.
21	Multiple years of data of unknown quality: Agency ESAL estimates are consistent with ESALs computed from distribution. Typical distribution accepted for use.
22	Multiple years of data of unknown quality: Agency ESAL estimates are reasonable but smaller than ESALs computed from distribution. Typical distribution accepted for use.
23	Multiple years of data of unknown quality: Agency ESAL estimates are reasonable but larger than with ESALs computed from distribution. Distributions selected based on estimated ESALs.

Code	Description
24	Multiple years of data of unknown quality: Agency ESAL estimates are not reasonable. Distributions selected based on ESALs computed from distributions.
25	Multiple years of data of unknown quality: Reasonable agency ESAL estimates. ESALs computed from distributions are lower than reasonable. Axle distributions selected based on agency ESAL estimates.
26	Multiple years of data of unknown quality: Reasonable agency ESAL estimates. ESALs computed from distributions are higher than reasonable. Axle distributions selected based on agency ESAL estimates.
27	Multiple years of data of unknown quality: Agency ESAL estimates and ESALs computed from distributions are higher than reasonable. Axle distributions selected based on location.
AA	Atypical axle type: Reported axle group is not typical for a given vehicle class. ALDF values are not recommended for development of the defaults.
ALC	Low axle count: Computed values are based on low axle count (<200 axles) and may not be representative of typical loading condition for a given site.
ALS	Small axle sample: Computed values are based on a low number of days with data and may not be representative of typical loading condition for a given site.
DEF	Vehicle class-axle combination not present in dataset: Default picked using the low-volume criterion for the class.
NA	Not applicable: Zero ALDF; vehicle class is not present.

QC = quality control.

Table 12. Codes for REP_LOAD_USE_RATING fields.

Code	Description
1	Best: Based on WIM data that satisfies accuracy requirements for ASTM E1318-09[17] Type I WIM systems passing data reasonableness checks. Data include at least one of each DOW in each month.
2	Better: Based on WIM data that satisfies accuracy requirements for ASTM E1318-09 Type I WIM systems passing data reasonableness checks. Data available for at least 1 year, not necessarily all months.
3	Good: Based on WIM data collected by the equipment that does not have a calibration record. Data quality cannot be quantified. Values based on annual data summaries passing QC checks.
4	Fair: Based on WIM data collected by the equipment that does not have a calibration record. Data quality cannot be quantified. Values based on selected annual data summaries passing QC checks.
10	Estimate based on axle distributions selected using ESAL values and truck volumes as inputs
12	Based on typical site axle distribution.
13	Estimate based on axle distributions selected as a function of site location.
99	Linked site quality undetermined.

Table 13. Codes for the APT_USE_RATING field.

Code	Description
1	Extensive data availability: APT is based on >200 truck sample size from more than 365 days, recommended for site-specific analysis. Use for development of defaults if no A codes exist.
2	Good data availability: APT is based on >200 truck sample size from between 210 and 364 days, recommended for site-specific analysis. Use for development of defaults if no A codes exist.
3	Sufficient data availability: APT is based on a sample of more than 200 trucks collected over <210 days in total. APT values are recommended for site-specific analysis.
4	Limited data availability: APT is based on <200 truck sample, use with caution in site-specific analysis or consider use of defaults. Values are not recommended for default value development.
5	Marginal data availability: APT is based on <100 truck sample, use with caution in site-specific analysis or consider use of defaults. Values are not recommended for default value development.
A0	Atypical total axles: Total number of APT does not follow FHWA 13-bin vehicle classification rules for given vehicle class. Values are not recommended for development of defaults.
A1	Atypically low single axles: <0.95 single APT (all trucks should have at least one single steering axle). Values are not recommended for development of default values.
A2	Atypical tandem axle type: Tandem axle is atypical for a given vehicle class. Values are not recommended for development of default values.
A3	Atypical tridem axle type: Tridem axle is atypical for a given vehicle class. Values are not recommended for development of default values.
A4	Atypical quad axle type: Quad axle is atypical for a given vehicle class. Values are not recommended for development of default values.
AW	Low-quality weight data: The quality of the associated data is too low for estimating weight but does not affect classification and axle count data applicability.
D0	Based on available annual estimated truck and axle counts.
D1	State- and route-based default using average axles for routes in the same State/Province with the same type of route signing (Interstate, U.S., etc.).
D2	Country- and route-based default using average axles for routes in the same country with the same type of route signing (Interstate, U.S., etc.).
D3	State-based default using average axles for all routes in the same State/Province.
NA	Not applicable zero APT: Vehicle class is not present in supporting data.

Table 14. Codes for the VEH_CLASS_GROWTH_USE_RATING field.

Code	Description
1	Best: >75 percent of years used are monitored vehicle class data, *and* no year-to-year percentage in any class changes by >15 percent in the period.
2	Better: >50 percent of years used are monitored vehicle class data, *and* no year-to-year percentage change in any class >15 percent, *and* no years have a large year-to-year change in AADTT.
3	Good: >50 percent but <75 percent of years used are monitored vehicle class data, *and* no year-to-year change in any class >15 percent in <3 years.
4	Fair: >25 percent but <50 percent of years used are monitored vehicle class data *or* at least one year-to-year change in any truck class >15 percent.
5	Poor: <25 percent of the years used are monitored vehicle class data.
6	Bad: No monitoring data are present.

CHAPTER 4. SELECTING LTPP TRAFFIC DATA AND PARAMETERS FOR LTPP ANALYSES

This chapter contains recommendations for selecting traffic data and parameters, including references to LTPP traffic parameter names and LTPP tables containing these parameters, suitable for most common pavement analyses.

OVERVIEW OF TRAFFIC PARAMETERS USED FOR PAVEMENT ANALYSIS AND DESIGN

The LTPP InfoPave portal contains multiple tables with traffic parameters.(3) These parameters are summary statistics or application-specific input parameters that support a broad range of research topics related to pavement response and performance modeling and analysis, and pavement design. Based on the intended application, LTPP traffic parameters could be categorized as follows:

- Data and parameters for a detailed characterization or study of traffic loading effects.
- Traffic summary parameters for high-level empirical pavement analyses.
- Parameters for use in specialized pavement analysis and design software (such as AASHTOWare Pavement ME Design).(5)

Parameters providing detailed characterizations of traffic loading are used for mechanistic and mechanistic–empirical pavement response and performance modeling. These models require detailed information about traffic loading, including information about wheel- and/or axle load magnitude, load position and configuration (i.e., axle configuration and the position of the wheels on the pavement), area of load application or tire footprint, load duration, and time history of load application (i.e., changes in load magnitude over time). For pavement performance modeling, traffic loading history for the whole analysis period is needed (i.e., the number and magnitudes of loads reported for specified time increments used in the analysis).

Aggregated traffic summary parameters are used for empirical pavement performance analyses and modeling, empirical pavement designs, and high-level analyses supporting pavement management models and decision-support tools. Typically, for these analyses, a single-value traffic summary statistic is desired, like ESAL, AADTT, CTV, or total load. Also, these summary statistics are used to identify and group LTPP sites into categories representing different levels of traffic.

Another set of traffic parameters available through the InfoPave web portal(3) is parameters that can be used as a direct input for specialized pavement analysis or design software, such as those used in the AASHTOWare Pavement ME Design software.

TRAFFIC PARAMETERS RECOMMENDED FOR ANALYSES REQUIRING DETAILED CHARACTERIZATIONS OF TRAFFIC LOADING

Parameters for Pavement Response Prediction Based on Mechanistic Models

Pavement response analysis and modeling studies are focused on stresses, strains, and deflections that pavements experience under each traffic load application. Pavement responses can be predicted using static or dynamic mechanistic modeling methods. Static analysis methods assume that the truck load is constantly applied to the pavement. The dynamic methods consider changes over time in traffic loads and pavement responses, as loads move over the pavement. In the latter case, in addition to static load, a vertical load component caused by truck bounce, road geometry, and pavement surface irregularities is considered, along with the speed or time history of the load application.

Pavement responses predicted by static models (i.e., elastic, viscoelastic, and elastoplastic) depend on the following traffic loading parameters:

- Magnitude of the load transferred by each wheel.
- Load configuration (i.e., location and number of wheel loads simultaneously applied on the pavement surface).
- Load distribution within the tire footprint.
- Position of the wheels and axles relative to the edges of the pavement or concrete slab.
- Area and shape of load application (i.e., tire footprint).
- Sequence of loads.

Pavement responses predicted by dynamic models, in addition to these parameters, also require the following additional inputs:

- Load duration.
- Rate of load application (i.e., number of load applications per time unit measure).
- Speed of moving load.
- Time history of load application (i.e., change in load magnitude or pressure within the tire footprint over time as each wheel passes over a specific pavement location).

LTPP Tables Containing Traffic Parameters for Mechanistic Pavement Response Modeling

Table 15 summarizes the traffic parameters necessary for mechanistic pavement response evaluation and modeling and the LTPP sources for these parameters. Often, significant data processing is required to compute these parameters, and not all LTPP sites have the necessary data for parameter computation. For parameters that do not have supporting LTPP data, alternative data sources, when available, are recommended.

Table 15. Traffic parameters for mechanistic pavement response modeling.

Input Parameter	Parameter Description	LTPP Data Source
Vehicle class for each vehicle passage.	Vehicle class (FHWA vehicle classes 4–13)[11] or truck configuration for each vehicle passage, including the number and spacing of axles.	LTPP WIM IVR files are stored offline in the AIMS.[12]
Axle-to-axle spacing for each vehicle passage, or annual average for each FHWA vehicle class 4–13.	Distance between pairs of consecutive vehicles' axles for each vehicle passage.	LTPP WIM IVR files are stored offline in the AIMS.
Axle load for each axle for each vehicle passage or annual average for each FHWA vehicle class 4–13.	Static weight estimated by the WIM system for each axle for each vehicle passage.	LTPP WIM IVR files are stored offline in AIMS and could be used to obtain axle load for each axle for each vehicle passage; NALS tables available through InfoPave[3] could be used to compute average loads.
Wheel load for each axle for each vehicle passage or annual average for each FHWA vehicle class 4–13.	Static weight estimated by the WIM system for each axle for each vehicle passage; can be converted to an estimate of wheel load given assumptions about the number of tires on each axle.	This information is available from some WIM equipment but is not stored by LTPP in the AIMS; LTPP NALS tables could be used to compute average wheel loads.
Duration of each axle- or wheel-load application.	Time during which the axle load was applied on the monitored pavement section; used for dynamic pavement response modeling only.	This information is not collected by LTPP; data could be obtained from some WIM controller records.
Time history of changes in load magnitude for each axle or wheel passage at a point of interest.	Dynamic-load amplitude estimated based on the WIM signal for each millisecond during axle passage over the WIM sensor; used for dynamic pavement response modeling only.	This information is not collected by LTPP; data could be obtained from some WIM controller records but is not routinely reported by WIM equipment.
Wheel location on the pavement associated with each axle and vehicle passage, or annual average for each FHWA vehicle class 4–13.	Wheel location measured in inches from the outer edge of the wheel to the pavement marking for each axle and vehicle passage.	This information is not collected by LTPP; data could be obtained from specially configured quartz-piezo sensor arrays and from the advanced WIM sensors that record tire footprint and tire position data.
Tire footprint area for each axle associated with each vehicle passage, or annual average for each FHWA vehicle class 4–13.	Tire footprint area of each axle and vehicle passage.	This information is not collected by LTPP; the advanced WIM sensors that capture tire footprint and tire position data are currently available for pilot implementations.

Input Parameter	Parameter Description	LTPP Data Source
Load distribution within a tire footprint.	Load distribution over the footprint area for each axle and vehicle passage.	This information is not collected by LTPP; the advanced WIM sensors capable of recording pressure distribution under the tire footprint are currently available for pilot implementations.
Axle width from each vehicle passage, or annual average for each FHWA vehicle class 4–13.	Distance in feet between two outside edges of an axle.	This information is not collected by LTPP; default values may be appropriate due to expected low variability of this parameter.
Dual-tire spacing from each vehicle passage, or annual average for each FHWA vehicle class 4–13.	Distance in feet between two tires.	This information is not collected by LTPP; default values may be appropriate due to expected low variability of this parameter.
Tire pressure for the wheels of each vehicle, or annual average for each FHWA vehicle class 4–13.	Tire pressure (could be used as alternative means for computing size of tire footprint).	This information is not collected by LTPP.
Truck speed for each vehicle passage with each vehicle passage, or annual average for each FHWA vehicle class 4–13.	Truck speed.	Value could be obtained from available LTPP WIM IVRs recorded for each vehicle passage; LTPP WIM IVR files are stored offline in the AIMS.

IVR = individual vehicle record.

Parameters for Mechanistic–Empirical Pavement Performance Predictions

While pavement response analysis and modeling studies are focused on stresses, strains, and deflections that pavements experience under each traffic load application, pavement performance analysis and modeling studies are focused on pavement distresses (cracking, rutting, faulting, etc.) that develop over time. Many pavement distresses develop from incremental or cumulative changes in pavement structure over time due to material aging, environmental impacts, and traffic loading. Therefore, for traffic loading characterization, in addition to information about individual traffic load applications, it is important to know the sequence and cumulative total number of traffic load applications that lead to pavement deterioration over time.

Many mechanistic–empirical pavement performance analyses are carried out using the MEPDG method and software products, such as AASHTOWare Pavement ME Design.(5) This software uses a defined set of traffic input parameters in a specific format. These parameters are described later in this chapter in section, Traffic Parameters for MEPDG Applications Using AASHTOWARE Pavement ME Design Software. The following sections detail recommendations for traffic parameters needed for generic mechanistic–empirical pavement performance analysis and modeling. The traffic parameters that are formatted specifically for use in the AASHTOWare Pavement ME Design software are described in a separate section.

Axle Loading Characterization

To provide a means for tracking and summarizing traffic load applications over time, traffic loads are summarized in the form of an axle load spectrum (note that, in some pavement applications, “axle load spectrum” is referred to as “axle load distribution”). An axle load spectrum represents a frequency distribution of axle loads, where counts of axle load applications observed during a specified period of time are summed and reported using predefined load bins. Recognizing the importance of axle load configuration, separate axle load spectra are used to summarize axle load counts for typical axle groups: single, tandem, tridem, and quad. Depending on the intended use, load spectra could be created for an individual truck class or for all truck classes combined. In summary, input from axle load spectra provides information about axle load magnitudes, the number of axle load applications over a specified period of time at that magnitude, and axle load configuration (i.e., the number of axles in each axle load group). If no site-specific axle weight data are available to compute an axle load spectrum, default axle weights could be used.

In addition to axle load spectra, information about the relative position of axle loads on the pavement is also important, especially for jointed rigid pavements.

Such detailed characterization of traffic loading allows modeling of pavement responses and performance using methods where each axle load application on the pavement, expected or observed during the analysis period, is modeled, and its effect on pavement response and performance is predicted.

LTPP Tables Containing Traffic Parameters for Mechanistic–Empirical Pavement Performance Modeling

Table 16 summarizes traffic parameters recommended for generic mechanistic–empirical pavement performance modeling using pavement response models with static loads. LTPP sources for these parameters are also provided in the table.

Table 16. Traffic parameters for generic mechanistic–empirical pavement performance modeling.

Input Parameter	Parameter Description	LTPP Data Source
Axle load spectrum	Frequency distribution, where a number of axle load applications observed during a specified period of time is reported in predefined load bins. Separate axle load spectra are used to summarize axle loading for typical axle load groups: single, tandem, tridem, and quad. Axle load spectra could represent daily, monthly, or annual traffic loading summaries. This input must cover the whole analysis period, using time increments specified for analysis, so that the number of axle load applications can be used to model incremental changes in pavement structure over the selected analysis period.	This parameter is available in InfoPave[3] tables DD_AX (daily), MM_AX (monthly), YY_AX (annual), and TRF_MONITOR_AXLE_DISTRIB (annualized) for each year with WIM data, MEPDG_AXLE_LOAD_DIST_FACTOR (representative values for a typical day of the month or year).
Number of APT	Annual or representative number of single, tandem, tridem, and quad axles for each truck class (FHWA vehicle classes 4–13).[11]	This parameter is available in InfoPave[3] table TRF_MEPDG_AX_PER_ TRUCK for each year with sufficient WIM data or MEPDG_AXLE_PER _TRUCK (representative set of values per LTPP site). Additional values could be computed from LTPP WIM IVR files.

Input Parameter	Parameter Description	LTPP Data Source
Axle spacing for tandem, tridem, and quad axle groups	Average axle spacing in inches for tandem, tridem, and quad+ axles.	This parameter is not available through LTPP sources. It could be computed using LTPP WIM IVR files.
Axle spacing distribution	Frequency of longitudinal spacing of consecutive axles in feet, excluding spacing within tandem, tridem, and quad+ axles. Used to model locations of the load for JPCP pavements.	This parameter is not available in InfoPave.[3] It could be computed using LTPP WIM IVR files.
Average axle width	The distance in feet between two outside edges of an axle. Only needed for rigid pavement analysis.	This information is not collected by LTPP. Use manufacturers' truck specifications to find typical values.
Operational speed	Average truck speed.	This information could be obtained from WIM IVR records that follow the 2016 or later TMG data submission format.
Dual-tire spacing	Dual tire spacing.	This information is not collected by LTPP. Use manufacturers' truck specifications to find typical values.
Tire pressure	One value representing hot tire-inflation pressure.	This information is not collected by LTPP.
Mean wheel location	The distance from the outer edge of the wheel to the pavement marking. Used to model location of the load.	This information is not collected by LTPP.
Truck wander	Standard deviation from the mean wheel location, based on wheel-location measurements from the lane marking. Used to model location of the load.	This information is not collected by LTPP.

JPCP = jointed plain concrete pavement.

TRAFFIC SUMMARY PARAMETERS RECOMMENDED FOR HIGH-LEVEL AND EMPIRICAL ANALYSES

Many LTPP studies of pavement performance use empirical methods or statistical models to correlate pavement performance parameters (e.g., road roughness) to traffic and environmental loads, site conditions, material properties, and construction practices. These studies frequently use a single traffic summary parameter to describe traffic in the LTPP lane at each LTPP site. These analyses may require a complete history of changes in the selected traffic summary parameter (computed annually for the duration of the pavement's service life, LTPP experiment, or analysis period), a single cumulative value aggregated over the analysis period, or one representative traffic summary value for each LTPP site. The most frequently used traffic summary parameters for empirical analyses are AADTT and ESAL. More details about different summary statistics and recommendations for their uses are provided in the ensuing sections.

Traffic Loading Summary Parameters

ESAL as a Traditional Traffic Loading Summary Statistic

ESAL has been used as a summary traffic loading statistic for pavement design and analysis applications since the 1960s. ESAL is a concept developed from data collected at the American Association of State Highway Officials (AASHO) Road Test to establish a relationship to compare the effects of axles carrying different loads on pavement damage.[18] In ESAL computation, load-equivalency factors (LEFs) are used to convert a mixed stream of traffic consisting of different axle loads and configurations predicted over a design or analysis period into an equivalent number of 18,000-lb single-axle load applications summed over that period. Thus, ESAL is a cumulative traffic loading summary statistic. Although general understanding and consensus exist in the pavement engineering community that ESALs or LEFs do not precisely describe the relationship between axle loads and specific pavement distresses like rutting or cracking, ESAL continues to be a convenient statistic for sizing and quantifying traffic loading levels for empirical pavement analysis and design.

It is important to note that in addition to traffic loading, ESAL values depend on pavement type, pavement thickness, and road condition, expressed through a subjective pavement serviceability index. As a result, ESAL values representing the same traffic stream can vary due to a change in the pavement type or because the pavement was rehabilitated and, thus, its thickness and/or roughness changed.

GESAL

GESAL is a parameter computed similar to ESAL, using LEFs for flexible pavements with an SN equal to 5 and pavement terminal serviceability index equal to 2.5.[19] Because LEFs are set to a constant, GESALs are independent of pavement type and thickness and the level and type of pavement distress. Therefore, any changes in GESAL values can be directly attributed to changes in traffic loads. This makes GESAL a more desired summary traffic loading statistic for comparing loads, correlating the effect of traffic loads to pavement performance or for comparing traffic loading between LTPP sites. This summary statistic is more sensitive to the importance of heavy loads on pavement performance compared to the average traffic load or total traffic load summary statistics. However, use of constant LEF parameters makes GESAL not applicable as a direct input to empirical pavement design using the methodology in the 1993 version of the AASHTO *Guide for Design of Pavement Structures*.[8]

RPPIF

RPPIF is a parameter designed to aid in identifying LTPP sites with similar traffic-loading levels.[10] Like ESAL, RPPIF computation uses factors that are applied to load spectrum, but instead of using LEFs based on data from the AASHO Road Test,[18] it uses a parameter called W-factor. W-factors were determined through MEPDG analysis, based on globally calibrated distress-prediction models included in the MEPDG report and software.[10] W-factors are not normalized with respect to 18-kip single-axle loads like LEFs, but instead are normalized with respect to a fully loaded tandem-axle load, which is 34 kips. The main purpose or usability of this statistic is to compare axle loading distributions between different sites. As MEPDG models evolve, W-factors used for RPPIF computation may need to be updated, or distress-specific W-factors and RPPIF statistics may be desired for a particular pavement performance modeling task. As with GESAL, the RPPIF statistic is independent of pavement type and thickness and level of pavement distress.

Annual Total Load and Cumulative Total Load

The annual total truck load (ATL) parameter is an estimate or summation of all truck traffic loads accumulated over a year. The cumulative total truck load (CTL) parameter is an estimate or summation of all truck traffic loads accumulated over the entire analysis period. The main advantage of ATL and CTL parameters is that they are independent of empirically derived relationships that relate load to pavement damage, like ESAL. However, these parameters cannot be used to infer whether trucks are empty or loaded and whether their values are affected by the number or the weight of trucks (i.e., a small number of heavy trucks and large number of light trucks may produce the same ATL value). These limitation makes ATL and CTL parameters less desirable for analyses of pavement performance that have a nonlinear relationship with load magnitude.

Traffic and Truck Volume Summary Parameters

For analyses focused on characterizing total traffic or truck volumes at LTPP sites, several statistical parameters are available through InfoPave web portal.[3] The most widely used traffic volume parameters are AADT and AADTT in LTPP lane. The AADTT parameter is more relevant for pavement analysis and management applications than AADT because trucks have a much higher contribution to pavement damage than the lighter vehicles that make up most of the AADT number. The AADT parameter may be more appropriate as an input in road prioritization decision algorithms within pavement or road maintenance management applications.

Other traffic volume statistics used in pavement analyses are total annual truck volume, annual truck volume by vehicle class, the ratio of FHWA vehicle class 5 to class 9 truck volumes, cumulative volume of FHWA vehicle class 9 vehicles, and cumulative volume of heavy vehicles (FHWA vehicle classes 4 and 6–13[11]). In some empirical analyses, annual volume of FHWA vehicle class 9 vehicles or the portion of AADTT attributed to FHWA vehicle class 9 vehicles may be used. Typically, in the United States, FHWA vehicle class 9 vehicles carry the largest portion of total load due to their heavy weight, and they typically make up a high percentage of the truck population.

Recommendations for Selecting Summary Traffic Loading Parameters Based on the Purpose of the Analysis

The following recommendations are for the situations when a single traffic loading summary parameter is a desired input for pavement analysis. No single traffic loading summary parameter works equally well for all pavement analysis applications, mostly due to the differences in sensitivity of different pavement distresses to load magnitude versus the number of axle load applications. The choice of a traffic loading statistic should be based on the intent of the analysis and perceived relationship between the load and pavement distress. The following is guidance for selecting a traffic loading summary parameter based on the type of pavement distress being analyzed:

- If a pavement distress is primarily caused by the repeated heavy axle loads (as in the case of fatigue cracking), then a summary loading statistic that properly accounts for the number of heavy-load applications should be used, such as ESAL or GESAL.

- If a pavement distress is caused by overloaded trucks or axles (as in the case of rigid pavement slab cracking), then the summary loading statistic should accurately describe the number of fully loaded and overloaded axles and average weight of these axles, such as the number of fully loaded and overloaded axles or the number and average weight of heavy trucks (FHWA vehicle classes 4 and 6–13[11]).

- If a pavement distress is primarily caused by repeated load application (as in the case of raveling and, to some degree, rutting), then a summary loading statistic that accurately describes the number of load applications should be used, such as AADTT, cumulative total truck volume, CTL, or the total number of axle loads for FHWA vehicle classes 4–13.

- If the cause of the distress is not known but perceived to be load related and a single traffic loading summary parameter is desired for the analysis, then GESAL or RPPIF may be the traffic loading summary statistic of choice. The reasoning behind this recommendation is that these statistics are independent of pavement-related variables but recognize the higher significance of heavier traffic loads in pavement deterioration. These parameters are based on an actual axle load spectrum, as well as truck volume. Another alternative is to use a parameter that represents the total number of heavy axle load applications (those that are at or above of 50, 75, or 100 percent of the Federal legal load limit per axle or per truck).

- If a traffic loading statistic that is free of any adjustments with respect to significance of load magnitude to pavement damage development is needed, either the ATL or CTL summary statistic can be used. These parameters are suitable for higher level pavement network-level performance analyses.

- If no site-specific vehicle weight data are available to compute axle or truck weights for use as a loading traffic summary statistic, default axle weights can be selected for individual truck FHWA vehicle classes 4–13,[11] such as defaults provided in LTPP PLUG.[9] These default weights, in combination with site-specific truck volume and vehicle classification data, can be used to estimate traffic loads and compute a traffic loading summary statistic of choice for any LTPP site.

- If a parameter to characterize or differentiate traffic loading intensity between LTPP sites is desired, the average truck weight, GESAL per truck, or RPPIF per truck can be used as a traffic loading summary statistic. Another alternative is to characterize traffic loading intensity between LTPP sites with respect to the percentage of heavy axles (75 percent or more of the Federal legal load limit per axle) that are present on a test section. For example, a test site might be characterized to have light loading (i.e., less than one-third of axle applications are heavy), moderate loading (i.e., between one-third and one-half of axle applications are heavy), or heavy loading (i.e., greater than one-half of axle applications are heavy).

LTPP Tables Containing Traffic Loading Summary Parameters

Table 17 summarizes different traffic summary parameters, specifies the types of analyses for which these parameters are appropriate to use, and provides references to LTPP traffic data tables (accessible through InfoPave web portal[3]) containing these parameters.

Table 17. Traffic summary parameters.

Parameter	Description	Recommended Use and Limitations	LTPP Data Sources
AADT	Traffic summary statistic used to measure average daily road use by all vehicular traffic.	Can be used to quantify road importance for pavement management applications to quantify the level of facility use and as an input for safety and congestion studies; should not be used for evaluating the effect of traffic loads on pavement performance.	AADT_ALL_VEHIC_2WAY and AADT_ALL_VEHIC fields from TRF_MON_EST_ ESAL and TRF_HIST_EST_ ESAL tables. Data are not available for all LTPP test sites or all in-service years. Additional data interpolation and extrapolation required to estimate AADT for all years.
AADTT	Truck traffic summary statistic used to measure average daily road use by heavy vehicles (FHWA vehicle classes 4–13).[11]	Can be used to quantify road importance for pavement management applications; not sufficient as a single summary statistic for evaluating the effect of traffic loads on pavement performance.	AADTT_ALL_TRUCKS_ TREND field from TRF_TREND table (for LTPP lane only).
Cumulative truck traffic volume	Traffic summary statistic used to measure total road use by heavy vehicles (FHWA vehicle classes 4–13) from the pavement's open to traffic date to the end of pavement service life or end of the LTPP experiment.	Can be used as an input in analyses of effects of traffic on nonstructural pavement distresses and as supplemental input in analyses of effects of traffic on structural pavement response and performance; not sufficient as a single summary statistic for evaluating the effect of traffic on structural pavement performance.	Compute by summing ANNUAL_TRUCK_ VOLUME_TREND values from TRF_TREND table.
Cumulative volume of FHWA vehicle class 9 trucks	Traffic summary statistic used to measure road use by FHWA vehicle class 9 vehicles from the pavement's open to the end of pavement service life or end of the LTPP experiment.	Can be used as a primary or supplemental input for analyses of pavement performance for LTPP sites with dominant FHWA vehicle class 9 trucks; limitations associated with variable loads carried by FHWA vehicle class 9 trucks should be understood.	CUMULATIVE_VEH_ CLASS_9_TREND field from TRF_TREND table.
Cumulative volume of heavy trucks (FHWA vehicle classes 4 and 6–13)	Traffic summary statistic used to measure road use by FHWA vehicle classes 4 and 6–13 from the pavement's open to traffic date to the end of pavement service life or end of the LTPP experiment.	Can be used as a primary or supplemental input for analyses of pavement performance; limitations associated with variable loads carried by these trucks should be understood.	CMLTV_VOL_HEAVY_ TRUCKS_TREND field from TRF_TREND table.

Parameter	Description	Recommended Use and Limitations	LTPP Data Sources
Annual ESAL	Traffic loading summary statistic that uses coefficients developed from the AASHO Road Test to convert traffic stream to an equivalent number of 18,000-lb single-axle loads.	Historically used as a primary input parameter to relate pavement performance to traffic loading; can be used to characterize traffic loading at the site, but can be affected by nontraffic parameters (i.e., pavement structure, thickness, and serviceability); if used as a direct input to analyze pavement response or performance, limitations associated with the ESAL statistic should be understood.	ANL_KESAL_LTPP_LN_YR field from TRF_HIST_EST_ESAL or TRF_MON_EST_ESAL tables; TRF_ESAL_COMPUTED table KESAL_YEAR field; TRF_TREND table ANNUAL_ESAL_TREND field.
Cumulative ESAL	Traffic loading summary statistic that provides total measure of traffic load accumulated from the pavement's open to traffic date to the end of pavement service life or end of the LTPP experiment; uses coefficients developed from the AASHO Road Test to convert traffic stream to an equivalent number of 18,000-lb single-axle loads.	Historically used as a parameter to relate pavement performance to traffic loading; used as traffic input to the AASHTO guide from 1993[8] and earlier pavement design methods; can be used as a general estimate of cumulative traffic loading; however, because it is affected by nontraffic parameters (i.e., pavement structure, thickness, and serviceability), its applicability may be limited.	Compute by summing the annual ESAL values from TRF_HIST_EST_ESAL, TRF_MON_EST_ESAL, TRF_ESAL_COMPUTED, or TRF_TREND tables.
Annual GESAL	Similar to ESAL computation for flexible pavements but has pavement structure and pavement condition inputs set to a constant value.	Can be used as a general estimate of traffic loading at the site and as an input parameter to relate pavement performance to traffic loading when multiple sites are considered in the analysis; if used in the analysis, limitations and assumptions associated with the GESAL formulation must be taken in consideration.	ANNUAL_GESAL_TREND field from TRF_TREND table.
Cumulative GESAL	Traffic loading summary statistic similar to cumulative ESAL but has pavement structure and pavement condition inputs set to constant values.	Can be used as a general estimate of traffic loading at the site and as an input parameter to relate pavement performance to traffic loading when multiple sites are considered in the analysis; if used in the analysis, limitations and assumptions associated with GESAL formulation need to be considered by the analyst.	Compute by summing the annual GESAL values from ANNUAL_GESAL_TREND field of TRF_TREND table.

Parameter	Description	Recommended Use and Limitations	LTPP Data Sources
Representative RPPIF per truck axle	Summary loading statistic similar to ESAL per axle (i.e., single, tandem, tridem, and quad) but with LEF estimated based on MEPDG simulations and normalized to fully loaded 34,000-lb tandem-axle loads.	Used to quantify differences in axle loading between different axle load spectra; can be used to identify load spectra likely to produce different levels of pavement distresses, especially for distress that are sensitive to heavy axle load applications.	REP_RPPIF_SINGLE_AXLE, REP_RPPIF_TANDEM_AXLE, REP_RPPIF_TRIDEM_AXLE, and REP_RPPIF_QUAD_AXLE fields from TRF_REP table.
Representative RPPIF per truck	Similar to ESAL per truck statistic but with LEF estimated based on MEPDG simulations and normalized to fully loaded 34,000-lb tandem-axle loads.	Can be used to quantify differences in loading between different truck classes or for the same truck class between different LTPP sites.	REP_RPPIF_PER_TRUCK and REP_RPPIF_PER_VEH_CLASS_# fields from TRF_REP table.
ATL	Summary loading statistic that represents an estimate of the total weight of all vehicles in FHWA vehicle classes 4–13 applied to the pavement during the reporting year.	Can be used as an input parameter to relate pavement performance to traffic loading; major limitation is that it does not contain information on the number of heavy loads that are especially damaging for pavements.	ANNUAL_TOTAL_LOAD_TREND field from TRF_TREND table.
CTL	Summary loading statistic that represents an estimate of a total weight of all vehicles in FHWA vehicle classes 4–13 applied to the pavement from the pavement's open to traffic date to the end of pavement service life or end of the LTPP experiment.	Can be used as an input parameter to relate pavement performance to traffic loading; major limitation is that it does not contain information on the number of heavy loads that are especially damaging for pavements.	Compute by summing annual traffic load values from ANNUAL_TOTAL_LOAD_TREND field of TRF_TREND table.
Representative average GVW for each FHWA vehicle class 4–13	Representative average GVW for each FHWA vehicle class 4–13.	Describes typical weight of different types of trucks but does not contain information about truck volume or total loading experienced by the site; in combination with AADTT by vehicle class information, can be used to define traffic loading associated with each FHWA vehicle class 4–13 at the site.	REP_GVW_VEH_CLASS_# field from TRF_REP table.

Parameter	Description	Recommended Use and Limitations	LTPP Data Sources
Representative average GVW for FHWA vehicle classes 4–13 combined	Representative average GVW for the site for FHWA vehicle classes 4–13 combined.	Can be used to identify or group LTPP sites with a similar rate of traffic loading; provides a description of expected traffic loading but does not contain information about truck volume or total loading experienced by the site; in combination with AADTT information, can be used to characterize total traffic at the site.	REP_GVW_TRUCK field from TRF_REP table.

TRAFFIC PARAMETERS FOR MEPDG APPLICATIONS USING AASHTOWARE PAVEMENT ME DESIGN SOFTWARE

A complete list of input traffic parameters required by AASHTOWare Pavement ME Design software(5) is shown in table 18. This software provides a means to analyze pavement response and performance using MEPDG models. The parameters shown in table 18 are also used for the local calibration of MEPDG models and for developing and testing new performance prediction models.

Table 18. Traffic input parameters required by AASHTOWare Pavement ME Design software.(5)

Input Parameter	Parameter Description	LTPP Data Source
ALDF for single, tandem, tridem, and quad axles (percent)	ALDF represents a percentile axle load distribution for a typical day for each calendar month for a typical design/analysis year; one set of ALDF is provided for each vehicle class (FHWA vehicle classes 4–13),(11) axle group type (i.e., single, tandem, tridem, and quad+), and calendar month (January through December); ALDF stay constant between analysis years.	This parameter is available in MEPDG_ AXLE_LOAD_DIST_FACTOR table in MEPDG_LG01… MEPDG_LG39 fields.
Vehicle class volume distribution (percent)	One percentile distribution of vehicles in FHWA vehicle classes 4–13 is provided to represent an average VCD for the base design/analysis year.	This parameter is available in MEPDG_TRUCK_VOL_PARAMETERS table in VEH_CLASS_DISTRIBUTION _PERCENT field, where vehicle class is defined by the VEH_CLASS field.
Monthly adjustment factors	One set of 12 monthly coefficients is provided for each FHWA vehicle class 4–13 to represent differences in truck volumes between different calendar months for the base design/analysis year; the sum of factors for all months for one truck class should equal 12.	Information to compute this parameter is available for some sites through the InfoPave web portal(3) in the form of monthly summary statistics for each year with data; see the TRF_MEPDG_MONTH_ADJ_FACTR table and MONTHLY_RATIO field; compute the average factors, considering all or selected years of data; one representative set of factors should be used in AASHTOWare Pavement ME Design software.

Input Parameter	Parameter Description	LTPP Data Source
Hourly adjustment factors (percent)	One set of 24 hourly factors is provided, showing the representative percentage of total truck traffic for each hour; values are the same for all truck classes and only apply to truck volumes; the sum of factors for all hours should equal 100; this input parameter only applies to PCC pavements.	Information to compute this parameter is available through the InfoPave web portal[3] for each year with monitored traffic data; see TRF_MEPDG_HOURLY_DIST table and PCT_HOURLY field; compute the average factors, considering all or selected a years of data; one representative set of factors should be used in AASHTOWare Pavement ME Design software.
Number of APT	One representative set of values is provided, showing the average number of single, tandem, tridem, and quad axles for each truck class (FHWA vehicle classes 4–13).	This parameter is available through InfoPave web portal[3] in MEPDG_AXLE_PER_TRUCK table in SINGLE_AXLES, TANDEM_AXLES, TRIDEM_AXLES, and QUAD_AXLES fields.
Base year AADTT for LTPP lane	One value representing the annual average daily volume of vehicles in FHWA vehicle classes 4–13 for the first full (base) design/analysis year is provided. If this input parameter is used in the AASHTOWare Pavement ME Design software in place of two-way AADTT, enter the following values: percent trucks in design direction = 100, and percent trucks in design lane = 100; alternative input to AADTT for LTPP lane: base year two-way AADTT.	This parameter is available through InfoPave web portal[3] in MEPDG_ TRUCK_VOL_PARAMETERS table in AADTT_FIRST_YEAR_LTPP_LANE field.
Base year two-way AADTT	Two-way AADTT is provided, computed for the first full (base) design/analysis year.	Information to compute this parameter using a limited number of years is available in the LTPP database for many LTPP sites; instead of this parameter, a better approach is to use the parameter and corresponding instructions for base year AADTT for LTPP lane.
Number of lanes in design direction	Number of lanes in the design direction (direction of LTPP lane) is provided.	This parameter is available in SHRP_INFO table in LANES_LTPP_DIR field.
Percentage of trucks in design direction	Percentage of trucks in the design direction (direction of LTPP lane) is provided for the base design/analysis year.	This parameter is not available in the LTPP sources; instead, use the parameter and corresponding instructions for base year AADTT for LTPP lane.
Percentage of trucks in design lane	Percentage of trucks in the design lane (LTPP lane) is provided for the base design/analysis year.	This parameter is not available in the LTPP sources; instead, use the parameter and corresponding instructions for base year AADTT for LTPP lane.
Growth rate by vehicle class (percent)	Annual growth rate (percent) for each truck class (FHWA vehicle classes 4–13) is provided. This parameter is used together with the growth function parameter (linear or compound) to estimate truck volume from AADTT values provided for the base design/analysis year for each year of the analysis/design period.	This parameter is available in MEPDG_TRUCK_VOL_PARAMETERS table in VEH_CLASS_GROWTH_RATE field.

Input Parameter	Parameter Description	LTPP Data Source
Vehicle class growth function by vehicle class	Type of truck volume growth function (linear or compound) is provided by FHWA vehicle classes 4–13. This parameter is used together with the growth rate parameter to estimate truck volume over the analysis/design period from the base design/analysis year AADTT values.	This parameter is available in MEPDG_TRUCK_VOL_PARAMETERS table in VEH_CLASS_GROWTH _FUNCTION field.
Operational speed (mph)	This parameter is defined as the posted speed limit or the average speed of heavier trucks through the project limits.	This parameter is not available in the LTPP sources but could be computed from WIM IVR files submitted in the 2016 TMG(11) format; alternatively, use the posted speed limit.
Axle spacing for tandem, tridem, and quad axles (inches)	Average representative axle spacing (inches) is provided for tandem, tridem, and quad axles.	This parameter is not available in the LTPP sources but could be computed from WIM IVR files; alternatively, use the LTPP default in the LTPP PLUG report.(9)
Percentage of trucks with short, medium, and long wheelbases (percent)	This parameter provides percentages of trucks with wheelbases that fall in the following three categories: short (≤12 ft), medium (>12 and ≤15 ft), and long (>15 and ≤20 ft); for multiunit and combination trucks, only the wheelbase of the truck power-unit (i.e., first unit) is considered; used for top–down JPCP cracking model only.	This parameter is not available in the LTPP sources but could be computed from WIM IVR files; alternatively, use the LTPP default in the LTPP PLUG report.
Average axle width (ft)	The average distance (feet) between two outside edges of an axle is provided as a representative value for all truck classes; only needed for rigid pavement designs.	This parameter is not available in the LTPP sources; use the default in AASHTOWare Pavement ME Design software.
Mean wheel location (inches)	The mean distance (inches) from the outer edge of the wheel to the pavement marking is kept constant between all truck classes and does not change over time.	This parameter is not available in the LTPP sources; use the default in AASHTOWare Pavement ME Design software.
Truck wander standard deviation (inches)	Standard deviation (inches) from the mean wheel location is computed based on measurements from the lane marking.	This parameter is not available in the LTPP sources; use the default in AASHTOWare Pavement ME Design software.
Dual-tire spacing (inches)	Average spacing (inches) of dual tires is kept constant between all truck classes and does not change over time.	This parameter is not available in the LTPP sources; use the default in AASHTOWare Pavement ME Design software.
Tire pressure (psi)	One value representing hot tire inflation pressure is kept constant between all truck classes and does not change over time.	This parameter is not available in the LTPP sources; use the default in AASHTOWare Pavement ME Design software.

MEPDG Parameters Requiring Special Input Formats

Most input parameters can be manually entered into AASHTOWare Pavement ME Design software user interface.(5) However, two input parameters—axle load distribution factors and monthly truck volume adjustment factors—consist of a large set of values. Due to the large size of these input parameters, the preferable way to enter them into AASHTOWare Pavement ME Design software is to upload files in a format readable by the software. Alternatively, these input parameters could be entered into the software by copying values from the MEPDG_AXLE_LOAD_DIST_FACTOR table and pasting into the AASHTOWare Pavement ME Design software user interface.

RECOMMENDATIONS FOR ASSESSING AXLE LOADING DISTRIBUTION DATA RATIONALITY

For successful use in pavement analyses, axle loading distributions factors or NALS must be computed using accurate axle loading data. Accurate estimates of heavy axle loads are especially important for load-related pavement response and distress modeling. Therefore, WIM data should be collected by a calibrated WIM system that satisfies ASTM E1318-09 requirements for Type I WIM systems for the duration of the data collection period.(17)

Only a limited number of LTPP WIM sites have the necessary information in TRF_EQUIPMENT_MASTER and TRF_CALIBRATION_WIM tables (available through InfoPave web portal(3)) to quantify WIM data quality and conclude that the available data satisfy the ASTM E1318-09 requirements for Type I WIM systems. To overcome this limitation, several WIM data rationality checks have been developed to help LTPP users evaluate the reasonableness and usability of available axle loading data.

The WIM data rationality checks detailed in this section could be used to identify axle loading distributions likely affected by a strong measurement bias (due to a lack of calibration or calibration drift) and/or low precision in heavy weight measurements or by vehicle misclassification. These checks apply to monthly and annual single and tandem NALS for FHWA vehicle class 9 trucks.(11) FHWA vehicle class 9 NALS are used because this vehicle class has a well-known and predictable axle loading distribution. Changes in NALS over time or unusual distributions are used to identify data with suspected quality issues.

These checks are designed to identify high percentages of unusually light or heavy axle loads for FHWA vehicle class 9 vehicles, as well as atypical weights corresponding to loaded and unloaded tandem axles of FHWA vehicle class 9 vehicles. High percentages of very light loads typically indicate a vehicle misclassification issue or calibration drift. Very high percentages of loads exceeding the legal load limit on tandem axles typically indicate calibration drift. Annual or monthly NALS that have high percentages of both very light and very heavy loads could also indicate low precision or temperature sensitivity of WIM weight measurements. Knowledge of local truck traffic trends and commodities is important for making decisions about usability of WIM datasets flagged through reasonableness checks.

The following are class 9 single-axle NALS checks:

- Ten percent or greater are <5,000 lb.
- Three percent or greater are ≥20,000 lb.
- Average single-axle weight or peak load in NALS is <9,000 lb.
- Average single-axle weight or peak load in NALS is >12,500 lb.

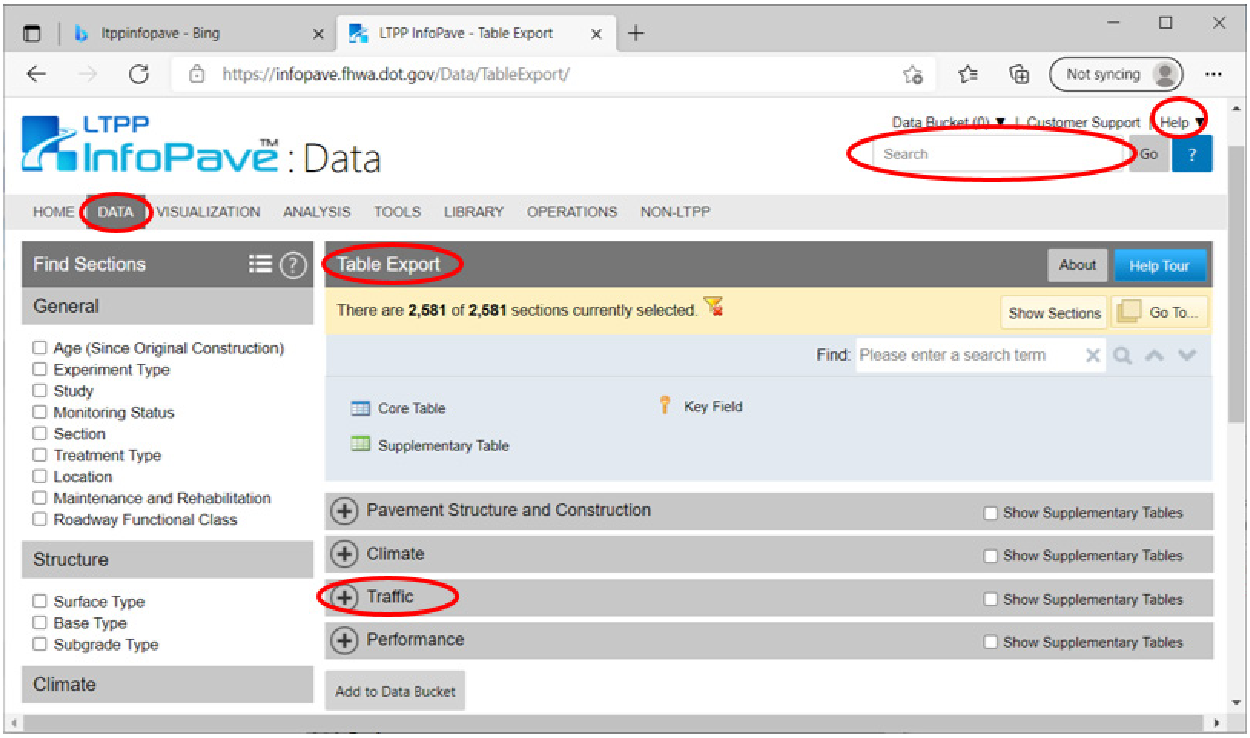
The following are class 9 tandem-axle NALS checks:

- U.S. sites: 10 percent or greater are <8,000 lb.
- U.S. sites: 20 percent or greater are ≥34,000 lb.
- Canadian sites: 10 percent or greater are <8,000 lb.
- Canadian sites: 20 percent or greater are ≥38,000 lb.
- WIM sites located on a road with predominantly empty class 9 trucks have >7 percent of overloaded tandems.
- Calibration drift check: Sites are likely to be out of calibration if the following applies:
    - Percentage of axles between 30,000 and 35,999 lb is less than the percentage of axles between 36,000 and 41,999 lb. (Note: This condition is likely an overestimation of loads.)
    - Percentage of axles between 26,000 and 33,999 lb is less than the percentage of axles between 20,000 and 25,999 lb for sites with less than 30 percent of axles between 10,000 and 15,999 lb. (Note: This condition is likely an underestimation of loads.)
- The first loading peak (for tandem axles on empty trucks) is not between 10,000 and 15,999 lb.
- The second loading peak (for tandem axles on loaded trucks) is not between 30,000 and 33,999 lb.
- Average loaded tandem-axle weight (this parameter is computed as the average weight of class 9 tandem axles weighing 26,000 lb or more) is <29,000 lb.
- Average loaded tandem-axle weight is ≥34,000 lb.

CHAPTER 5. WHERE TO GET LTPP TRAFFIC DATA

LTPP INFOPAVE

The InfoPave web portal is one way to get LTPP traffic data and information (figure 1).(3) The web portal provides a means to search for and download specific LTPP data tables and parameters. The Help feature, shown in the top right corner of figure 1, provides information on how to use and navigate the InfoPave web portal. Detailed instructions on how to use InfoPave to extract traffic parameters are provided in part 2 of this Guide.



Source: FHWA.

Figure 1. Screenshot. InfoPave Table Export page.(3)

The following InfoPave features are most useful for obtaining traffic data:

- Search bar: This feature, shown in the top right corner of figure 1 underneath the Help feature, allows users to find information, documents, and specific data tables by searching for a keyword or phrase. This feature is especially helpful if users do not know what LTPP table or document contains the desired traffic information.

- Data module: This module contains the InfoPave table export feature, which allows LTPP users to quickly locate and download LTPP data tables that have the desired traffic information. In addition to downloading data using this module, users may download documents and other ancillary traffic information.

CUSTOM REQUESTS

For data or information not included in LTPP data tables or not found through the InfoPave web portal, a custom request can be sent via e-mail to the LTPP Customer Support Service Center at ltppinfo@dot.gov. Other contact information is posted on the LTPP program website.[20]

PART 2. PLAYBOOK

OVERVIEW

Part 2 of the Guide serves as a playbook showing practical examples of how to identify and extract the desired LTPP traffic data and parameters for different pavement analysis applications. The examples are presented for the following scenarios in the corresponding chapters:

- Chapter 6—Generic Steps to Select and Extract Data Tables Using LTPP InfoPave.
- Chapter 7—Scenario 1: Obtain Truck Traffic and Volume Information.
- Chapter 8—Scenario 2: Obtain Vehicle Classification Information.
- Chapter 9—Scenario 3: Obtain Axle or Truck Loading Information.
- Chapter 10—Scenario 4: Obtain Summary Traffic Loading Information (ESAL or Alternative Statistics).
- Chapter 11—Scenario 5: Obtain MEPDG Traffic Inputs for Use in AASHTOWare Pavement ME Design software.

CHAPTER 6. GENERIC STEPS TO SELECT AND EXTRACT LTPP TRAFFIC PARAMETER TABLES USING LTPP INFOPAVE

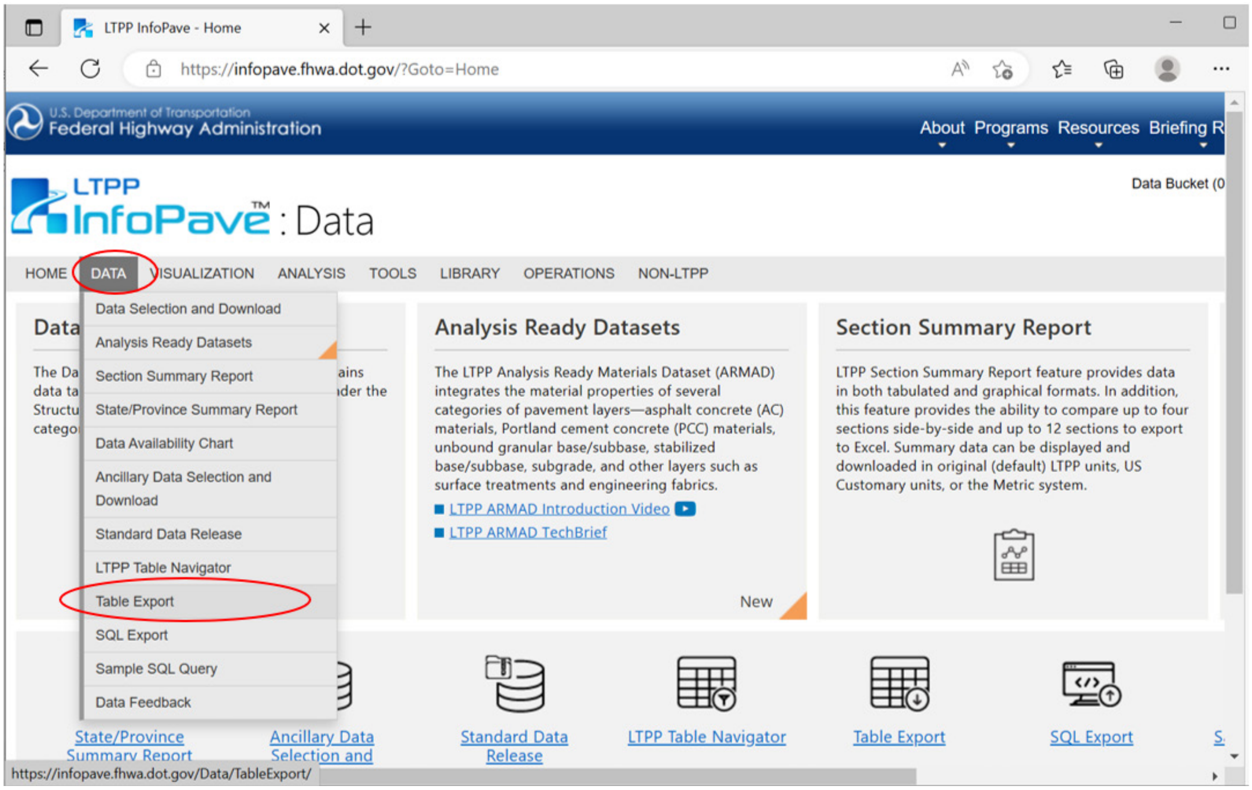
The generic steps to select and extract a table with the desired LTPP traffic parameter from InfoPave are listed as follows.[3] A detailed data extraction example using these steps is provided in the next section.

1. From the DATA tab on the InfoPave application Data screen, select "Table Export" option. This action will display the Table Export menu in the InfoPave application.
2. Select the "+" to the left of the word "Traffic" from the Table Export menu, which will reveal the list of tables containing traffic parameters that can be downloaded.
3. Select the table name that contains the desired parameter.
4. Click on the button "Add to Data Bucket" located at the bottom of the Table Export menu.
5. Locate the "Data Bucket" menu label on the top right of the main InfoPave screen and click on it. Select the "Data" option from the drop-down Data Bucket menu.
6. On the displayed Data Bucket form, specify the email address to receive data extraction notifications and the desired data extraction format (typically Microsoft Excel® or Access) and click on the "Submit for Data Extraction" button shown on the bottom of the Data Bucket form.
7. Open the email account specified on the Data Bucket form.
8. Find a new email from InfoPave (noreply@infopave.com) containing Data Bucket unique ID number and a web link to check the status of data extraction.
9. Use the weblink and the Data Bucket ID number to access File Download form.
10. Click on the word "Download" displayed on the pop-up File Download form to download the data table to a desired location on a local computer.

Generic Example of LTPP Traffic Parameter Extraction Using InfoPave

The generic data extraction steps described in the following example can be used to extract LTPP data tables using the InfoPave web portal.[3]

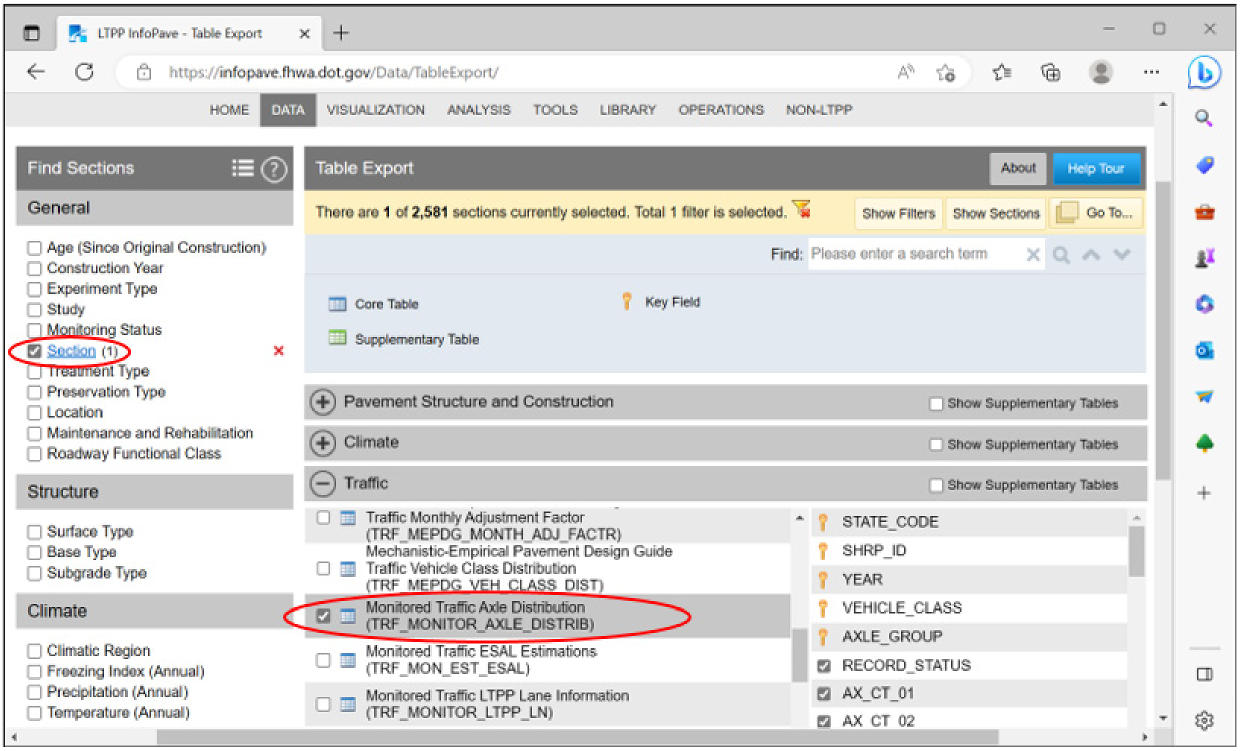
1. Open the InfoPave website: https://infopave.fhwa.dot.gov.[3]
2. On the InfoPave screen, click on the DATA tab displayed on the top toolbar. When the drop-down list appears under DATA tab, click on "Table Export" option located on the drop-down list, as shown in figure 2.



Source: FHWA.

Figure 2. Screenshot. InfoPave Data screen with the DATA drop-down box displayed and "Table Export" option selected.[(3)]

3. When the Table Export menu is displayed, find the word "Traffic" and click on the circle with "+" sign displayed to the left of the word "Traffic." This action will display a list of available traffic parameters and associated traffic data tables. It will also change the "+" sign to a "–" sign to the left of the word "Traffic," as shown in figure 3.



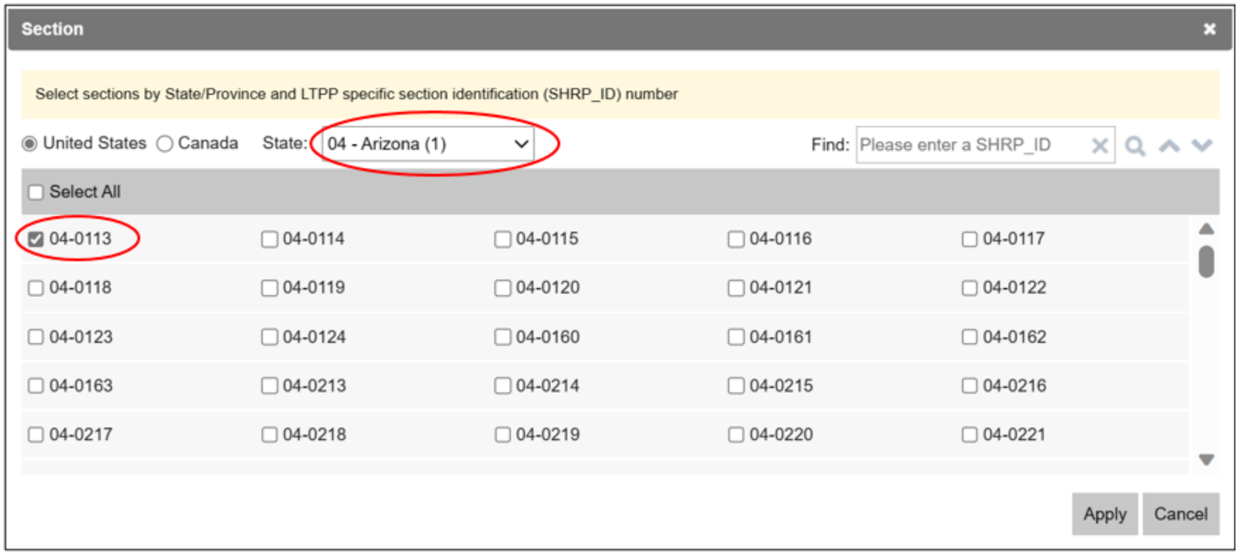
Source: FHWA.

Figure 3. Screenshot. InfoPave Table Export menu with checkboxes selecting the "Section" label and the traffic table label "Monitored Traffic Axle Distribution (TRF_MONITOR_AXLE_DISTRIB)."(3)

4. Scroll down the list until you find the desired parameter and/or table name. The list item "Monitored Traffic Axle Distribution (TRF_MONITOR_AXLE_DISTRIB)" is used in this example.

5. Click on the checkbox to the left of the desired table name, as shown in figure 3. No additional selection is needed to download the whole table. However, if data are needed for a specific LTPP section or a set of sections, look on the left-hand side of the screen shown in figure 3 and find the word "Section" displayed on the left side of the screen under headers "Find Sections," and "General."

6. Click on the checkbox displayed to the left of the word "Section." A pop-up screen will be displayed with LTPP section IDs, filtered by the State name, as shown in figure 4.



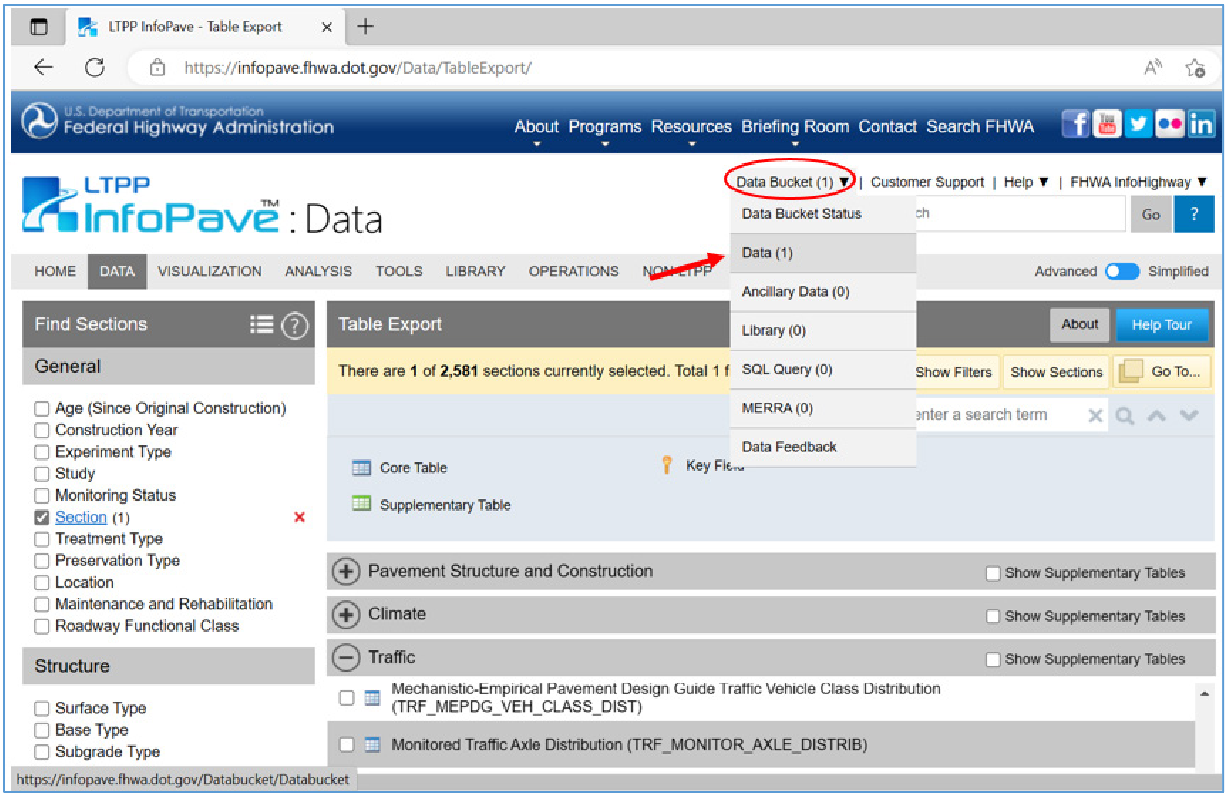
Source: FHWA.

Figure 4. Screenshot. InfoPave Section pop-up screen with site IDs displayed for the selected State (Arizona is selected).(3)

7. Select the desired State and LTPP section ID by placing a checkmark to the left of the section ID and click the "Apply" button.

8. Scroll to the bottom of the Table Export form and click on the "Add to Data Bucket" button located at the bottom.

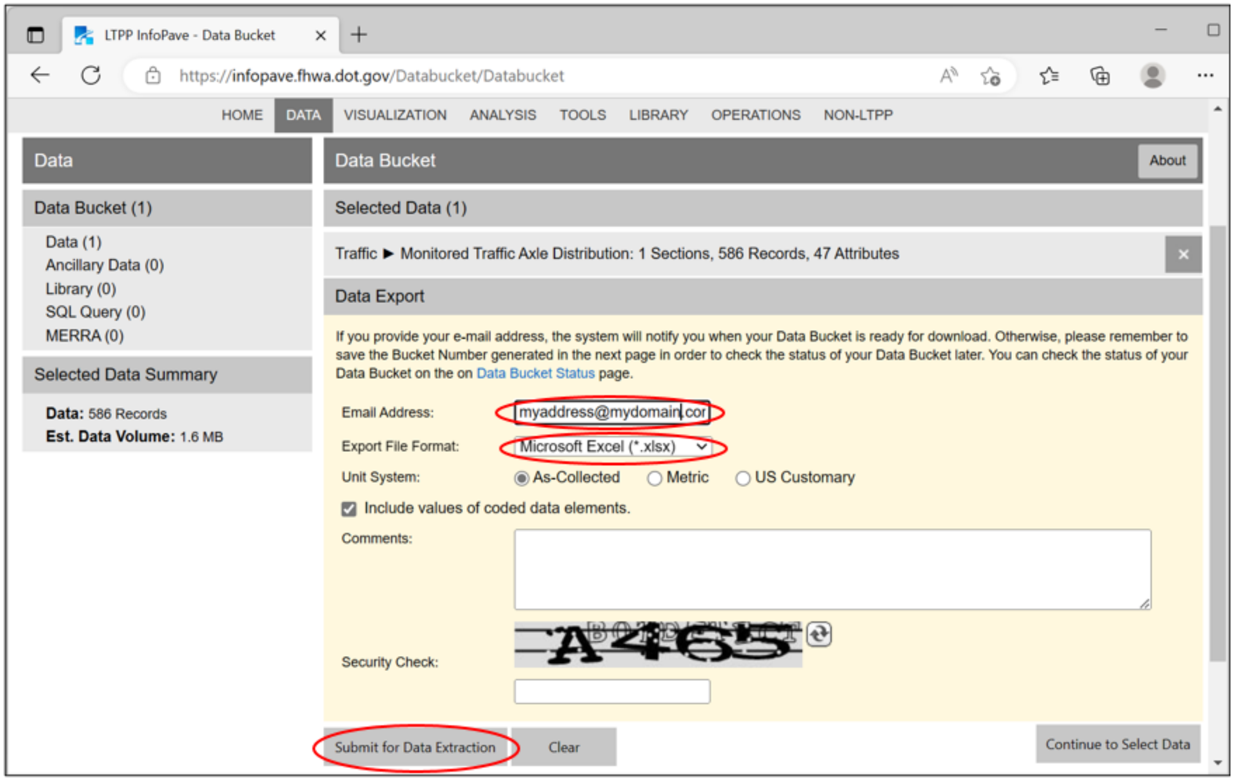
9. Locate the "Data Bucket" label on the top of the main InfoPave screen (figure 5) and put mouse pointer over it. A drop-down list will be displayed, as shown in figure 5. Find the "Data" option on that list and click on it.



Source: FHWA.

Figure 5. Screenshot. InfoPave screen displaying the top bars with the "Data Bucket" label displayed.[(3)]

10. On the Data Bucket form that will show up (figure 6), specify your email address and the desired data extraction format (typically Excel or Access) and click on the "Submit for Data Extraction" button shown at the bottom of that screen.

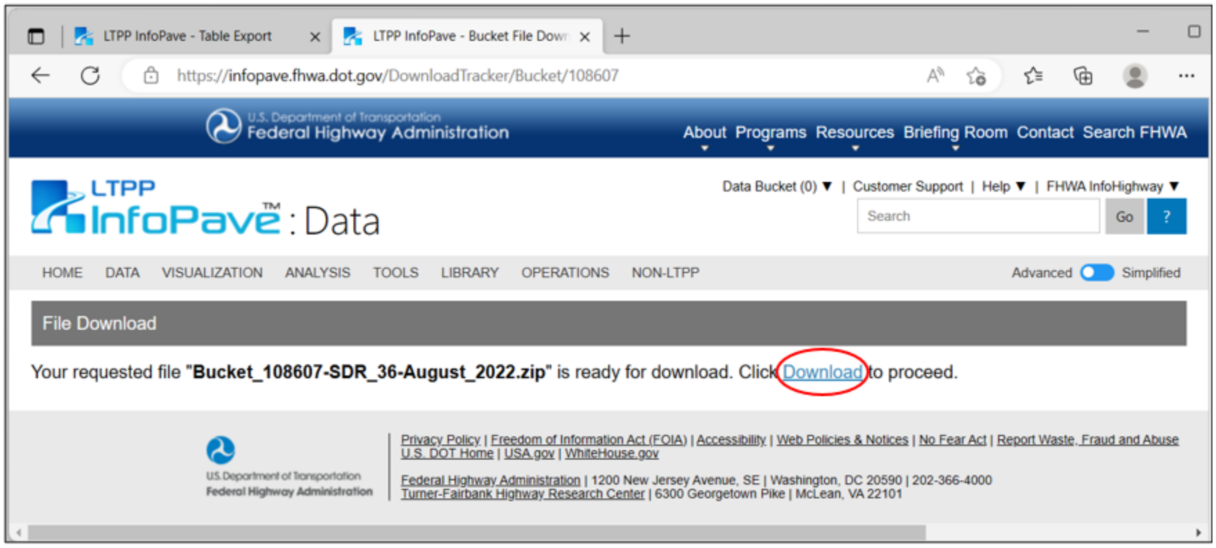


Source: FHWA.

Figure 6. Screenshot. InfoPave Data Bucket screen with data export format options.[3]

11. Open the email account provided on the Data Bucket form. Find a new email from InfoPave (noreply@infopave.com) containing a Download URL.

12. Click on the weblink provided on the Download URL line in the email. A File Download web form within the InfoPave website will open as illustrated in figure 7.

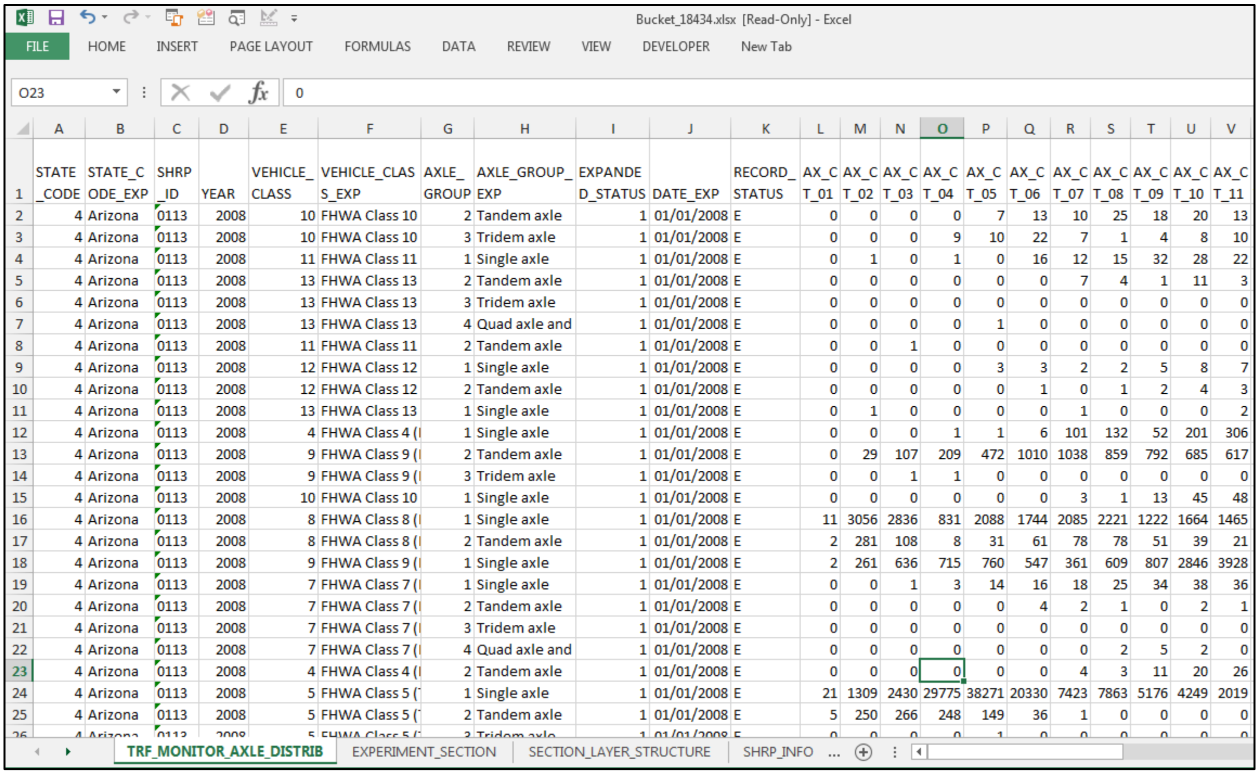


Source: FHWA.

Figure 7. Screenshot. InfoPave File Download screen with a clickable hyperlink to download data.[3]

13. Click on the word “Download” displayed on the File Download form to download the data table to a desired location on a local computer.

14. Review the downloaded data table by opening the downloaded file with the appropriate software. Figure 8 illustrates this step using Excel.



STATE_CODE	STATE_CODE_EXP	SHRP_ID	YEAR	VEHICLE_CLASS	VEHICLE_CLASS_EXP	AXLE_GROUP	AXLE_GROUP_EXP	EXPANDED_STATUS	DATE_EXP	RECORD_STATUS	AX_CT_01	AX_CT_02	AX_CT_03	AX_CT_04	AX_CT_05	AX_CT_06	AX_CT_07	AX_CT_08	AX_CT_09	AX_CT_10	AX_CT_11
4	Arizona	0113	2008	10	FHWA Class 10	2	Tandem axle	1	01/01/2008	E	0	0	0	0	7	13	10	25	18	20	13
4	Arizona	0113	2008	10	FHWA Class 10	3	Tridem axle	1	01/01/2008	E	0	0	0	9	10	22	7	1	4	8	10
4	Arizona	0113	2008	11	FHWA Class 11	1	Single axle	1	01/01/2008	E	0	1	0	1	0	16	12	15	32	28	22
4	Arizona	0113	2008	13	FHWA Class 13	2	Tandem axle	1	01/01/2008	E	0	0	0	0	0	0	7	4	1	11	3
4	Arizona	0113	2008	13	FHWA Class 13	3	Tridem axle	1	01/01/2008	E	0	0	0	0	0	0	0	0	0	0	0
4	Arizona	0113	2008	13	FHWA Class 13	4	Quad axle and	1	01/01/2008	E	0	0	0	0	1	0	0	0	0	0	0
4	Arizona	0113	2008	11	FHWA Class 11	2	Tandem axle	1	01/01/2008	E	0	0	1	0	0	0	0	0	0	0	0
4	Arizona	0113	2008	12	FHWA Class 12	1	Single axle	1	01/01/2008	E	0	0	0	0	3	3	2	2	5	8	7
4	Arizona	0113	2008	12	FHWA Class 12	2	Tandem axle	1	01/01/2008	E	0	0	0	0	0	1	0	1	2	4	3
4	Arizona	0113	2008	13	FHWA Class 13	1	Single axle	1	01/01/2008	E	0	1	0	0	0	0	1	0	0	0	2
4	Arizona	0113	2008	4	FHWA Class 4 (I	1	Single axle	1	01/01/2008	E	0	0	0	1	1	6	101	132	52	201	306
4	Arizona	0113	2008	9	FHWA Class 9 (I	2	Tandem axle	1	01/01/2008	E	0	29	107	209	472	1010	1038	859	792	685	617
4	Arizona	0113	2008	9	FHWA Class 9 (I	3	Tridem axle	1	01/01/2008	E	0	0	1	1	0	0	0	0	0	0	0
4	Arizona	0113	2008	10	FHWA Class 10	1	Single axle	1	01/01/2008	E	0	0	0	0	0	0	3	1	13	45	48
4	Arizona	0113	2008	8	FHWA Class 8 (I	1	Single axle	1	01/01/2008	E	11	3056	2836	831	2088	1744	2085	2221	1222	1664	1465
4	Arizona	0113	2008	8	FHWA Class 8 (I	2	Tandem axle	1	01/01/2008	E	2	281	108	8	31	61	78	78	51	39	21
4	Arizona	0113	2008	9	FHWA Class 9 (I	1	Single axle	1	01/01/2008	E	2	261	636	715	760	547	361	609	807	2846	3928
4	Arizona	0113	2008	7	FHWA Class 7 (I	1	Single axle	1	01/01/2008	E	0	0	1	3	14	16	18	25	34	38	36
4	Arizona	0113	2008	7	FHWA Class 7 (I	2	Tandem axle	1	01/01/2008	E	0	0	0	0	0	4	2	1	0	2	1
4	Arizona	0113	2008	7	FHWA Class 7 (I	3	Tridem axle	1	01/01/2008	E	0	0	0	0	0	0	0	0	0	0	0
4	Arizona	0113	2008	7	FHWA Class 7 (I	4	Quad axle and	1	01/01/2008	E	0	0	0	0	0	0	0	2	5	2	0
4	Arizona	0113	2008	4	FHWA Class 4 (I	2	Tandem axle	1	01/01/2008	E	0	0	0	0	0	0	4	3	11	20	26
4	Arizona	0113	2008	5	FHWA Class 5 (T	1	Single axle	1	01/01/2008	E	21	1309	2430	29775	38271	20330	7423	7863	5176	4249	2019
4	Arizona	0113	2008	5	FHWA Class 5 (T	2	Tandem axle	1	01/01/2008	E	5	250	266	248	149	36	1	0	0	0	0

Source: FHWA.

Figure 8. Screenshot. Excel screen capture showing the downloaded and saved data from the TRF_MONITOR_AXLE_DISTRIB table.(3)

CHAPTER 7. SCENARIO 1: OBTAIN TRUCK TRAFFIC AND TRUCK VOLUME INFORMATION

PARAMETER 1.1: ANNUAL AVERAGE DAILY TRAFFIC VOLUME

By definition, "AADT" refers to the annual average daily traffic volume occurring in all lanes and in both directions of travel at a location. AADT is typically used only for high-level pavement management analyses either to characterize the daily use of a highway facility by all vehicular traffic or as a preliminary traffic statistic. AADT can be used along with other available traffic statistics, such as "percent trucks" and "number of lanes," to estimate truck traffic volumes on a specific lane of pavement for which estimates of expected pavement performance are desired. Because these more desirable detailed truck volume statistics are readily available within the LTPP traffic data tables, use of the AADT parameter for LTPP analyses is very limited.

Due to its modest connection to changes in LTPP lane pavement performance over time, AADT was not a focus of the LTPP traffic data collection program. Thus, AADT is not always present in the current LTPP database tables. The AADT values available in the LTPP database are either computed by the LTPP traffic data processing software using State-submitted traffic data or are State-computed and -submitted parameters. These values can be extracted and used as overall estimates of roadway traffic.

Option 1: Download AADT Values from LTPP Database Tables

AADT values can be found in several LTPP traffic data tables available on InfoPave:(3)

- TRF_HIST_VOLUME_COUNT (contains State-computed AADT values).
- TRF_HIST_EST_ESAL (contains State-computed AADT values that may not be in TRF_HIST_VOLUME_COUNT).
- TRF_MON_EST_ESAL (contains State-computed AADT values for years without monitoring data or without monitored loading data).

To download these three tables, use the instructions provided in chapter 6, Generic Steps to Select and Extract LTPP Traffic Parameter Tables Using LTPP InfoPave. Once data have been extracted, open the downloaded files, and use the AADT values included in the following fields in the three tables as follows:

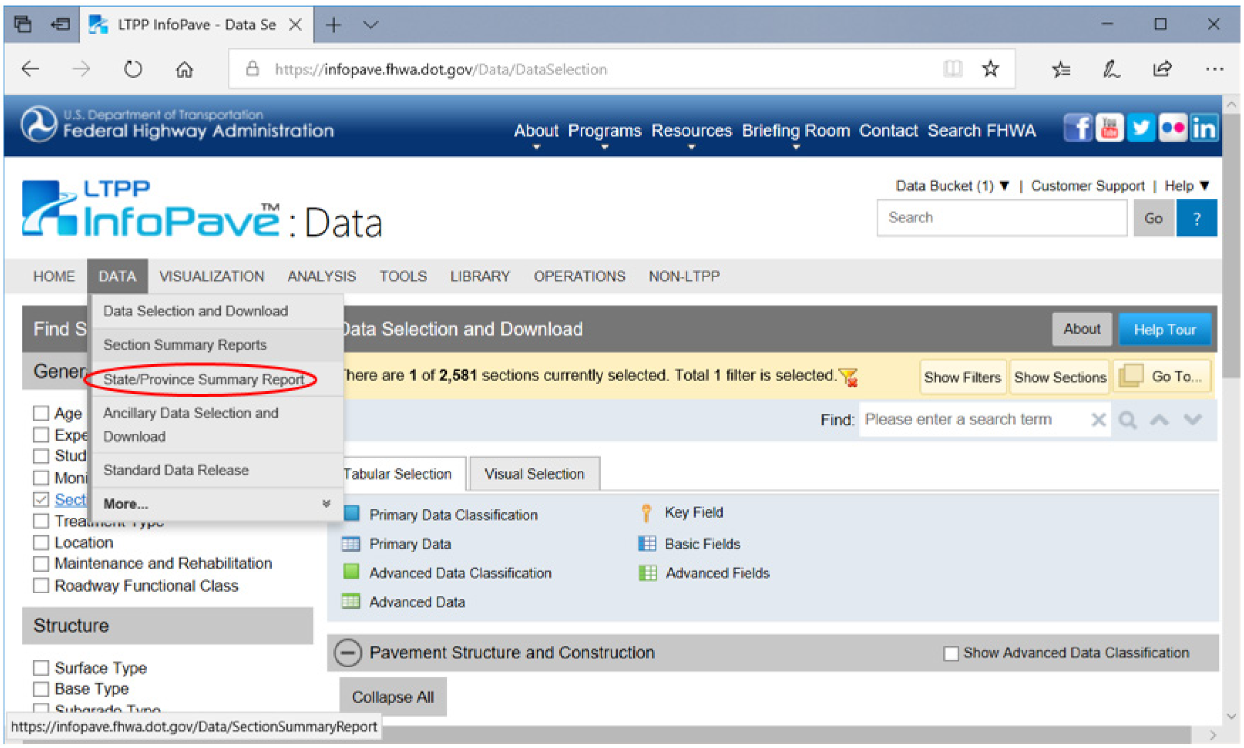
- Table = TRF_HIST_VOLUME_COUNT, field = COUNT_AADT.
- Table = TRF_HIST_EST_ESAL, field = AADT_ALL_VEHIC_2WAY.
- Table = TRF_MON_EST_ESAL, field = AADT_ALL_VEHIC_2WAY.

Option 2: View AADT Values in InfoPave Section Summary Report

In addition to the data download option described in option 1, the AADT values can be viewed in InfoPave on the Section Summary Report screen. The AADT values shown on the Section

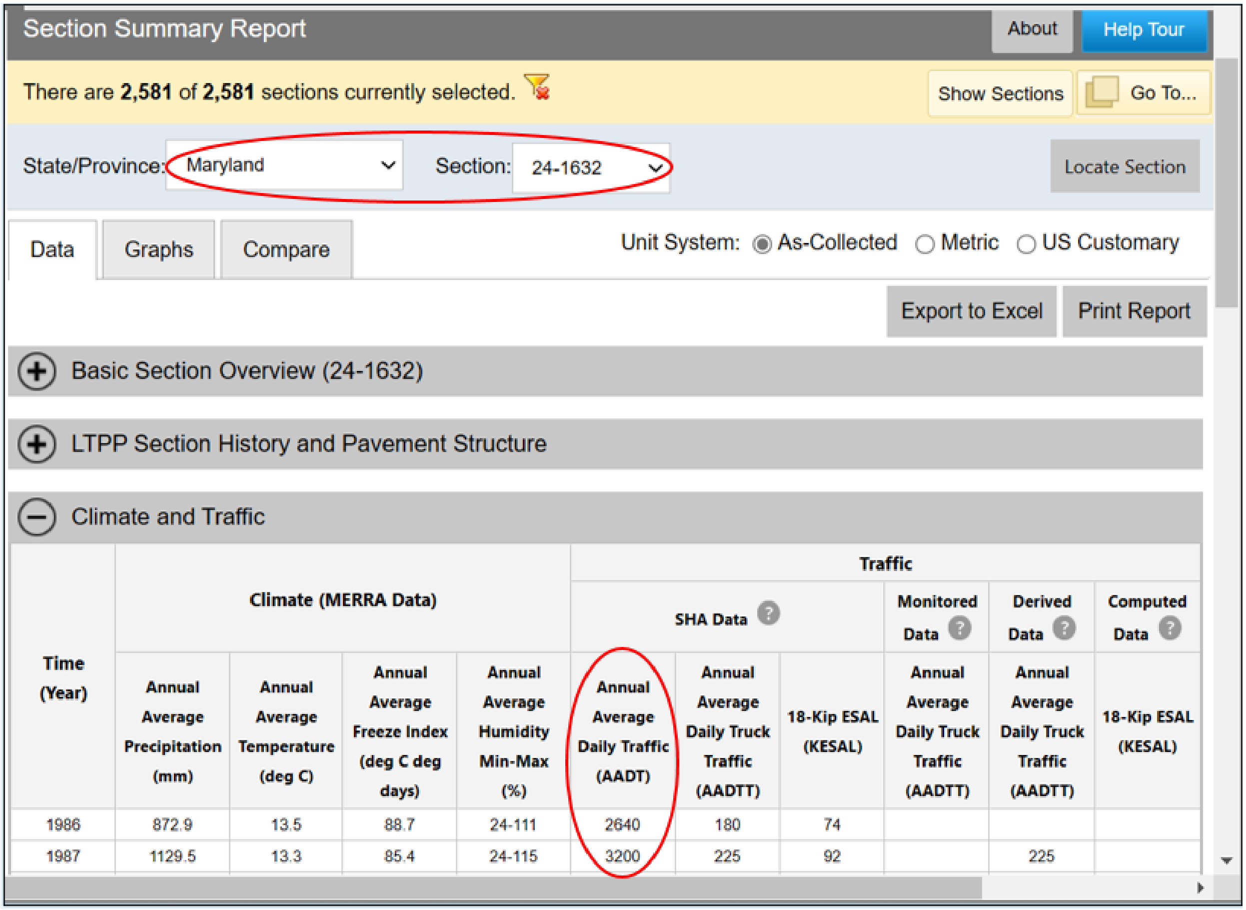
Summary Report screen are not roadway AADT values. The InfoPave values are AADT in the direction of travel of the LTPP test section. The InfoPave AADT values are roughly half of the AADT for the road section that contains the LTPP test section. To differentiate from the standard AADT definition, these values are referred to as "Directional AADT" in this Guide.

To use InfoPave to view Directional AADT values, first select the "State/Province Summary Report" option under the DATA menu (figure 9), and then select the State and Section ID for the site of interest on the Section Summary Report form. Select the "+" sign next to "Climate and Traffic" heading shown in the middle of the Section Summary Report form. InfoPave will respond with an image that looks like figure 10.



Source: FHWA.

Figure 9. Screenshot. Example of the "State/Province Summary Reports" option selected.[3]



Source: FHWA.

Figure 10. Screenshot. Example of AADT values available in the "Section Summary Report."(3)

If Directional AADT values are available at this site, they will be found in the first traffic estimate column. For example, an InfoPave screen capture in figure 10 shows Directional AADT estimates for 1986 to 1990 for Maryland section 1632.

Example 1.1: Obtain an Estimate of AADT for an LTPP Test Site

The availability of that data may vary considerably between LTPP test sites. No simple mechanism exists for obtaining a single representative AADT value for a given site, nor does one exist for obtaining AADT values for all pavement in-service years for all sites. If a user requires a representative AADT value, the recommended option is to download the available AADT values from the three tables listed under option 1 and analyze the data found in those tables. A representative value can then be constructed. Although there are many ways to develop such a value, the suggested method is to:

1. Determine the years for which the representative value is to be applied.
2. Take the values available on InfoPave[3] and determine a linear equation for those data. (For example, use Excel's "Add Trendline" feature and select the "Linear" option and the "Display equation on chart" option.)
3. Use that equation to estimate the AADT value for any years for which the data are missing.
4. Compute an average of the AADT values for all years, including both the downloaded data and estimates for the missing years. This helps remove biases that might result from more data being present in some portions of a pavement's life compared to other years.

Other methods for interpolating missing years of data (such as compound growth) can also be used and may be more appropriate if the AADT trend line is nonlinear.

For example, to obtain a representative AADT value (both directions of traffic) for Arizona site 1024, during that site's participation in the GPS-1 experiment, use the instructions in chapter 6 to extract the available AADT data from the three tables listed under option 1. Once the tables are downloaded, then extract the values for each year from the following table fields:

- Table = TRF_HIST_VOLUME_COUNT, field = COUNT_AADT.
- Table = TRF_HIST_EST_ESAL, field = AADT_ALL_VEHIC_2WAY.
- Table = TRF_MON_EST_ESAL, field = AADT_ALL_VEHIC_2WAY.

The result is a table that contains the data in the AADT Extracted from LTPP Data Tables column in table 19. Running a linear regression on that data results in the following formula:

$$AADT = (294.37 * Year) - 576{,}971 \quad (1)$$

Apply this equation to estimate the missing AADT values for 1977, 1993, 1998, and 1999 (the last year this site was part of the GPS-1 experiment). These values are shown in the right-hand column of table 19. The average of the AADT values provided in the right-hand column is 8,220. This number (8,220) is the representative AADT value for Arizona site 1024 for the GPS-1 experiment.

Table 19. AADT values for Arizona site 1024, GPS-1 experiment.

Table Data were Taken From	Year	AADT Extracted from LTPP Data Tables	AADT Including Estimated Missing Values
—	1977	—	4,998
TRF_HIST_EST_ESAL	1978	5,500	5,500
TRF_HIST_EST_ESAL	1979	5,500	5,500
TRF_HIST_EST_ESAL	1980	4,700	4,700
TRF_HIST_EST_ESAL	1981	5,600	5,600
TRF_HIST_EST_ESAL	1982	6,000	6,000
TRF_HIST_EST_ESAL	1983	6,000	6,000
TRF_HIST_EST_ESAL	1984	6,600	6,600
TRF_HIST_EST_ESAL	1985	7,300	7,300
TRF_HIST_EST_ESAL	1986	8,600	8,600
TRF_HIST_EST_ESAL	1987	9,300	9,300
TRF_HIST_EST_ESAL	1988	9,300	9,300
TRF_HIST_EST_ESAL	1989	9,800	9,800
TRF_MON_EST_ESAL	1990	10,500	10,500
TRF_MON_EST_ESAL	1991	9,400	9,400
TRF_MON_EST_ESAL	1992	9,900	9,900
—	1993	—	9,708
TRF_MON_EST_ESAL	1994	9,600	9,600
TRF_MON_EST_ESAL	1995	8,900	8,900
TRF_MON_EST_ESAL	1996	9,400	9,400
TRF_MON_EST_ESAL	1997	9,800	9,800
—	1998	—	11,180
—	1999	—	11,475

—No data.

PARAMETER 1.2: ANNUAL AVERAGE DAILY TRUCK TRAFFIC VOLUME FOR THE LTPP LANE

AADTT is the key truck volume statistic used in the pavement analyses. AADTT values for the LTPP test lane are used in analyses that require information about typical daily truck volumes in a specific traffic lane. AADTT for the test lane is an easily understood, if imprecise, statistic that describes the general level of truck traffic loading a pavement is experiencing. Most of the LTPP data analyses involving prediction of pavement performance, service life, or design pavement thickness use this parameter. AADTT for the road segment is a different statistic, as it includes truck volume in all lanes and all directions of traffic on that road segment. AADTT for the LTPP test lane measures only truck traffic that actually drives over the test pavement.

The LTPP tables that contain the AADTT statistics for the LTPP test lane include:

- TRF_TREND contains an analysis-ready complete history of AADTT estimates for all pavement in-service years. These values are based on either monitored traffic data or estimates and are periodically updated by the LTPP program. Special codes provide information about the data source for each statistic.

- MEPDG_TRUCK_VOL_PARAMETERS contains the estimate of AADTT for the test lane that serves as the first-year truck traffic volume statistic that should be input to MEPDG analyses for each site (field = AADTT_FIRST_YEAR_LTPP_LANE).

- TRF_REP contains a single AADTT value for each LTPP test lane, which can be used as the best simple summary of the annual truck traffic volume crossing that test site during the time that site is part of the LTPP experiment.

- TRF_MON_EST_ESAL contains AADTT values submitted by State and Provincial highway agencies during LTPP monitoring years.

- TRF_HIST_EST_ESAL contains AADTT values when provided by State and Provincial highway agencies for years prior to LTPP monitoring years.

The TRF_TREND table contains an easily obtainable, LTPP lane-specific AADTT estimate for all years for which an experimental site is in service. This estimate is based on monitored data (where available) or historical data (where monitoring data were not collected but the State submitted an estimate), or it is estimated based on a mathematical extrapolation of those data (where the State did not submit data for a given year). The TRF_TREND table contains a metadata flag (AADTT_SOURCE field with codes) that indicates the source of each AADTT value: whether the data were submitted as a historical estimate (H or S) by a State or Provincial highway agency, a value computed from data collected during the LTPP traffic monitoring effort (M, Mc), or estimated for that year by LTPP because no other estimate exists (E). To download this entire table from InfoPave,(3) use the instructions provided in chapter 6 and simply select the entire table.

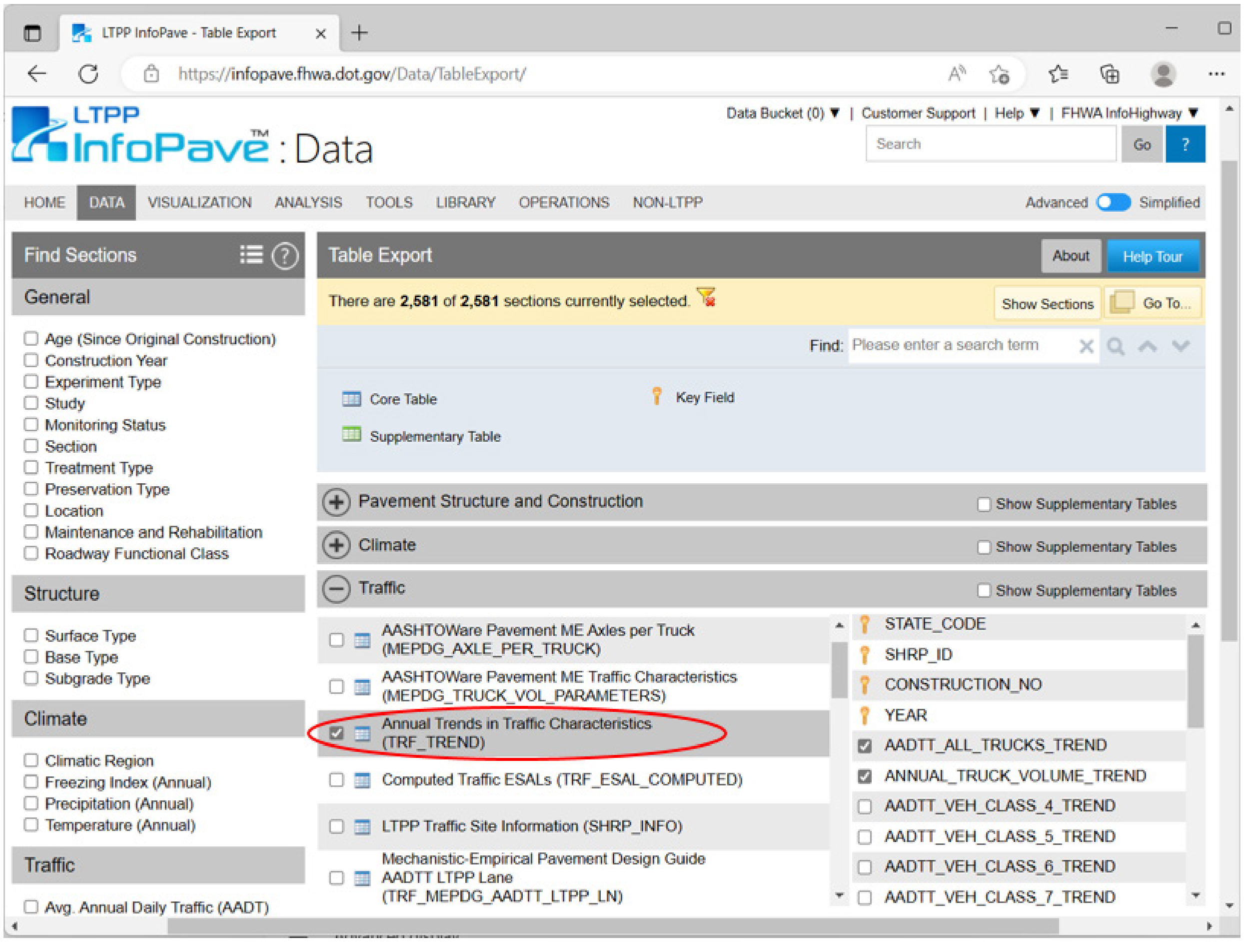
In addition to AADTT for the LTPP lane, some State agencies collected or submitted data that described the total volume of trucks in both directions at a test site. Thus, two-directional truck traffic volume data are available but not for all LTPP sites. If these data are desired, the tables that contain these values are shown as follows along with the table field name that contains that information. All data present in these tables are year specific.

- Table = TRF_HIST_EST_ESAL, field = AADT_TRUCK_COMBO_2WAY.
- Table = TRF_MON_EST_ESAL, field = AADT_TRUCK_COMBO_2WAY.

The supporting data on truck volumes by FHWA vehicle class can be found in the table TRF_MONITOR_LTPP_LN, along with the number of days traffic monitoring data were collected.

Example 1.2.1: Extract AADTT for Each Year in Service or Analysis Period

An estimate of annual total truck volume for each year in service can be found in the TRF_TREND table, in the field AADTT_ALL_TRUCKS_TREND. The InfoPave screen showing how to select this table is shown in figure 11.



Source: FHWA.

Figure 11. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)."(3)

For example, to obtain the AADTT values for all years during which Arizona test site 7613 was part of the LTPP experiment, follow the generic InfoPave data extraction instructions given in chapter 6 to download TRF_TREND table.

The downloaded table will show that Arizona test site 7613 has data reported for two construction number events during its time with the LTPP experiment. The construction number field in TRF_TREND table is used to identify changes in the pavement section because of construction, rehabilitation, or maintenance events that occurred during the site's participation in the LTPP experiment. The construction number 1 corresponds to the pavement structure at the start of that segment's participation in an LTPP experiment. The subsequent construction numbers (2, 3, 4, etc.) are used to track changes in pavement structure or surface condition because of pavement rehabilitation or maintenance activities. Major changes in pavement structure typically result in the pavement test section being placed out of study from the LTPP experiment or being reassigned to another LTPP experiment. Once initiated, the construction number remains active and assigned to all years until the site is de-assigned from the specific LTPP experiment or changes LTPP experiments.

If the user would like to find AADTT values for the LTPP lane corresponding to the years when Arizona test site 7613 was part of construction event 1 (i.e., covering all years from the initial participation to the time when the LTPP site left the LTPP experiment), this could be accomplished by filtering the TRF_TREND table by STATE_CODE = 4, SHRP_ID = 7613, and CONSTRUCTION_NO = 1. Applying this filter would provide the AADTT values from 1979 to 2001, as shown in table 20.

Table 20. AADTT values for Arizona test site 7613, construction event 1.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	AADTT_ALL_TRUCKS_TREND
4	7613	1	1979	275
4	7613	1	1980	350
4	7613	1	1981	400
4	7613	1	1982	575
4	7613	1	1983	650
4	7613	1	1984	650
4	7613	1	1985	700
4	7613	1	1986	825
4	7613	1	1987	925
4	7613	1	1988	925
4	7613	1	1989	1,000
4	7613	1	1990	817
4	7613	1	1991	847
4	7613	1	1992	876
4	7613	1	1993	760
4	7613	1	1994	1,056
4	7613	1	1995	1,267
4	7613	1	1996	1,274
4	7613	1	1997	522
4	7613	1	1998	941
4	7613	1	1999	1,089
4	7613	1	2000	916
4	7613	1	2001	1,145

Example 1.2.2: Extract or Estimate AADTT for the Year Selected for Analysis

A user could extract an AADTT value for a specific year of analysis following the same procedure described in example 1.2.1. Once the data for all years have been extracted, a value for a specific year can be identified in the extracted table. For example, for Arizona site 7613, the AADTT value for the first year after pavement construction was 275, and for the last year participation in LTPP experiment it was 1,145.

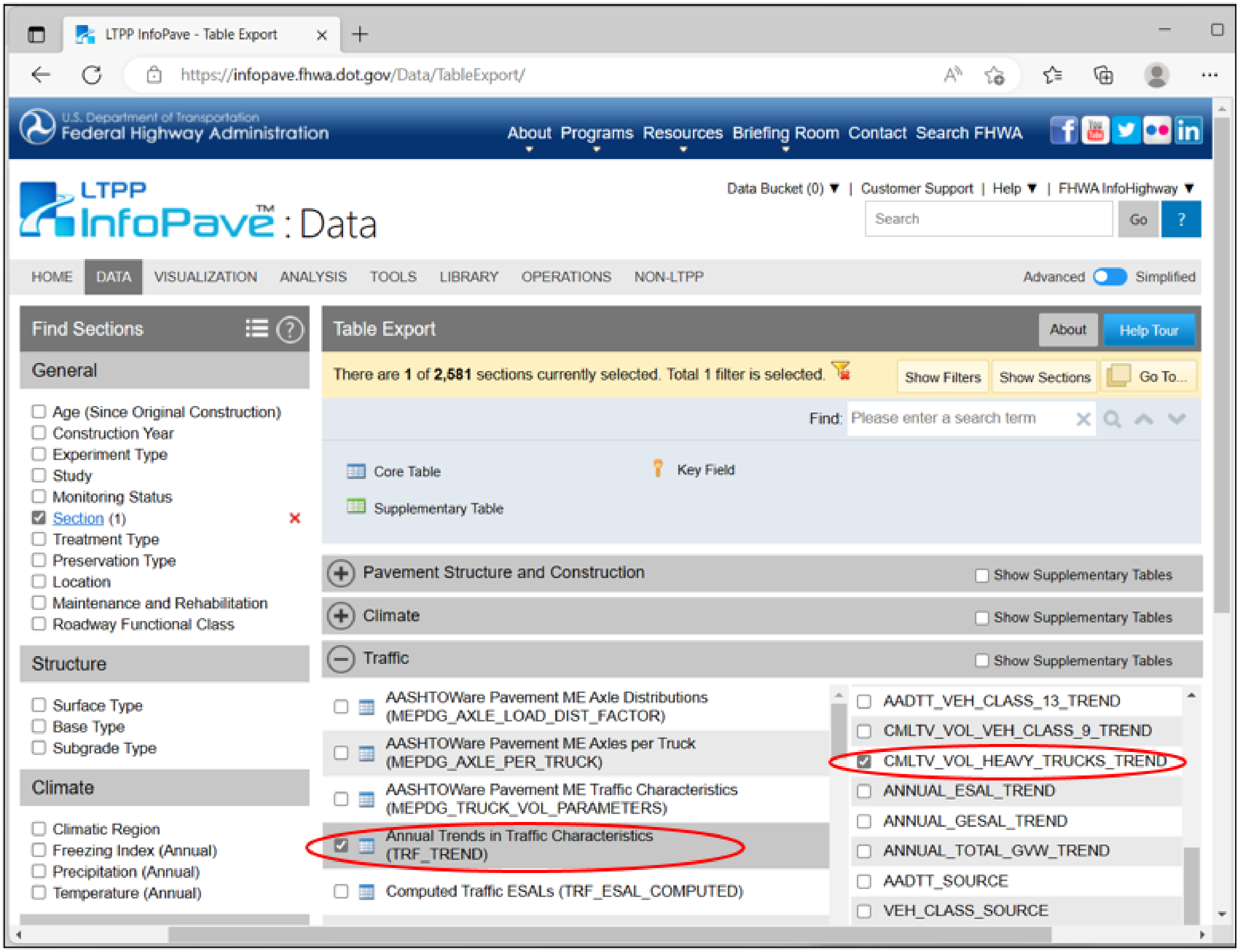
PARAMETER 1.3: ANNUAL TOTAL TRUCK VOLUME

Annual total truck volume values are used in LTPP analyses that require information about total truck volume for each year over the user-defined analysis period or for specific years. Typically these are the same years pavement condition or nondestructive-testing data were collected.

An estimate of annual total truck volume for each year in service can be obtained from the field ANNUAL_TRUCK_VOLUME_TREND in the TRF_TREND table. This field provides annual total truck volume value for each year since the site was opened to traffic, until the end of site participation in the LTPP experiment or the last year for which the TRF_TREND table was updated. For those years when a site participated in the LTPP experiment only during some months, these annual values cover only those months when the site was part of an LTPP experiment. For example, if a new SPS site was opened to traffic on July 1, 2004, truck volumes for 2004 include only the period from July 1 to December 31 for that year. Similarly, if a site leaves the LTPP experiment on June 30, 2008, the annual truck volume statistic for 2008 includes only the truck volumes crossing that site from January 1 to June 30, 2008.

Example 1.3.1: Obtain Annual Total Truck Volume for Each Year in Service or Analysis Period

To obtain the annual total truck volume for each in-service year for Arizona test site 7613, extract records from TRF_TREND table field ANNUAL_TRUCK_VOLUME_TREND (figure 12) using the generic InfoPave data extraction instructions given in chapter 6. Once the table has been extracted, filter records for STATE_CODE = 4, SHRP_ID = 7613, and CONSTRUCTION_NO = 1. Applying this filter provides the annual total truck volume values in ANNUAL_TRUCK_VOLUME_TREND column shown in table 21.



Source: FHWA.

Figure 12. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)" and next to the field name "CMLTV_VOL_HEAVY_TRUCKS_TREND."(3)

Table 21. Annual total truck volume values for Arizona test site 7613, construction event 1.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	ANNUAL_TRUCK_VOLUME_TREND
4	7613	1	1979	25,300
4	7613	1	1980	128,100
4	7613	1	1981	146,000
4	7613	1	1982	209,875
4	7613	1	1983	237,250
4	7613	1	1984	237,900
4	7613	1	1985	255,500
4	7613	1	1986	301,125
4	7613	1	1987	337,625
4	7613	1	1988	338,550
4	7613	1	1989	365,000
4	7613	1	1990	298,205
4	7613	1	1991	309,155
4	7613	1	1992	320,616
4	7613	1	1993	277,400
4	7613	1	1994	385,440
4	7613	1	1995	462,455
4	7613	1	1996	466,284
4	7613	1	1997	190,530
4	7613	1	1998	343,465
4	7613	1	1999	397,485
4	7613	1	2000	335,256
4	7613	1	2001	365,255

PARAMETER 1.4: CUMULATIVE TRUCK VOLUME FOR THE ANALYSIS PERIOD

The total cumulative truck volume (CTV) data are needed for analyses that require information about the cumulative use of the LTPP test pavement by heavy vehicles or all trucks over a selected analysis period. Total truck traffic volume is based on counts of vehicles in FHWA vehicle classes 4–13.[11] This parameter is computed by summing annual total truck volume values available in the TRF_TREND table, field ANNUAL_TRUCK_VOLUME_TREND.

In addition, for the convenience of LTPP users, the TRF_TREND table includes a total cumulative heavy truck volume statistic (CMLTV_VOL_HEAVY_TRUCKS_TREND) for analyses that require information about the cumulative use of the LTPP test pavement by heavy vehicles over a selected analysis period. (This statistic ignores class 5 trucks, which typically impose very little pavement damage because of their light weight.) An accumulation of class 9 truck traffic is also provided (CMLTV_VOL_VEH_CLASS_9_TREND). A separate accumulated traffic statistic is present for each year, for each construction event, for each LTPP test site.

Accumulated heavy truck traffic for construction event 1 starts from whenever that site opens to traffic, regardless of when that occurs. For each subsequent year that site and construction event is part of LTPP experiment, a cumulative traffic record will be present. The combination "State + SHRP_ID + Construction Number" is used as the unique identifier for the heavy truck traffic accumulation in the TRF_TREND table. When a new construction number event occurs for an LTPP site, the traffic accumulation starts over. Thus, the accumulated traffic for construction event 1 starts when the site opens to traffic, and it continues until construction event 1 ends (typically at the end of site participation in a given LTPP experiment). The accumulated traffic for construction event 2 at that same site starts when construction event 2 is assigned in the TRF_TREND table and continues until construction event 2 ends (typically at the end of site participation in a given LTPP experiment). For some SPS sites, records are present prior to the site opening to traffic because a record is present for each year the site is part of the LTPP experiment. All years present prior to the site opening to traffic are given zero traffic volumes.

Example 1.4.1: Extract Cumulative Heavy Truck Traffic Volume Through the End of LTPP Section Participation in the Experiment or Last Reporting Year

Because the TRF_TREND table already has computed these values, researchers need to determine only the sites for which these values are desired. The user may select either the entire TRF_TREND table or a specific set of sites. The cumulative value is computed for the period starting from the date when the pavement is first opened to traffic and ending when the pavement is removed from participation in the LTPP experiment or the last reporting year, whichever is earlier. A CTV statistic is provided for every year that pavement exists. If the site ends active participation in one experiment (e.g., GPS-1) and joins a second experiment (e.g., GPS-6B), the cumulative traffic statistic for that site ends with the first experiment, and a new cumulative statistic starts over for the new experiment.

The annual estimate of CTV for each year in service can be found in the TRF_TREND table, field = CMLTV_VOL_HEAVY_TRUCKS_TREND (figure 12). These values are available for each construction event for each site.

For example, to obtain the cumulative heavy truck traffic volume for all years during which Arizona test site 7613 was part of the LTPP experiment, extract records for Arizona test site 7613 from the TRF_TREND table using the generic InfoPave data extraction instructions given in chapter 6.

Once the records have been extracted, review cumulative heavy truck traffic volume for each year during construction event 1, starting from 1979, when the site first open to traffic, and ending in 2001, when the site left the LTPP experiment. At the end of 1979, cumulative heavy traffic volume was 10,948 vehicles, and at the end of 2001, cumulative heavy truck traffic volume was 2,865,083 vehicles, as shown in table 22.

Table 22. Cumulative heavy truck traffic volume for Arizona test site 7613, construction event 1.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	CMLTV_VOL_HEAVY TRUCKS_TREND
4	7613	1	1979	10,948
4	7613	1	1980	65,848
4	7613	1	1981	128,993
4	7613	1	1982	219,513
4	7613	1	1983	322,078
4	7613	1	1984	424,924
4	7613	1	1985	535,519
4	7613	1	1986	665,459
4	7613	1	1987	810,729
4	7613	1	1988	956,397
4	7613	1	1989	1,113,347
4	7613	1	1990	1,241,827
4	7613	1	1991	1,375,052
4	7613	1	1992	1,513,034
4	7613	1	1993	1,647,354
4	7613	1	1994	1,781,674
4	7613	1	1995	1,930,229
4	7613	1	1996	2,120,183
4	7613	1	1997	2,222,018
4	7613	1	1998	2,377,143
4	7613	1	1999	2,563,293
4	7613	1	2000	2,707,497
4	7613	1	2001	2,865,083

Example 1.4.2: Compute Cumulative Heavy Truck Traffic Volume Based on User-Specified Start and End Dates

Although the cumulative total of heavy truck traffic volume can be read directly from the TRF_TREND table, the user can compute a cumulative total of all truck traffic (thus including class 5 light trucks), if desired. To make these computations, follow the directions for example 1.3.1 to download the appropriate data (field AADTT_ALL_TRUCKS_TREND) from the LTPP table TRF_TREND, and then add the annual truck volume totals as shown in the right-hand column in table 23.

Table 23. Annual cumulative total truck volume values for Arizona test site 7613, construction event 1.

STATE_CODE	SHRP_ID	YEAR	ANNUAL_TRUCK_ VOLUME_TREND	Cumulative Total Truck Volume
4	7613	1979	25,300	25,300
4	7613	1980	128,100	153,400
4	7613	1981	146,000	299,400
4	7613	1982	209,875	509,275
4	7613	1983	237,250	746,525
4	7613	1984	237,900	984,425
4	7613	1985	255,500	1,239,925
4	7613	1986	301,125	1,541,050
4	7613	1987	337,625	1,878,675
4	7613	1988	338,550	2,217,225
4	7613	1989	365,000	2,582,225
4	7613	1990	298,205	2,880,430
4	7613	1991	309,155	3,189,585
4	7613	1992	320,616	3,510,201
4	7613	1993	277,400	3,787,601
4	7613	1994	385,440	4,173,041
4	7613	1995	462,455	4,635,496
4	7613	1996	466,284	5,101,780
4	7613	1997	190,530	5,292,310
4	7613	1998	343,465	5,635,775
4	7613	1999	397,485	6,033,260
4	7613	2000	335,256	6,368,516
4	7613	2001	365,255	6,733,771

CHAPTER 8. SCENARIO 2: OBTAIN VEHICLE CLASSIFICATION INFORMATION

PARAMETER 2.1: ANNUAL TRUCK VOLUME BY VEHICLE CLASS

Annual truck volume by vehicle class values are used in LTPP analyses that require information about the volume of different types of trucks for each analysis year, such as mechanistic-empirical pavement analyses, or analyses that focus on the effect of certain vehicle types on pavement performance.

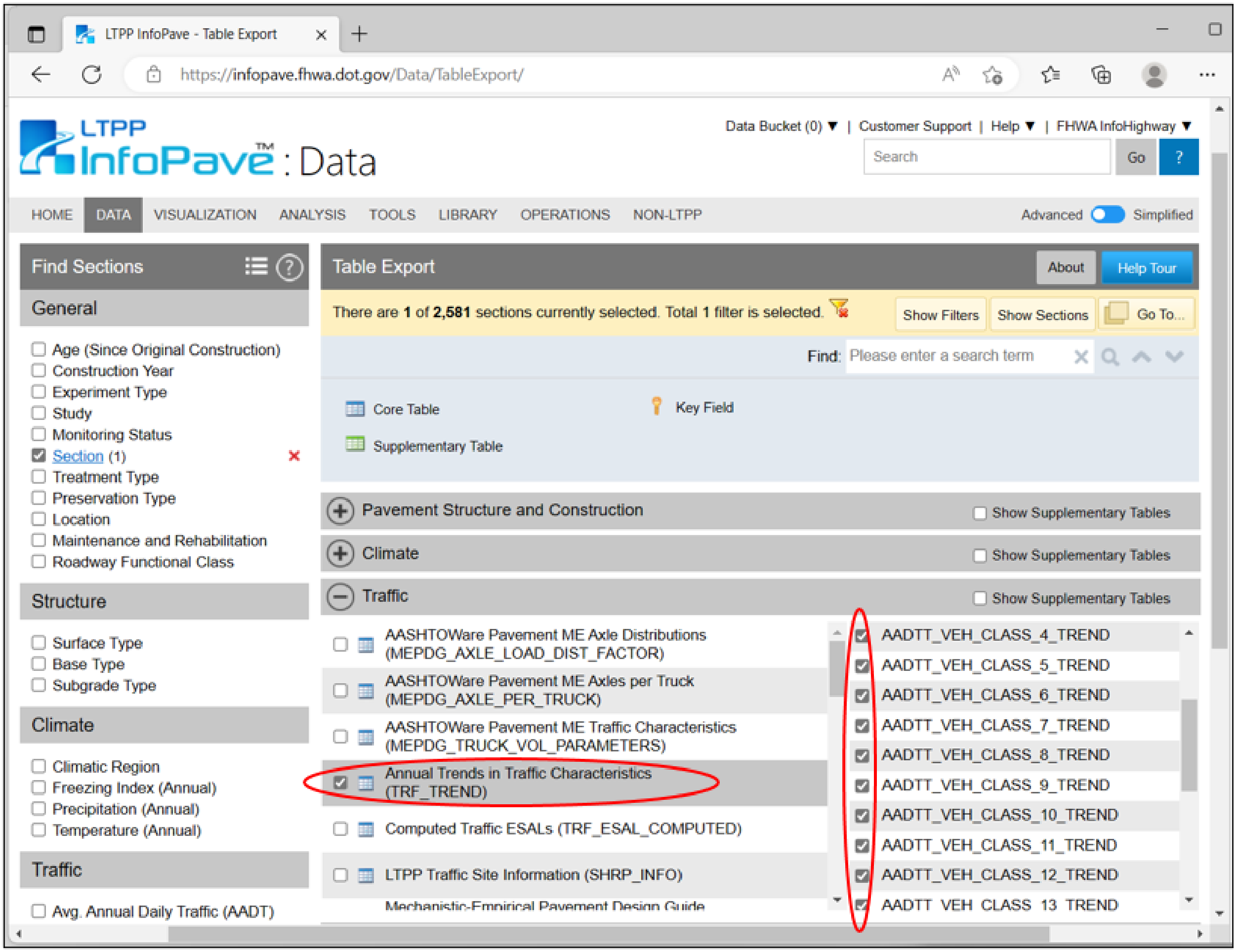
The data fields AADTT_VEH_CLASS_#_TREND (where # refers to FHWA vehicle classes 4–13)[11] in the LTPP table TRF_TREND contain estimates of AADTT volume by vehicle class for each year from when the LTPP site either is open to traffic or joins the LTPP experiment (whichever is earlier) to the time when that test site is no longer part of an LTPP experiment (or the last year for which data were available when this table was produced, if the site is still in the experiment).

If the user needs very detailed data on truck volume distributions, the HH_CL_CT, DD_CL_CT, and MM_CT tables from the LTAS database (accessible through InfoPave[3]) provide data about detailed hourly, daily, or monthly variation in truck volumes by class when vehicle classification data were collected as part of the LTPP traffic monitoring program.

Example 2.1.1: Obtain Annual Truck Volume by Vehicle Class for Each Year in Service or Analysis Period

For example, to obtain annual truck volume by vehicle class values for each year in service or analysis period during which Arizona test site 7613 was part of the LTPP experiment, follow this sequence of steps:

1. Extract records for Arizona test site 7613 from the TRF_TREND table (figure 13) using the generic InfoPave data extraction instructions given in chapter 6. A portion of the extracted table for construction event 1 is shown in table 24. A second portion of the table for construction event 2 is shown in table 25.



Source: FHWA.

Figure 13. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)" and next to the field name "AADTT_VEH_CLASS_#_TREND."(3)

Table 24. TRF_TREND truck volumes for Arizona test site 7613, construction event 1.

YEAR	AADTT_VEH_CLASS_4_TREND	AADTT_VEH_CLASS_5_TREND	AADTT_VEH_CLASS_6_TREND	AADTT_VEH_CLASS_7_TREND	AADTT_VEH_CLASS_8_TREND	AADTT_VEH_CLASS_9_TREND	AADTT_VEH_CLASS_10_TREND	AADTT_VEH_CLASS_11_TREND	AADTT_VEH_CLASS_12_TREND	AADTT_VEH_CLASS_13_TREND	CMLTV_VOL_VEH_CLASS_9_TREND	CMLTV_VOL_HEAVY_TRUCKS_TREND	AADTT_ALL_TRUCKS_TREND	ANNUAL_TRUCK_VOLUME_TREND
1979	5	156	24	1	26	57	1	3	0	2	5,244	10,948	275	25,300
1980	6	200	30	1	33	73	1	3	0	2	31,962	65,848	350	128,100
1981	7	227	35	1	38	83	2	4	0	3	62,257	128,993	400	146,000
1982	11	327	50	1	55	119	2	5	1	4	105,692	219,513	575	209,875
1983	12	369	56	2	62	135	3	6	1	4	154,967	322,078	650	237,250
1984	12	369	56	2	62	135	3	6	1	4	204,377	424,924	650	237,900
1985	13	397	61	2	67	145	3	6	1	5	257,302	535,519	700	255,500
1986	15	469	71	2	79	171	3	8	1	6	319,717	665,459	825	301,125
1987	17	527	80	2	88	192	4	8	1	6	389,797	810,729	925	337,625
1988	17	527	80	2	88	192	4	8	1	6	460,069	956,397	925	338,550
1989	18	570	87	2	95	207	4	9	1	7	535,624	1,113,347	1,000	365,000
1990	15	465	71	2	78	169	3	7	1	6	597,309	1,241,827	817	298,205
1991	16	482	73	2	81	175	3	8	1	6	661,184	1,375,052	847	309,155
1992	16	499	76	2	83	181	3	8	1	6	727,430	1,513,034	876	320,616
1993	24	392	76	0	73	179	2	8	1	5	792,765	1,647,354	760	277,400
1994	18	688	74	0	83	171	3	11	1	7	855,180	1,781,674	1,056	385,440
1995	5	860	79	1	101	202	2	11	1	5	928,910	1,930,229	1,267	462,455
1996	21	755	94	5	162	214	5	8	2	8	1,007,234	2,120,183	1,274	466,284
1997	11	243	60	1	65	128	3	5	1	5	1,053,954	2,222,018	522	190,530
1998	19	516	84	5	77	217	5	9	1	8	1,133,159	2,377,143	941	343,465
1999	20	579	104	6	85	271	6	10	1	7	1,232,074	2,563,293	1,089	397,485
2000	17	522	79	2	87	190	4	8	1	6	1,301,614	2,707,497	916	335,256
2001	21	651	99	3	109	237	5	11	1	8	1,377,217	2,865,083	1,145	365,255

Table 25. TRF_TREND truck volumes for Arizona test site 7613, construction event 2.

YEAR	AADTT_VEH_ CLASS_4_TREND	AADTT_VEH_ CLASS_5_TREND	AADTT_VEH_ CLASS_6_TREND	AADTT_VEH_ CLASS_7_TREND	AADTT_VEH_ CLASS_8_TREND	AADTT_VEH_ CLASS_9_TREND	AADTT_VEH_ CLASS_10_TREND	AADTT_VEH_ CLASS_11_TREND	AADTT_VEH_ CLASS_12_TREND	AADTT_VEH_ CLASS_13_TREND	CMLTV_VOL_ VEH_CLASS_9 _TREND	CMLTV_VOL_ HEAVY TRUCKS _TREND	AADTT_ALL_ TRUCKS_TREND	ANNUAL_TRUCK_ VOLUME_TREND
1990	15	465	71	2	78	169	3	7	1	6	61,685	128,480	817	298,205
1991	16	482	73	2	81	175	3	8	1	6	125,560	261,705	847	309,155
1992	16	499	76	2	83	181	3	8	1	6	191,806	399,687	876	320,616
1993	24	392	76	0	73	179	2	8	1	5	257,141	534,007	760	277,400
1994	18	688	74	0	83	171	3	11	1	7	319,556	668,327	1,056	385,440
1995	5	860	79	1	101	202	2	11	1	5	393,286	816,882	1,267	462,455
1996	21	755	94	5	162	214	5	8	2	8	471,610	1,006,836	1,274	466,284
1997	11	243	60	1	65	128	3	5	1	5	518,330	1,108,671	522	190,530
1998	19	516	84	5	77	217	5	9	1	8	597,535	1,263,796	941	343,465
1999	20	579	104	6	85	271	6	10	1	7	696,450	1,449,946	1,089	397,485
2000	17	522	79	2	87	190	4	8	1	6	765,990	1,594,150	916	335,256
2001	21	651	99	3	109	237	5	11	1	8	841,593	1,751,736	1,145	365,255

2. Once the records have been extracted, it can be seen that on the average day 156, class 5 trucks crossed the LTPP test section in 1979. This grew to 651 class 5 trucks per day in 2001.

3. To compute the annual truck volume for a specific class of trucks, it is necessary to know the number of days during that year the LTPP site was open to traffic in that year. To obtain this number, for each year, divide the value found in the field ANNUAL_TRUCK_VOLUME_TREND by the value found in the field AADTT_ALL_TRUCKS_TREND. So, for the first year for construction event 1 (1979), the ANNUAL_TRUCK_VOLUME_TREND is 25,300 vehicles, and the AADTT_ALL_TRUCKS_TREND is 275. Thus, this LTPP section was open for 92 days (25,300/275 = 92). Since 1980 was a leap year, there are 366 days of truck volume data (128,100/350 = 366). Consequently, if the total volume of class 13 trucks passing over the site is desired for 1980, this can be computed by multiplying the value for AADTT_VEH_CLASS_13_TREND for 1980 by the number of days: 2 × 366 = 732.

PARAMETER 2.2: NORMALIZED VEHICLE CLASS DISTRIBUTION

Another commonly used set of traffic inputs is the normalized VCD. For pavement analyses, these distributions typically consider only the heavy vehicle classes (FHWA vehicle classes 4–13).[11] These statistics indicate the percentage of truck traffic occurring in each truck class. The normalized VCDs are used in mechanistic-empirical pavement response and performance analyses and design.

These distributions can be obtained in several ways. To obtain these values for specific years, use the AADTT by class value in the TRF_TREND table (examples of which were previously shown in table 24 and table 25) and simply divide the AADTT for each class value by sum of those values for all classes.

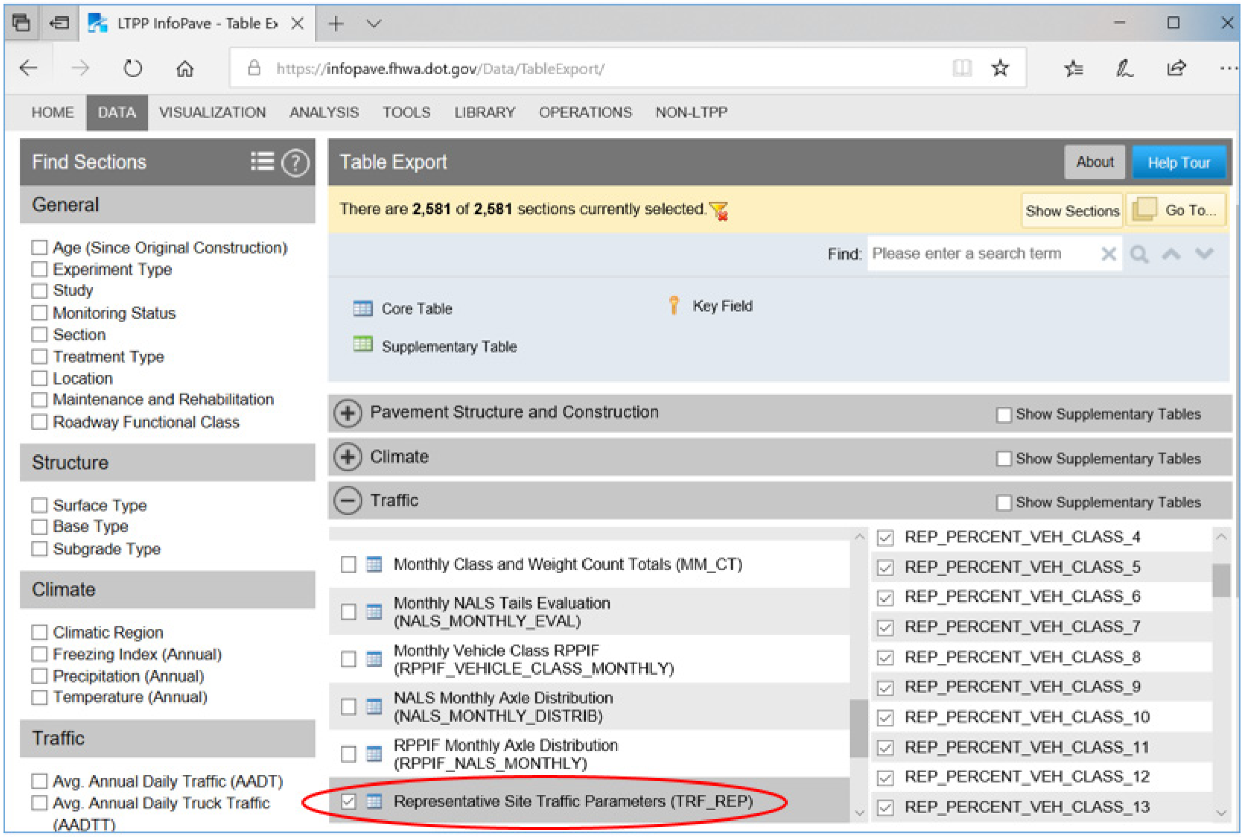
Alternatively, the table TRF_REP includes a single distribution of vehicle classification percentages that provides a single set of values that estimates the percentage of truck traffic that occurs in each class of vehicles. The values found in the TRF_TREND table illustrate the variation in what percentage of trucks falls within each truck class. For some sites, these percentages can vary considerably from year to year. In some cases, this variation is caused by differences in the equipment being used to collect these data. In other cases, changes in the economy result in significant changes to the truck volumes for some or all vehicle classes. Thus, the annual values found in the TRF_TREND table are particularly useful in examining changes in truck travel over a road segment, but the variables in the TRF_REP table are easier to use if the intent is to get a general understanding of the types of truck traffic present at a test site.

For a limited number of LTPP sites, normalized VCD values are available in the LTPP data table TRF_MEPDG_VEH_CLASS_DIST, for the years that had sufficient monitored vehicle classification or weight data (a minimum of 210 days per year of classification or weight data).

Finally, the representative or annual average condition of the normalized VCD, covering FHWA vehicle classes 4–13, is stored in the computed parameter table, MEPDG_TRUCK_VOL_PARAMETERS.

Example 2.2.1: Obtain Representative Normalized VCD

The annual average condition of the normalized VCD, covering FHWA vehicle classes 4–13,[11] can be extracted from the table TRF_REP. The InfoPave screen showing how to select this table is shown in figure 14.



Source: FHWA.

Figure 14. Screenshot. InfoPave Table Export menu with a checkbox showing “selected” next to the traffic table label “Representative Site Traffic Parameters (TRF_REP).”[3]

For example, to obtain the representative normalized VCD for Arizona test site 7613 while it was a part of the LTPP experiment, extract records for Arizona test site 7613 from the TRF_REP table using the generic InfoPave data extraction instructions given in chapter 6. The results of this extract were used to develop table 26.

Table 26. Normalized VCD from the TRF_REP table for Arizona site 7613.

Field in TRF_REP Table	Percentage of Trucks in That Vehicle Class
REP_PERCENT_VEH_CLASS_4	1.84
REP_PERCENT_VEH_CLASS_5	56.9
REP_PERCENT_VEH_CLASS_6	8.66
REP_PERCENT_VEH_CLASS_7	0.25
REP_PERCENT_VEH_CLASS_8	9.52
REP_PERCENT_VEH_CLASS_9	20.72
REP_PERCENT_VEH_CLASS_10	0.39
REP_PERCENT_VEH_CLASS_11	0.92
REP_PERCENT_VEH_CLASS_12	0.12
REP_PERCENT_VEH_CLASS_13	0.68

PARAMETER 2.3: MONTHLY TRUCK VOLUME BY VEHICLE CLASS

The total monthly truck volume by vehicle class parameters are used in the analyses that focus on evaluation of the effect of seasonal changes in truck traffic volume and environment on pavement response and performance.

Monthly truck volume for a selected calendar month, year, and FHWA vehicle class (trucks are FHWA classes are 4 to 13), can be computed by multiplying the AADTT value for that year and vehicle class by a monthly adjustment factor (MAF) for that truck class and month and then multiplying the resulting average day of month truck volume statistic by the number of days in that month. Each truck class has a different MAF because truck travel patterns can be quite different for each vehicle class. Monthly truck patterns can also change from year to year, given variations in economic activity occurring on that specific roadway.

In addition, only those LTPP sites that have continuous traffic classifier or WIM equipment installed have data that support computation of this parameter. Many of these sites only have data for a limited set of years because of either delays in getting permanent equipment installed or equipment issues that result in some years of data not being present in the LTPP data tables available on InfoPave.(3) MAFs are stored in the TRF_MEPDG_MONTH_ADJ_FACTR table and accessible through the InfoPave web portal.(3)

Example 2.3.1: Obtain Monthly Truck Volume by Vehicle Class

To compute this parameter for a specific site, first follow the InfoPave table extraction instructions given in chapter 6 to download two LTPP tables:

- TRF_MEPDG_MONTH_ADJ_FACTR.
- TRF_TREND.

The downloaded TRF_TREND file contains the AADTT values for each FHWA vehicle class (see data fields AADTT_VEH_CLASS_#_TREND) for each year and for each experiment and construction number for those sites requested. The TRF_MEPDG_MONTH_ADJ_FACTR table contains the monthly vehicle volume adjustment factors by vehicle class for each year for which sufficient data were collected at each site for which data were requested.

Table 27 illustrates the TRF_TREND data for Arizona site 7614 for construction event 1. Only a portion of this table is shown. The data fields shown include the annual daily traffic volumes for each of the 10 FHWA vehicle classes.[11]

As can be seen in table 27, Arizona site 7614 starts with an average daily class 9 volume of 1,233 trucks per day in 1984. This number then declines to only 423 class 9 trucks per day in 1994, before growing again to over 1,000 class 9 trucks in 2004. These annual values are the control totals used to estimate monthly truck volumes for class 9.

Table 27. Annual average daily truck volumes by classification from the TRF_TREND table.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	AADTT_ALL_TRUCKS_TREND	AADTT_VEH_CLASS_4_TREND	AADTT_VEH_CLASS_5_TREND	AADTT_VEH_CLASS_6_TREND	AADTT_VEH_CLASS_7_TREND	AADTT_VEH_CLASS_8_TREND	AADTT_VEH_CLASS_9_TREND	AADTT_VEH_CLASS_10_TREND	AADTT_VEH_CLASS_11_TREND	AADTT_VEH_CLASS_12_TREND	AADTT_VEH_CLASS_13_TREND
4	7614	1	1984	2,080	13	371	117	7	195	1,233	16	91	28	9
4	7614	1	1985	2,240	14	400	126	8	210	1,327	17	98	30	10
4	7614	1	1986	2,560	16	457	144	9	240	1,516	20	112	35	11
4	7614	1	1987	3,520	22	628	199	12	330	2,086	27	153	48	15
4	7614	1	1988	3,840	24	686	217	13	360	2,275	29	167	52	17
4	7614	1	1989	2,123	13	379	120	7	199	1,258	16	93	29	9
4	7614	1	1990	2,066	13	369	117	7	194	1,223	16	90	28	9
4	7614	1	1991	1,250	8	223	71	4	117	741	10	54	17	5
4	7614	1	1992	1,325	8	237	75	5	124	784	10	58	18	6
4	7614	1	1993	1,109	9	287	37	3	54	591	19	68	23	18
4	7614	1	1994	743	6	79	29	4	139	423	3	43	15	2
4	7614	1	1995	1,218	7	192	48	9	131	720	8	74	25	4
4	7614	1	1996	1,496	10	398	64	7	142	754	9	79	22	11
4	7614	1	1997	1,600	10	286	90	5	150	948	12	70	22	7
4	7614	1	1998	1,501	2	320	114	5	106	859	13	63	13	6
4	7614	1	1999	1,518	3	344	111	4	109	829	21	75	16	5
4	7614	1	2000	1,466	9	262	83	5	138	868	11	64	20	6
4	7614	1	2001	1,549	6	205	97	4	156	995	9	56	17	4
4	7614	1	2002	1,552	10	230	99	4	127	1,002	9	50	17	4
4	7614	1	2003	1,743	8	244	108	4	171	1,123	10	51	20	4
4	7614	1	2004	1,742	14	260	106	4	164	1,110	10	52	18	4

Table 28 illustrates the MAFs (in MONTHLY_RATIO column) available for Arizona site 7614. Because of its size, only a portion of the extracted table is shown in table 28. This illustrative table shows only 2 months of data for 2 years (1994 and 1995) for all 10 vehicle classes, but it also shows all years of data available for class 9 for the months of April and May. At this site, MAFs are available only for 1994, 1995, 1996, 1998, 2003, and 2004. Also note that the factor for May is missing from 1994. The complete table contains data for all vehicle classes, but some months and years of data are missing because of the equipment issues.

Table 28. Illustrative monthly truck volume adjustment factors from the TRF_MEPDG_MONTH_ADJ_FACTR table.

STATE _CODE	SHRP _ID	YEAR	MONTH	VEHICLE _CLASS	VEHICLE_CLASS _EXP	MONTHLY _RATIO	DATE_EXP
4	7614	1994	4	4	FHWA class 4	1.98	04/01/1994
4	7614	1994	4	5	FHWA class 5	1.52	04/01/1994
4	7614	1994	4	6	FHWA class 6	1.46	04/01/1994
4	7614	1994	4	7	FHWA class 7	0.98	04/01/1994
4	7614	1994	4	8	FHWA class 8	1.85	04/01/1994
4	7614	1994	4	9	FHWA class 9	1.66	04/01/1994
4	7614	1994	4	10	FHWA class 10	2.01	04/01/1994
4	7614	1994	4	11	FHWA class 11	1.73	04/01/1994
4	7614	1994	4	12	FHWA class 12	1.84	04/01/1994
4	7614	1994	4	13	FHWA class 13	2.20	04/01/1994
4	7614	1995	4	4	FHWA class 4	0.70	04/01/1995
4	7614	1995	4	5	FHWA class 5	0.59	04/01/1995
4	7614	1995	4	6	FHWA class 6	0.99	04/01/1995
4	7614	1995	4	7	FHWA class 7	0.64	04/01/1995
4	7614	1995	4	8	FHWA class 8	1.09	04/01/1995
4	7614	1995	4	9	FHWA class 9	0.97	04/01/1995
4	7614	1995	4	10	FHWA class 10	0.88	04/01/1995
4	7614	1995	4	11	FHWA class 11	0.98	04/01/1995
4	7614	1995	4	12	FHWA class 12	1.07	04/01/1995
4	7614	1995	4	13	FHWA class 13	0.91	04/01/1995
4	7614	1995	5	4	FHWA class 4	0.70	05/01/1995
4	7614	1995	5	5	FHWA class 5	0.63	05/01/1995
4	7614	1995	5	6	FHWA class 6	1.31	05/01/1995
4	7614	1995	5	7	FHWA class 7	0.85	05/01/1995
4	7614	1995	5	8	FHWA class 8	1.09	05/01/1995
4	7614	1995	5	9	FHWA class 9	1.03	05/01/1995
4	7614	1995	5	10	FHWA class 10	1.00	05/01/1995
4	7614	1995	5	11	FHWA class 11	1.13	05/01/1995
4	7614	1995	5	12	FHWA class 12	1.11	05/01/1995
4	7614	1995	5	13	FHWA class 13	1.36	05/01/1995

STATE _CODE	SHRP _ID	YEAR	MONTH	VEHICLE _CLASS	VEHICLE_CLASS _EXP	MONTHLY _RATIO	DATE_EXP
4	7614	1996	4	9	FHWA class 9	0.97	04/01/1996
4	7614	1996	5	9	FHWA class 9	1.00	05/01/1996
4	7614	1998	4	9	FHWA class 9	0.96	04/01/1998
4	7614	1998	5	9	FHWA class 9	0.95	05/01/1998
4	7614	2003	4	9	FHWA class 9	1.00	04/01/2003
4	7614	2003	5	9	FHWA class 9	1.00	05/01/2003
4	7614	2004	4	9	FHWA class 9	1.02	04/01/2004
4	7614	2004	5	9	FHWA class 9	1.01	05/01/2004

To obtain an estimate of monthly truck volumes, take the AADTT value for each vehicle class for each desired year (from TRF_TREND as shown in table 27) and multiply that value by the appropriate monthly factor for that vehicle class and month. If data were collected for that specific year, use the value for that class, for that year from the TRF_MEPDG_MONTH_ADJ_FACTR table (using MONTHLY_RATIO field as shown in table 28).

For example, if class 9 volumes for May 1995 were required, the AADTT value for class 9 in 1995 is 720 (as shown in table 27). The MONTHLY_RATIO in table 28 is 1.03. Thus, the monthly class 9 AADTT volume in May 1995 is:

$$720 * 1.03 = 742 \qquad (2)$$

To estimate total monthly class 9 volume, multiply this value by the number of days in the month of May (31):

$$742 * 31 = 23{,}002 \qquad (3)$$

If a monthly volume is required for a year in which MAFs are unavailable in the TRF_MEPDG_MONTH_ADJ_FACTR TREND table, create an average value for that vehicle class and month from the years for which factors are available and apply that average.

For example, if a class 9 volume was needed for May for 2002, the first step is to take all May factors for class 9 that are available (1.03, 1.00, 0.95, 1.00, and 1.01) and compute the average (1.00). This value is then used as the class 9 May factor for any year that lacks a value in the table. Thus, the class 9 AADTT volume for May 2002 would be computed as:

$$1{,}002 * 1.00 = 1{,}002 \qquad (4)$$

And the total monthly volume for that month would be 31,062.

Note that the sum of monthly truck volumes will at times be slightly off from the value found in the TRF_TREND table's ANNUAL_TRUCK_VOLUME_TREND variable because of different rounding errors occurring in this process versus the process used to compute those values.

CHAPTER 9. SCENARIO 3: OBTAIN AXLE OR TRUCK LOADING INFORMATION

PARAMETER 3.1: AXLE LOAD DISTRIBUTION OR AXLE LOAD SPECTRA

Axle load distribution and axle load spectrum are two names frequently used by pavement engineers for the same parameter. Axle load distribution is a frequency distribution of axle loads, whereby counts of axle load applications, observed during a specified period of time, are reported using predefined load bins. When the distribution of loads is expressed as a percentile with the percentages of loads reported for each load bin instead of the axle counts, the distribution or axle load spectrum is called "normalized." In the LTPP data tables,(3) axle load spectra are reported separately for each vehicle class 4–13(11) and each axle group (i.e., single, tandem, tridem, and quad+).

Typically, an axle load spectrum is used to characterize the traffic loading for the mechanistic-empirical pavement response and performance modeling. Also, it is used to compute summary axle loading statistics such as ESAL, RPPIF, and cumulative total load. When the AASHTOWare Pavement ME Design software(5) is used, specifically formatted ALDF are used as an input. The following examples are for the use of axle load spectra for analyses based on the MEPDG method not tied to AASHTOWare software.

Axle load spectra are available in several LTPP tables(3) at different level of aggregation or estimation:

- DD_AX (LTAS table)—Axle load distribution summarized for each day with weight data.
- MM_AX (LTAS table)—Axle load distribution summarized by DOW, month, and year for each month with weight data.
- YY_AX (LTAS table)—Axle load distribution summarized by DOW and year for each year with weight data.
- TRF_MONITOR_AXLE_DISTRIB—Annualized axle load distribution for years with WIM data (1990 or later).
- TRF_MEPDG_AX_DIST—Monthly normalized axle load distribution for years with at least 210 days of WIM data.
- TRF_MEPDG_AX_DIST_ANL—Annual normalized axle load distribution for years with at least 210 days of WIM data.
- MEPDG_AXLE_LOAD_DIST_FACTOR—ALDF or normalized axle load distribution representing a typical day of each calendar month formatted for use in AASHTOWare Pavement ME Design software, based on either site-specific WIM data or defaults.

The accuracy of WIM data varies greatly from site to site. The MEPDG_AXLE_LOAD_DIST_FACTOR table contains representative NALS and a code field with WIM data usability rating based on the assessment of WIM data quality and reasonableness conducted by LTPP data analysis contractors.

Example 3.1.1: Obtain Annual Axle Load Spectra

Annual axle load spectra provide annualized counts of axle loads, stored by axle load bins. These parameters are used in analyses based on the MEPDG method when month-to-month variation in distribution of axle loads is random (i.e., for sites with no definable seasonal pattern) or when seasonal variations are unimportant or excluded from the analysis. Annual axle load spectra are also used for computation of annual ESAL.

If axle load spectra are unavailable for the entire analysis period, values for missing periods could be estimated using available load spectra and information about truck volume growth for a given LTPP site. *Estimating Cumulative Traffic Loads, Volume II: Traffic Data Assessment and Axle Load Projection for the Sites with Acceptable Axle Weight Data, Final Report for Phase 2* provides detailed information about a recommended methodology for estimating and projecting axle load spectra for the design period.(19)

An example of how to obtain annual axle load spectra for LTPP SPS-1 site, section 0113 in Arizona using the TRF_MONITOR_AXLE_DISTRIB table is provided in chapter 6.

Once the data have been extracted, it is recommended to check the rationality of the axle load distribution using the procedure included in chapter 4 of part 1 of this Guide.

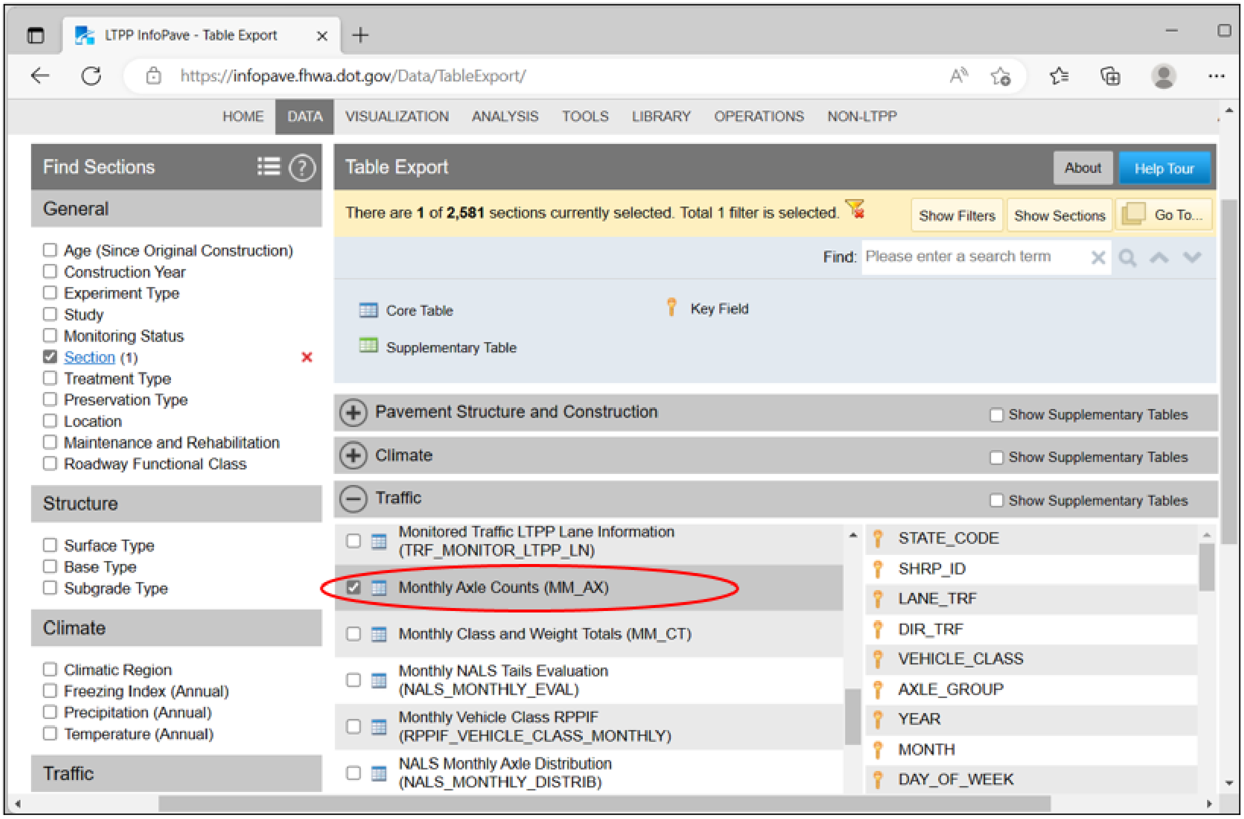
Example 3.1.2: Compute Monthly Axle Load Spectra

Monthly axle load spectra provide monthly counts of axle loads, stored by axle load bins. These parameters are used when month-to-month variation in distribution of axle loads is important for analysis.

The LTPP LTAS MM_AX table contains axle counts by site, year, month, lane, direction, vehicle classification, axle group, DOW, and the number of DOW occurrences in a month. This table is created by summing the number of daily axle counts in each load bin by DOW, axle group, vehicle class, and LTPP site for each month and year with WIM data.

To compute monthly axle load spectra for a selected LTPP site, vehicle class, axle group, year, and month:

1. Obtain records of axle counts by load bin from the MM_AX table using the generic InfoPave data extraction instructions given in chapter 6, as shown in figure 15. An example of the extracted records for Arizona site 7613 is shown in table 29. Because of a large volume of data, only partial records are shown, depicting single-axle counts for class 9 vehicles for each DOW in June 1998.



Source: FHWA.

Figure 15. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label, "Monthly Axle Counts (MM_AX)."(3)

Table 29. Total single-axle counts for class 9 vehicles for each DOW in June 1998 for Arizona site 7613 extracted from the MM_AX table.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	AXLE_GROUP	YEAR	MONTH	DAY_OF_WEEK	NUM_DAY_OCCURRENCES	AX_CT_01	AX_CT_02	AX_CT_03	AX_CT_04	AX_CT_05	AX_CT_06	AX_CT_07	AX_CT_08	AX_CT_09	AX_CT_10	AX_CT_11	…*	AX_CT_40
4	7613	9	1	1998	6	1	3	0	0	6	1	3	6	6	10	33	41	62	…	0
4	7613	9	1	1998	6	2	4	0	0	9	5	24	57	72	93	174	287	331	…	0
4	7613	9	1	1998	6	3	5	0	0	9	11	38	52	60	107	233	328	324	…	0
4	7613	9	1	1998	6	4	4	0	0	3	1	30	64	61	81	182	279	321	…	0
4	7613	9	1	1998	6	5	3	0	0	11	12	18	39	52	96	157	180	194	…	0
4	7613	9	1	1998	6	6	3	0	0	7	7	28	37	50	76	188	224	237	…	0
4	7613	9	1	1998	6	7	3	0	0	6	0	7	16	12	30	71	74	75	…	0

*Load bins AX_CT_12 to AX_CT_39 are not shown.

2. Divide the axle counts reported in each load bin and each DOW by the number of DOW occurrences reported in the MM_AX table. This step will produce an average axle count by load bin for each DOW, as shown in table 30.

Table 30. Average single-axle counts for class 9 for each DOW in June 1998 for Arizona site 7613 extracted from the MM_AX table.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	AXLE_GROUP	YEAR	MONTH	DAY_OF_WEEK	AX_CT_01	AX_CT_02	AX_CT_03	AX_CT_04	AX_CT_05	AX_CT_06	AX_CT_07	AX_CT_08	AX_CT_09	AX_CT_10	AX_CT_11	…*	AX_CT_40
4	7613	9	1	1998	6	1	0	0	2	0	1	2	2	3	11	14	21	…	0
4	7613	9	1	1998	6	2	0	0	2	1	6	14	18	23	44	72	83	…	0
4	7613	9	1	1998	6	3	0	0	2	2	8	10	12	21	47	66	65	…	0
4	7613	9	1	1998	6	4	0	0	1	0	8	16	15	20	46	70	80	…	0
4	7613	9	1	1998	6	5	0	0	4	4	6	13	17	32	52	60	65	…	0
4	7613	9	1	1998	6	6	0	0	2	2	9	12	17	25	63	75	79	…	0
4	7613	9	1	1998	6	7	0	0	2	0	2	5	4	10	24	25	25	…	0

*Load bins AX_CT_12 to AX_CT_39 are not shown.

3. Average the average DOW axle counts by load bin over seven DOW to compute an average daily axle counts for a given month and year. The results are shown in table 31.

Table 31. Average daily single-axle counts for class 9 for June 1998 for Arizona site 7613.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	AXLE_GROUP	YEAR	MONTH	AX_CT_01	AX_CT_02	AX_CT_03	AX_CT_04	AX_CT_05	AX_CT_06	AX_CT_07	AX_CT_08	AX_CT_09	AX_CT_10	AX_CT_11	…*	AX_CT_40
4	7613	9	1	1998	6	0	0	2	1	6	10	12	19	41	54	60	…	0

*Load bins AX_CT_12 to AX_CT_39 are not shown.

4. Multiply the average daily counts by the total number of days in the given calendar month to get average monthly axle counts, as shown in table 32.

Table 32. Average monthly single-axle counts for class 9 for June 1998 for Arizona site 7613.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	AXLE_GROUP	YEAR	MONTH	AX_CT_01	AX_CT_02	AX_CT_03	AX_CT_04	AX_CT_05	AX_CT_06	AX_CT_07	AX_CT_08	AX_CT_09	AX_CT_10	AX_CT_11	…*	AX_CT_40
4	7613	9	1	1998	6	0	0	63	44	170	314	365	581	1223	1629	1788	…	0

*Load bins AX_CT_12 to AX_CT_39 are not shown.

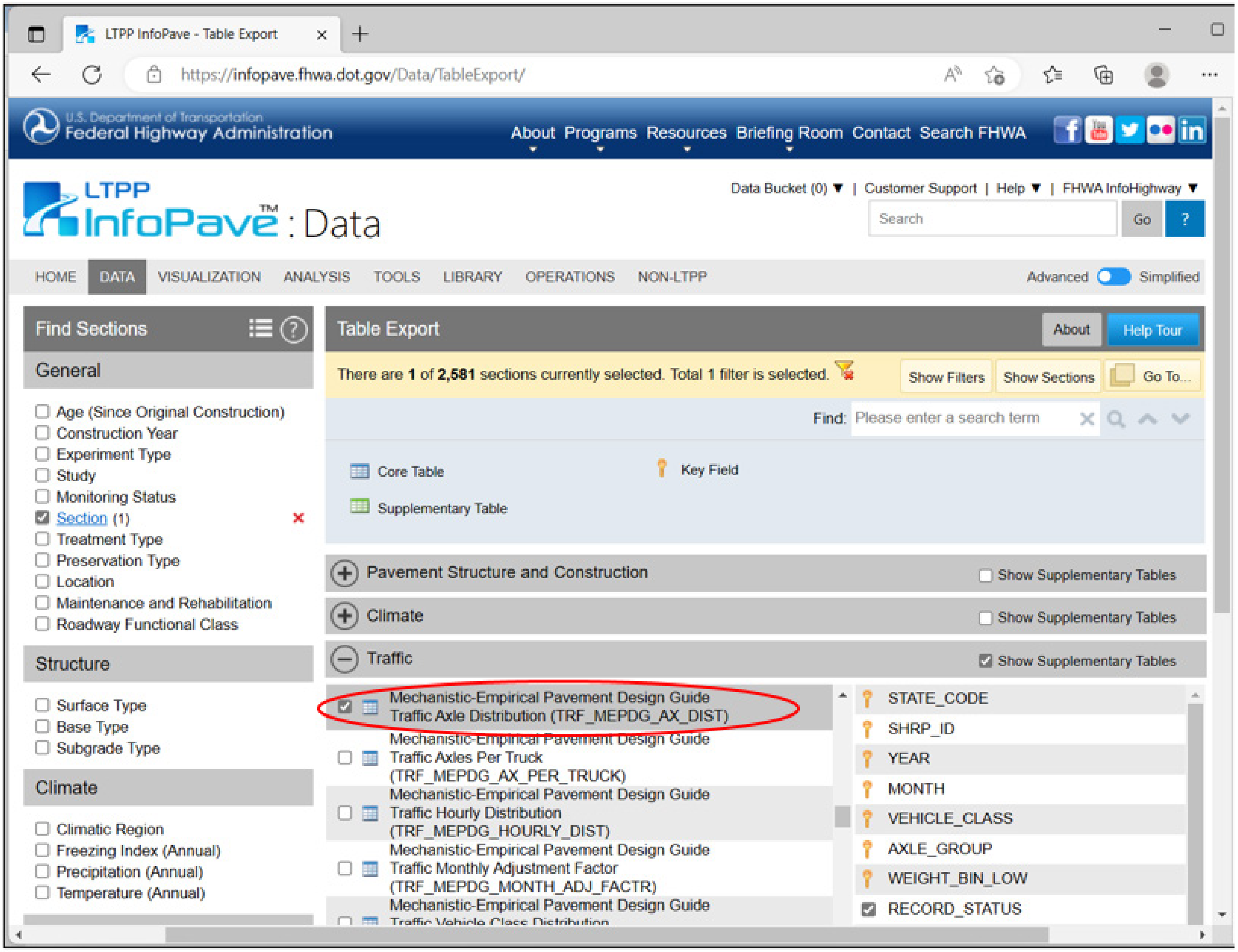
Example 3.1.3: Obtain Normalized Monthly Axle Load Spectra

Monthly NALS provide monthly percentages of axle loads by axle load bin, axle group, and vehicle class. These parameters are used when month-to-month variation in distribution of axle loads is important for analysis. Also, monthly NALS are the key traffic loading input for the AASHTOWare Pavement ME Design software[(5)] (See chapter 5 of this Guide for AASHTOWare Pavement ME Design software use example.)

LTPP table NALS_MONTHLY_DISTRIB contains monthly NALS for months and years when WIM data were collected and passed LTPP level E checks (the highest QC hierarchy level for traffic data). In addition, the TRF_MEPDG_AX_DIST table contains monthly NALS for selected LTPP sites with sufficient number of days with monitored axle weight data (a minimum of 210 days per year of classification or weight data).

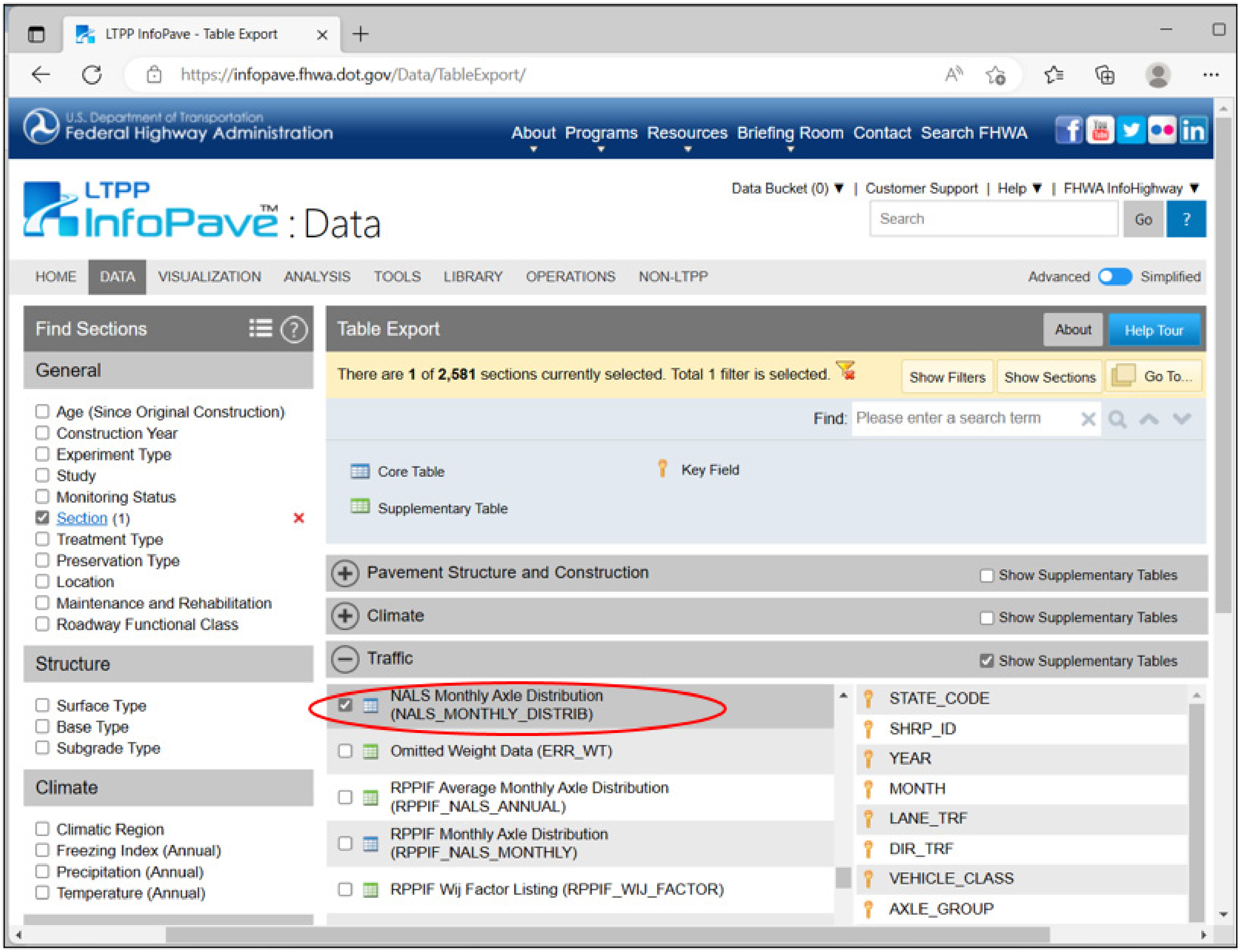
To get the data from these tables, use the InfoPave data extraction instructions given in chapter 6 and identify tables of interest, as shown in figure 16 and figure 17.

Review the downloaded data for reasonableness using the procedure included in chapter 4 of part 1 of this Guide and decide about data usability for the intended pavement analysis.



Source: FHWA.

Figure 16. Screenshot. InfoPave Table Export menu with a checkbox showing “selected” next to the traffic table label, “Mechanistic-Empirical Pavement Design Guide Traffic Axle Distribution (TRF_MEPDG_AX_DIST).”(3)



Source: FHWA.

Figure 17. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label, "NALS Monthly Axle Distribution (NALS_MONTHLY_DISTRIB)."(3)

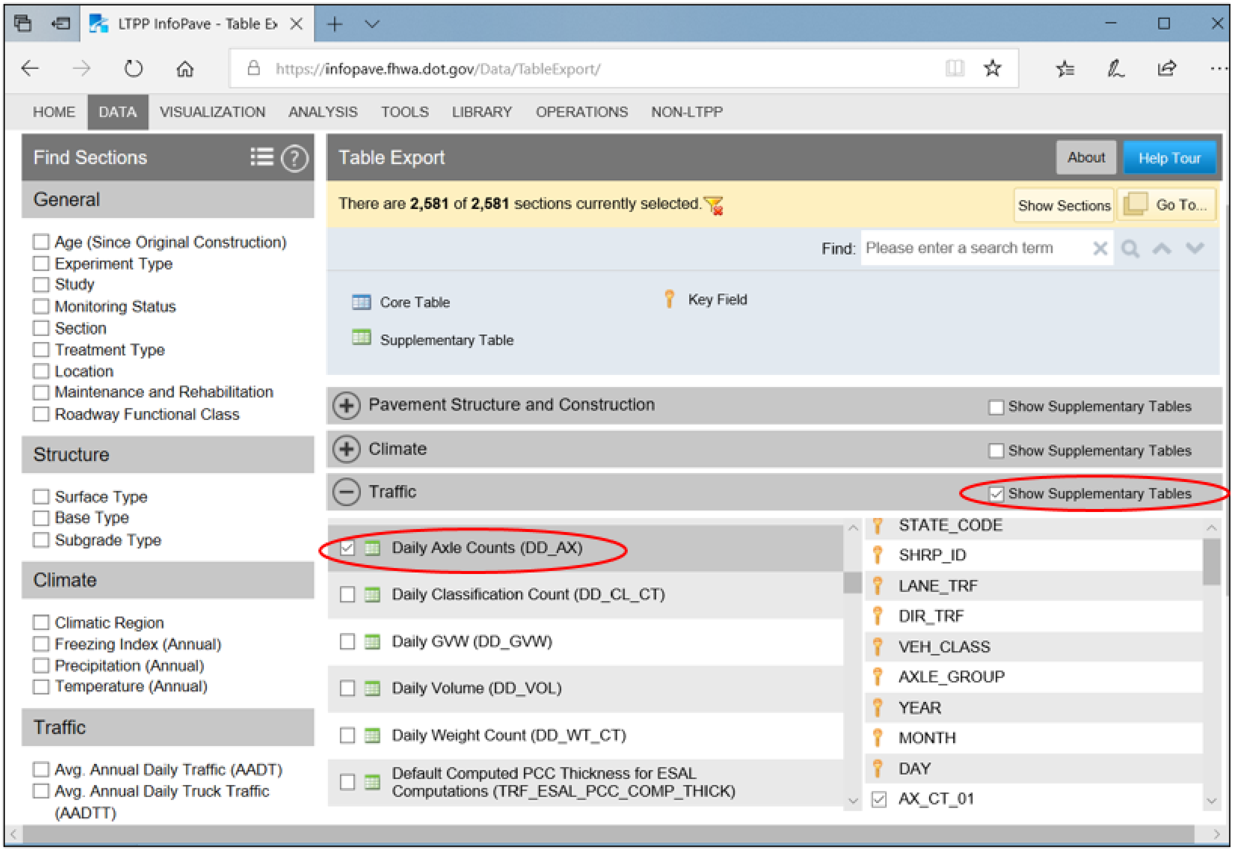
Example 3.1.4: Obtain Daily Axle Load Spectra

Daily axle weight data are used to investigate variations in axle loading to gain a better understanding of the changes in truck loads occurring on each DOW.

Daily axle load spectra are stored in the DD_AX table. These spectra provide counts of axle loads, stored by axle load bin, axle group, and vehicle class for each day with monitored traffic loading data. Vehicle classes provided in this table are based on classification schemes implemented by different State and Provincial agencies that are providing the data to LTPP and may differ from LTPP vehicle classification method (scheme).

To get the daily axle load spectra, use the generic InfoPave data extraction instructions given in chapter 6 and select the DD_AX table for download. Place a checkmark next to "Show Supplementary Tables" option on the Traffic bar, as shown in figure 18.

Review the downloaded data for reasonableness using procedure included in chapter 4 of part 1 of this Guide.



Source: FHWA.

Figure 18. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Daily Axle Counts (DD_AX)."(3)

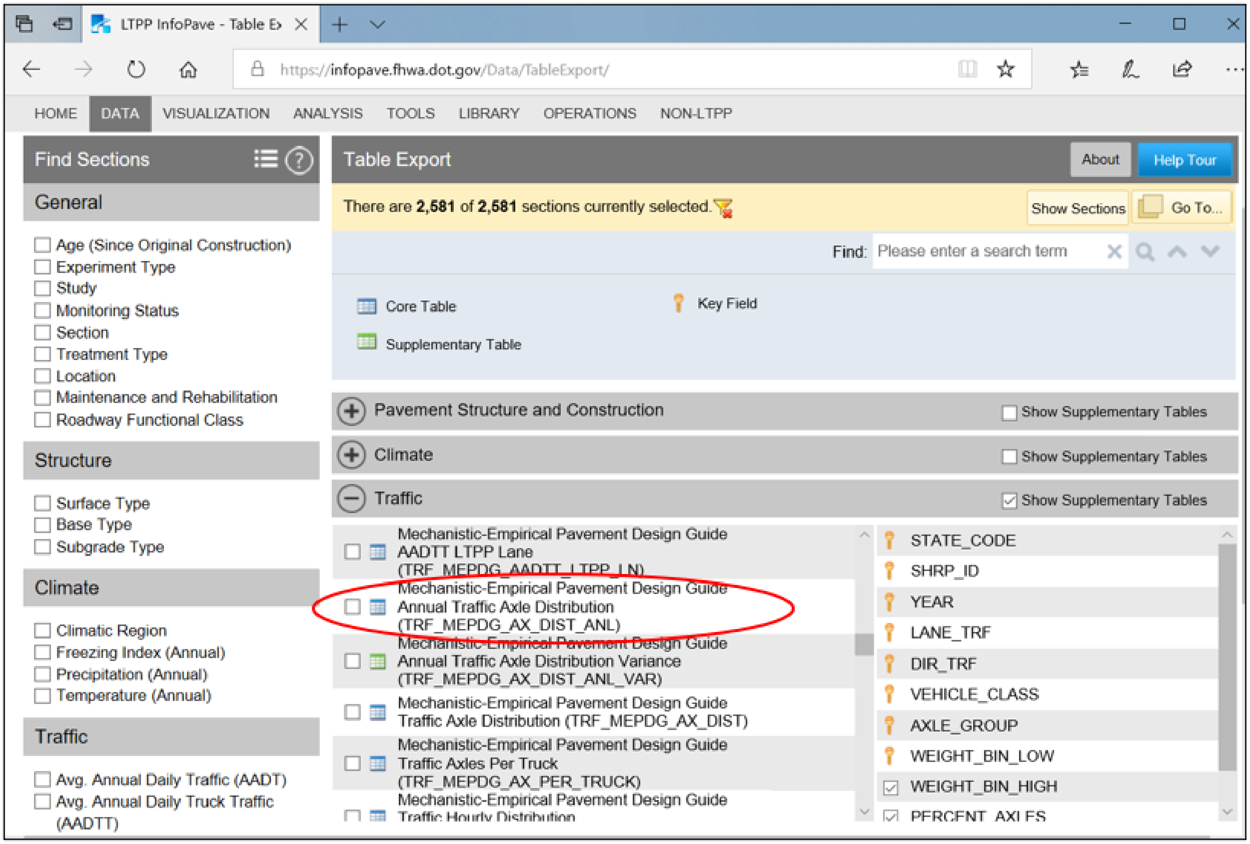
Example 3.1.5: Obtain Normalized Annual Load Spectra

NALS are used to investigate the differences in the shape of axle load distributions by removing the effect of truck volumes from the load spectra. This parameter allows users to analyze how heavy different axles are, the typical axle weights of loaded and unloaded trucks at the site, and how frequently light, moderate, heavy, and overloaded axles are observed for a given LTPP site or a group of sites.

LTPP table NALS_ANNUAL_DISTRIB contains annual NALS for all LTPP sites with WIM data that passed LTPP level E checks. In addition, annual NALS are available in the database table TRF_MEPDG_AX_DIST_ANL for LTPP sites with a sufficient number of days with monitored axle weight data (a minimum of 210 days per year of classification or weight data).

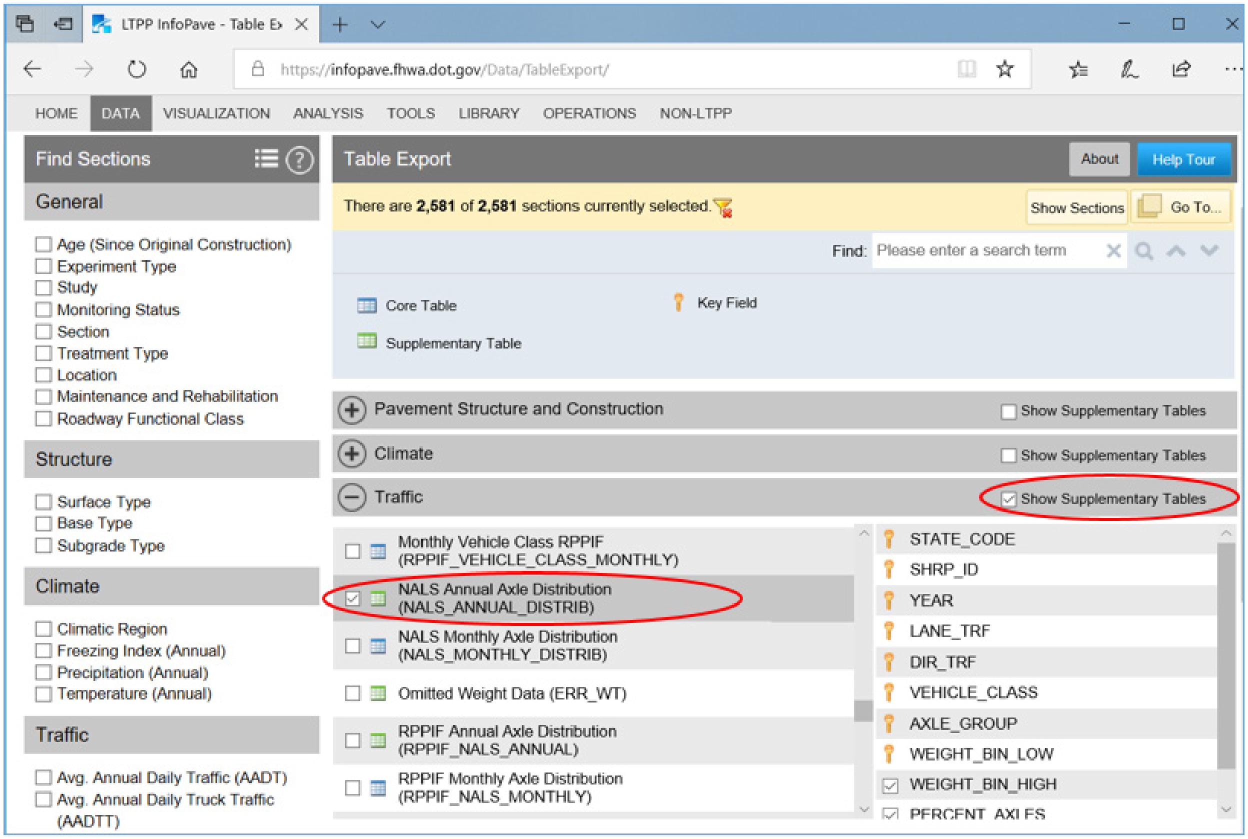
To get the data from these tables, use the generic InfoPave data extraction instructions given at the beginning of part 2 of this guide and identify tables of interest, as shown in figure 19 and figure 20. Place a checkmark next to "Show Supplementary Tables" option under the Traffic bar to see the NALS_ANNUAL_DISTRIB table.

After download, review the downloaded NALS for reasonableness using the procedure included in chapter 4 of part 1 of this Guide.



Source: FHWA.

Figure 19. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Mechanistic-Empirical Pavement Design Guide Annual Traffic Axle Distribution (TRF_MEPDG_AX_DIST_ANL)."[3]

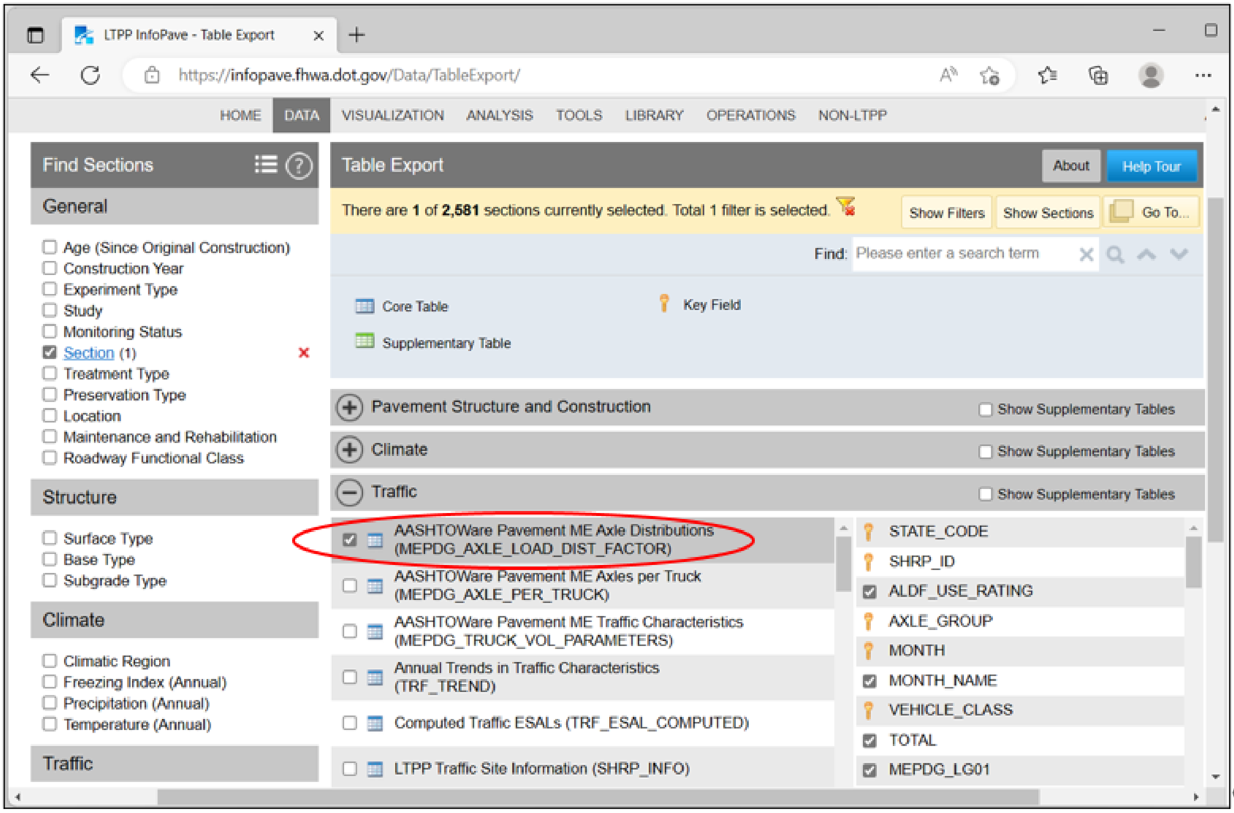


Source: FHWA.

Figure 20. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "NALS Annual Axle Distribution (NALS_ANNUAL_DISTRIB)."(3)

Example 3.1.6: Estimated NALS for Sites with Limited or No Site-Specific Axle Load Spectra

LTPP traffic analysis-ready table MEPDG_AXLE_LOAD_DIST_FACTOR contains ALDF or NALS representing a typical day of the year, including the default values assigned for each LTPP site, including sites with limited or no site-specific axle load spectra. The values representing a typical day of the year have been assigned to each month of the year. This table can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting the MEPDG_AXLE_LOAD_DIST_FACTOR table for extraction from the InfoPave Table Export menu is shown in figure 21.



Source: FHWA.

Figure 21. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "AASHTOWare Pavement ME Axle Distributions (MEPDG_AXLE_LOAD_DIST_FACTOR)."[(3)]

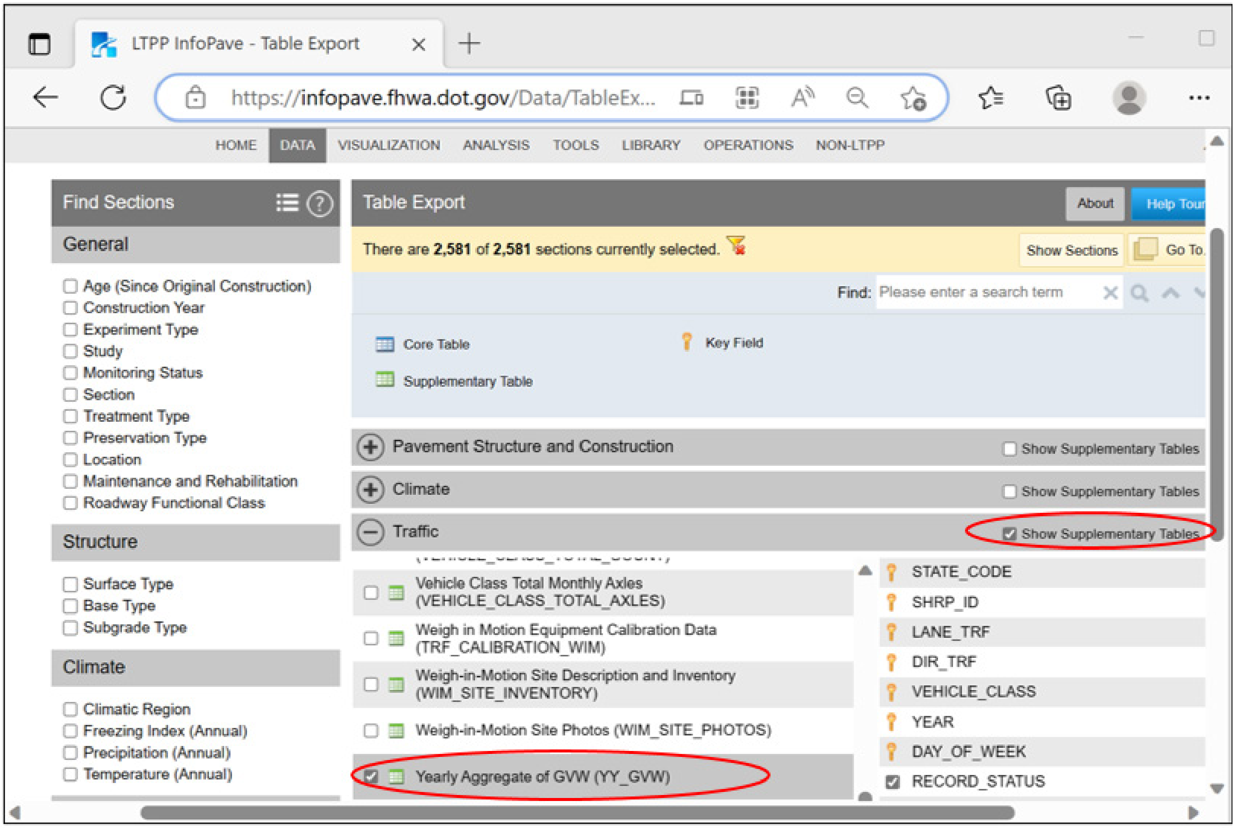
PARAMETER 3.2: GROSS VEHICLE WEIGHT DISTRIBUTION

GVW distribution information may be needed to compute average truck weight for some of the analyses that use aggregated traffic loading summary statistics and to investigate variations in traffic loading that may be associated with WIM equipment calibration drift over time.

The GVW distributions are available for the selected LTPP sites with WIM data collected after 2002. The following tables in LTPP LTAS database contain GVW distributions for FHWA vehicle classes 4–13:[(11)]

- DD_GVW—Daily aggregate of GVW distribution data (data reported using State-specific vehicle classification scheme).
- MM_GVW—Monthly aggregate of GVW distribution data by DOW (data reported using FHWA vehicle classification scheme).
- YY_GVW—Yearly aggregate of GVW distribution data (data reported using FHWA vehicle classification scheme).

These tables can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting the YY_GVW table for extraction from the InfoPave Table Export menu is shown in figure 22.



Source: FHWA.

Figure 22. Screenshot. InfoPave Table Export menu with a checkbox showing “selected” next to the traffic table label “Yearly Aggregate of GVW (YY_GVW).”[3]

CHAPTER 10. SCENARIO 4: OBTAIN SUMMARY TRAFFIC LOADING INFORMATION (ESAL OR ALTERNATIVE STATISTICS)

The summary traffic loading parameters are used for analyses that require a single parameter to describe traffic loading for an LTPP site. These parameters are applied in situations when a quick judgment about traffic loading is needed (that does not include analysis of axle load distributions) or for high-level analyses that are not focused on the investigation of the specific mechanisms of pavement deterioration because of traffic but need some estimate of traffic loading. A number of such parameters are available through InfoPave,(3) including the following:

- ESAL—Most commonly use traffic loading summary statistic since the 1960s based on weighted averaging (heavier, more damaging loads carry higher weight compared to light loads). Its main drawback is that, in addition to traffic loading inputs, it also considers pavement type, structure, and serviceability rating. In ESAL computation, axle loads are statistically weighted based on their damaging potential to the pavement using test data from the AASHO Road Test.(18) (Heavy loads have exponentially higher weights in the formula.)

- GESAL—Similar to ESAL but with pavement type, structure, and serviceability rating set to constant values in the ESAL formula. This parameter is useful for comparing loading between different sites.

- RPPIF—Similar to GESAL but with weight factors computed based on MEPDG model predictions instead of test data from the AASHO Road Test.(10) This parameter is useful for comparing loading between different sites. RPPIF values are available for LTPP sites with WIM data on a monthly and annual basis and reported at different levels of aggregation: per axle, per vehicle class, and for all truck classes combined.

- ATL—An estimate of ATL. It represents a simple summary of all the loads from heavy vehicles (computed as a summation of GVWs of the vehicles in FHWA vehicle classes 4–13(4) that traveled over the pavement during the year) to which a pavement was subjected over a year. Its main drawback is that it lacks the means for differentiating between sites exposed to large numbers of low to moderate loads and sites exposed to fewer numbers of heavier loads. For some pavement distresses, the lower number of heavier loads may be more critical than the higher number of light loads because of a complex relationship between the load magnitude, the number of load applications, and the pavement responses and damage accumulation.

- CTL—An estimate of cumulative total load for the period of interest (multiple years). It represents a simple summary of all the loads from heavy vehicles to which the pavement was subjected over the analysis period (computed as a summation of GVWs of all the vehicles in FHWA vehicle classes 4–13 that traveled over the pavement during the analysis period). It has advantages and disadvantages similar to those of the ATL parameter.

PARAMETER 4.1: ANNUAL ESAL FOR EACH YEAR IN THE ANALYSIS PERIOD

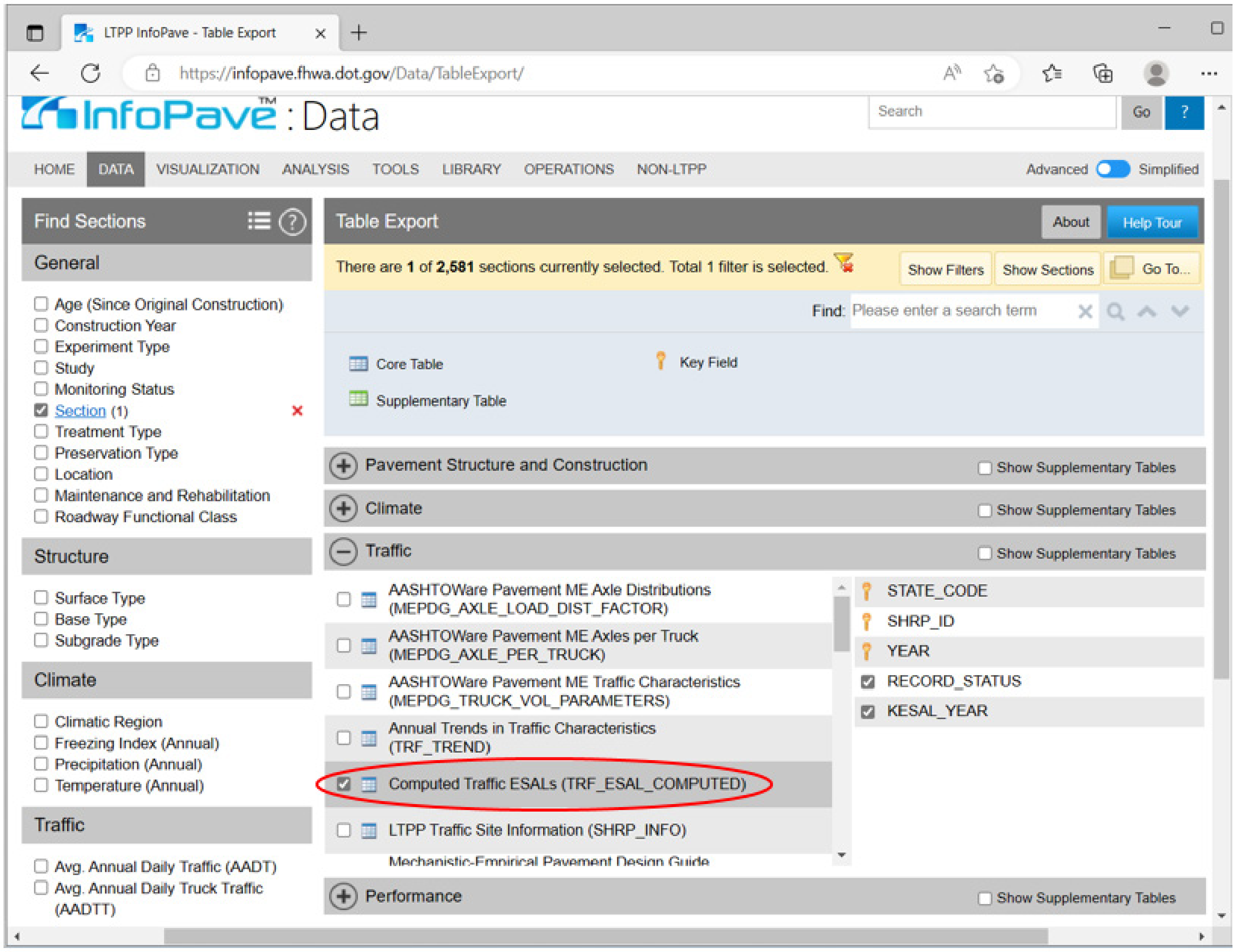
Annual ESAL for each year in the analysis period are used in the empirical analyses correlating pavement performance parameters collected or computed for specific years with traffic loading obtained during the same years. In these analyses, ESAL is used as a single parameter characterizing traffic loading at the site. When using this parameter in an analysis involving multiple LTPP sites, the user must pay attention to the nontraffic factors affecting ESAL values, such as road functional class, pavement type, pavement thickness, drainage, and others.

Annual ESAL values can be found in the following LTPP tables:

- TRF_ESAL_COMPUTED—Values based on monitored traffic loading data, available for years with WIM data.
- TRF_MON_EST_ESAL—Estimated ESAL values during the monitoring period (post-1989) when no weight data were collected.
- TRF_HIST_EST_ESAL—Historical values provided by local highway agencies based on various data sources prior to 1989.
- TRF_TREND—Estimated annual ESAL values for all in-service years based on all available monitored and historical values, as well as projections to fill in the gap years.

These tables can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting TRF_ESAL_COMPUTED table for extraction from the InfoPave Table Export menu is shown in figure 23.

Note that ESAL values may be affected by errors because of incorrect vehicle classification, as well as weighing errors. Critical review and evaluation of changes in the annual ESAL values year to year is recommended. Comparison with the expected ESAL per truck values is recommended to identify outliers and identify reasonableness of ESAL values.



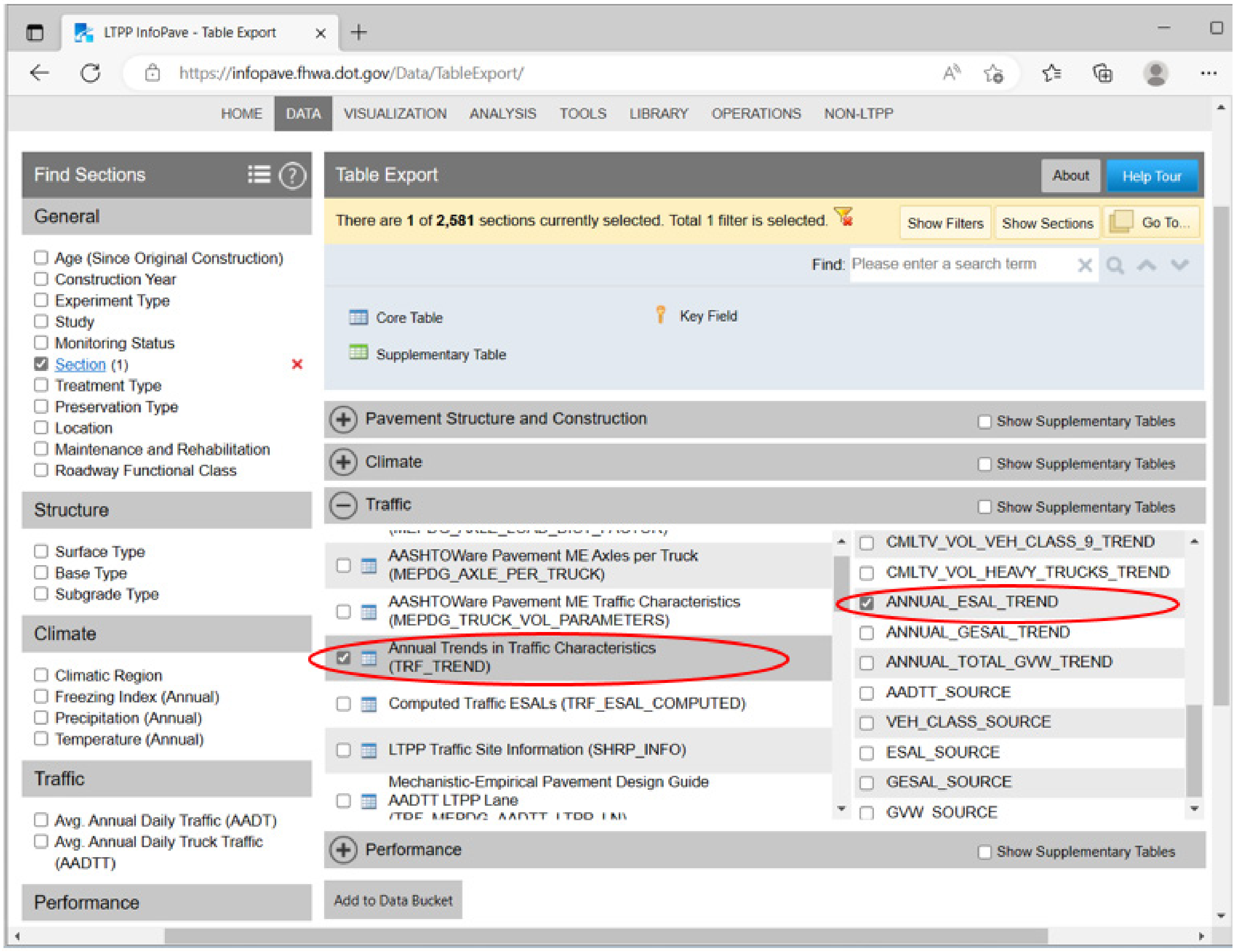
Source: FHWA.

Figure 23. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Computed Traffic ESALs (TRF_ESAL_COMPUTED)."(3)

Example 4.1.1: Obtain Annual ESAL for Each Year in the Analysis Period

The following example demonstrates how to obtain the annual ESAL values for Arizona test site 7613 for years corresponding to construction number 1.

1. To obtain the annual ESAL values for each in-service year corresponding to CONSTRUCTION_NO = 1 for Arizona test site 7613, extract records from the TRF_TREND table field ANNUAL_ESAL_TREND using the generic InfoPave data extraction instructions given in chapter 6 and the example demonstrated in figure 24.



Source: FHWA.

Figure 24. Screenshot. InfoPave Table Export menu with checkboxes showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)" and ANNUAL_ESAL_TREND field.[3]

2. Once the table has been extracted to an Excel or Access file, identify columns (fields) with headers STATE_CODE, SHRP_ID, YEAR, CONSTRUCTION_NO, and ANNUAL_ESAL_TREND. Filter records for STATE_CODE=4, SHRP_ID = 7613, and CONSTRUCTION_NO = 1. Applying this filter would provide the annual ESAL values in the ANNUAL_ESAL_TREND column shown in table 33.

Table 33. Annual ESAL trend table for Arizona site 7613 extracted from the TRF_TREND table.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	ANNUAL_ESAL_TREND
4	7613	1	1979	14,168
4	7613	1	1980	71,736
4	7613	1	1981	81,760
4	7613	1	1982	117,530
4	7613	1	1983	132,860
4	7613	1	1984	133,224
4	7613	1	1985	143,080
4	7613	1	1986	168,630
4	7613	1	1987	189,070
4	7613	1	1988	189,588
4	7613	1	1989	204,400
4	7613	1	1990	166,995
4	7613	1	1991	190,000
4	7613	1	1992	200,000
4	7613	1	1993	187,000
4	7613	1	1994	249,000
4	7613	1	1995	275,000
4	7613	1	1996	261,119
4	7613	1	1997	106,697
4	7613	1	1998	192,340
4	7613	1	1999	223,000
4	7613	1	2000	187,743
4	7613	1	2001	204,543

PARAMETER 4.2: CUMULATIVE ESAL FOR THE ANALYSIS PERIOD

Cumulative ESAL is used in analyses requiring correlation between pavement deterioration and traffic loading accumulated at certain time points (typically dates when pavement performance data have been collected). This also includes analyses when pavement performance is evaluated at the end of the analysis period and involves accumulation of ESALs from the year when the site was first opened to traffic to the last year in which the site was part of the experiment or the last year of pavement monitoring.

Cumulative ESAL values can be computed by summing annual ESAL values extracted from the LTPP table TRF_TREND for the years identified for the analysis.

Example 4.2.1: Obtain Cumulative ESAL for the Analysis Period

Cumulative ESAL values can be computed by summing annual ESAL values extracted from the TRF_TREND table for the years identified for the analysis period. Typically, this includes years from the first year when the site was first opened to traffic to the last year in which the site was part of the experiment or the last year of pavement monitoring.

An example of the cumulative ESAL computation for the years corresponding to construction event 1 for Arizona site 7613 is shown in table 34. Annual ESAL values for each year are shown in the ANNUAL_ESAL_TREND column. Cumulative ESAL values for each year are shown in the Cumulative ESAL column. Cumulative ESAL for any selected year is computed as a summation of annual ESAL values from all the previous years. For example, cumulative ESAL for 1981 is computed as a summation of annual ESAL values for 1979, 1980, and 1981. With the use of the annual ESAL values from the ANNUAL_ESAL_TREND column corresponding to the above-mentioned 3 years, the following computation can be made: 14,168 + 71,736 + 81,760 = 167,664. For the example shown in table 34, cumulative total ESAL, accumulated over the years corresponding to construction event 1, could be found on the last row of the Cumulative ESAL column: 3,889,483. This value is a result of summation of all annual ESAL values from the ANNUAL_ESAL_TREND column.

Table 34. Cumulative ESAL for construction event 1 for Arizona site 7613.

STATE_ CODE	SHRP_ID	CONSTRUCTION _NO	YEAR	ANNUAL_ESAL_ TREND	Cumulative ESAL
4	7613	1	1979	14,168	14,168
4	7613	1	1980	71,736	85,904
4	7613	1	1981	81,760	167,664
4	7613	1	1982	117,530	285,194
4	7613	1	1983	132,860	418,054
4	7613	1	1984	133,224	551,278
4	7613	1	1985	143,080	694,358
4	7613	1	1986	168,630	862,988
4	7613	1	1987	189,070	1,052,058
4	7613	1	1988	189,588	1,241,646
4	7613	1	1989	204,400	1,446,046
4	7613	1	1990	166,995	1,613,041
4	7613	1	1991	190,000	1,803,041
4	7613	1	1992	200,000	2,003,041
4	7613	1	1993	187,000	2,190,041
4	7613	1	1994	249,000	2,439,041
4	7613	1	1995	275,000	2,714,041
4	7613	1	1996	261,119	2,975,160
4	7613	1	1997	106,697	3,081,857
4	7613	1	1998	192,340	3,274,197

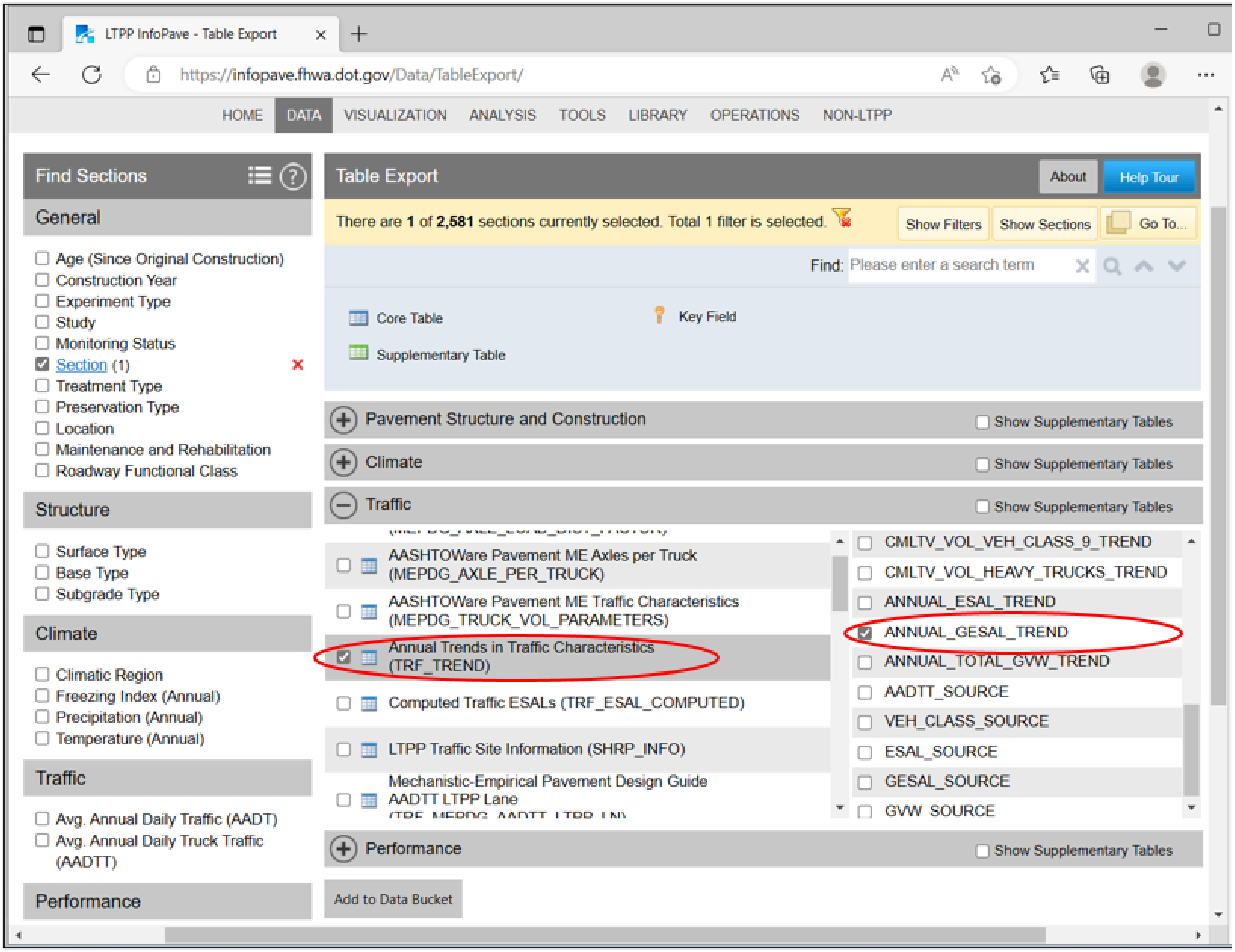
STATE_ CODE	SHRP_ID	CONSTRUCTION _NO	YEAR	ANNUAL_ESAL_ TREND	Cumulative ESAL
4	7613	1	1999	223,000	3,497,197
4	7613	1	2000	187,743	3,684,940
4	7613	1	2001	204,543	3,889,483

PARAMETER 4.3: ANNUAL GESAL FOR EACH YEAR IN THE ANALYSIS PERIOD

This parameter is similar to ESAL but with constant values used for pavement thickness or SN and serviceability inputs. Thus, this traffic summary statistic is independent of pavement structure and pavement condition. This parameter is recommended for LTPP empirical analyses where a single-value traffic loading statistic is desired. Also, GESAL could be used for quantifying and comparing traffic loads between sites. GESAL is not intended for use with the AASHTO 1993 pavement design procedure.

An estimate of annual GESAL for each in-service and in-experiment year can be obtained from the TRF_TREND table, field ANNUAL_GESAL_TREND, using the InfoPave data table extraction instructions provided in chapter 6. ANNUAL_GESAL_TREND values are consolidated from multiple sources, with any data discrepancies between multiple sources resolved and missing values estimated. The source of data or estimation method for each year is also provided in the TRF_TREND table, field LOAD_SOURCE.

The TRF_TREND table can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting TRF_TREND table and ANNUAL_GESAL_TREND field for extraction from the InfoPave Table Export menu is shown in figure 25.



Source: FHWA.

Figure 25. Screenshot. InfoPave Table Export menu with checkboxes showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)" and ANNUAL_GESAL_TREND field name.(3)

Example 4.3.1: Obtain Annual GESAL for Each Year in the Analysis Period

This example demonstrates how to obtain the annual GESAL values for Arizona test site 7613 for in-service years corresponding to LTPP construction event number 1.

1. To obtain the annual GESAL values for each in-service year corresponding to CONSTRUCTION_NO = 1 for Arizona test site 7613, extract records from the TRF_TREND table field ANNUAL_GESAL_TREND using the generic InfoPave data extraction instructions given in chapter 6 (figure 25).

2. Once the table has been extracted to an Excel or Access file, identify columns (fields) with headers STATE_CODE, SHRP_ID, YEAR, CONSTRUCTION_NO, and ANNUAL_GESAL_TREND. Filter records for STATE_CODE = 4, SHRP_ID = 7613, and CONSTRUCTION_NO = 1. Applying this filter would provide the annual GESAL values in the ANNUAL_GESAL_TREND column shown in table 35.

Table 35. Annual GESAL trend for Arizona site 7613 from the TRF_TREND table.

STATE_CODE	SHRP_ ID	CONSTRUCTION _NO	YEAR	ANNUAL_GESAL_ TREND
4	7613	1	1979	11,808
4	7613	1	1980	59,083
4	7613	1	1981	68,116
4	7613	1	1982	97,484
4	7613	1	1983	110,239
4	7613	1	1984	110,541
4	7613	1	1985	118,999
4	7613	1	1986	140,130
4	7613	1	1987	156,692
4	7613	1	1988	157,121
4	7613	1	1989	169,546
4	7613	1	1990	138,712
4	7613	1	1991	143,743
4	7613	1	1992	148,683
4	7613	1	1993	133,580
4	7613	1	1994	168,743
4	7613	1	1995	196,663
4	7613	1	1996	211,790
4	7613	1	1997	95,157
4	7613	1	1998	163,393
4	7613	1	1999	189,561
4	7613	1	2000	155,614
4	7613	1	2001	169,964

Example 4.3.2: Obtain Cumulative GESAL for the Analysis Period

Cumulative GESAL values can be computed by summing annual GESAL values extracted from the TRF_TREND table ANNUAL_GESAL_TREND column for the years identified for the analysis period. Typically, this includes years from the first year when the site was first opened to traffic to the last year in which the site was part of the experiment or the last year of pavement monitoring.

An example of the cumulative GESAL computation for the years corresponding to construction event 1 for Arizona site 7613 is shown in table 36. The last row in the Cumulative GESAL column shows the total GESAL, accumulated over the years corresponding to construction event 1. This value is a summation of all annual GESAL values shown in the ANNUAL_GESAL_TREND column.

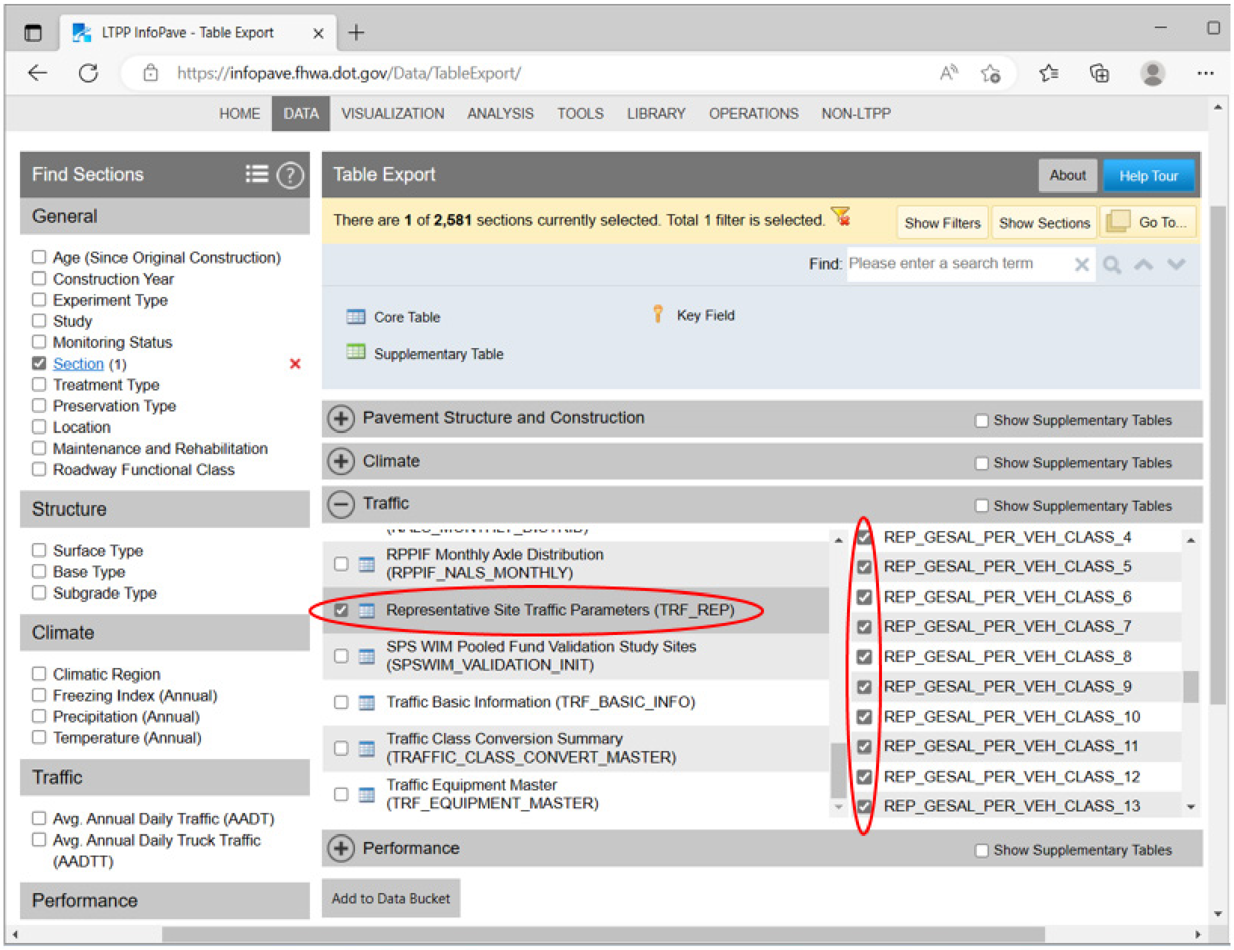
Table 36. Cumulative GESAL for construction event 1 for Arizona site 7613.

STATE CODE	SHRP_ ID	CONSTRUCTION _NO	YEAR	ANNUAL_GESAL_ TREND	Cumulative GESAL
4	7613	1	1979	11,808	11,808
4	7613	1	1980	59,083	70,891
4	7613	1	1981	68,116	139,007
4	7613	1	1982	97,484	236,491
4	7613	1	1983	110,239	346,730
4	7613	1	1984	110,541	457,271
4	7613	1	1985	118,999	576,270
4	7613	1	1986	140,130	716,400
4	7613	1	1987	156,692	873,092
4	7613	1	1988	157,121	1,030,213
4	7613	1	1989	169,546	1,199,759
4	7613	1	1990	138,712	1,338,471
4	7613	1	1991	143,743	1,482,214
4	7613	1	1992	148,683	1,630,897
4	7613	1	1993	133,580	1,764,477
4	7613	1	1994	168,743	1,933,220
4	7613	1	1995	196,663	2,129,883
4	7613	1	1996	211,790	2,341,673
4	7613	1	1997	95,157	2,436,830
4	7613	1	1998	163,393	2,600,223
4	7613	1	1999	189,561	2,789,784
4	7613	1	2000	155,614	2,945,398
4	7613	1	2001	169,964	3,115,362

PARAMETER 4.4: GESAL PER TRUCK, PER VEHICLE CLASS, AND PER AXLE

GESAL per truck values could be used to judge how heavy different trucks are. These values are also known as truck factors and are being used by State highway agencies for estimating loads. LTPP table TRF_REP contains estimates of representative GESAL per truck, representative GESAL per vehicle class, and representative GESAL per axle values for all LTPP sites.

The TRF_REP table can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting the TRF_REP table and related GESAL fields for extraction from the InfoPave Table Export menu is shown in figure 26.



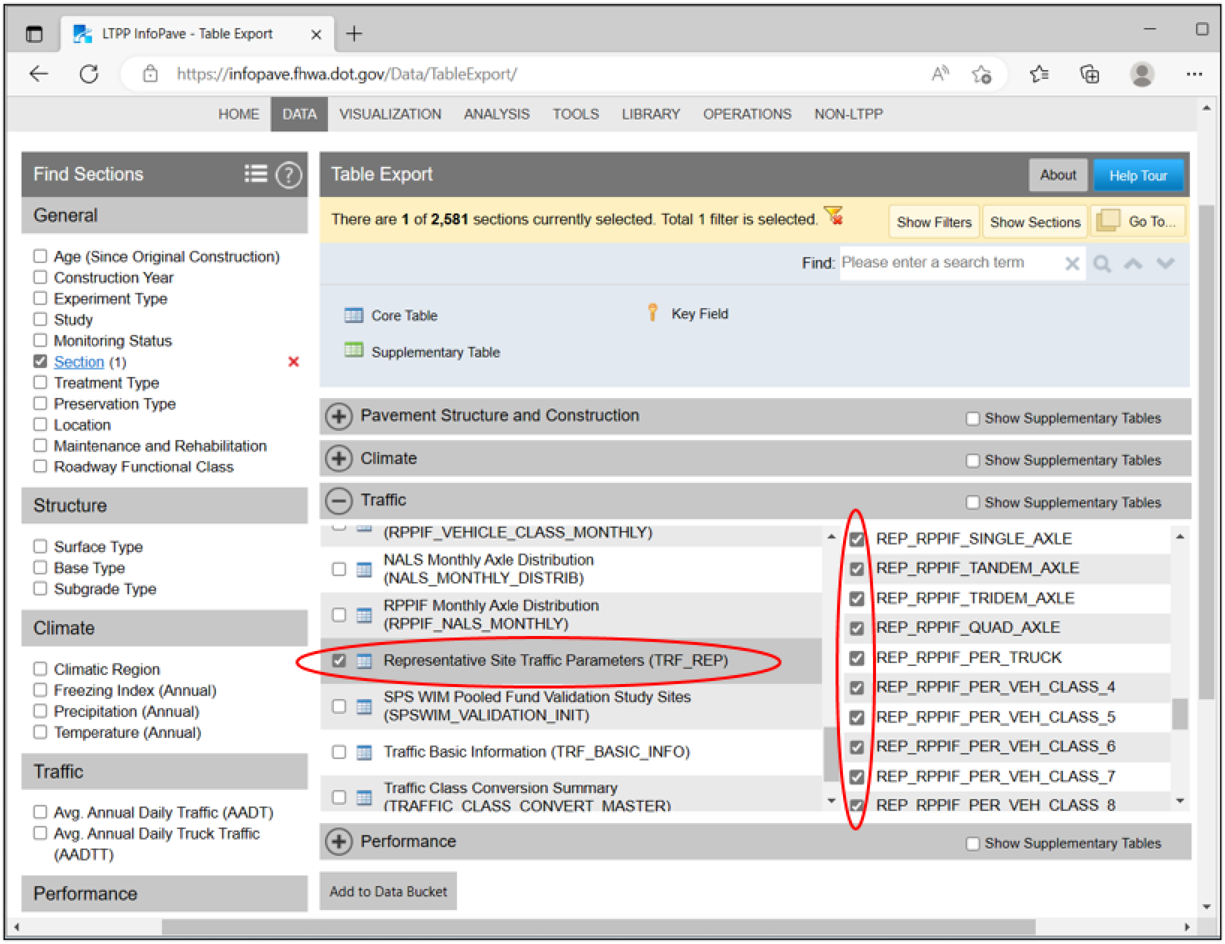
Source: FHWA.

Figure 26. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Representative Site Traffic Parameters (TRF_REP)."(3)

PARAMETER 4.5: RPPIF PER TRUCK, PER VEHICLE CLASS, AND PER AXLE

RPPIF values per truck, per vehicle class, and per axle could be used to judge how heavy different trucks and axles are and to compare axle loads between different sites. LTPP table TRF_REP contains representative RPPIF per truck, per vehicle class, and per axle values for LTPP sites.

The TRF_REP table can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting the TRF_REP table and related RPPIF fields for extraction from the InfoPave Table Export menu is shown in figure 27.



Source: FHWA.

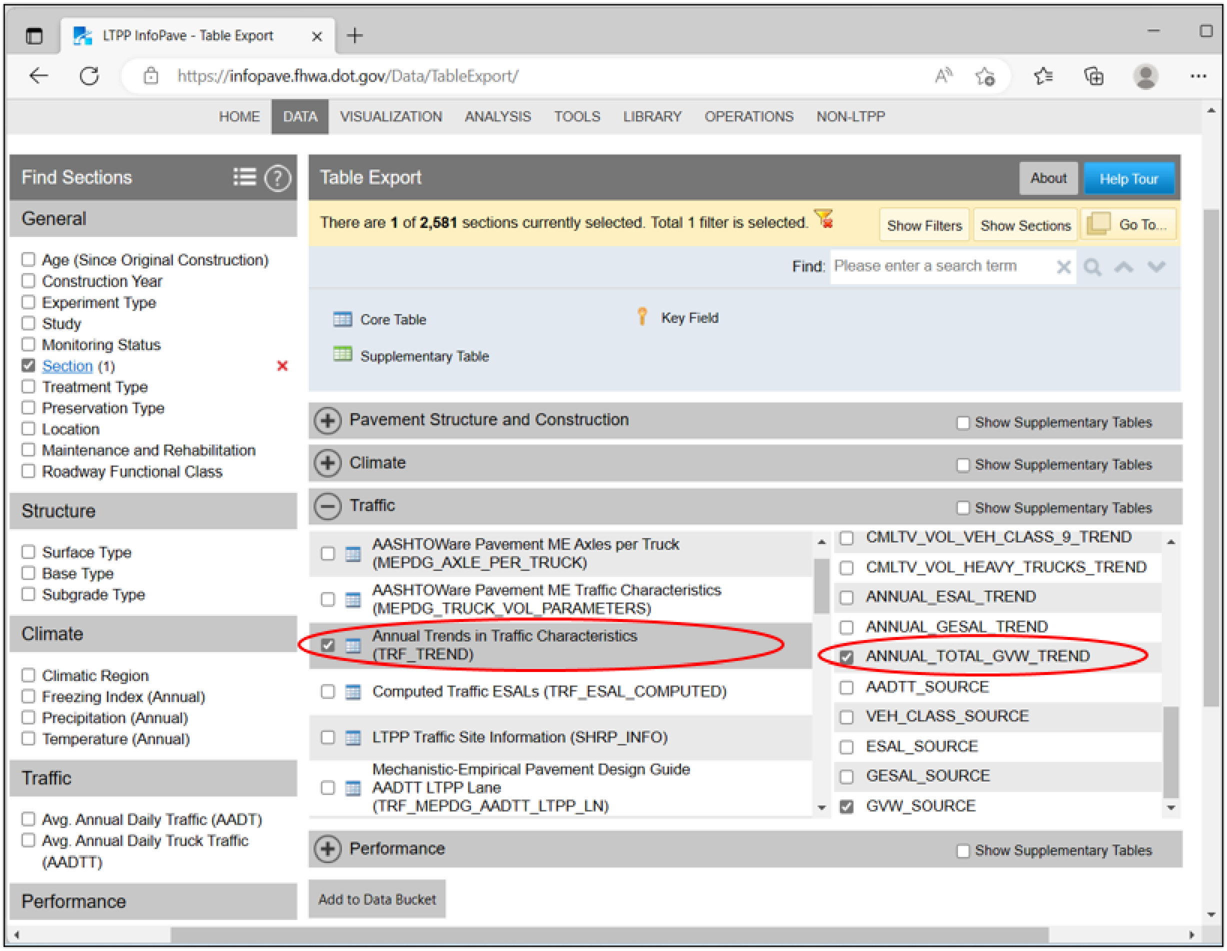
Figure 27. Screenshot. InfoPave Table Export menu with checkboxes showing “selected” next to the traffic table label “Representative Site Traffic Parameters (TRF_REP)” and REP_RPPIF field names.(3)

PARAMETER 4.6: ATL FOR EACH YEAR IN THE ANALYSIS PERIOD

The ATL parameter provides an estimate of the total load transferred to the pavement by heavy vehicles over a year. This parameter is recommended for LTPP empirical analyses where a single-value traffic loading statistic is desired and for quantifying and comparing traffic loads between sites. It is computed or estimated.

TRF_TREND table field ANNUAL_TOTAL_GVW_TREND contains ATL estimates for each year that a pavement site was in service, up to the end of the site’s participation in the LTPP experiment. The source of data or estimation method for each year is also provided in this table.

The TRF_TREND table can be downloaded using the generic InfoPave data extraction instructions given in chapter 6. An example of selecting the TRF_TREND table and ANNUAL_TOTAL_GVW_TREND field for extraction from the InfoPave Table Export menu is shown in figure 28.



Source: FHWA.

Figure 28. Screenshot. InfoPave Table Export menu with checkboxes showing "selected" next to the traffic table label "Annual Trends in Traffic Characteristics (TRF_TREND)" and ANNUAL_TOTAL_GVW_TREND field name.[3]

Example 4.6.1: Obtain ATL for Each Year in the Analysis Period

This example demonstrates how to obtain the ATL values for Arizona test site 7613 for in-service years corresponding to LTPP construction event number 1.

1. To obtain the ATL values for each in-service year corresponding to CONSTRUCTION_NO = 1 for Arizona test site 7613, extract records from the TRF_TREND table field ANNUAL_TOTAL_GVW_TREND using the generic InfoPave data extraction instructions given in chapter 6 (figure 28).

2. Once the table has been extracted to an Excel or Access file, identify columns (fields) with headers STATE_CODE, SHRP_ID, YEAR, CONSTRUCTION_NO, and ANNUAL_TOTAL_GVW_TREND. Filter records for STATE_CODE = 4, SHRP_ID = 7613, and CONSTRUCTION_NO = 1. Applying this filter would provide the ATL values in the ANNUAL_TOTAL_GVW_TREND column shown in table 37.

Table 37. ATL trend table for Arizona site 7613 extracted from the TRF_TREND table.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	ANNUAL_TOTAL_GVW_TREND (lb)
4	7613	1	1979	651,165,328
4	7613	1	1980	3,266,769,234
4	7613	1	1981	3,760,213,940
4	7613	1	1982	5,386,448,445
4	7613	1	1983	6,101,174,290
4	7613	1	1984	6,117,889,836
4	7613	1	1985	6,575,295,420
4	7613	1	1986	7,740,417,395
4	7613	1	1987	8,664,241,155
4	7613	1	1988	8,687,978,802
4	7613	1	1989	9,367,088,805
4	7613	1	1990	7,659,231,175
4	7613	1	1991	7,936,237,340
4	7613	1	1992	8,212,741,710
4	7613	1	1993	7,408,415,950
4	7613	1	1994	9,162,449,730
4	7613	1	1995	10,764,915,435
4	7613	1	1996	11,574,653,376
4	7613	1	1997	5,315,578,585
4	7613	1	1998	9,076,371,415
4	7613	1	1999	10,694,238,000
4	7613	1	2000	8,603,131,218
4	7613	1	2001	9,388,623,618

PARAMETER 4.7: CUMULATIVE TOTAL LOAD FOR THE ANALYSIS PERIOD

CTL values can be computed by summing the ATL values extracted from the LTPP table TRF_TREND column ANNUAL_TOTAL_GVW_TREND for the years identified for the analysis period. Typically, this includes years from the first year when the site was first opened to traffic to the last year in which the site was part of the experiment or the last year of pavement monitoring.

An example of the CTL computation for the years corresponding to construction event 1 for Arizona site 7613 is shown in table 38. The last row in the Cumulative Total Load column shows the total cumulative load, accumulated over the years corresponding to construction event 1. The value of 172,115,270,202 lb is a result of summing the values shown in ANNUAL_TOTAL_GVW_TREND column.

Table 38. Cumulative total load computed for the years during construction event 1 for Arizona site 7613.

STATE_CODE	SHRP_ID	CONSTRUCTION_NO	YEAR	ANNUAL_TOTAL_GVW_TREND (lb)	Cumulative Total Load (lb)
4	7613	1	1979	651,165,328	651,165,328
4	7613	1	1980	3,266,769,234	3,917,934,562
4	7613	1	1981	3,760,213,940	7,678,148,502
4	7613	1	1982	5,386,448,445	13,064,596,947
4	7613	1	1983	6,101,174,290	19,165,771,237
4	7613	1	1984	6,117,889,836	25,283,661,073
4	7613	1	1985	6,575,295,420	31,858,956,493
4	7613	1	1986	7,740,417,395	39,599,373,888
4	7613	1	1987	8,664,241,155	48,263,615,043
4	7613	1	1988	8,687,978,802	56,951,593,845
4	7613	1	1989	9,367,088,805	66,318,682,650
4	7613	1	1990	7,659,231,175	73,977,913,825
4	7613	1	1991	7,936,237,340	81,914,151,165
4	7613	1	1992	8,212,741,710	90,126,892,875
4	7613	1	1993	7,408,415,950	97,535,308,825
4	7613	1	1994	9,162,449,730	106,697,758,555
4	7613	1	1995	10,764,915,435	117,462,673,990
4	7613	1	1996	11,574,653,376	129,037,327,366
4	7613	1	1997	5,315,578,585	134,352,905,951
4	7613	1	1998	9,076,371,415	143,429,277,366
4	7613	1	1999	10,694,238,000	154,123,515,366
4	7613	1	2000	8,603,131,218	162,726,646,584
4	7613	1	2001	9,388,623,618	172,115,270,202

CHAPTER 11. SCENARIO 5: OBTAIN MEPDG TRAFFIC INPUTS FOR USE IN AASHTOWARE PAVEMENT ME DESIGN SOFTWARE

The AASHTOWare Pavement ME Design software requires a large number of traffic input parameters.(5) This Guide demonstrates how LTPP traffic parameters can be used as AASHTOWare software inputs. The screenshot examples provided in this Guide are consistent with the AASHTOWare Pavement ME Design versions 2.2 through 2.6. A screenshot of the software with Traffic Inputs menu is shown in figure 29.

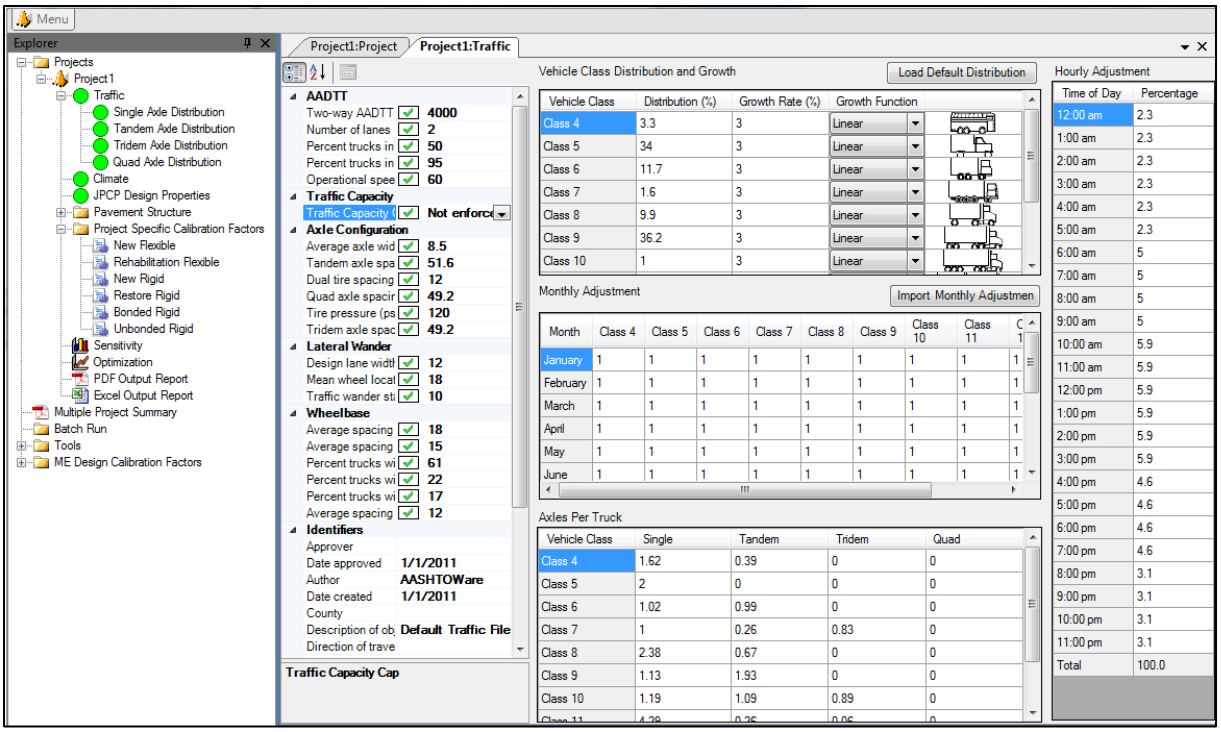


Figure 29. Screenshot. AASHTOWare Pavement ME Design software Project 1: Traffic input screen.(5)

Most of the required traffic inputs for the AASHTOWare Pavement ME Design software can be found in the LTPP traffic data tables or could be computed using LTPP traffic data. Still, a number of the input parameters are unavailable from the LTPP database. For these parameters, the use of default values (either included in the AASHTOWare Pavement ME Design software(5) or published by LTPP or State/Provincial highway agencies) is recommended. Table 18 in part 1 of this Guide contains a complete listing of the AASHTOWare Pavement ME Design traffic input parameters and the LTPP sources where these parameters can be found. For parameters unavailable through the LTPP database, references to recommended default values are also provided in table 18.

To make an informed selection of the MEPDG traffic input parameters, it is important to understand how each of these parameters is used by the AASHTOWare Pavement ME Design software.(5) To estimate the number of axle load applications of different magnitudes applied during a design or analysis time increment (the time increment typically equals 1 day for flexible pavement or 1 h for rigid pavements), the following inputs are multiplied inside the AASHTOWare Pavement ME Design software:

- Base year AADTT is the estimated total number of trucks for the first year in the analysis or design period. This parameter has a direct effect on the estimate of the total number of axle load applications. If a two-way AADTT is used, then it is also multiplied by the number of lanes, by the percentage of trucks in the design direction, and by the percentage of trucks in the design lane.

- Vehicle Class Distribution (VCD) provides the percentile distribution by vehicle class of vehicle volume in FHWA vehicle classes 4–13[(11)] for the base design or analysis year. This parameter does not contain information about the total number of vehicles. The parameter contains just the percentile distribution of vehicles by vehicle type. The AASHTOWare Pavement ME Design program has a capability to change this distribution over the years and between different months by applying annual growth rates and monthly truck volume adjustment factors, separately for each vehicle class.

- Annual Vehicle Volume Growth Rate and Growth Function by Vehicle Class are values applied against the base year AADTT value to estimate the total number of trucks for each year in the analysis or design period, starting with analysis year 2. These parameters have a direct effect on the estimate of the total number of axle load applications in every year of the analysis period.

- Monthly Adjustment Factors (MAFs) are multipliers used to adjust truck volume for each FHWA vehicle classes 4–13 between different calendar months within the design/analysis period. This monthly distribution stays constant over the design period.

- Hourly Distribution Factors (HDF) (used for rigid pavements only) are multipliers used to estimate total truck volume occurring during each hour during the day. These values are the same for all truck classes and apply only to total truck volume. This distribution stays constant over the design period. These factors used for rigid pavement analysis only.

- Axle Load Distribution Factors (ALDF) provide the *percentile* distribution of axle counts by load magnitude for each heavy vehicle class (FHWA vehicle classes 4–13) and axle type/group (single, tandem, tridem, and quad). This parameter is the same as the NALS. Both ALDF and NALS are used in conjunction with the MEPDG method interchangeably. Use of the term ALDF is limited primarily to the AASHTOWare Pavement ME Design software. This parameter does not contain information about the total number of axles. It contains just the percentile distribution of axles by load magnitude (i.e., it shows percentages of light, moderate, and heavy loads) that characterizes the base year condition, provided separately for each vehicle class and axle type. For a given vehicle class and axle type, this distribution stays constant over the design or analysis period.

- Number of axles per truck (APT) coefficients, provided for each vehicle class (FHWA vehicle classes 4–13) and axle type/group (single, tandem, tridem, and quad), is used as multipliers for estimating the total number of axle loads from the total number of trucks. An APT is needed for each truck class and axle type. To compute the total number of single, tandem, tridem, or quad axle loads, single, tandem, tridem, or quad APTs for each vehicle class are multiplied by the total number of trucks for each truck class; these products are then summed across different vehicle classes.

To determine the location of the load and load configuration, the following parameters are used inside the software:

- Axle group and axle spacing for tandem, tridem, and quad axles.
- Average axle width.
- Dual tire spacing.
- Truck wander described using mean wheel location and standard deviation of wheel location.
- Average spacing of short, medium, and long wheelbase axles and corresponding percentage of trucks.

The following sections provide examples of how to obtain individual MEPDG traffic parameters, listed in the order that these parameters are entered in the AASHTOWare Pavement ME Design software.

PARAMETER 5.1: MEPDG BASE YEAR AADTT

The AASHTOWare Pavement ME Design software requires input of two-way AADTT computed for the base design/analysis year.[5] However, the analysis is for one design lane only. The two-way AADTT is converted inside the AASHTOWare software to the design lane AADTT. In the case of the LTPP traffic data, AADTT for the LTPP lane is already known and does not need this conversion.

To use the LTPP lane's AADTT value in the AASHTOWare Pavement ME Design software, the following MEPDG parameters must be entered:

1. Enter AADTT values for the LTPP lane.
2. Enter percent trucks in the design direction = 100 percent.
3. Enter percent trucks in the design lane = 100 percent.

Example 5.1.1: Obtain Base Year AADTT for Use in the AASHTOWare Pavement ME Software

For example, to obtain base year AADTT for the analysis period during which Arizona test site 7613 was part of the LTPP experiment, extract records for Arizona test site 7613 from the MEPDG_TRUCK_VOL_PARAMETERS table using the generic InfoPave data extraction instructions given in chapter 6. The result will be as shown in table 39.

Table 39. AADTT for the base design year from MEPDG_TRUCK_VOL_PARAMETERS for Arizona site 7613.

STATE_CODE	SHRP_ID	TRAFFIC_OPEN_DATE_EXP_NO	TRAFFIC_OPEN_YEAR_EXP_NO	END_YEAR	AADTT_FIRST_YEAR_LTPP_LANE
4	7613	10/1/1979	1979	2001	275

Once extracted from the TRF_TREND table, the design lane AADTT value then could be entered on the traffic input screen of the AASHTOWare Pavement ME Design software, as shown in figure 30.(5)

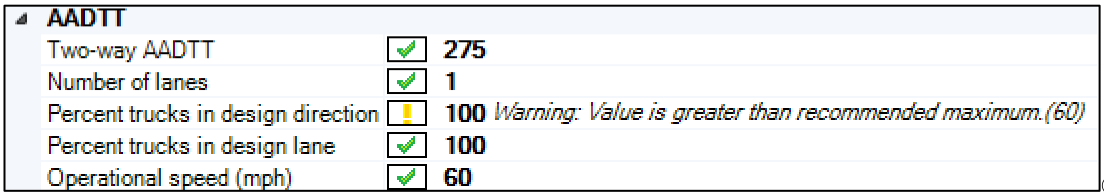


Figure 30. Screenshot. AASHTOWare Pavement ME Design software showing AADTT input screen.(5)

The software will automatically issue a warning for the "Percent trucks in the design direction" input because it lacks an option for a one-way, one-lane road. To remove the warning, AADTT can be multiplied by 2, and then 50 percent can be used for the "Percent trucks in the design direction" input, as shown in figure 31.

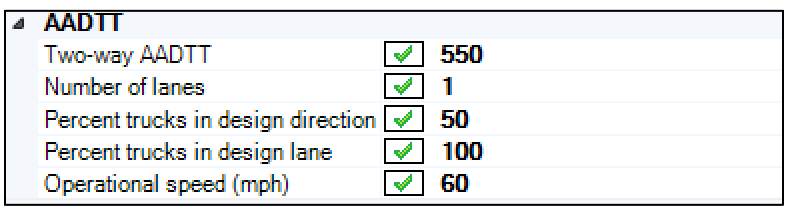


Figure 31. Screenshot. AASHTOWare Pavement ME Design software showing AADTT input screen with modified input values.(5)

PARAMETER 5.2: MEPDG NUMBER OF LANES IN DESIGN DIRECTION

Because the software is designed for general application, not just for use in the analysis of LTPP data, the AASHTOWare Pavement ME Design software requires the input of the number of lanes in the design direction (i.e., the direction of LTPP lane).(5) The LTPP table TRF_BASIC_INFO contains information about the number of lanes in the direction of the LTPP section in the field NO_LTPP_LANES. The LTPP table SHRP_INFO has a similar field called LANES_LTPP_DIR. If all other input entries for the AASHTOWare Pavement ME Design software are set to LTPP lane only, use a value of 1 for number of lanes input.

PARAMETER 5.3: MEPDG PERCENTAGE OF TRUCKS IN DESIGN DIRECTION (PERCENT)

For reasons stated in parameter 5.2, the AASHTOWare Pavement ME software[5] requires the input of the percentage of trucks operating in the design direction (i.e., the direction of LTPP lane) for the base design/analysis year. Because all LTPP traffic parameters are computed and reported for just the LTPP lane, the user needs to tell the software that the data entered are specifically for the LTPP lane. To do this, enter the Percent of Trucks in the Design Direction = 100.

PARAMETER 5.4: MEPDG PERCENT OF TRUCKS IN DESIGN LANE (PERCENT)

Because many roads contain more than one lane in the design direction, the AASHTOWare Pavement ME Design software requires the input of the percentage of trucks in the design lane (LTPP lane) for the base design/analysis year.[5] Because all LTPP traffic parameters are computed and reported for just the LTPP lane, the user needs to tell the software that the data entered are specifically for the LTPP lane. To do this, enter Percent of Trucks in Design Lane = 100.

PARAMETER 5.5: MEPDG VEHICLE CLASS DISTRIBUTION

VCD is one of the parameters used to estimate total traffic loading for MEPDG analysis. It represents an average VCD for a base design or analysis year. For LTPP sites, one set of normalized VCD values is stored in the LTPP table MEPDG_TRUCK_VOL_PARAMETERS. Each LTPP site has a set of 10 values. If an LTPP site is included in more than one LTPP experiment, a set of 10 values is stored for each LTPP experiment. Each set of 10 values represents the percentage of trucks found in one of the FHWA vehicle classes 4–13.[11] The sum of the 10 values is equal to 100 percent.

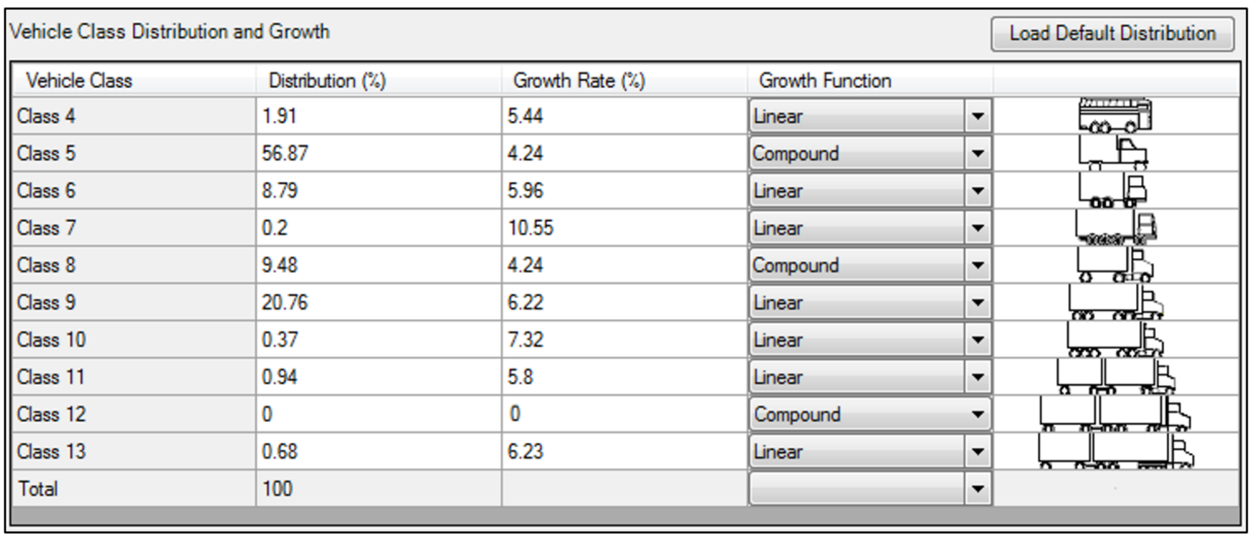
Example 5.5.1: Obtain Normalized VCD for the Base Year Specified for the Analysis

The normalized VCD, for the base year corresponding to the opening to traffic date for a given LTPP site specified for the analysis, can be extracted from the table MEPDG_TRUCK_VOL_PARAMETERS using the generic InfoPave data extraction instructions given in chapter 6. For example, the normalized VCD representing the base year for the analysis period during which Arizona test site 7613 was part of the LTPP experiment is shown in table 40.

Table 40. Normalized VCD for the base design year from the MEPDG_TRUCK_VOL_PARAMETERS table for Arizona site 7613.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	VEH_CLASS_DIST_PERCENT
4	7613	4	1.91
4	7613	5	56.87
4	7613	6	8.79
4	7613	7	0.2
4	7613	8	9.48
4	7613	9	20.76
4	7613	10	0.37
4	7613	11	0.94
4	7613	12	0
4	7613	13	0.68

Once the data have been extracted, copy the 10 VCD values from the field VEH_CLASS_DIST_PERCENT and paste them into the Vehicle Class Distribution and Growth input screen of the AASHTOWare Pavement ME Design software, as shown in figure 32.[(5)]


Vehicle Class Distribution and Growth

Load Default Distribution

Vehicle Class	Distribution (%)	Growth Rate (%)	Growth Function
Class 4	1.91	5.44	Linear
Class 5	56.87	4.24	Compound
Class 6	8.79	5.96	Linear
Class 7	0.2	10.55	Linear
Class 8	9.48	4.24	Compound
Class 9	20.76	6.22	Linear
Class 10	0.37	7.32	Linear
Class 11	0.94	5.8	Linear
Class 12	0	0	Compound
Class 13	0.68	6.23	Linear
Total	100		

Figure 32. Screenshot. AASHTOWare Pavement ME Design software Vehicle Class Distribution and Growth input screen.[(5)]

PARAMETER 5.6: MEPDG ANNUAL VEHICLE VOLUME GROWTH RATE AND GROWTH FUNCTION BY VEHICLE CLASS

The AASHTOWare Pavement ME Design software[(5)] requires input of growth rate (percent) and the designation of whether that growth takes the shape of a linear or composite growth function. Growth rates are applied to each truck class (FHWA vehicle classes 4–13[(11)]) from the base design/analysis year through the end of the required analysis period to compute annual truck traffic volume for each vehicle class. These parameters could be obtained from the LTPP table

MEPDG_TRUCK_VOL_PARAMETERS, fields VEH_CLASS_GROWTH_RATE and VEH_CLASS_GROWTH_FUNCTION.

For example, to extract annual vehicle volume growth rate and growth function records for Arizona test site 7613 from the MEPDG_TRUCK_VOL_PARAMETERS table, use the generic InfoPave data extraction instructions given in chapter 6. The results are shown in table 41.

Table 41. Annual vehicle volume growth rate and growth function by vehicle class from the MEPDG_TRUCK_VOL_PARAMETERS table for Arizona site 7613.

STATE_CODE	SHRP_ID	TRAFFIC_OPEN_YEAR_EXP_NO	END_YEAR	AADTT_FIRST_YEAR_LTPP_LANE	VEHICLE_CLASS	VEH_CLASS_DIST_PERCENT	VEH_CLASS_GROWTH_FUNCTION	VEH_CLASS_GROWTH_RATE
4	7613	1979	2001	275	4	1.91	Linear	5.44
4	7613	1979	2001	275	5	56.87	Compound	4.24
4	7613	1979	2001	275	6	8.79	Linear	5.96
4	7613	1979	2001	275	7	0.2	Linear	10.55
4	7613	1979	2001	275	8	9.48	Compound	4.24
4	7613	1979	2001	275	9	20.76	Linear	6.22
4	7613	1979	2001	275	10	0.37	Linear	7.32
4	7613	1979	2001	275	11	0.94	Linear	5.8
4	7613	1979	2001	275	12	0	Compound	41.37
4	7613	1979	2001	275	13	0.68	Linear	6.23

Once the data have been extracted, enter these values into the Vehicle Class Distribution and Growth input screen of the AASHTOWare Pavement ME Design software, as shown in figure 32.

PARAMETER 5.7: MEPDG MONTHLY ADJUSTMENT FACTORS

MAFs are used as multipliers to adjust the annual average truck volume statistic for each of the 10 heavy vehicle classes (FHWA vehicle classes 4–13),[11] to reflect the monthly or seasonal variations present in the truck traffic stream. The monthly distribution pattern is assumed to remain constant over multiple years for any length analysis period. One set of 12 representative monthly factors is required for each vehicle class. These factors represent the difference in truck volume, relative to the annual total, for each of the 12 months in any given year. The sum of factors for all months for one truck class equals 12.

The LTPP table TRF_MEPDG_MONTH_ADJ_FACTR contains MAFs for LTPP sites with sufficient vehicle classification data to allow computation of these factors for each calendar month. For all other LTPP sites, use default values provided in the AASHTOWare Pavement ME Design software.[5] The default assumes no monthly variation in truck volume, and all MAFs are equal to 1, as shown in figure 33.

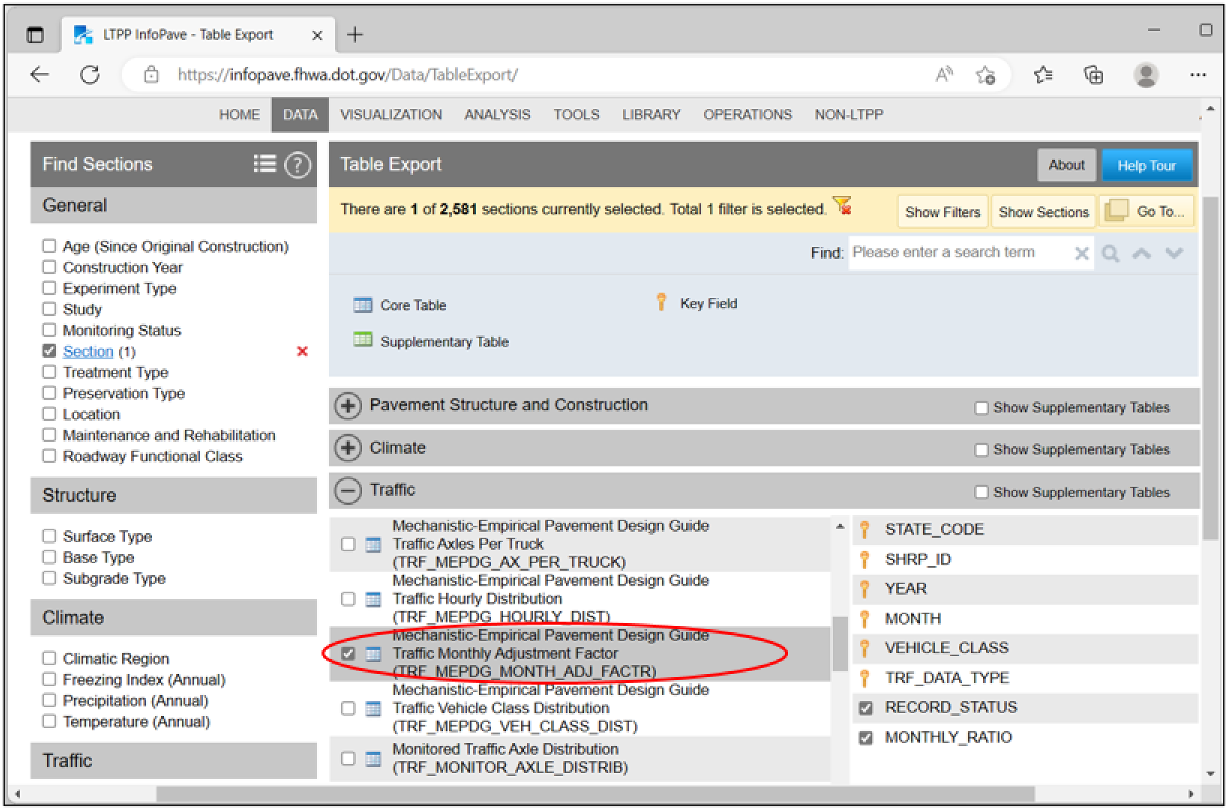
Monthly Adjustment

Import Monthly Adjustmen

Month	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
January	1	1	1	1	1	1	1	1	1	1
February	1	1	1	1	1	1	1	1	1	1
March	1	1	1	1	1	1	1	1	1	1
April	1	1	1	1	1	1	1	1	1	1
May	1	1	1	1	1	1	1	1	1	1
June	1	1	1	1	1	1	1	1	1	1
July	1	1	1	1	1	1	1	1	1	1
August	1	1	1	1	1	1	1	1	1	1
September	1	1	1	1	1	1	1	1	1	1
October	1	1	1	1	1	1	1	1	1	1
November	1	1	1	1	1	1	1	1	1	1
December	1	1	1	1	1	1	1	1	1	1

Figure 33. Screenshot. AASHTOWare Pavement ME Design software Monthly Adjustment input screen.[(5)]

For example, to extract records from the TRF_MEPDG_MONTH_ADJ_FACTR table for LTPP test section 0501 in Maryland, use the generic InfoPave data extraction instructions given in chapter 6 and select the TRF_MEPDG_MONTH_ADJ_FACTR table from the Table Export menu, as shown in figure 34. Then use the following procedure.



Source: FHWA.

Figure 34. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "Mechanistic-Empirical Pavement Design Guide Traffic Monthly Adjustment Factor (TRF_MEPDG_MONTH_ADJ_FACTR)."[3]

1. Once the TRF_MEPDG_MONTH_ADJ_FACTR table is extracted for LTPP test section 0501 in Maryland, open the table in Excel and review values in the field MONTHLY_RATIO. Note that for the LTPP sites that report the weight data and vehicle classification data separately, there may be two sets of MONTHLY_RATIO values for the same year (see Weight and/or Classification values in the TRF_DATA_TYPE_EXP field of the TRF_MEPDG_MONTH_ADJ_FACTR table). Since the purpose of the MEPDG MAFs is to adjust the number of axle load applications, use the MONTHLY_RATIO values computed from the weight data, unless the weight data were not available for the whole year.

2. Select a year with MONTHLY_RATIO values representing vehicle volume distribution for each FHWA vehicle class 4–13 by calendar month, as shown in table 42 for vehicle class 9. Alternatively, compute the average MONTHLY_RATIO values by averaging the values across all the available or selected years for each calendar month and for each FHWA vehicle classes 4–13 (in this case, renormalize the computed average values so that sum of 12 monthly average factors is equal to 12 for each vehicle class).

3. Enter computed or selected MONTHLY_RATIO values onto the Monthly Adjustment input screen of the AASHTOWare Pavement ME Design software (figure 33).[5]

Table 42. MAFs for class 9 vehicles for 2016 for LTPP site 24-0501.

STATE_ CODE	SHRP_ ID	YEAR	MONTH	VEHICLE_ CLASS	MONTHLY_ RATIO*
24	0501	2016	1	9	0.8
24	0501	2016	2	9	0.85
24	0501	2016	3	9	1.03
24	0501	2016	4	9	1.02
24	0501	2016	5	9	0.91
24	0501	2016	6	9	1.16
24	0501	2016	7	9	1.03
24	0501	2016	8	9	1.12
24	0501	2016	9	9	1.06
24	0501	2016	10	9	1.04
24	0501	2016	11	9	1.03
24	0501	2016	12	9	0.95

*This column contains the MAFs.

PARAMETER 5.8: MEPDG HOURLY DISTRIBUTION FACTORS

HDFs apply only to PCC pavements. These factors are used to account for curling and warping associated with PCC pavement during different times of the day. HDF are used as multipliers to estimate truck volume for each hour within a 24-h period. These values are the same for all truck classes and apply to total truck volume. The HDF stay constant over the design or analysis period. One set of 24-h factors is used as an input to the AASHTOWare Pavement ME Design software[5] to represent the fraction of total truck traffic for each hour.

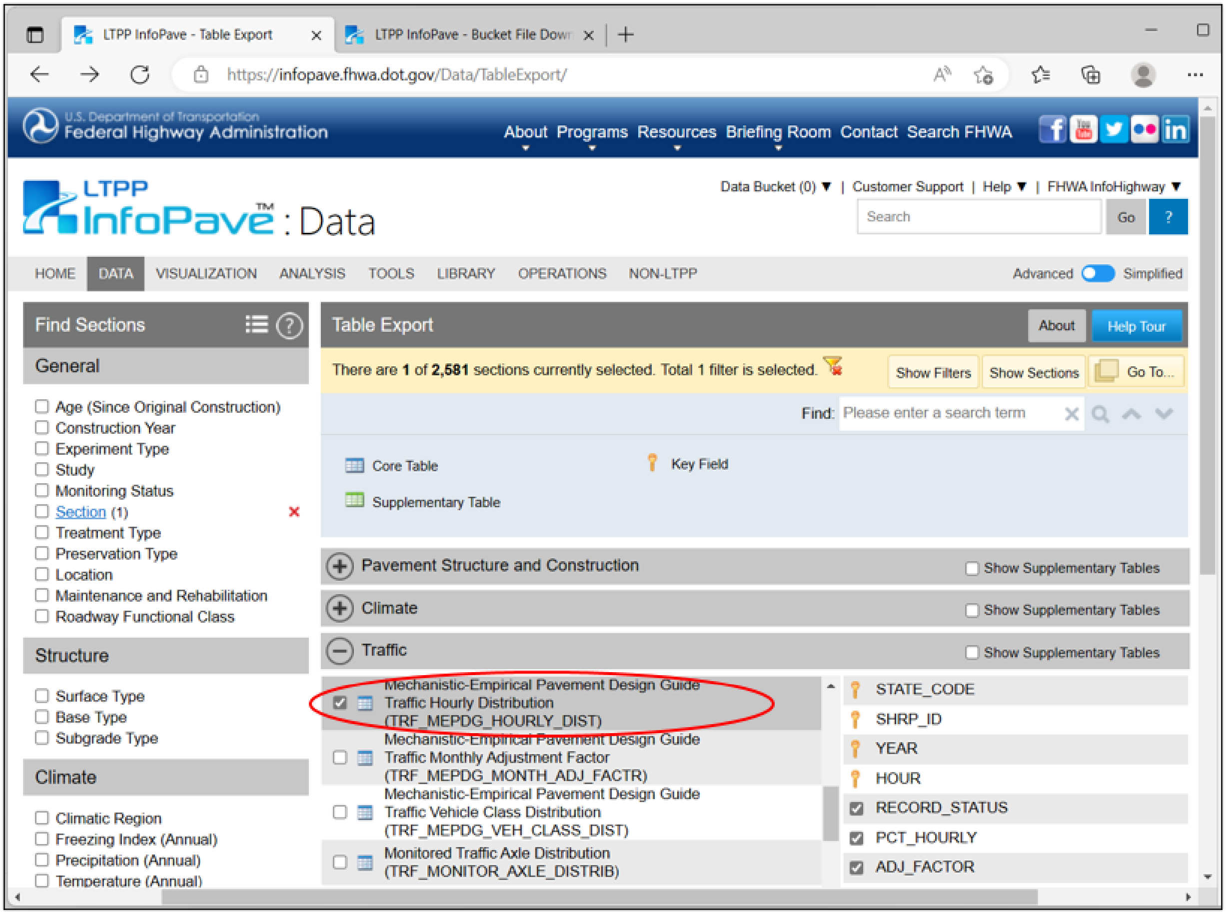
For a limited number of LTPP sites, this parameter is reported in the LTPP data table TRF_MEPDG_HOURLY_DIST in the field PCT_HOURLY. The PCT_HOURLY values are available for each year with hourly volume data submitted by vehicle class. For all other LTPP sites, use the default values from the AASHTOWare Pavement ME Design software (figure 35). It is expected that hourly adjustment factors will be different for the following two groups of roads: roads that serve primarily local businesses or deliveries, and roads primarily used by the throughway long-haul trucks. If local agency defaults are available for these two road types, use these defaults instead of the AASHTOWare Pavement ME Design software default.

Hourly Adjustment

Time of Day	Percentage
12:00 am	2.3
1:00 am	2.3
2:00 am	2.3
3:00 am	2.3
4:00 am	2.3
5:00 am	2.3
6:00 am	5
7:00 am	5
8:00 am	5
9:00 am	5
10:00 am	5.9
11:00 am	5.9
12:00 pm	5.9
1:00 pm	5.9
2:00 pm	5.9
3:00 pm	5.9
4:00 pm	4.6
5:00 pm	4.6
6:00 pm	4.6
7:00 pm	4.6
8:00 pm	3.1
9:00 pm	3.1
10:00 pm	3.1
11:00 pm	3.1
Total	100.0

Figure 35. Screenshot. AASHTOWare Pavement ME Design software Hourly Adjustment input screen with default values.[(5)]

For example, to obtain the HDF from the TRF_MEPDG_HOURLY_DIST table for LTPP test section 0501 in Maryland, use the generic InfoPave data extraction instructions given in chapter 6, and select the TRF_MEPDG_HOURLY_DIST table from Table Export menu, as shown in figure 36. Then use the following procedure.



Source: FHWA.

Figure 36. Screenshot. InfoPave Table Export menu with a checkbox showing “selected” next to the traffic table label “Mechanistic-Empirical Pavement Design Guide Traffic Hourly Distribution (TRF_MEPDG_HOURLY_DIST).”(3)

1. Open the Excel file with the extracted data and review values in the field PCT_HOURLY. Sort hours in ascending order from 0 to 24.

2. Select a year with PCT_HOURLY values representing typical hourly distribution, as shown in table 43. Alternatively, compute the average PCT_HOURLY values across all the available or selected years (in the latter case, renormalize the computed average values so that the sum of percentile values from PCT_HOURLY over 24 h is equal to 100 percent).

Table 43. HDF for 2016 for LTPP site 24-0501.

STATE_CODE	SHRP_ID	YEAR	HOUR	PCT_HOURLY
24	0501	2016	0	0.77
24	0501	2016	1	0.71
24	0501	2016	2	0.65
24	0501	2016	3	0.74
24	0501	2016	4	1.14
24	0501	2016	5	2.36
24	0501	2016	6	3.87
24	0501	2016	7	5.21
24	0501	2016	8	6.16
24	0501	2016	9	6.53
24	0501	2016	10	6.4
24	0501	2016	11	6.44
24	0501	2016	12	6.56
24	0501	2016	13	7.26
24	0501	2016	14	8.62
24	0501	2016	15	8.68
24	0501	2016	16	7.36
24	0501	2016	17	6.12
24	0501	2016	18	4.99
24	0501	2016	19	3.36
24	0501	2016	20	2.06
24	0501	2016	21	1.53
24	0501	2016	22	1.33
24	0501	2016	23	1.15

Enter selected or computed PCT_HOURLY values onto the Hourly Adjustment input screen of the AASHTOWare Pavement ME Design software, as shown in figure 37.(5)

Hourly Adjustment	
Time of Day	Percentage
12:00 am	0.77
1:00 am	0.71
2:00 am	0.65
3:00 am	0.74
4:00 am	1.14
5:00 am	2.36
6:00 am	3.87
7:00 am	5.21
8:00 am	6.16
9:00 am	6.53
10:00 am	6.4
11:00 am	6.44
12:00 pm	6.56
1:00 pm	7.26
2:00 pm	8.62
3:00 pm	8.68
4:00 pm	7.36
5:00 pm	6.12
6:00 pm	4.99
7:00 pm	3.36
8:00 pm	2.06
9:00 pm	1.53
10:00 pm	1.33
11:00 pm	1.15
Total	100.0

Figure 37. Screenshot. AASHTOWare Pavement ME Design software Hourly Adjustment input screen with values entered for LTPP site 24-0501.[5]

PARAMETER 5.9: MEPDG AXLE LOAD DISTRIBUTION FACTORS

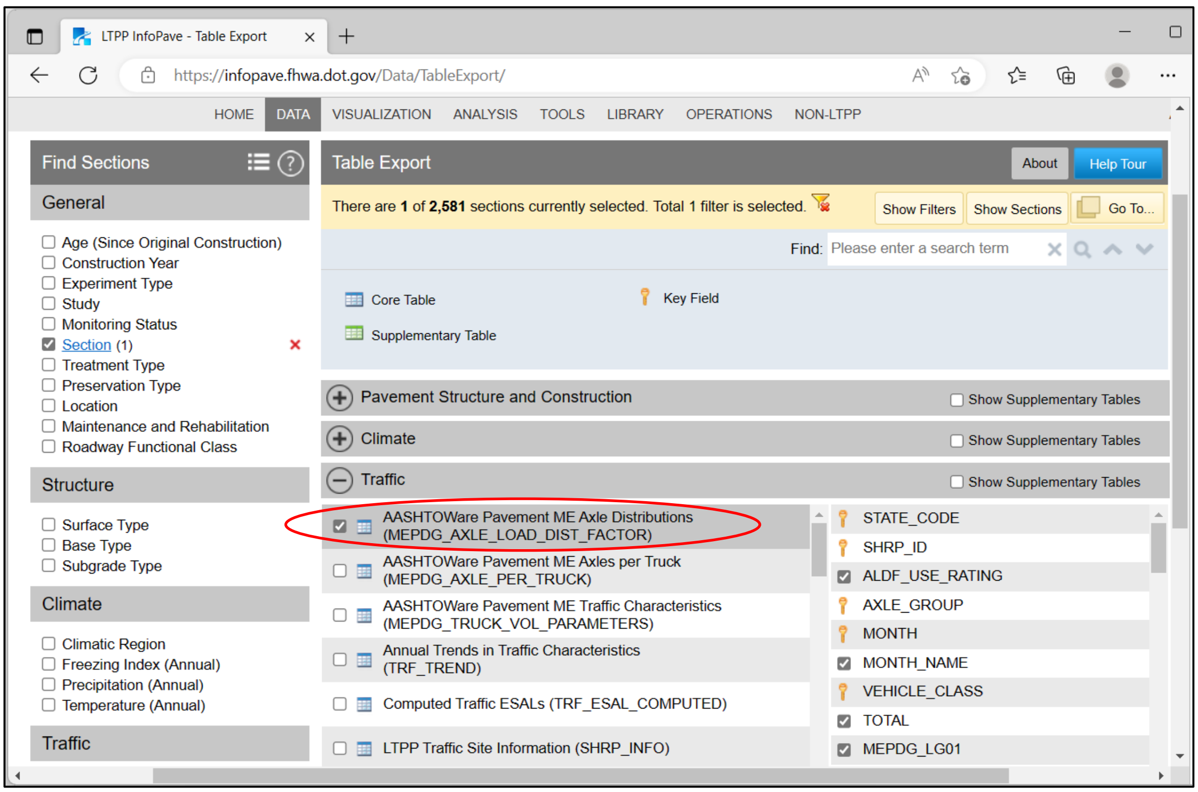
The AASHTOWare Pavement ME Design software[5] uses ALDF to compute traffic loads. One set of normalized ALDF is available in the LTPP data table MEPDG_AXLE_LOAD_DIST_FACTOR for each LTPP site, vehicle class (classes 4–13),[11] axle group type (single, tandem, tridem, quad), and calendar month (January through December). Depending on data availability and data quality, these ALDF represent axle load for a typical day of the year (same values are reported for each calendar month) or a typical day of each of the 12 calendar months (unique values are reported for each calendar month) observed during pavement service life. Each LTPP site in the MEPDG_AXLE_LOAD_DIST_FACTOR table has an index that provides ALDF usability rating based on the quality and quantity of the data used for ALDF development.

Because of the large size of this input parameter, in addition to the direct input on the ALDF screen, the AASHTOWare Pavement ME Design software accepts ALDF inputs in specially formatted XML files. These files could be downloaded from InfoPave or requested from LTPP Customer Service.

Example 5.9.1: Enter ALDF Values in AASHTOWare Software From MEPDG_AXLE_LOAD_DIST_FACTOR Table

To enter the ALDF values from the LTPP MEPDG_AXLE_LOAD_DIST_FACTOR table, use the following procedure:

1. Use InfoPave table extraction steps provided in chapter 6 to extract the MEPDG_AXLE_LOAD_DIST_FACTOR table from the InfoPave Table Export menu, shown in figure 38, for Arizona site 7613.



Source: FHWA.

Figure 38. Screenshot. InfoPave Table Export menu with a checkbox showing "selected" next to the traffic table label "AASHTOWare Pavement ME Axle Distributions (MEPDG_AXLE_LOAD_DIST_FACTOR)."(3)

2. Download the MEPDG_AXLE_LOAD_DIST_FACTOR table for LTPP site 04-7613 to an Excel file.
3. Make sure that the exported data are sorted in ascending order by axle group, then by the calendar month (January to December), then by vehicle class. A portion of the extracted ALDF file for site 04-7613 single-axle group is shown in table 44.

Table 44. ALDF sample for LTPP site 04-6713.

STATE_CODE	SHRP_ID	AXLE_GROUP	Month	VEH_CLASS	TOTAL	MEPDG_LG01	MEPDG_LG02	MEPDG_LG03	MEPDG_LG04	MEPDG_LG05	MEPDG_LG06	…*	MEPDG_LG39
4	7613	1	January	4	100	0	0	0.17	2.33	10.69	13.86	…	7.64
4	7613	1	January	5	100	3.91	1.39	19.03	14.46	11.61	9.78	…	2.41
4	7613	1	January	6	100	0	0	1.75	2.71	5.56	10.6	…	4.39
4	7613	1	January	7	100	0	0	0	1.96	4.69	9.62	…	3.83
4	7613	1	January	8	100	3.73	1.82	10.84	8.58	10.81	12.87	…	2.98
4	7613	1	January	9	100	1.68	2.82	4.76	3.54	5.38	13.92	…	1.35
4	7613	1	January	10	100	0.14	0.28	0.75	0.87	2.53	9.22	…	0.8
4	7613	1	January	11	100	1.73	10.24	12.18	11.61	16.67	13.74	…	1.3
4	7613	1	January	12	100	1.35	5.81	6.43	13.37	18.51	11.04	…	1.25
4	7613	1	January	13	100	1.15	0.43	1.77	2.09	4.84	20.49	…	1.17
4	7613	1	February	4	100	0	0	0.17	2.33	10.69	13.86	…	7.64
4	7613	1	February	5	100	3.91	1.39	19.03	14.46	11.61	9.78	…	2.41
4	7613	1	February	6	100	0	0	1.75	2.71	5.56	10.6	…	4.39
4	7613	1	February	7	100	0	0	0	1.96	4.69	9.62	…	3.83
4	7613	1	February	8	100	3.73	1.82	10.84	8.58	10.81	12.87	…	2.98
4	7613	1	February	9	100	1.68	2.82	4.76	3.54	5.38	13.92	…	1.35
4	7613	1	February	10	100	0.14	0.28	0.75	0.87	2.53	9.22	…	0.8
4	7613	1	February	11	100	1.73	10.24	12.18	11.61	16.67	13.74	…	1.3
4	7613	1	February	12	100	1.35	5.81	6.43	13.37	18.51	11.04	…	1.25
4	7613	1	February	13	100	1.15	0.43	1.77	2.09	4.84	20.49	…	1.17
4	7613	1	March	4	100	0	0	0.17	2.33	10.69	13.86	…	7.64
4	7613	1	March	5	100	3.91	1.39	19.03	14.46	11.61	9.78	…	2.41
4	7613	1	March	6	100	0	0	1.75	2.71	5.56	10.6	…	4.39
4	7613	1	March	7	100	0	0	0	1.96	4.69	9.62	…	3.83
4	7613	1	March	8	100	3.73	1.82	10.84	8.58	10.81	12.87	…	2.98
4	7613	1	March	9	100	1.68	2.82	4.76	3.54	5.38	13.92	…	1.35
4	7613	1	March	10	100	0.14	0.28	0.75	0.87	2.53	9.22	…	0.8
4	7613	1	March	11	100	1.73	10.24	12.18	11.61	16.67	13.74	…	1.3
4	7613	1	March	12	100	1.35	5.81	6.43	13.37	18.51	11.04	…	1.25
4	7613	1	March	13	100	1.15	0.43	1.77	2.09	4.84	20.49	…	1.17

*Load bins MEPDG_LG07 to MEPDG_LG38 are not shown in the table.

4. Open or create a new project in AASHTOWare Pavement ME Design.

5. On the AASHTOWare project main menu, locate the green circle and “Traffic” label in the upper left corner under the “Projects” folder. Left-click on the “+” sign to the left of the “Traffic” label, and four options for “Single,” “Tandem,” “Tridem,” and “Quad Axle” distribution inputs will appear, as shown in figure 39.

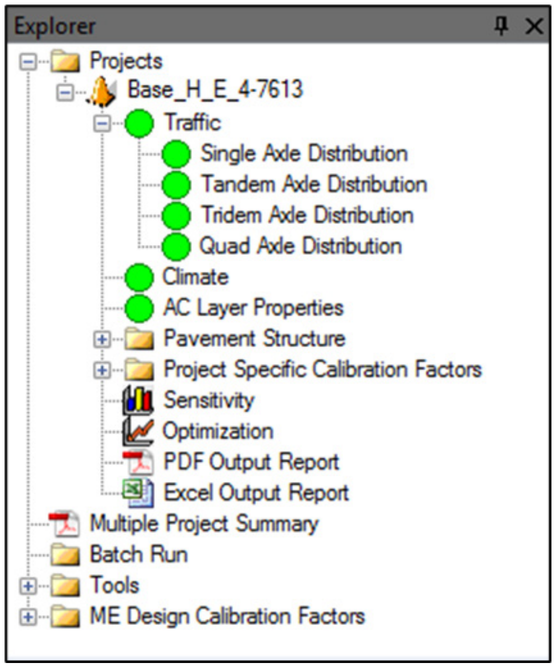


Figure 39. Screenshot. AASHTOWare Pavement ME Design software Explorer menu with traffic options expanded.[5]

6. Double click on each of the axle load distribution types (“Single,” “Tandem,” “Tridem,” and “Quad”) shown in figure 39. A window will appear to enter axle load distribution inputs shown in figure 40. The tabs on the top of the window show different axle groups. (The words “Single,” “Tandem,” “Tridem,” and “Quad” are shown at the end of each tab label.)

Base_H_E_4-7613:Project | **Base_H_E_4-7613:Single** | Base_H_E_4-7613:Tandem | Base_H_E_4-7613:Tridem | Base_H_E_4-7613:Quad

Month	Class	Total	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000
January	4	100	0	0	0.17	2.33	10.69	13.86	10.67	10.01	5.87	5	6.85	7.64
January	5	100	3.91	1.39	19.03	14.46	11.61	9.78	8.44	7.01	5.4	3.96	3.05	2.41
January	6	100	0	0	1.75	2.71	5.56	10.6	16.84	19.78	14.82	10.07	6.31	4.39
January	7	100	0	0	0	1.96	4.69	9.62	12.86	14.45	16.06	13.04	4.88	3.83
January	8	100	3.73	1.82	10.84	8.58	10.81	12.87	11.88	9.32	6.53	5.3	3.75	2.98
January	9	100	1.68	2.82	4.76	3.54	5.38	13.92	20.89	20.59	13.11	5.25	2.02	1.35
January	10	100	0.14	0.28	0.75	0.87	2.53	9.22	24.57	24.71	20.58	10.89	2.11	0.8
January	11	100	1.73	10.24	12.18	11.61	16.67	13.74	10.3	5.88	2.62	1.54	1.81	1.3
January	12	100	1.35	5.81	6.43	13.37	18.51	11.04	12.86	13.08	7.6	4.3	2.5	1.25
January	13	100	1.15	0.43	1.77	2.09	4.84	20.49	30.56	18.56	7.28	2.16	1.76	1.17
February	4	100.000...	0	0	0.17	2.33	10.69	13.86	10.67	10.01	5.87	5	6.85	7.64
February	5	100.000...	3.91	1.39	19.03	14.46	11.61	9.78	8.44	7.01	5.4	3.96	3.05	2.41
February	6	99.9999...	0	0	1.75	2.71	5.56	10.6	16.84	19.78	14.82	10.07	6.31	4.39
February	7	100	0	0	0	1.96	4.69	9.62	12.86	14.45	16.06	13.04	4.88	3.83
February	8	99.9999...	3.73	1.82	10.84	8.58	10.81	12.87	11.88	9.32	6.53	5.3	3.75	2.98
February	9	99.9999...	1.68	2.82	4.76	3.54	5.38	13.92	20.89	20.59	13.11	5.25	2.02	1.35
February	10	99.9999...	0.14	0.28	0.75	0.87	2.53	9.22	24.57	24.71	20.58	10.89	2.11	0.8
February	11	100.000...	1.73	10.24	12.18	11.61	16.67	13.74	10.3	5.88	2.62	1.54	1.81	1.3
February	12	99.9999...	1.35	5.81	6.43	13.37	18.51	11.04	12.86	13.08	7.6	4.3	2.5	1.25
February	13	100	1.15	0.43	1.77	2.09	4.84	20.49	30.56	18.56	7.28	2.16	1.76	1.17
March	4	99.9999...	0	0	0.17	2.33	10.69	13.86	10.67	10.01	5.87	5	6.85	7.64
March	5	99.9999...	3.91	1.39	19.03	14.46	11.61	9.78	8.44	7.01	5.4	3.96	3.05	2.41
March	6	100.000...	0	0	1.75	2.71	5.56	10.6	16.84	19.78	14.82	10.07	6.31	4.39
March	7	100	0	0	0	1.96	4.69	9.62	12.86	14.45	16.06	13.04	4.88	3.83
March	8	100.000...	3.73	1.82	10.84	8.58	10.81	12.87	11.88	9.32	6.53	5.3	3.75	2.98
March	9	100.000...	1.68	2.82	4.76	3.54	5.38	13.92	20.89	20.59	13.11	5.25	2.02	1.35
March	10	99.9999...	0.14	0.28	0.75	0.87	2.53	9.22	24.57	24.71	20.58	10.89	2.11	0.8

Figure 40. Screenshot. AASHTOWare Pavement ME Design software screen showing the ALDF inputs.(5)

7. For each axle group (one at a time), go back to the Excel file containing the MEPDG_AXLE_LOAD_DIST_FACTOR table (see example in table 44) and select values from 120 rows (for months January to December) and 39 columns (starting from column MEPDG_LG01 to column MEPDG_LG39) for a given axle type (AXLE_GROUP = 1 or Single is shown in table 44). Copy the selected information by right-clicking on the selected area and selecting "Copy" from the pop-up window (or use Ctrl + C keys).

8. To paste the copied cells into the AASHTOWare input table shown in figure 40, right-click on the top cell under the first load bin (load bin 3,000 is highlighted in blue in figure 40 for "Single" axle) and select the "Paste" option in the pop-up menu (or use Ctrl + V keys).

9. Repeat steps 6 and 7 to paste ALDF for the other three axle types (tandem, tridem, and quad).

10. Save results in the AASHTOWare Pavement ME Design project file.

Example 5.9.2: Importing ALDF XML File to AASHTOWare Pavement ME Design Project

Use the following procedure to import an ALDF XML file saved on a local computer to an AASHTOWare Pavement ME Design project.

1. Open or create a new project in AASHTOWare Pavement ME Design.(5)

2. On the AASHTOWare project main menu, right click on the "Traffic" label located in the upper left corner under the "Projects" folder, as shown in figure 41. Use the drop-down menus under "Traffic" to click on the "Axle Load Distributions" option and then click on Import XML…, as shown in figure 41.

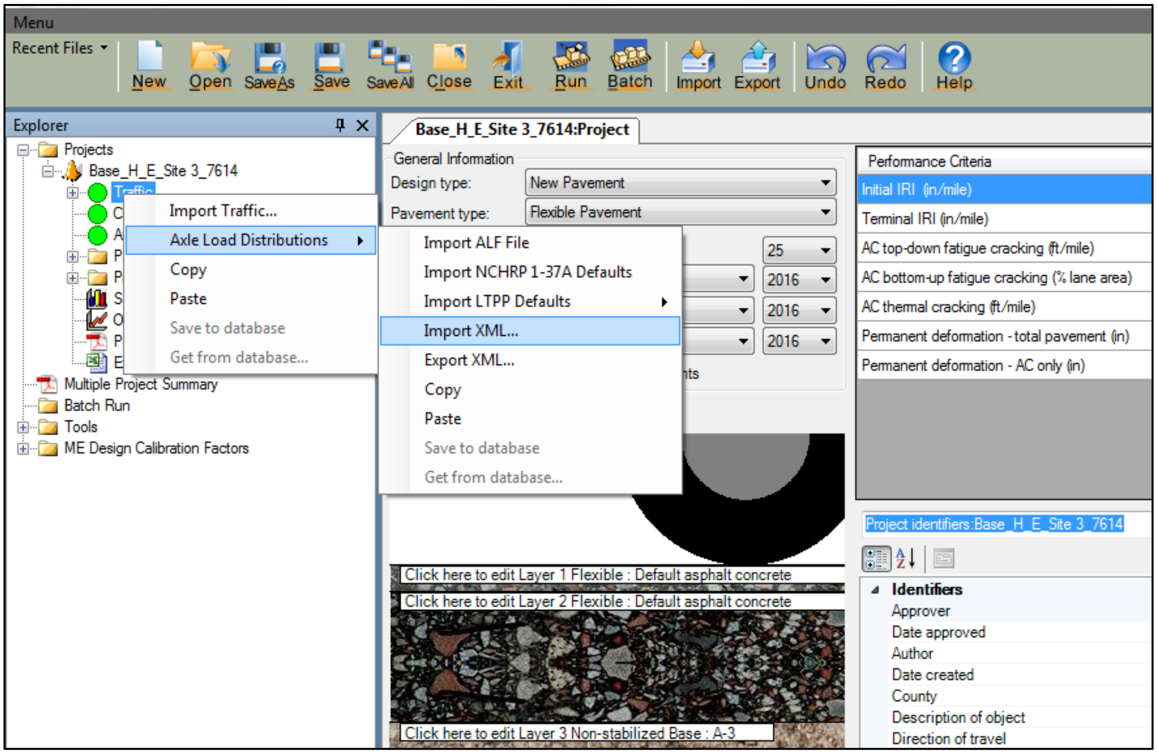


Figure 41. Screenshot. AASHTOWare Pavement ME Design software screen showing import options for Axle Load Distributions.(5)

3. A standard "Open" file dialog window will appear, as shown in figure 42. Use the "Open" file dialog box to select the ALDF XML file and click on the "Open" button.

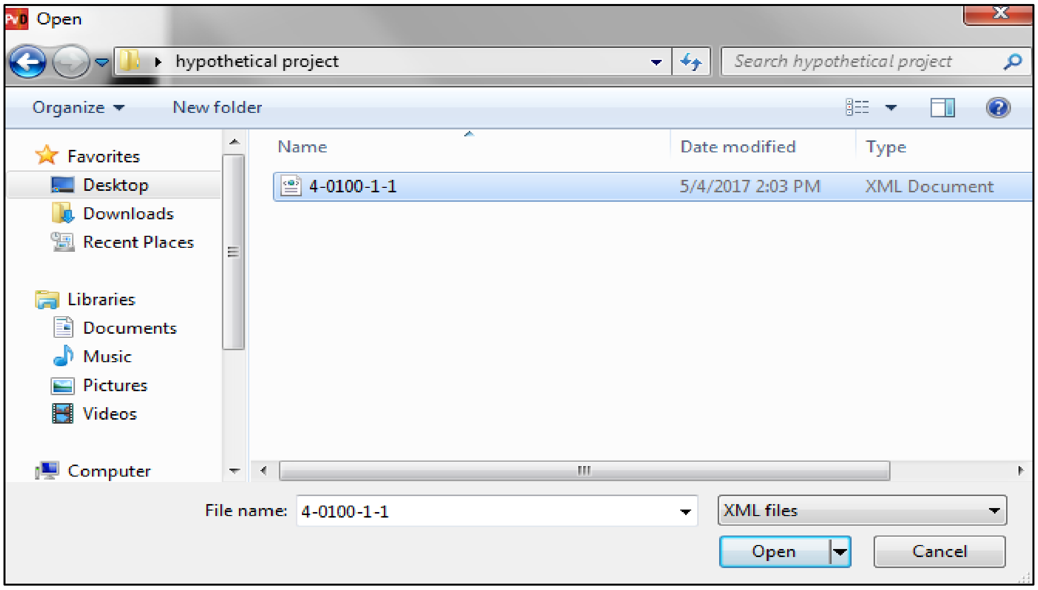


Figure 42. Screenshot. AASHTOWare Pavement ME Design software screen showing the Open XML file dialog screen.[5]

4. If the software is able to successfully load the XML file, the following message (figure 43) will appear in the Output window of the AASHTOWare Pavement ME Design software.[5]

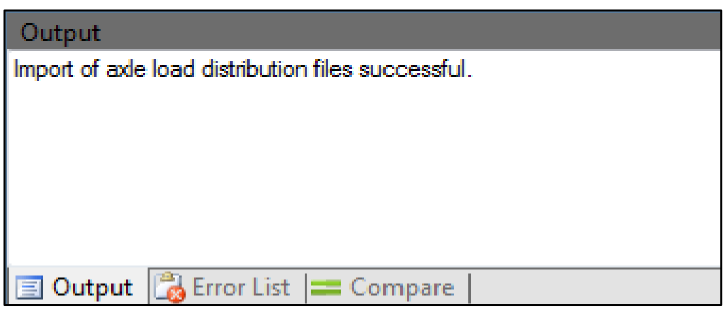


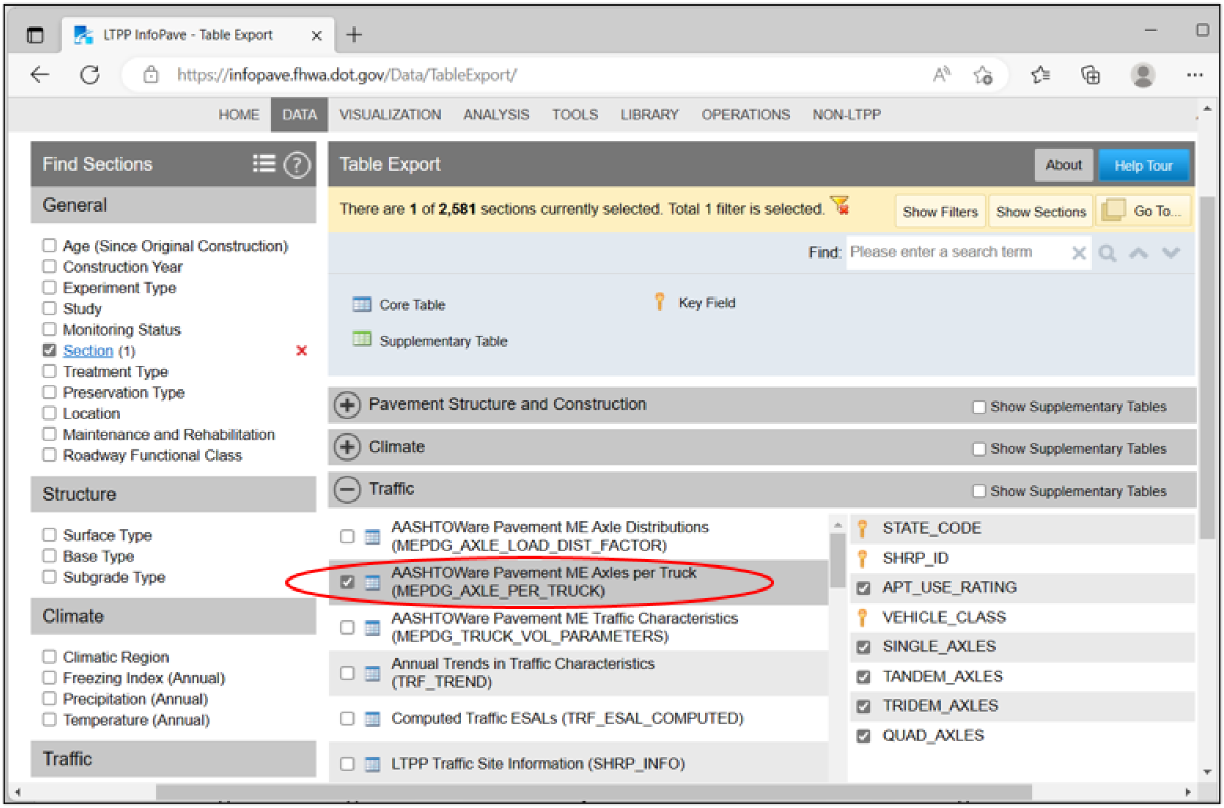
Figure 43. Screenshot. AASHTOWare Pavement ME Design software screen showing successful file import message.[5]

PARAMETER 5.10: MEPDG NUMBER OF AXLES PER TRUCK

The number of APT parameter is used as a multiplier to estimate the total number of axle loads (single, tandem, tridem, and quad) based on the total number of trucks reported for each truck class (FHWA vehicle classes 4–13).[11] In the AASHTOWare Pavement ME Design software,[5] one set of values is used to represent the average number of single, tandem, tridem, and quad axles for each truck class. These values could be copied from the MEPDG_AXLE_PER_TRUCK table and pasted in the AASHTOware Pavement ME Design software input screen.

To obtain the APT for an LTPP site, use the following procedure:

1. Use the InfoPave table extraction steps provided in chapter 6 to select the MEPDG_AXLE_PER_TRUCK table from the InfoPave Table Export menu, as shown in figure 44.



Source: FHWA.

Figure 44. Screenshot. InfoPave Table Export menu with a checkbox showing “selected” next to the traffic table label “AASHTOWare Pavement ME Axles per Truck (MEPDG_AXLE_PER_TRUCK).”(3)

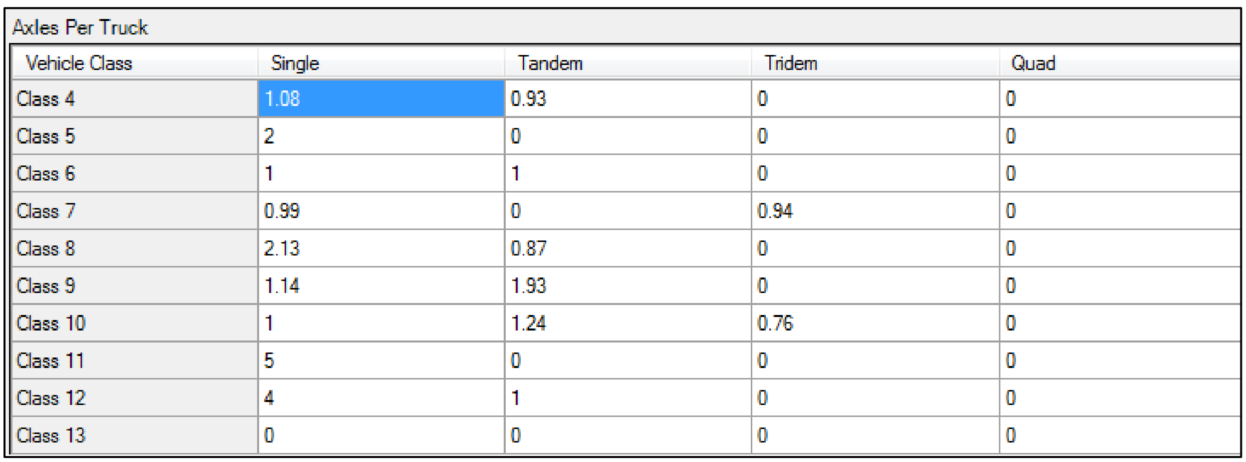
2. Filter the APT dataset for the selected LTPP site. (Site 01-4073 was selected for this example.)

3. Download the MEPDG_AXLE_PER_TRUCK table for LTPP site 01-4073 to an Excel file.

4. Copy the 40 APT values from the spreadsheet, as shown in table 45 in the columns “SINGLE,” “TANDEM,” “TRIDEM,” and “QUAD,” and paste them into the AASHTOWare Pavement ME Design software traffic input screen, as shown in figure 45.

Table 45. APT values from MEPDG_AXLE_PER_TRUCK table for LTPP site 01-4073.

STATE_CODE	SHRP_ID	VEHICLE_CLASS	SINGLE	TANDEM	TRIDEM	QUAD
1	4073	4	1.08	0.93	0	0
1	4073	5	2	0	0	0
1	4073	6	1	1	0	0
1	4073	7	0.99	0	0.94	0
1	4073	8	2.13	0.87	0	0
1	4073	9	1.14	1.93	0	0
1	4073	10	1	1.24	0.76	0
1	4073	11	5	0	0	0
1	4073	12	4	1	0	0
1	4073	13	0	0	0	0


Axles Per Truck

Vehicle Class	Single	Tandem	Tridem	Quad
Class 4	1.08	0.93	0	0
Class 5	2	0	0	0
Class 6	1	1	0	0
Class 7	0.99	0	0.94	0
Class 8	2.13	0.87	0	0
Class 9	1.14	1.93	0	0
Class 10	1	1.24	0.76	0
Class 11	5	0	0	0
Class 12	4	1	0	0
Class 13	0	0	0	0

Figure 45. Screenshot. AASHTOWare Pavement ME Design software showing table with APT values.[5]

PARAMETER 5.11: MEPDG AXLE SPACING FOR TANDEM, TRIDEM, AND QUAD AXLES

For the average axle spacing values for tandem, tridem, and quad axles, use the default values from the LTPP PLUG[9] report developed using data from the LTPP TPF-5(004) SPS WIM sites[14] or the defaults from the National Cooperative Highway Research Program (NCHRP) 1-37A project[7] (under which the MEPDG was developed) presented in table 46.

Table 46. Average axle spacing in inches for multi-axle groups.

Default Source	Tandem (inches)	Tridem (inches)	Quads (inches)
NCHRP 1-37A[5,7]	51.6	49.2	49.2
LTPP SPS TPF-5(004)[10]	49.0	50.8	51.8

This information is entered under the Axle Configuration section of the AASHTOWare traffic input screen, as shown in figure 46.

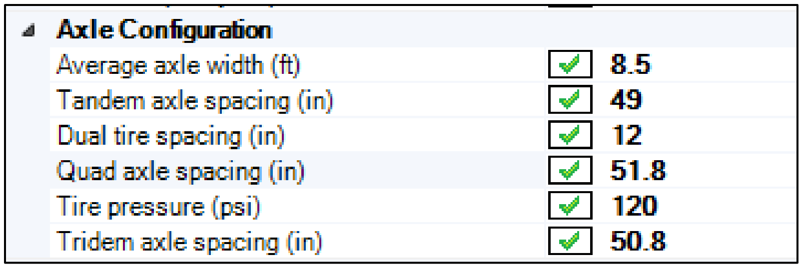


Figure 46. Screenshot. AASHTOWare Pavement ME Design software showing Axle Configuration input screen.[(5)]

PARAMETER 5.12: MEPDG AVERAGE AXLE WIDTH

Average axle width is the distance in feet between the two outside edges of an axle. One value, constant between all truck classes, is used by the AASHTOWare Pavement ME Design software, but only for rigid pavement designs.[(5)] For this parameter, use the default values provided in the AASHTOWare Pavement ME Design software, as shown in figure 46.

PARAMETER 5.13: MEPDG DUAL TIRE SPACING

The AASHTOWare Pavement ME Design software[(5)] requires one input value for this parameter. This parameter is treated as constant between all truck classes and does not change over time. For this parameter, use the default values provided in the AASHTOWare Pavement ME Design software, as shown in figure 46.

PARAMETER 5.14: MEPDG TIRE PRESSURE

The AASHTOWare Pavement ME Design software[(5)] requires one value representing the average hot tire inflation pressure. This parameter is treated as constant between all truck classes and does not change over time. For this parameter, use the default values provided in the AASHTOWare Pavement ME Design software, as shown in figure 46.

PARAMETER 5.15: MEPDG MEAN WHEEL LOCATION

The AASHTOWare Pavement ME Design software[(5)] requires the distance in inches from the outer edge of the outer wheel path to the pavement marking. This parameter is treated as constant between all truck classes and does not change over time. For this parameter, use the default values provided in the AASHTOWare Pavement ME Design software. This information is entered under the “Lateral Wander” section of the AASHTOWare traffic input screen, as shown in figure 47.

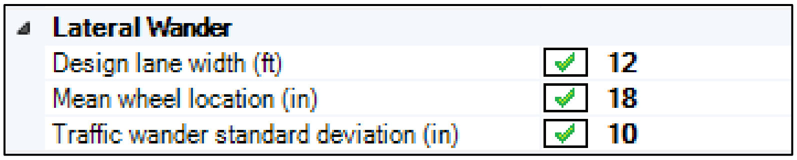


Figure 47. Screenshot. AASHTOWare Pavement ME Design software showing Lateral Wander input screen.(5)

PARAMETER 5.16: MEPDG TRUCK WANDER STANDARD DEVIATION

The AASHTOWare Pavement ME Design software(5) uses a statistic that represents the standard deviation of the Mean Wheel Location statistic to represent the fact that different vehicles use different wheel paths as they travel down the road. This statistic is computed in inches and is based on measurements from the lane marking. For this parameter, use the default values provided in the AASHTOWare Pavement ME Design software, as shown in figure 47.

PARAMETER 5.17: MEPDG OPERATIONAL SPEED

This value is defined as the expected or observed speed of traffic traveling in the design lane. This input impacts design or analysis of pavements with an AC top layer. This parameter is available for LTPP SPS TPF-5(004) sites on LTPP Traffic Sheet 21. For other sites, use the posted speed limit, which is available from public domain sources. Operational speed information is entered under the AADTT section of the traffic input screen of the AASHTOWare Pavement ME Design software,(5) as shown in figure 48.

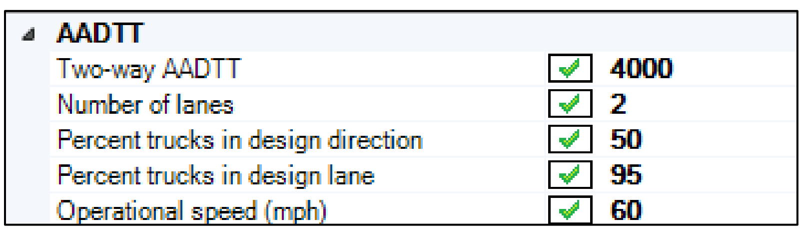


Figure 48. Screenshot. AASHTOWare Pavement ME Design software showing AADTT input screen.(5)

PARAMETER 5.18: MEPDG AVERAGE SPACING OF SHORT, MEDIUM, AND LONG WHEELBASE AXLES AND CORRESPONDING PERCENTAGE OF TRUCKS

This input is required for jointed plain concrete pavement (JPCP) only. The AASHTOWare Pavement ME Design software(5) requires the input of the average longitudinal spacing, in feet, of truck wheelbases with short (≤12 ft), medium (>12 ft and ≤15 ft), and long (>15 ft and ≤20 ft) axle spacings and the corresponding percentages of trucks with these wheelbases. This primarily applies to power units of tractor semitrailer trucks in FHWA vehicle classes 8–13(11) plus any other axles that fall in the same axle spacing categories, excluding the spacing within tandem, tridem, and quad+ axles.

Table 47 and table 48 contain data extracted from the LTPP PLUG[9] report and can be used to compute the percentage of short, medium, and long axle spacings for the desired joint spacing. Table 47 shows the distribution of axle spacings on tractor units for FHWA vehicle classes 8–13. In addition, the axle spacing distribution for units *other* than tractor wheelbases for FHWA vehicle classes 4–13, based on the SPS TPF-5(004) data, are shown in table 48. These distributions provide information about vehicle classes that are likely to have axle spacings that could contribute to the development of top-down cracking in JPCP.

Table 47. Distribution of axle spacing on power units (tractor) for FHWA vehicle classes 8–13.

Axle Spacing (feet)	Percentage of Axle Spacings on the Tractor Unit
≤7	0.0
>7 and ≤8	0.0
>8 and ≤9	0.0
>9 and ≤10	0.1
>10 and ≤11	0.7
>11 and ≤12	3.5
>12 and ≤13	7.8
>13 and ≤14	5.4
>14 and ≤15	3.0
>15 and ≤16	8.1
>16 and ≤17	12.9
>17 and ≤18	32.9
>18 and ≤19	9.8
>19 and ≤20	7.3
>20 and ≤21	6.9
>21 and ≤22	0.9
>22 and ≤23	0.3
>23 and ≤24	0.2
>24	0.2

Table 48. Distribution of axle spacing by vehicle class using sample of SPS TPF-5(004) WIM data (excluding power-unit wheelbase spacing for FHWA vehicle classes 8–13).

Axle Spacing (feet)	Percentage of Axle Spacing by Class									
	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
≤8	37	13	49	66	25	47	62	0	20	50
>8 and ≤9	0	1	0	0	3	0	0	2	6	4
>9 and ≤10	0	1	0	1	1	0	1	17	11	5
>10 and ≤11	0	2	0	3	1	3	1	3	3	3
>11 and ≤12	0	12	1	11	2	1	1	2	5	3
>12 and ≤13	0	7	2	9	8	1	2	12	2	3
>13 and ≤14	0	21	3	3	8	1	2	7	0	2
>14 and ≤15	0	12	3	2	4	1	1	2	0	2
>15 and ≤16	0	4	6	1	2	2	2	2	2	3
>16 and ≤17	0	3	6	0	2	4	2	2	3	3
>17 and ≤18	0	4	9	0	4	9	3	4	6	3
>18 and ≤19	0	3	6	1	4	3	4	2	2	5
>19 and ≤20	0	3	5	0	4	2	2	1	5	4
>20 and ≤21	0	4	6	0	6	2	1	6	13	2
>21 and ≤22	0	5	2	0	5	0	1	24	8	2
>22 and ≤23	1	3	1	0	3	0	0	15	12	1
>23 and ≤24	20	1	0	0	1	0	0	1	1	1
>24	42	2	0	0	16	25	15	0	0	5

Average spacing of axles is entered under the "Wheelbase" section of the traffic input screen of the AASHTOWare Pavement ME Design software,[5] as shown in figure 49.

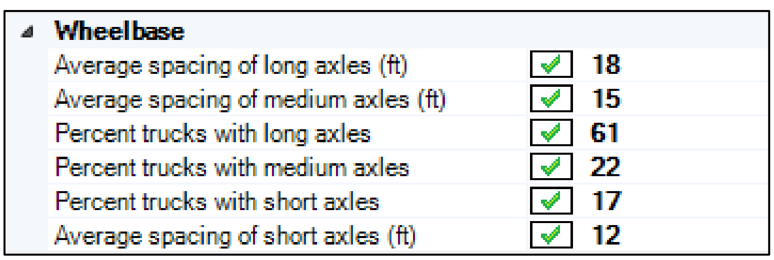


Figure 49. Screenshot. AASHTOWare Pavement ME Design software Wheelbase input screen.[5]

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Recommended citation: Federal Highway Administration,
Guide to Select Long-Term Pavement Performance Traffic Data for Multiple Uses
(Washington, DC: 2024) https://doi.org/10.21949/1521493

HRDI-30/03-24(WEB)E