HCAS Supplementary Documents

2017–2019 Biennium

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Appendix A: Glossary

GLOSSARY OF HIGHWAY COST ALLOCATION TERMS

LIST OF ACRONYMS

AAA	American Automobile Association
AMT	Axle Miles of Travel
ATR	Automatic Traffic Recorder
DAS	Department of Administrative Services
DL	Dead Load
DMV	Division of Motor Vehicles
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
HCAS	Highway Cost Allocation Study
HPMS	Highway Performance Monitoring System
LL	Live Load
MCTD	Motor Carrier Transportation Division
NAPCOM	National Pavement Cost Model
NAPHCAS	National Pavement Model for Highway Cost Allocation
ODOT	Oregon Department of Transportation
OHCAS	Oregon Highway Cost Allocation Study
OTIA	Oregon Transportation Investment Act
PCE	Passenger Car Equivalent
SRT	Study Review Team
VMT	Vehicle Miles of Travel
WIM	Weigh-In-Motion

DEFINITIONS

Alternative Fee: A fee charged to some vehicles in place of the usual fee (e.g., a lower registration fee for publicly owned vehicles).

AMT: See Axle Miles of Travel

Arterial: A road or highway used primarily for through traffic.

ATR: See Automatic Traffic Recorder

Automatic Traffic Recorder: A device that records the number of vehicles passing a point on a road. May be permanent or temporary, may record individual lanes separately, may identify vehicle configurations, and may also record vehicle speeds.

Attributable Costs: Costs that are a function of vehicle size, weight, or other operating characteristics and can therefore be attributed to vehicle classes based on those characteristics.

Axle Miles of Travel (AMT): Vehicle miles of travel multiplied by number of axles. Because trucks, on average, have roughly twice as many axles as cars (i.e., four versus two), their share of the total axle miles of travel on any given highway system will be about double their share of the vehicle miles of travel on that system.

Axle Weight or Axle Load: The gross load carried by an axle. In Oregon, 20,000 pounds is the legal maximum for a single axle and 34,000 pounds is the legal maximum for a tandem (double) axle.

Benefits: Things that make people better off, or the value of such things.

Collector: A road that connects local roads with arterial roads.

Common Costs: Expenditures that are independent of vehicle size, weight, or other operating characteristics and so cannot be attributed to any specific class of vehicles.

These expenditures must therefore be treated as a common responsibility of all vehicle classes and are most typically assigned to all classes on the basis of a relative measure of use, such as vehicle miles of travel.

Cost Allocation: The analytical process of determining the cost responsibility of highway system users.

Cost-Occasioned Approach: An approach that determines responsibility for highway expenditures/costs based on the costs occasioned or caused by each vehicle class. Such an approach is not based solely on relative use, nor does it attempt to quantify the benefits received by different classes of road users.

Cost Responsibility: The principle that those who use the public roads should pay for them and, more specifically, that payments from road users should be in proportion to the road costs for which they are responsible. The proportionate share of highway costs legitimately assignable to a given vehicle type user group.

Cost-Based Approach: An approach in which the dollars allocated to the vehicle classes are measures of the costs imposed during the study period, rather than expenditures made during

the study period. The difference between the cost-based and expenditure-based approaches is most evident when considering large investments in long-lived structures and when deferred maintenance moves the expenditures associated with one period's use into another period.

Cross-Subsidization: A condition where some vehicles are overpaying and others are underpaying relative to their respective responsibilities.

Dead Load: The load on a bridge when it is empty.

Debt Financing: Funding current activities by issuing debt to be repaid in the future.

Debt Service: Funds used for the repayment of previously incurred debt (both principal and interest).

Deck: The roadway or surface of a bridge.

Declared Weight: In Oregon, vehicles choose a declared weight and pay the weight-mile tax based on that weight. They may not exceed that weight while operating without obtaining a special trip permit. For tractor-trailer combinations, a single tractor may have multiple declared weights, one for each configuration it expects to be a part of.

Depreciation: The amount of decrease in value of a physical asset due to aging in a time period.

Efficiency: The degree to which potential benefits are realized for a given expenditure.

Efficient Pricing: Setting prices for the use of highway facilities so that each vehicle pays the costs it imposes at the time and place it is traveling. Efficient pricing promotes the most efficient use of existing facilities and generates the right amount of revenue to build the most efficient system and perform the optimal amount of maintenance.

Equity: Generally interpreted as the state of being just, impartial, or fair. Horizontal equity refers to the fair treatment of individuals with similar circumstances. Vertical equity refers to the fair treatment of individuals in different circumstances.

Equity Ratio: The ratio of the share of revenues paid by a highway user group to the share of costs imposed by that group.

Equivalent Single Axle Load (ESAL): The pavement stress imposed by a single axle with an 18,000-pound axle load. ESAL-miles are equivalent single-axle loads times miles traveled. Research has concluded that the relationship between axle weight and ESALs is an approximate third- or fourth-power exponential relationship; ESALs therefore rise rapidly with increases in axle weight.

ESAL: See Equivalent Single Axle Load

Excise Tax: A tax levied on the production or sale of a specific item such as gasoline, diesel fuel, or vehicles.

Expenditure: The amount of money spent in a time period.

External Cost: A cost imposed on individuals who do not use the facility.

Federal Highway Funds: Funds collected from federal highway user fees and distributed to states by the Federal Highway Administration for spending on transportation projects by state and local governments.

FHWA: Federal Highway Administration, an agency within the US Department of Transportation that supports State and local governments in the design, construction, and maintenance of the Nation's highway system.

Functional Classification: The classification of roads according to their general use, character, or relative importance. Definitions are provided by the Federal Highway Administration for Rural Interstate, Rural Other Principal Arterial, Rural Minor Arterial, Rural Major Collector, Rural Minor Collector, Rural Local, Urban Interstate, Urban Other Expressway, Urban Other Principal Arterial, Urban Minor Arterial, Urban Collector, and Urban Local.

Fungibility: The relative ability to use funds from different sources for the same purposes. Funds from some sources carry restrictions on how they may be spent; to the extent that those funds free up unrestricted funds that would otherwise be spent that way, they may be considered fungible with the unrestricted funds.

Gross Vehicle Weight: The maximum loaded weight for a vehicle.

HCAS: See Highway Cost Allocation Study

Heavy Vehicles: All vehicles weighing more than the upper limit in the definition of a light (basic) vehicle (see light vehicle). Includes trucks, buses, and other vehicles weighing 10,001 pounds or more.

Highway Cost Allocation Study (HCAS): A study that estimates and compares the costs imposed and the revenues paid by different classes of vehicles over some time period.

Highway Performance Monitoring System (HPMS): The Federal Highway Administration collects and reports data about a sample of road segments in every state in a common format.

Highway User: A person responsible for the operation of a motor vehicle in use on highways, roads, and streets. In the case of passenger vehicles, the users are the people in the vehicles. In the case of goods-transporting trucks, the user is the entity transporting the goods.

HPMS: See Highway Performance Measurement System

Incremental Cost: The additional costs associated with building a facility to handle an additional, heavier (or larger) class of vehicle.

Incremental Method: A method of assigning responsibility for highway costs by comparing the costs of constructing and maintaining facilities for the lightest class of vehicles only and for each increment of larger and heavier vehicles. Under this method, vehicles share the incremental cost of a facility designed to accommodate that class as well as the cost of each lower increment.

Light (or Basic) Vehicles: The lightest vehicle class, usually including passenger cars. In Oregon, the current definition of Light Vehicles includes vehicles up to 10,000 pounds, which account for more than 90 percent of the total vehicle miles of travel on Oregon roads.

Live Load: The additional load on a structure by traffic (beyond the load imposed by holding itself up).

Load-Related Costs: Costs that vary with the load imposed by traffic on a facility.

Marginal Cost: The increase in total cost that results from producing one additional unit of output. With respect to highway use, the marginal cost is the increase in total highway costs that results from one additional vehicle trip. Economic efficiency is achieved when the price charged to the user is equal to the marginal cost.

MCTD: See Oregon Motor Carrier Transportation Division

NAPCOM: See National Pavement Cost Model

National Highway System (NHS): A set of highways throughout the United States that have been designated as National Highways by the federal government. The Federal Highway Administration sets design and maintenance standards and provides funding for national highways, but the highways are owned by the states.

National Pavement Cost Model (NAPCOM): A model of pavement costs that incorporates the wear-and-tear costs imposed by vehicle traffic of different weights and configurations as well as deterioration from age and environmental factors, taking into account the soil type, road base depth, pavement material, pavement thickness, and climate zone.

Non-Divisible Load: Large pieces of equipment or materials that cannot be feasibly divided into smaller individual shipments. All states issue special permits for non-divisible loads that would otherwise violate state and federal gross vehicle weight, axle weight, and bridge formula limits.

ODOT: Oregon Department of Transportation

Operating Weight: The actual weight of a vehicle at a particular time.

Oregon Motor Carrier Transportation Division: A division within the Oregon Department of Transportation that regulates commercial trucking within the state.

Overhead Costs: Costs that vary in proportion to the overall level of construction and maintenance activities but are not directly associated with specific projects.

Passenger Car Equivalent (PCE): A measure of road space effectively occupied by a vehicle of a given type under given terrain, vehicle mix, road type, and congestion conditions. The reference unit is the standard passenger car operating under the conditions on the road category in question.

PCE: See Passenger Car Equivalent

Registered Weight: The weight that determines the registration fee paid by a single-unit truck or a tractor. For a tractor, it is typically the highest of that vehicle's declared weights.

Revenue Attribution: The process of associating revenue amounts with the classes of vehicles that produce the revenues.

Right of Way: The strip of land, property, or interest therein, over which a highway or roadway is built.

Road Use Assessment Fee: In Oregon, vehicles carrying non-divisible loads over 98,000 pounds on special permit pay a fee based on the number of ESAL-miles for the trip (see Equivalent Single-Axle Load).

Social (or Indirect) Costs: Costs that highway users impose on other users or on non-users. Costs typically included in this category are those associated with noise, air and water pollution, traffic congestion, and injury and property damage due to traffic accidents.

Span: A section of a bridge.

SRT: Study Review Team

State Highway System: Roads under the jurisdiction of the Oregon Department of Transportation.

Studded Tire: A tire with metal studs imbedded in its tread for better traction on icy roads.

Tax Avoidance: The legal avoidance of a tax or fee.

Tax Evasion: The illegal failure to pay a tax or fee.

Truck: A general term denoting a motor vehicle designed for transportation of goods. The term includes single-unit trucks and truck combinations.

User Charge: A fee, tax, or charge that is imposed on facility users as a condition of usage.

User Revenues: Highway revenues raised through the imposition of user charges or fees.

Value Pricing: Prices set in proportion to the benefits received, rather than the cost of production.

Vehicle Class: Any grouping of vehicles having similar characteristics for cost allocation, taxation, or other purposes. The number of vehicle classes used in a cost responsibility (allocation) study will depend on the needs, purpose, and resources of the study. Since the Oregon weight-mile tax rates are graduated in 2,000-pound increments, the Oregon studies have traditionally divided heavy vehicles into 2,000-pound gross weight classes. Light (basic) vehicles are considered as one class in the Oregon studies. Potential distinguishing characteristics include weight, size, number of axles, type of fuel, time of operation, and place of operation.

Vehicle Miles of Travel (VMT): The sum over vehicles of the number of miles each vehicle travels within a time period.

Vehicle Registration Fees: Fees charged for being allowed to operate a vehicle on public roads.

VMT: See Vehicle Miles of Travel

Weigh in Motion: A device embedded in the roadway that captures the weight of each axle passing over it. May also record transponder IDs of transponder-equipped trucks, axle spacing, and speeds.

Weight-Mile Tax: In Oregon, commercial vehicles over 26,000 pounds pay a user fee based on the number of miles traveled on public roads within Oregon. The per-mile rate is based on the declared weight of the vehicle, and for vehicles weighing over 80,000 pounds, the number of axles. Vehicles paying the weight-mile tax are exempt from the use-fuel (diesel) tax.

WIM: See Weigh in Motion

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Appendix B: Other State HCASs

INTRODUCTION

This document summarizes three highway cost allocation studies (HCAS) published during 2009 to 2016: Nevada 2009, Idaho 2010, and Minnesota 2012. This review of recent HCAS is intended to investigate HCAS processes and methods used in other states, with particular attention paid to innovations, issues, or other methodologies or data that might be of use or interest for the Oregon HCAS process. The document also summarizes the findings from recent papers and reports on HCAS methods.

SUMMARY

OVERVIEW OF HCAS STUDIES

2009 Nevada Highway Cost Allocation Study

The Nevada HCAS used the FHWA State HCAS software and methodology, conducted the study using ten vehicle classes (based on the HPMS vehicle classes), and presents equity ratios for vehicle weight using 2,000 lb. increments. The study included revenues from the vehicle sales tax and ad valorem tax for passenger vehicles. As a result, total state revenues were roughly 75% higher than total state expenditures in calculating the unadjusted state equity ratios. Inclusion of revenues that are diverted to non-highway increases the revenue shares for passenger vehicles. Two other unique aspects of the study are the inclusion of deferred maintenance costs for vehicle cost responsibility and the subtraction of federal stimulus funding from deferred maintenance. The study found that heavy vehicle user fees do not increase as fast as heavy vehicle cost responsibility. Light vehicle classes have equity ratios greater than 1.0 and heavy vehicles have equity ratios less than 1.0.

2010 Idaho Highway Cost Allocation Study

The report considers the equity of Idaho's tax structure for highway users and whether different vehicle classes are paying their proportional share of highway costs. The Idaho HCAS used a refined version of the FHWA State HCAS Model. The model was used to consider how adjustments to the current tax and fee structure and the implementation of a vehicle miles travelled (VMT) fee could affect equity ratios. The study differentiates user classes by vehicle class and weight for a total of 20 user classes. For state and federal programs combined, the study finds that highway user payments fall short of expenditures by 20% ($139.5 million per year). The study also finds that when collections from state and federal programs are combined, payments from combination trucks fall short of cost responsibility by 33%, whereas payments from automobiles exceed cost responsibility by 47%. At a state level, similar results hold, with combination trucks' payments falling 27% short of cost responsibility and automobiles' payments exceeding cost responsibility by 26%.

Minnesota Highway Cost Allocation and Determination of Heavy Freight Truck Permit Fees, 2012

The report examines the pros and cons of different highway cost allocation methods to use in Minnesota and presents a methodology that is most appropriate for the conditions in Minnesota. The report first presents the results of using the State HCAS tool developed by the FHWA. The report then develops and presents the results from a HCAS that was customized for the state, Minnesota Highway Cost Allocation Tool (MHCAT). The report also presents the findings from experiments on auction-based permitting systems.

OREGON'S HCAS AND DIFFERENCES WITH OTHER STATES

Cost-Occasioned Approach and Incremental Method

Oregon, in addition to other states, uses the cost-occasioned approach for its HCAS. The basic idea behind this approach is that each class of road user should pay for the road system in proportion to the costs associated with the road use by that class.

Within the cost occasioned approach, Oregon uses the incremental method. This method divides particular aspects of highway costs into increments. It allocates the costs of successive increments to only the vehicles needing the higher cost increment.

A primary example of the incremental method is with bridge allocation costs. The first increment for a new bridge identifies the cost of building the bridge to support its own weight and other non-load related stresses. This is a common cost responsibility, and allocated across vehicle classes on basis of each user class's share of total VMT. The next increments identify the additional cost of building the bridge to accommodate progressively heavier weight classes of vehicle and the costs are allocated on the basis of relative VMT within a truncated range of vehicle weight classes.

Oregon's Weight Mile Tax

A key difference between Oregon and other states is that Oregon implements a weight mile tax in addition to a fuel tax. The Federal FHWA HCAS tool does not support a weight mile tax. Oregon has developed its own HCAS tool that supports a weight mile tax. The weight mile tax is structured in terms of 2,000 pound increments.

Oregon's use of a weight mile tax means that it is able to achieve much better equity ratios. Without a weight mile tax, a state would have to rely on high truck registration fees since the fuel tax alone does not recover the damage to roads imposed by heavy trucks. As vehicle weights increase, the damages imposed to roads increases super-linearly, but fuel consumption increases sub-linearly. This means that as vehicle weights increase, the costs they impose on the road are increasingly higher than the amount of fuel taxes they pay. The inclusion of a weight mile tax allows the State to capture the higher costs from heavier vehicle weights.

It is interesting to note that the 2012 Minnesota report examines the hypothetical effects of including a weight-mileage fee where the user pays a usage fee based on vehicle miles traveled and the tax rate per mile is determined by the registered gross weight of the vehicle. Currently, Minnesota charges only a weight fee that is determined by a commercial vehicle's RGW (e.g., a registration fee). The report finds that adjusted equity ratios under both hypothetical weight-mile fee scenarios are closer to the target ratio (one) than the weight fees for most vehicle classes. Exhibit 2 (p. 105) shows the adjusted ratios at the state level for the weight fees and the weight-mile fees.

Other Differences

- Oregon uses 2,000 pound increments in its HCAS whereas most other states use 5,000 pound increments. This allows Oregon's HCAS to have a finer grain of analysis than other states.
- Oregon, Nevada, and Idaho use the National Pavement Cost Model (NAPCOM) for pavement costs. However, Oregon has modified NAPCOM to use 2,000 pound increments instead of 5,000 pound increments. The 2012 Minnesota report uses regression coefficients from NAPCOM for Minnesota to allocate pavement repair costs.
- Oregon uses different PCE VMT (regular and congested) allocators depending on the type of cost. For example, the common cost portion of projects that add highway capacity are allocated based on congested PCE VMT. Congested PCE VMT uses the shares of PCE-weighted VMT that are present during the most congested hour of the day on that functional class. Using congested PCE VMT in cases where costs are incurred to add capacity means that a portion of those costs is allocated based on the users that are driving the need for additional capacity.
- Unlike Nevada's 2009 HCAS, Oregon's HCAS does not include deferred maintenance. Oregon has looked at deferred maintenance when determining an efficient fee. However, Oregon does not include deferred maintenance in its HCAS because it has very well-defined costs that are within the upcoming biennium.
- Oregon includes a studded tire adjustment that takes into account the additional damage that they cause to the roads.
- Oregon uses truncated VMT allocators for different types of costs to allocate those costs to a subset of all vehicles. For example, the collection costs of the motor carrier Transportation Division are allocated on the basis of VMT for vehicles over 26,000 pounds.
- Oregon's adjusted equity ratios reflect adjustments for subsidized vehicles. In contrast, Nevada's adjusted equity ratios do not consider subsidized vehicles and instead are calculated based on share of revenue and cost responsibility share, rather than gross dollar amounts.
- Exhibit 4 (pp. 109-110) provides a high-level overview of different states' HCASs. The table provides information on the states' HCAS methods, key allocators, types of revenue examined, and cost responsibility for heavy vehicles.

OVERVIEW OF HCAS METHODS

Models for Highway Cost Allocation, 2013

The report reviews the traditional HCAS methods (incremental, proportional, or a combination of the two), and then presents an alternative, non-traditional HCAS method that is based on concepts from the theory of cooperative games.

A Road Pricing Methodology for Infrastructure Cost Recovery, 2010

The broad motivating question for the report is: How can governments equitably recover infrastructure costs from truck users based on real-time operations and individual vehicles? The report presents a framework for charging commercial vehicles using weigh-in-motion (WIM) systems.

Bridge Structure Comparative Analysis, Comprehensive Truck Size and Weight Limits Study, 2013

This study provides a list of agencies that provide technical support through research, ongoing studies, and practice. The study provides a list of documents that the study reviewed with short summaries. A number of the documents address the issue of how to recover costs from heavy vehicles in proportion to the damage they cause on bridges.

State Highway Cost Allocation Studies: A Synthesis of Highway Practice

This report is intended to help states with HCAS methods by laying the foundation on current HCAS methods and areas of improvement for HCAS methods. The report reviews the HCAS methods used by different states, the conceptual foundation of HCAS methods, methods for revenue attribution, and arising issues with HCAS methods.

HCAS BY OTHER STATES

2009 NEVADA HIGHWAY COST ALLOCATION STUDY

The 2009 Nevada HCAS used a refined version of the 1997 FHWA State HCAS program (HCASP). The study covers the eight-year time horizon between 2009 and 2016. Ten vehicle classes (auto, bus, and eight single unit or tractor trailer truck classes) are used, based on the twelve HPMS vehicle classes. Equity ratios are tabulated by vehicle class and also by registered vehicle weight (using 2,000 lb. increments).

The 1999 Nevada HCAS adopted many of the recommendations from the 1994 audit of the Nevada HCAS process. Two additional recommendations were adopted in the 2009 HCAS:

- The use of more vehicle classes. Previously only basic and heavy vehicle classes were differentiated for reporting purposes.
- Inclusion of highway user fees that are diverted to non-highway uses (e.g., inclusion of federal highway funds diverted to mass transit and inclusion of state vehicle sales tax and ad-valorem tax revenues which are diverted to general fund).

Nevada calculates unadjusted and adjusted equity ratios. Unlike Oregon, Nevada's adjusted equity ratios do not reflect subsidized vehicles. Rather, Nevada's adjusted equity ratios are calculated based on share of revenue and cost responsibility share, rather than gross dollar amounts.

The primary difference between the equity ratios in the 1999 Nevada HCAS and 2009 Nevada study is the inclusion of revenues from the vehicle sales tax and the ad valorem (government service) tax. Another difference in the 2009 study from previous Nevada DOT studies is the use of the improved NAPCOM model and more accurate weigh-in-motion (WIM) data for operating weights of heavy vehicles.

Nevada DOT data sources were used when available for calculating revenue, determining future VMT, and determining expenditure classifications. The VMT forecast is based on the Nevada DOT VMT forecast and is validated by applying an assumed per-person annual mileage to Nevada's forecasted population growth rate. There is no mention of differentiating VMT growth rates by vehicle class, although there is some discussion of per person mileage in rural versus urban areas of the state.

Revenue Attribution

The Nevada HCAS includes both federal and state revenues, and also includes all revenue sources regardless of their use (e.g., includes highway revenues diverted to non-highway purposes). As a consequence of including the vehicle sales tax and ad valorem tax, state revenues are forecast to exceed state highway expenditures by 75%. The study notes that this difference is "counterbalanced" by local expenditures, which exceed local user payments (since the state and local governments direct a portion of general funds to local roadways).

Cost Responsibility

Assignment of expenditures to work categories is based on previous expenditures, funded projects data (e.g., STIP, etc.), and trends in project expenditures. In addition to funded future expenditures, the Nevada HCAS also includes estimates of deferred pavement and bridge preservation for allocation of system preservation costs. Nine project work types, covering the typical project categories for pavement, bridges, maintenance, preservation, etc., were used to classify highway expenditures.

Nevada received $201 million in federal stimulus funding, of which $130 million is deducted from the backlog of preservation and the remaining ($71 million) is applied to projects along the National Highway System and urban projects in the STIP. The forecast of future expenditures was developed using recent trends in expenditures and anticipated revenues and consultation with NDOT. Projects were assigned work types based on recent year expenditures and programmed expenditures in the STIP. The FHWA State HCAS Model was used to estimate cost responsibility by vehicle class using the categorized expenditures and allocators for each type of expenditure. Cost allocation by work type is summarized based on the information in the HCAS report:

- Pavement cost responsibility is determined using NAPCOM and vehicle class weight distributions developed from weigh-in-motion data. New bridge construction costs were allocated based on an incremental method, as applied in the FHWA HCASP model.
- Bridge replacement costs were allocated based on the replacement attributed to deficient load-bearing capacities relative to total degradation using the FHWA Bridge Sufficiency Rating formula.
- Bridge rehabilitation costs were apportioned based on determining the share of load-related costs relative to all costs based on a sample of bridge repair projects and default values from the FHWA's Bridge Needs and Investment Process.
- DMV expenditures related to the Motor Carrier Program were allocated to heavy vehicles, based on heavy vehicle VMT. The remaining DMV expenditures are allocated across all vehicle classes, based on shares of travel.
- Department of Public Safety expenditures include the State Emergency Response Commission (SERC), which responds to highway incidents. Heavy vehicles are allocated half of the SERC costs, based on the rationale that heavy vehicle crashes are more severe and require more time and expense to clear. The remaining DPS expenditures are allocated based on shares of travel.
- Administrative and overhead costs are allocated to vehicle classes in the same proportion as the sum of the capital and maintenance programs.
- Bond expenditures, both capital expenditures and debt service, are allocated in the same proportion as capital expenditures on urban interstate systems where the bond-financed projects are located.

Equity Ratios and Findings

The study results are presented as unadjusted and adjusted equity ratios for each vehicle class and by registered gross vehicle weight. Unadjusted equity ratios are constructed as the ratio of gross (dollar amounts) revenues to expenditures from each vehicle class. Adjusted equity ratios are constructed as the ratio of the vehicle class share of revenues to share of expenditures.

As a result of the inclusion of the state vehicle sales tax and ad valorem taxes, state revenues exceed state expenditures. This results in an "overpayment" of highway revenues compared to expenditures and produces a total unadjusted equity ratio for state-only revenues and expenditures of 1.75, reflecting that state revenues exceed state expenditures by 75%.

The effect of including revenues used for non-highway purposes is partially obscured by the inclusion of deferred maintenance and the subtraction of federal stimulus dollars from those deferred preservation expenditures. Excluding vehicle sales tax and ad valorem tax revenues from the total state revenues increases the adjusted heavy vehicle class share of state revenues to 31.1% from 18.9%. The heavy vehicle adjusted equity ratio goes from 0.42 up to 0.74 (state revenues and expenditures only) when these non-highway revenues are excluded.

The findings from the study suggest that Nevada's heavy vehicle fee structure does not increase proportionally with registered weight; hence heavy vehicles tend to underpay. Only vehicles less than 8,000 lbs. have an adjusted equity ratio of 1.50. This is consistent with the findings from other states' HCAS.

2010 IDAHO HIGHWAY COST ALLOCATION STUDY

The report considers the equity of Idaho's tax structure for highway users and whether different vehicle classes are paying their proportional share of highway costs. The 2010 Idaho HCAS used a refined version of the FHWA State Highway Cost Allocation Tool (HCAT). The HCAT was used to consider how adjustments to the current tax and fee structure and the implementation of a vehicle miles travelled (VMT) fee could affect equity ratios.

Two factors affecting the 2010 Idaho HCAS include the repeal of the weight-distance tax in favor of a mileage-based registration fee system and the types of projects that are funded by the Grant Anticipation Revenue Vehicle (GARVEE) bonds influence the equity ratios in the report. Idaho issued GARVEE bonds that are backed by federal aid to advance its construction program. The GARVEE bond program affects the cost allocation, as a higher portion of expenditures are pavement-related, which in turn affects the cost responsibility for heavy trucks. Under the reduced GARVEE scenario, expenditures are equal to the annual debt service payments during the six-year time period.

The study uses 20 vehicle classes. Vehicle classes are differentiated by vehicle type and weight. The study has a six-year time period from 2007 to 2012. The study considers three levels of government: state, federal, and local expenditures and revenues. Travel and expenditure data are broken down by rural and urban highway functional classes. Rural includes interstate, principal arterials, minor arterials, major collectors, minor collectors and local. Urban includes interstate, principal arterials, minor arterials, collectors and local. Travel data includes total vehicle miles traveled by the 20 vehicle classes and 11 functional road classifications.

Key findings from the Idaho HCAS include:

- Highway user payments fall short of expenditures by 20% ($139.5 million per year) for state and federal programs combined.
- With state and federal programs combined, combination trucks' payments fall 33% short of cost responsibility (28% under reduced GARVEE scenario), whereas automobiles' payments exceed cost responsibility by 47% (38% under reduced GARVEE scenario).
- Considering state programs alone, combination trucks' payments fall 27% short of cost responsibility (14% under reduced GARVEE scenario), whereas automobiles' payments exceed cost responsibility by 26% (8% under reduced GARVEE scenario).

Revenue Attribution

Revenue data include state and federal historical data from 2007 to 2009 and revenue forecasts based on Idaho Transportation Department (ITD) forecasts from 2010 to 2012. Revenue data include receipts from highway users from the tax and fee structure (e.g., registration fees, motor fuel taxes, driver's license fees, permit fees, and title fees).

The study obtained federal revenues that are attributable to highway users in Idaho for 2008 and 2009 from FHWA 2009 Highway Statistics. The FHWA estimates were forecast forward until 2012 using the revenue forecasts prepared by ITD. The federal tax revenue estimates reflect what Idahoans pay into the Federal Highway Trust Fund.

The study attributed revenue to the 20 vehicle classes and to registered gross weight classes in 2,000 lb. increments above 8,000 lbs. Some of the default data estimates in the FHWA HCAT were replaced with Idaho-specific inputs. The study worked with the ITD and other data sources to estimate the following characteristics for each vehicle class: VMT, percentage of VMT outside of Idaho, MPG, and number of registered vehicles. This allowed tax revenue to be attributed to each vehicle class. Fuel tax revenues were attributed by vehicle class based on the VMT estimates and the vehicle class's MPG. Revenues from registration fees were attributed based on the breakdown of fees by vehicle class (passenger vehicles, trucks, and buses). The study also estimated the number of full fee equivalent vehicles by registered weight class based on total VMT and the average VMT per vehicle estimates.

Cost Responsibility

The study uses expenditure data for nine categories: new pavements, rehabilitated pavements, new bridge, replacement bridge, repair bridge, grading, other construction, maintenance, and administration and other expenditures. Expenditure data were obtained for capital expenditures from ITD for the 2007-2012 time period.

The study estimated cost responsibility for each vehicle class using the FHWA HCAT. Idaho updated the FHWA HCAT to reflect Idaho's

highway system and vehicle use. The study used weigh-in-motion (WIM) data to refine weight-related HCAT model inputs. The study used a recent FHWA run of the National Pavement Cost Model (NAPCOM) with 2007 highway section data from ITD. The study uses bridge cost allocation procedures developed by the FHWA in the Federal HCASs in 1982 and 1997.

Travel Data

The study derived VMT data by functional road class and by vehicle class using vehicle classification data from 2004-2008, breakdowns of VMT by functional class from 2008 and 2009, and weigh-in-motion (WIM) data from 2008 and 2009 from ITD. The Idaho Highway Performance Monitoring System (HPMS) has 12 vehicle classes but the FHWA HCAT uses 20 vehicle classes. Idaho used the two years of WIM data to map the 12 HPMS vehicles classes estimated from the classification count data into the 20 vehicle classes. WIM data were only provided for three functional classes: rural interstate, rural principal arterial, and rural minor arterial. The study had to make further assumptions on how to apply the vehicle splits to other roads.

Equity Ratios and Findings

The Idaho HCAS reports the unadjusted and adjusted equity ratios for the state level as well as the state and federal levels combined. Similar to HCAS in other states, as registered gross weights increase, equity ratios decrease.

One particularity of the Idaho HCAS is the GARVEE bond program. The GARVEE bond program affects the cost allocation, in that a much higher proportion of highway funds are directed toward pavement expenditures. Since most pavement costs are a result of the impact of heavy trucks, the bond program significantly increases the cost responsibility to heavy trucks (in particular, trucks with 12,000-18,000 lbs. per axle or 28,000-34,000 lbs. per pair of axles).

The researchers performed a sensitivity analysis to explore the effects of the GARVEE program on the HCAS findings. The researchers considered the scenario where expenditures are equal to the annual debt service payments during the 2007-2012 time period. The annual debt service payments over the six years are approximately equal to 26% of the GARVEE bond expenditures over the same time period. In the reduced GARVEE bond scenario, construction expenditures decrease by $96.9 million. Under this scenario, adjusted equity ratios increase for combination trucks and decrease for automobiles. On the state level, there is a greater difference in results between the two scenarios than on the level where state and federal are combined. On the state level, the adjusted equity ratio for automobiles drops from 1.26 to 1.08 under the reduced GARVEE scenario and increases for combination trucks from 0.73 to 0.86.

The other notable change for Idaho was the repeal of the weight-distance tax on trucks in favor of a mileage-based registration fee system in 2001. According to the study, if the weight-distance tax had remained in place, revenues were forecast to increase to $60.4 million in 2008 (based on analysis of historical trends). Instead, under the mileage-based registration fee system, revenues were $48.8 million in 2008 ($11.6 million lower than the forecasts under the weight-distance tax).

Policy Analysis

The Gubernatorial Task Force on Modernizing Transportation Funding evaluated 19 possible sources of revenue. They considered eight criteria in their evaluation: fairness, public acceptance, revenue predictability, trend (up or down), cost-effectiveness of implementation, readiness, competitiveness, and out-of-state equity. The top ten revenue sources are (from highest to lowest): fuel tax of 5 cents per gallon, fuel sales tax, index fuel tax, state truck registration fee, index passenger vehicle registration fee, county vehicle registration fee, sales tax on auto sales, parts, tires and accessories, weight distance tax, electric vehicles, and alternative fuels tax.

The study examines the equity impacts from seven different policy options. The seven policy options are listed below along with their outcomes on equity (equity ratios are for the state and federal levels combined):

1. *Gasoline and special fuel tax rates increase by 5 cents per gallon.* Revenues forecast to increase by $46.2 million annually. Tax falls on passenger vehicles and trucks equally, and there is little change in adjusted equity ratios.

2. *Gasoline tax rate increases by 5 cents per gallon.* Adjust the special fuel tax rate such that the equity ratio for vehicles with RGWs of over 26,000 lbs. is equal to one. Revenues forecast to increase by $307.6 million annually. Equity ratios improve across vehicle classes (move closer to one). Adjusted equity ratios for automobiles and DS8+ change from 1.47 to 1.06 and 0.49 to 0.67, respectively.

3. *Special fuel tax rate increases by 5 cents per gallon, and gasoline tax rate adjusts to the level needed to achieve equity.* Revenues forecast to decrease by $147.0 million annually. Equity is almost realized between broad vehicle classes (between vehicles above and below 26,000 lbs.).

4. *All vehicle registration fees increase by 10%.* Revenues forecast to increase by $11.6 million annually. Fees are applied to all vehicle classes, and have almost no effect on equity.

5. *Passenger car vehicle registration fees increase by 10% and heavy truck registration fees increase by level needed to achieve equity.* Revenues forecast to increase by $165.8 million annually. Heavy truck registration fees would need to increase by a factor of 4.07 to achieve equity. Equity would be achieved between light and heavy vehicle classes. However, payments from heaviest vehicle classes would still fall short of cost responsibility by up to 45%.

6. *Heavy truck registration fees increase by 10% and passenger car vehicle registration fees increase by level needed to achieve equity.* Revenues forecast to decrease by $47.7 million annually. Passenger car (light vehicle) registration fees would be eliminated. Equity would improve with the automobiles adjusted equity ratios decreasing from 1.47 to 1.38.

7. *Vehicles over 26,000 lbs. RGW pay a VMT tax.* Revenues forecast to increase by $81.9 million annually. VMT fees are around 5.3 cents per mile for vehicles with RGW of 80,000 lbs. and 11.1 cents per mile for RGW of 105,500 lbs. Equity ratios for heavy vehicles improve significantly. The adjusted equity ratio for the DS8+ vehicle class would increase from 0.49 to 0.85. For the LT4 vehicle class, the adjusted equity ratio would decrease from 1.18 to 1.03.

2012 MINNESOTA HIGHWAY COST ALLOCATION AND DETERMINATION OF HEAVY FREIGHT TRUCK PERMIT FEES

Minnesota conducted an HCAS in 2009 that used the FHWA's State Highway Cost Allocation Tool (HCAT), relying on some national default data and state specific data when it was available. In 2012, the Minnesota Department of Transportation (MnDOT) and the University of Minnesota developed a customized highway cost allocation tool for Minnesota based on the FHWA's tool, and compared the results of the customized tool to the results from the general tool. The report also presents the findings from the HCAS using the FHWA HCAT that are using the same methods as the 2009 HCAS (see 2009 Minnesota HCAS summary at the end of the paper after References).

In the 2012 HCAS, Minnesota compares the results from the FHWA HCAT and a customized tool for MnDOT, Minnesota Highway Cost Allocation Tool (MHCAT). MHCAT fixes known bugs in the FHWA HCAT and is intended to work with Minnesota-specific data. The FHWA HCAT does not allow certain tax revenues (e.g., registration and weight fees) to be attributed to a specific subset of vehicle classes. Additionally, the FHWA HCAT does not correctly allocate administrative costs associated with the collection of registration and weight fees. Another issue the study found was that the registered gross weight breakdowns for the vehicle configurations are based on representative data from 2001. Furthermore, the mapping of the 12-vehicle configurations to the 20-vehicle configurations is based on national VMT data from 1997.

MHCAT classifies vehicles according to Highway Performance Monitoring System, (HPMS) 12-class whereas FHWA HCAT classifies them according to HCA 20-class. Without a customized tool, use of the FHWA HCAT requires mapping the HPMS classification onto the HCA classification (as in the case of the 2010 Idaho HCAS and the previous 2009 Minnesota HCAS). The customized tool removes unnecessary data manipulation and increases accuracy. MHCAT also allows the user to enter up to eight customized vehicle classes. This is a useful tool for research purposes, such as considering specific changes to tax rules and cost allocation for specific vehicle classes.

The FHWA HCAT cannot allocate external costs such as environmental impacts, congestion, and accident costs. External costs are a result of highway use, and can be significant. However, they are difficult to include into the HCAT since they are dependent on the time of travel and route selected, and they do not depend solely on the type of vehicle and VMT. This is not an issue that is resolved in the MHCAT.

The report also evaluates the HCAS methods, with particular emphasis on tax equity (vertical and horizontal) and efficiency. In particular, the report compares a fuel versus a weight-distance tax using a stylized mathematical model.

The results support that a weight-distance tax or other mileage-based tax that can be differentiated by truck class can help achieve a more equitable tax policy than a universal fuel tax. However, the examples presented also indicate that equity can be improved if the universal tax encourages the truck industry to use trucks that cause less damage. The alternative is to achieve equity through a tax policy that differentiates by truck class and truck usage.

The report lists two categories with two options in each category as directions for future research that are associated with the equity and efficiency of the road-use tax structure.

- **Mileage-Based Taxation:** This can be implemented using a comprehensive *Electronic Road Pricing System (ERPS)* or a *weight-distance tax system.*
  - With an ERPS, tax rates can be set based on vehicle type, vehicle weights, number of axles, congestion levels, and the road conditions for the individual trip.
  - *Weight-distance* taxes are charged based on the vehicle's registration weight, distance travelled, and axle configuration.
- **Special Permits and Willingness-to-Pay:** The state currently issues special permits to oversized or overloaded trucks, but there is a need for a better pricing mechanism. Options to improve the pricing mechanism include:
- Estimating *Willingness-to-Pay* (WTP) using contingent valuation.
  - Implementing an *auction-based permitting system* (ABPS).

Minnesota Department of Transportation (MnDOT) provided revenue and expenditure data and traffic data for the 2003-2007 time period. MHCAT, like HCAT, requires pavement parameters, bridge parameters, and vehicles' features and travel-related data. The inputs are in nine different Excel tabs in the MHCAT workbook. Default bridge parameters are imported from HCAT but can be modified to reflect the state's conditions through assistance from the state engineer. The report uses VMT numbers from MnDOT that represent an average from 2004 to 2007.

The workbook requires registered gross weight distributions by vehicle class by 2,000 lb. increments from 8,000 lbs. to 152,000 lbs. These data were obtained from the Vehicle Inventory and Use Survey from 2002 (VIUS 2002) collected by the U.S. Census Bureau. The default data for MPG by vehicle class and RGW, the average annual distance travelled by vehicle class, and the distribution of vehicles by fuel type are all from VIUS 2002. Axle weight distribution data are from WIM systems from 2006.

Revenue

The MHCAT includes both federal and state revenues. At the federal level, inputs include fuel taxes, heavy vehicle use tax, vehicle sales taxes, and tire taxes. At the state level, inputs include fuel taxes, weight fees (only applicable to trucks), registration fees (passenger vehicles and light trucks), vehicle sales taxes, and permit fees.

Expenditures

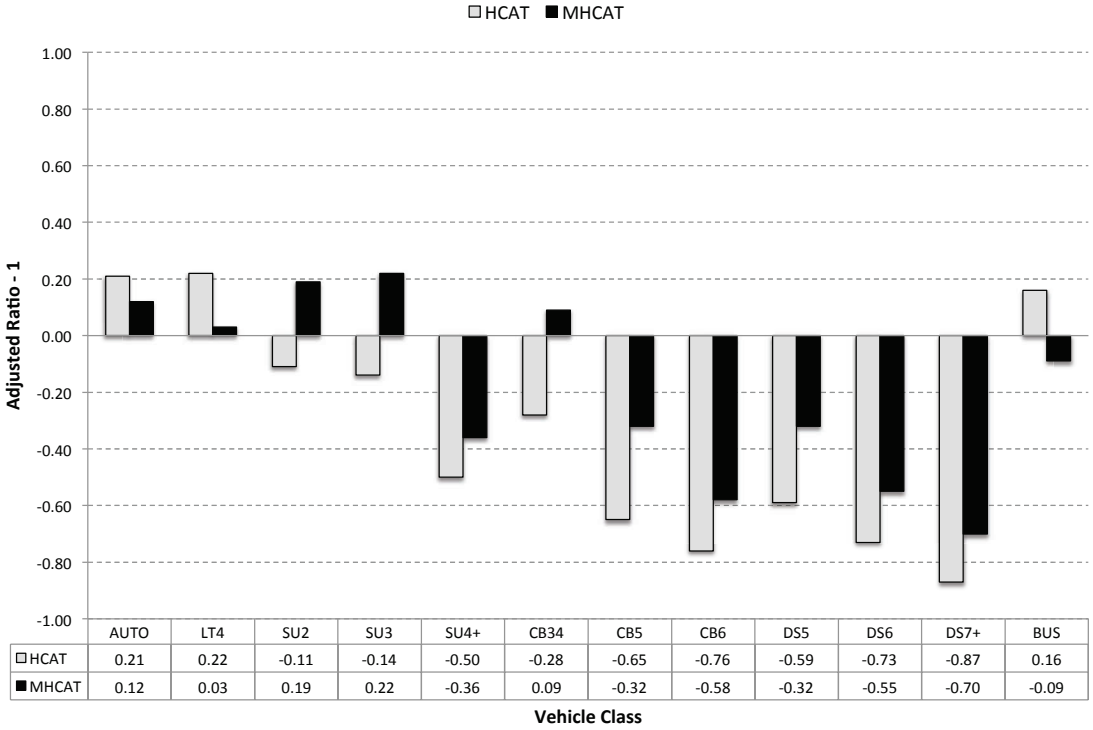
MHCAT inputs related to expenditures are categorized into six parts: state level construction and maintenance, state level administration, state-aid administration, state-aid construction and maintenance, federal-aid administration, and federal-aid construction and maintenance. Each part requires expenditures disaggregated by highway functional class for 25 categories. The categories include typical highway project categories such as pavement (new, repair, etc.), bridge (new, replacement, rehabilitation), and maintenance and administrative categories. MHCAT includes the costs of collecting user fees on fuel, which are assumed to be zero by many states.

The default inputs on how non-load-related expenditures are allocated are based on FHWA HCAT. These include grading, residual allocators, other costs, and systemwide and DMV costs. The user can specify the percentage of grading costs by vehicle weight. For residual allocators, other costs that are distributed by highway functional class, and systemwide costs and DMV administration costs, the user can specify VMT or PCE-VMT, or a fraction between 0 and 1 (e.g., 0.3 means that 30% is allocated based on VMT and 70% is allocated based on PCE-VMT).

Equity Ratios and Findings

The report compares the equity ratios obtained from FHWA HCAT and MHCAT. It considers the difference between the adjusted equity ratios from the two tools to the target ratio (one). Like the 2009 Nevada HCAS, unadjusted equity ratios are constructed as the ratio of gross (dollar amounts) revenues to expenditures from each vehicle class. Adjusted equity ratios are constructed as the ratio of the vehicle class share of revenues to share of expenditures.

Exhibit 1. HCAT (FHWA) and MHCAT: Adjusted Ratios minus Target Ratio (one), State Revenue and Expenditures Only



	AUTO	LT4	SU2	SU3	SU4+	CB34	CB5	CB6	DS5	DS6	DS7+	BUS
HCAT	0.21	0.22	-0.11	-0.14	-0.50	-0.28	-0.65	-0.76	-0.59	-0.73	-0.87	0.16
MHCAT	0.12	0.03	0.19	0.22	-0.36	0.09	-0.32	-0.58	-0.32	-0.55	-0.70	-0.09

Source: Minnesota HCAS 2012, Figure 4.1, p. 52.

In general, the equity ratios from MHCAT are less extreme than those from FHWA HCAT. Exhibit 1 shows the differences between the ratios for FHWA HCAT and MHCAT by vehicle class. The report attributes some of the differences to the fact that RGW, OGW, and axle distributions are based on Minnesota specific data in MHCAT, as opposed to national averages in the FHWA HCAT.

The report finds that automobiles, light trucks, and single-unit trucks (three axles or less) have equity ratios greater than one. The report also finds that all combination trucks (except for single trailer with four or fewer axles) have adjusted equity ratios less than one. As is the case in other states' HCASs, the study indicates that heavy trucks are not paying taxes in proportion to the damage they cause to road infrastructure.

Effects of a Weight-Mileage Fee

Currently, Minnesota charges a weight fee that is determined based on a commercial vehicle's RGW (e.g., a registration fee). The report examines the effects of including a weight-mileage fee where the user pays a usage fee based on vehicle miles traveled and the tax rate per mile is determined by the registered gross weight of the vehicle. The report considers two scenarios. The first scenario assumes that total revenues from trucks are not changed (Minnesota collects $98 million from the weight-mileage fee). The second scenario assumes that the state collects $160 million from the weight-mileage fee (the amount of load-related expenditures (pavement and bridge) allocated to trucks). The study estimates the cost per mile for each vehicle-RGW class and then sets the tax rate to be proportional to the estimated cost.

Exhibit 2. Adjusted Equity Ratios for Weight Fees (RGW registration fee) and Weight-Mile Fees, State

VC	Weight Fees	W-M Fees (Scenario 1)	W-M Fees (Scenario 2)
AUTO	1.12	1.12	1.08
LT4	1.03	1.03	1.00
SU2	1.19	0.89	0.86
SU3	1.22	0.89	1.00
SU4+	0.64	0.67	0.80
CB34	1.09	0.95	1.07
CB5	0.68	0.75	0.88
CB6+	0.42	0.57	0.71
DS5	0.68	0.81	0.93
DS6	0.45	0.63	0.77
DS7	0.30	0.52	0.67
BUS	0.91	0.91	0.88

Source: Minnesota HCAS 2012, Table 4.15, p. 56.

Exhibit 2 shows the adjusted ratios at the state level for the weight fees and the weight-mile fees under both scenarios. As the table illustrates, adjusted equity ratios under both weight-mile fee scenarios are closer to the target ratio (one) than the weight fees for most vehicle classes.

Auction-Based Permit System (ABPS)

This section discusses the development and testing of an ABPS that a state transportation agency could implement to learn the demand for permits and freight companies' willingness-to-pay for the permits. The researchers considered multi-item auctions and picked three mechanisms: Vickrey auction with reserve price, Ascending clock auction, and Clinched ascending clock auction. These three mechanisms were picked because they satisfied the following criteria:

- The price paid by a winning bid depends only on the opposing participants' bids.
- Bidders do not gain from over-bidding or under-bidding their true demand.
- The objective of the auction mechanism is to maximize revenue per permit sold.

The report explores the three auction mechanisms and how utility maximizing freight companies would bid under a competitive Nash equilibrium for each mechanism. The researchers then designed an experiment to test the different mechanisms using University of Minnesota graduate students and MnDOT staff members. The results of the experiment indicate that the ascending clock mechanism provided the maximum revenue per permit sold. Issues of auction fairness were not discussed in the report. The report considers the outcome of an auction as efficient when the individual item is sold to the bidder with the highest valuation for the item.

HCAS METHODS

A ROAD PRICING METHODOLOGY FOR INFRASTRUCTURE COST RECOVERY, 2010 (BY CONWAY & WALTON)

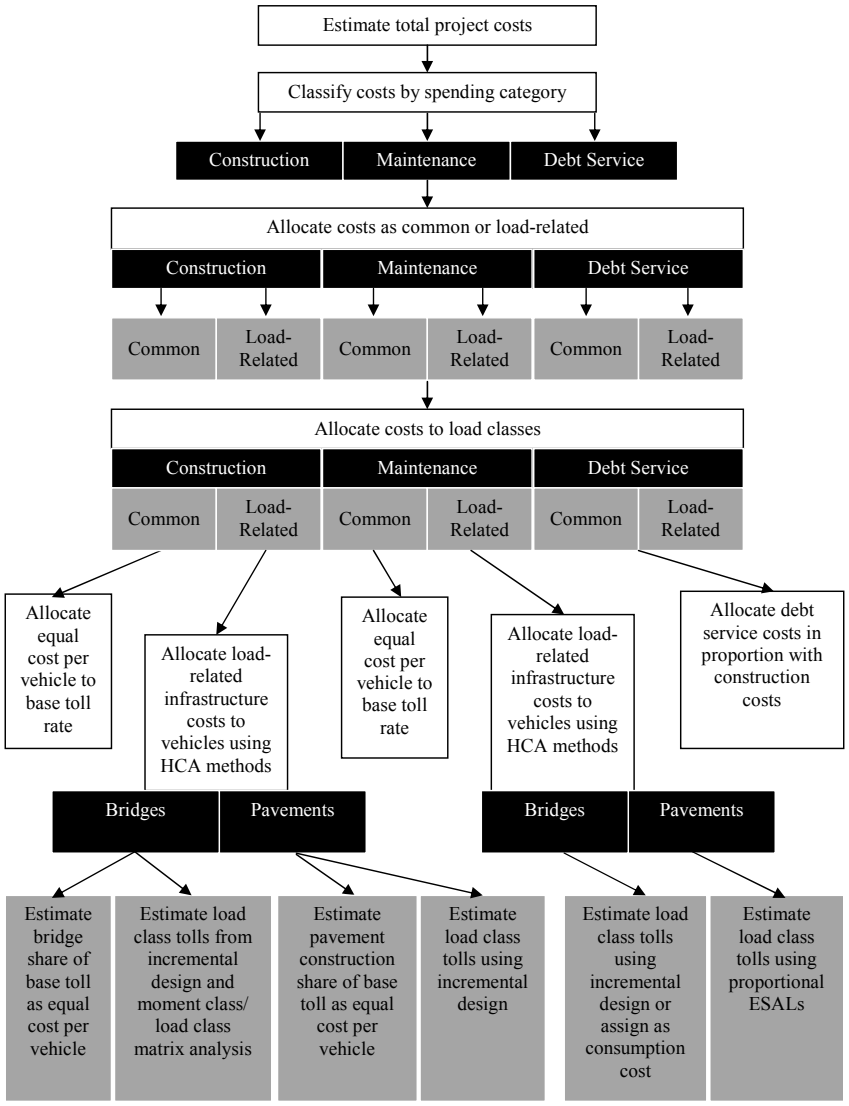
The broad motivating question for the report is, "What future method of truck user charging can be employed to equitably recover infrastructure costs from individual vehicles based on real-time operations?" (Conway & Walton, 2010, p. 3). The report presents a framework for charging commercial vehicles using weigh-in-motion (WIM) systems. The WIM systems collect real-time vehicle weight and configuration information that can be used to charge vehicles on a toll structure. The report proposes using highway cost allocation methods to estimate a more equitable toll structure based on the individual axle weights that can be measured real-time using the WIM systems. The report presents a hypothetical case study using information from Texas State Highway 130 to consider the improvements in equity that could be realized using the proposed methodology.

The study proposes a two-part toll. The first part is a base toll that is charged to all commercial and passenger vehicles that is calculated such that all common costs and basic infrastructure costs are recovered. The second part is an additional toll for heavy vehicles that is estimated using the "axle-load" estimation (preferred) or the "number-of-axle" estimation. Exhibit 3 (on the following page) illustrates the process.

Under an axle-load toll structure, heavy vehicles pay an additional cost per axle-load to recover infrastructure costs (pavement and bridge costs) that are required in order to support their weight. Pavement impacts are estimated as a function of individual axle loads, so initial load classes must be developed using the relative impacts on pavement by loads from individual classes. The particular characteristics of the facility with respect to traffic volumes, truck profiles, and axle load distribution need to be identified to determine the relative impacts of each class. Traffic analysis provides vehicle volumes, and WIM data can provide axle load distributions and truck profile information. This information can be used to calculate the probability that a load belongs to a given class and estimate the toll rates for each individual load class.

The case study considers State Highway 130 in Texas. The results indicate that the "axle-load" tolling structure recovers costs more equitable for heavy vehicle consumption than a "number-of-axle (n-1)" structure. The addition of an axle can lessen the load at a given point, reducing the pavement and bridge impacts. The pavement impact is lower from a 20,000 lb. load split across two axles than the same load on one axle. The "axle-load" structure is more effective at mirroring the estimated cost responsibility of different vehicle classes.

Exhibit 3. Center for Transportation Research/Southwest Region University Transportation Center - Cost Allocation Method for Toll Rate Determination



Source: Conway & Walton, 2010, Figure 9, p. 90.

MODELS FOR HIGHWAY COST ALLOCATION, 2013 (BY GARCIA-DIAZ & LEE)

The report reviews the traditional HCAS methods, incremental or proportional (or a combination of the two) and then presents an alternative, non-traditional HCAS method that is based on concepts from the theory of cooperative games. The study considers how well different HCAS methods fulfill three fundamental properties: completeness, rationality, and marginality. Completeness means that highway costs are fully recovered by all participating vehicle classes. Rationality means that each vehicle class will have a lower cost by participating in the large group of all vehicle classes. Marginality means that each vehicle class pays the incremental cost that is incurred by including it in the grand coalition. Traditional HCAS methods, incremental and proportional, satisfy completeness. The incremental method sometimes satisfies marginality.

The non-traditional method presented in the paper, the Generalized Method (known as the Nucleolus Method in game theory) is based on concepts from the theory of cooperative games. Villarreal and Garcia-Diaz (1985) first proposed the use of this method in HCAS.[1] With this method, all three properties are forcibly satisfied as a result of constraints in the method's mathematical formulation. The generalized method guarantees "that every vehicle class will be allocated a lower cost in the grand coalition (all vehicle classes), as compared to any other smaller coalition (one with fewer vehicle classes than the grand coalition)" (Garcia-Diaz & Lee, 2013, p. 137).

The average marginal cost for a vehicle class, considering all the permutations of vehicles in the grand coalition, is the Shapley Value. The Shapley Value represents the average marginal cost contribution that each vehicle class would make to the grand coalition if it were forming one vehicle class at a time (Garcia-Diaz & Lee, 2013, p. 138). The Aumann-Shapley Value considers two types of costs, the sum of which is the total cost allocated to a vehicle class. The first cost is for ESALs (pavement thickness) and the second is for highway lanes (traffic capacity). The method calculates a cost per ESAL and a cost per lane. This procedure has a number of advantages and tackles some obstacles often found in traditional HCAS. It "allows the consideration of the number of lanes as being a variable and

[1] A Development and Application of New Highway Cost Allocation Procedures. Villarreal-Cavazos A, Garcia-Diaz Transportation Research Record 1009: 34-41. 1985.

depending on the composition of the traffic using a highway (Garcia-Diaz & Lee, 2013, p. 138). This "addresses how seemingly conflicting objectives: lighter vehicles require less pavement thickness and more lanes while heavy vehicles require fewer lanes but thicker pavements" (Garcia-Diaz & Lee, 2013, p. 138). After calculating a cost per ESAL and a cost per lane, the method uses the Shapley Value to allocate the number of available lanes between vehicle classes. The paper provides examples using three vehicle classes.

The paper states that the Generalized Method distributes traffic-related costs more equitably than any other HCAS method, as it considers traffic loads and traffic capacity. The combination of the Aumann-Shapley Value (average cost per ESAL and average cost per lane) and the Shapley Value (used to allocate the total number of lanes among vehicle classes), allows for the possibility to calculate the cost per mile for each vehicle class. The paper also proposes a method for separating bridge construction and traffic capacity costs that is similar to the method for separating pavement thickness and traffic capacity costs. There is the additional step that allocates the traffic-load cost to each weight group in a vehicle class using the incremental method. The paper provides examples using three vehicle classes and four weight intervals.

BRIDGE STRUCTURE COMPARATIVE ANALYSIS, COMPREHENSIVE TRUCK SIZE AND WEIGHT LIMITS STUDY, 2013

This study provides a list of agencies that provide technical support through research, ongoing studies, and practice. This list includes national programs such as the Transportation Research Board (TRB), National Cooperative Highway Research Program (NCHRP) and Strategic Highway Research Program, (SHRP 2). It also includes federal and state transportation agencies and universities.

The second section of the study provides a list of documents that the study reviewed with a link to the document, a summary of the findings, and a discussion of the document's relevance to one of the Comprehensive Truck Size and Weight (CTSW) Study topics. A key discussion area is how to recover the relatively high structural and infrastructure costs on bridges from heavy trucks. The study examines resources in the literature from 1997 to 2013 that may inform approaches that may help recover these costs more equitably.

STATE HIGHWAY COST ALLOCATION STUDIES: A SYNTHESIS OF HIGHWAY PRACTICE, 2008 (BY BALDUCCI & STOWERS)

This report is intended to help states with HCAS methods by laying the foundation on current HCAS methods and areas of improvement for HCAS methods. The report reviews the HCAS methods used by different states, the conceptual foundation of HCAS methods, methods for revenue attribution, and arising issues with HCAS methods.

Since the 1997 Federal HCAS, there have not been many major changes in HCAS practice. A significant development in the past few years was FHWA's completion of the development and refinement of the National Pavement Cost Model (NAPCOM) and its development of NAPCOM into a model that can be used in state level HCAS. The FHWA also developed generalized state level HCAS software and documentation for the software.

Exhibit 4 summarizes recent state HCASs. Much of the data in the table is from a previous study by ECONorthwest in 2005, but has been updated through 2008 by the research team. The results in the method column indicate that the Incremental and Federal Methods are most commonly used for state HCASs. These fall under the cost-occasioned approach that determines cost responsibility using the costs imposed on the highway by the highway-user class and not just by relative use. A key issue in HCAS is the cost responsibility of heavy-truck vehicle classes. Studies consistently find that heavy trucks payments do not fully cover their cost responsibility.

Exhibit 4. State Highway Cost Allocation Studies

State	HCAS Years Completed	Method	% Heavy Vehicle Cost Responsibility	Key Allocators	Types of Revenues Examined
Arizona	1993, 1999, 2000, 2001, 2002, 2005	Federal	31.4% (1999)	VMT, Axle-Load, Gross Weight	State, Federal, and Local Funds Combined
Arkansas	1978	Incremental/Cost Function			
California	1987, 1997	Federal and Incremental	18.90%	ESALs	State, Federal, and Local Funds Analyzed Separately
Colorado	1981, 1988	Federal	37%	VMT, Truck-VMT, ESALs, Ton-Miles	
Delaware	1992, 1993	Federal and Incremental	20.33%	VMT, ESALs, PCE, Axle-Miles, Registrations	State and Federal Funds Combined Only
Florida	1979	Incremental	64.50%	VMT, ESALs, Axle-Miles, Registrations	State and Federal
Georgia	1979, 1982	Incremental	51.2% (1979)	VMT, ESALs, GVW, AMT	State and Federal
Idaho	1987, 1994, 2002, 2010	Prospective Cost-Occasioned, Modified Federal, NAPCOM	Federal & State: 43.5% or 40.9%* State: 40.6% or 34.1%*	VMT, ESALs, ADT	State, Federal, and Local Funds Combined
Indiana	1984, 1988, 1989, 2000	Incremental/Consumption	53.20%	ESALs	State, Federal, and Local
Iowa	1983, 1984	Federal	48.94%	VMT, ESALs, Ton-Miles, AMT, PCE	
Kansas	1978, 1985	Hybrid	41.85%	VMT, ESALs, PCE, AMT, Ton-Miles, Number of Vehicles	State Funds
Kentucky	1992, 1994, 1996, 1998, 2000	Federal	54.92%	VMT, ESAL-VMT, PCE, Axle-Miles	State and Federal Funds Combined
Maine	1956, 1961, 1982, 1989	Hybrid/Expenditure Allocation	35.60%	VMT, ESALs, PCE, Delphi, TMT, Standard Vehicle Equivalent	State and Federal funds
Maryland	1989, 2009	Federal	33.30%		State and Local Funds
Minnesota	1990 2009, 2012	Federal and Incremental, Modified Federal	Federal & State: 29.47%	VMT, ESALs, ADT	State and Federal Funds Combined and State
Mississippi	1980	Incremental	36%	VMT, Truck-VMT	

Exhibit 4 (continued). State Highway Cost Allocation Studies

State	HCAS Years Completed	Method	% Heavy Vehicle Cost Responsibility	Key Allocators	Types of Revenues Examined
Missouri	1984, 1987, 1990	Federal		VMT, Vehicle Size, Vehicle Weight	
Montana	1992, 1999	Federal	33%	VMT, ESALs, AMT	
Nevada	1984, 1985, 1988, 1990, 1992, 1994, 1999, 2009	Modified Incremental, Modified Federal with NAPCOM (2009)	All Levels: 34.66% State: 38.26%	VMT, ESALs, Axle-Miles, Ton-Miles	State, Federal, and Local Separately and Combined
New Mexico	1972				
North Carolina	1983	Federal		VMT, ESALs, PCE, Weight Axle-Miles	State and Federal Funds
Oregon	1937, 1947, 1963, 1974, 1980, 1984, 1986, 1990, 1992, 1994, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015	Cost-Occasioned with NAPCOM for Pavement Costs (Since 1999)	31.20%	VMT, Congested PCE, Uphill PCE, Truck-VMT, Basic Vehicle VMT	State, Federal, and Local Combined for Cost Allocation Purposes but State Only for Revenue Attribution Purposes
Pennsylvania	1989, 1990	Federal/ Cost-Occasioned			
Texas	1984, 1985, 1994, 2002				
Vermont	1990, 1993, 2006	Federal	25.70%	VMT, ESALs, ADT	State and Federal Funds
Virginia	1991, 1992	Federal	21.70%	VMT, ESALs, ADT	State and Federal Funds Combined
Washington	1977	Incremental			
Wisconsin	1982, 1992	Federal (1982)	31.70%	VMT, ESALs, PCE, Ton-Miles	State and Federal Funds Combined
Wyoming	1981, 1999	FHWA State HCAS Model	55.80%	VMT, Vehicle Size, Horsepower, Weight	

Source: Balducci and Stowers 2008. Adapted from ECONorthwest et al. (2005). Updated by ECONorthwest through 2014.

Exhibit 4 (continued). State Highway Cost Allocation Studies

State	HCAS Years Completed	Method	% Heavy Vehicle Cost Responsibility	Key Allocators	Types of Revenues Examined
Missouri	1984, 1987, 1990	Federal		VMT, Vehicle Size, Vehicle Weight	
Montana	1992, 1999	Federal	33%	VMT, ESALs, AMT	
Nevada	1984, 1985, 1988, 1990, 1992, 1994, 1999, 2009	Modified Incremental, Modified Federal with NAPCOM (2009)	All Levels: 34.66% State: 38.26%	VMT, ESALs, Axle-Miles, Ton-Miles	State, Federal, and Local Separately and Combined
New Mexico	1972				
North Carolina	1983	Federal		VMT, ESALs, PCE, Weight Axle-Miles	State and Federal Funds
Oregon	1937, 1947, 1963, 1974, 1980, 1984, 1986, 1990, 1992, 1994, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013	Cost-Occasioned with NAPCOM for Pavement Costs (Since 1999)	31.20%	VMT, Congested PCE, Uphill PCE, Truck-VMT, Basic Vehicle VMT	State, Federal, and Local Combined for Cost Allocation Purposes but State Only for Revenue Attribution Purposes
Pennsylvania	1989, 1990	Federal/ Cost-Occasioned			
Texas	1984, 1985, 1994, 2002				
Vermont	1990, 1993, 2006	Federal	25.70%	VMT, ESALs, ADT	State and Federal Funds
Virginia	1991, 1992	Federal	21.70%	VMT, ESALs, ADT	State and Federal Funds Combined
Washington	1977	Incremental			
Wisconsin	1982, 1992	Federal (1982)	31.70%	VMT, ESALs, PCE, Ton-Miles	State and Federal Funds Combined
Wyoming	1981, 1999	FHWA State HCAS Model	55.80%	VMT, Vehicle Size, Horsepower, Weight	

Source: Balducci and Stowers 2008. Adapted from ECONorthwest et al. (2005). Updated by ECONorthwest through 2014.

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ADDITIONAL HCAS STUDIES

Highway Cost Allocation and Determination of Heavy Freight Truck Permit Fees (MN/DOT): Task 1 Report – 2009 Minnesota Highway Cost Allocation Study.

Prior to the 2009 HCAS, Minnesota had conducted only one HCAS, roughly twenty years ago (published in 1989). Minnesota's 2009 HCAS was conducted by a faculty member and research assistant in the Engineering Department at the University of Minnesota. The study was conducted using FHWA's State HCAS program (HCASP), relying on some national default data and state-specific data when available. MNDOT provided financial (revenue and expenditure) and traffic data for the four-year period of July 2003 to 2007. Thus, the study is retrospective, in that it uses prior year expenditures and VMT; the study does not forecast future year spending, future expenditure work types, or VMT.

Following the Federal HCASP methodology, the study relied on the mapping of twelve HPMS vehicle classes into the 20 HCASP vehicle classes. The study used data from eleven weigh stations to develop distributions of registered Gross Weight for the vehicle classes. Default weight distributions from HCASP were used for those vehicle classes where the raw weigh station data could not be mapped into the HCASP vehicle classes.

The study found that the share of revenues from heavy vehicles is less than their share of costs.

Three "what-if" scenarios were analyzed to determine equity ratios under three different tax policies:

1. Increase in fees paid by vehicles greater than 16,000 lbs. by 26%.
2. Increase in the diesel tax by 25%.
3. Introduction of a weight-distance tax for vehicles more than 57,000 lbs.

Revenue Attribution

All federal, state, and local highway user revenues were included in the Minnesota HCAS. Federal revenues are based on those reported in the FHWA's Highway Statistics. The Federal HCASP contains default federal tax rates and attributes federal revenues to vehicle classes based on those rates and the VMT inputs. State highway user fees include motor fuel taxes, registration and license fees, vehicle sales tax, and an ad valorem tax. Similar to Nevada, Minnesota seems to include revenues that are diverted to non-highway uses. In the Minnesota HCAS, attributed state revenues exceed allocated state expenditures by 27%.

Cost Responsibility

Following the Federal State HCAS Program, the Minnesota HCAS categorized highway-related expenditures into 18 work categories. The work categories are typical highway project categories such as pavement (new, repair, etc.), bridge (new, replacement, rehabilitation), maintenance and administrative categories. Expenditures are also categorized by functional class, though administrative expenditures, rest area maintenance, state police and fuel/registration collection costs are not assigned a road functional class.

Equity Ratios and Findings

Like the Nevada HCAS, the Minnesota HCAS reports unadjusted and adjusted equity ratios. The unadjusted equity ratio is computed as gross revenues divided by expenditures for each vehicle class and the adjusted equity ratios are the ratio of a vehicle class' revenue share to their share of expenditures. Revenue per mile and cost per mile for each vehicle class is reported along with equity ratios, with equity ratios for state and federal reported separately.

The study finds that vehicle classes with weights greater than 16,000 lbs. have adjusted ratios less than 1.0 for state ratio and vehicles under 26,000 lbs. have federal plus state adjusted equity ratios greater than 1.0.

The scenario analysis demonstrates that a 25% increase in the diesel fuel tax is more effective at bringing the heavy vehicle equity ratios closer to 1.0 than a 25% increase in heavy vehicle fees. Both of these two policy scenarios are more effective at bring equity ratios closer to 1.0 for vehicles between 16,000 and 50,000 lbs., but adjusted equity ratios remain rather low for vehicles weighing more than 50,000 lbs.

The third "what-if" scenario examined equity ratios using weight-mile tax applied to vehicles weighing 57,000 lbs. and greater. The weight-mile tax rates were estimated by fitting a segmented regression model to the difference between the allocated cost per mile and current revenue per mile using registered gross vehicle weight categories. Equity ratios for heavy vehicle classes are closer to 1.0–in particular the equity ratio for five-axle tractor trailers is 1.03 under the weight-mile tax. However many vehicle classes still have equity ratios under 1.0.

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Appendix C: SRT Minutes

TEAM MEETING MINUTES: JUNE 1, 2016

1:00 p.m. to 3:00 p.m.
DAS Executive Building, First Floor 155 Cottage Street N.E. Salem, Oregon 97301-3966

Attendees:

Study Review Team Members

Waylon Buchan, Oregon Department of Transportation (for Jerri Bohard)
Gerik Kransky, Bicycle Transportation Alliance
Mazen Malik, Legislative Revenue Office
Mike McArthur, Association of Oregon Counties
Mark McMullen, Office of Economic Analysis (Chair, via phone)
Tim Morgan, AAA Oregon/Idaho
Don Negri, Willamette University
Bob Russell, Oregon Trucking Association

Support Staff and Friends of the SRT

Carl Batten, ECONorthwest
Craig Campbell, representing AAA Oregon/Idaho
Victor Dodier, Oregon Department of Transportation (retired)
Dan Hauser, Association of Oregon Counties
Lani Pennington, Oregon Department of Transportation
Amy Williams, Oregon Department of Administrative Services

Welcome, Introduction and Opening Remarks

The meeting began at 1:05 p.m. Mr. McMullen welcomed the Study Review Team (SRT) members and support staff. Participants introduced themselves. Mr. McMullen observed that while recent studies have been uncontentious, the next legislative session will include a transportation package which could bring more attention to the Study than it typically garners. He encouraged the team to focus on the core study and how it could help guide the legislature during the next session.

Review of Model Flowchart

Mr. Batten handed out the model flowchart for the Highway Cost Allocation Study (HCAS) and described how equity ratios are calculated from the allocated costs and attributed revenues. He then reviewed the list of allocators used in the 2015 Oregon HCAS and described them as the policy levers the SRT has the ability to change. It was asked whether local revenues are included in the revenue forecast. Mr. Batten said local revenues and expenditures are treated consistently with the way federal revenues and expenditures are treated. It was asked which allocator has the most elasticity or which work type had the largest dollar amount attached. Mr. Batten said for the 2015 Study, Administration (a grouping of administrative work types) was $762 million per biennium, followed by pavement maintenance at $444 million, other maintenance at $350 million, and modernization at $350 million. The total was $2.9 billion.
Mr. Batten said bonds are included but only one-tenth the dollar amount expended is allocated in the current study and another one tenth is allocated in each of the next nine studies. One-tenth of the total dollar amount is allocated in each two-year study because they are 20-year bonds. The allocation percentages are based on how the bond proceeds are spent in the study biennium in which they are spent and then then carried forward along with the dollars into future studies. Of the $434 million in bond expenditures counted in the 2015 Study, $390 million was from prior biennia that were allocated in previous studies.

Discussion of Potential Transportation Issues Facing the 2017 Legislature

Mr. McMullen brought up the issue of Initiative Petition (IP) 28, a ballot measure that would raise more than $6 billion in revenue each biennium for public education, healthcare and services for seniors. Oregon companies with more than $25 million per year in revenues would bear the new tax liabilities. If this measure passes in November it will have a big influence on the revenue side of the HCAS. Although the authors of the bill have dedicated the revenue to health services and education, it does not exempt revenue from the sales of motor fuels. Therefore, a large amount will have to go into the highway fund, because Article 9, Section 3a of the Oregon Constitution requires that revenues from taxes on motor fuel be dedicated to the highway fund.

If IP 28 passes it will go into effect in January of 2017, creating a revenue impact in the current biennium. The Legislative Revenue Office estimates that IP 28 would add $548 million in new revenue for the biennium ending June 30, 2017. Much of IP 28's impact will be due to stacking. The petroleum companies that sell motor fuel at the rack would be taxed and

then the receipts of the retailer would also be taxed. An IP 28 analysis would need to examine reduced VMT due to reduced economic activity. It was asked whether LRO could ask Legislative Counsel exactly what would be taxed under IP 28 and how this might affect the transportation arena. Another issue the SRT is not required to address but would be of interest to some people is the equity effects of local gas taxes and related revenue sources, which would require altering the model in order to produce results on a regional basis rather than statewide. Currently the Study does not attribute local revenues to vehicles but does allocate the expenditures of those revenues unless they are dedicated to a particular purpose. If the local government spends revenues in ways similar to the state then an increase will not make much difference, but if they spend revenues in different ways it could. However, it would take more than $30 million per year to do that. Local governments now are spending about $30 million per year of their own source money, $45 million per year of federal money, and $235 million per year of state money.

Starr McMullen, an Applied Economics Professor at OSU, performed research in which she found that the average miles per gallon for cars is 23.4 rather than 20. Ms. Pennington observed that the average car is almost 12 years old, so it may be worth examining how she determined that.

Discussion of Document Sharing Process and Future Meetings

It was agreed that DropBox would be used again for document sharing. Ms. Williams will notify participants via email when new documents are added. It was requested that the next meeting of the SRT include presentations from Dan Porter on the VMT and fuel tax forecast, and from Dave Ringeisen on the traffic data and the state of that data collection effort at ODOT. The SRT would also like Starr McMullen to attend and discuss her recent study, if possible.

The next meeting will be held at 1:00 pm on September 8th at the ECONorthwest offices located at 222 SW Columbia in Portland, Oregon.

Meeting adjourned: 2:35 p.m.

Follow-up

Dr. McMullen analyzed the 2013 Oregon Households Activity Survey (OHAS), a dataset collected by Oregon Department of Transportation (ODOT) between 2009 and 2011. The survey asked participants about their households, their vehicles, and their transportation options for various types of trips. It also asked them to record all travel activity for one day. After filtering out households based outside Oregon, who did not own any cars, or who did not drive on their survey day, responses from 14,389 households remained.

For each household, each vehicle's EPA combined city/highway mileage estimate from when it was new was weighted by that vehicle's miles to obtain a mileage-weighted arithmetic mean of miles per gallon. Miles per gallon across households were combined in a similar fashion to construct averages for geographic regions, income groups, and a statewide average of 23.4 MPG.

Unfortunately, the arithmetic mean of miles per gallon, even when weighted to account for differences in miles driven, does not measure the miles per gallon obtained by the fleet. One must first convert to gallons per mile, then take the average, and then convert back to miles per gallon.
An example: Assume two vehicles with individual MPGs of 10 and 40 mpg each drive 200 miles. One vehicle uses 20 gallons and the other uses 5 gallons. Together they travel 400 miles and use 25 gallons, for an average of 16 mpg. The average of their MPGs is 25 ((10+40)/2 = 25). Averaging MPGs will always overstate the MPG of the fleet. Averaging GPMs (GPM = 1/MPG) works correctly. ((1/10) + (1/40)) / 2 = 0.0625 GPM. 1/0.0625 = 16 MPG. The EPA uses the correct method for estimating fleet MPG.

TEAM MEETING MINUTES: SEPTEMBER 8, 2016

1:00 p.m. to 3:00 p.m.
DAS Executive Building, First Floor 155 Cottage Street N.E. Salem, Oregon 97301-3966

Attendees:

Study Review Team Members

Jerri Bohard, Oregon Department of Transportation
Gerik Kransky, Bicycle Transportation Alliance
Mazen Malik, Legislative Revenue Office
Mike McArthur, Association of Oregon Counties
Mark McMullen, Office of Economic Analysis (Chair)
Tim Morgan, AAA Oregon/Idaho
Don Negri, Willamette University
Bob Russell, Oregon Trucking Association

Support Staff and Friends of the SRT

Carl Batten, ECONorthwest
Waylon Buchan, Oregon Department of Transportation
Craig Campbell, representing AAA Oregon/Idaho
Victor Dodier, Oregon Department of Transportation (retired)
Josh Lehner, Office of Economic Analysis
Lani Pennington, Oregon Department of Transportation
Dan Porter, Oregon Department of Transportation
Dave Ringeisen, Oregon Department of Transportation
Amy Williams, Oregon Department of Administrative Services

Welcome, Introduction and Opening Remarks

The meeting began at 1:05 p.m. Mr. McMullen welcomed the Study Review Team (SRT) members and support staff. Participants introduced themselves. The minutes from the June 1, 2016 meeting received unanimous approval.
Prior to Mr. Ringeisen and Mr. Porter of the Oregon Department of Transportation (ODOT) discussing the Vehicle Miles Traveled (VMT) calculation process, estimate and forecast, Mr. Batten explained that VMT is important to the Highway Cost Allocation Study (HCAS) because costs are allocated and revenues are attributed based on vehicle classes, and VMT is the basis for the allocation of both.

ODOT's Traffic Counting and VMT Process

Mr. Ringeisen stated that all states are required to provide VMT figures to the Federal Highway Administration on an annual basis, which are based on traffic counts and road inventory data. Traffic counts are used for state planning, design and maintenance purposes, and to help local governments. A complete road inventory is required to make the calculation. This data is also used in an annual federal report issued to Congress.

ODOT's Highway Performance Monitoring System (HPMS) has specific rules to follow while doing traffic counts, including determining the number of counts by function or class on federal, state, local, and other public roads. There are 504 continuous counting sites, which record data 365 days per year. This includes 180 Automatic Traffic Recorder (ATR) sites, 22 Weigh-in-Motion sites, and 302 ramp metering sites. Along with the continuous count sites, there are about 9,500 short-term (48-hour) count sites, with 6,200 of these on State roads and 3,300 on non-State roads. Traffic counts on individual roads are updated every three years. The Federal Highway Administration reviews and certifies ODOT's processes and data annually.

ODOT's VMT Estimate and Forecast and Fuel Tax Forecast
Mr. Porter was asked to provide the SRT with a VMT estimate for 2015 and a forecast for 2018. Mr. Porter recently took on this function at ODOT and felt a change in methodology was necessary. In the past, a fuels-based approach had been used. Moving away from the fuels-based approach would align better with the VMT data, eliminate competing numbers, and correct for recent overestimation compared with the HPMS.

The 2015 estimate will still be made for three different classes of vehicles, and there will be no change in the methodology used for vehicles classified as Heavy (>26,000 lbs) or Medium-Heavy (10,000-26,000 lbs). For Light vehicles (<10,000 lbs), however, the estimate will be derived by taking the total HPMS mileage figure and subtracting out the results for heavy and medium-heavy vehicles.

Mr. Porter said the 2015 estimate for the statewide VMT is 36 billion miles. This includes heavy vehicles at 1.9 billion miles, medium-heavy vehicles at .8 billion miles, and light vehicles at 33.3 billion miles.

The 2018 forecast will still be made for three different classes of vehicle, but there will be changes to the methodology for determining each. For Heavy vehicles, the prior method had the Weight-Mile annual growth rate applied to the most recent heavy VMT estimate, but the new method will also add the Road Use Assessment fee mileage resulting in a combined Heavy VMT growth rate to apply to the most recent estimate. For Medium-Heavy vehicles, the prior method was to find a simple average of the forecast year's Light and Heavy vehicle growth rates. The new method will take an average of the last seven years' share of total VMT, which currently averages 2.2%. For Light vehicles, the prior method was to multiply taxable motor fuel gallons by the Light vehicle stock average fuel economy. For 2016, it will be assumed that the preliminary total VMT growth of 3.3% from January through June will continue and the calculation will be Light VMT = Total VMT – Heavy VMT - Medium-Heavy VMT. For 2017 and 2018, the Light VMT growth rate from the Road User Charge Financial Model will be used, making the 2017 rate 2.4% and the 2018 rate 1.5%.

The forecast for 2018 for the statewide VMT is 38.6 billion miles. This includes Heavy vehicles at 2 billion miles, Medium-Heavy vehicles at .9 billion miles, and Light vehicles at 35.7 billion miles.
Mr. Porter also provided an overview on motor fuel usage and efficiency. Motor fuel usage has increased at a fairly steady pace since the early 1980s, but saw a significant drop-off between 2007 and 2014. Initially it seemed to reflect the downturn in the economy, but it took much longer to bounce back.

When the 1980s and early 1990s were removed from the model, the forecast changed from continual growth in motor fuel consumption to one that has negative growth in motor fuel consumption beginning in 2020. The primary reason is that the fuel efficiency variable is more impactful than it was before. There is slowing employment and income growth, as well as higher fuel prices, which are all factors pushing fuel growth down. Fuel efficiency is a variable that will continue to grow well into the 2030s because the fleet takes so much time to turn over.

Status Report on Data Collection and Model Updating Efforts

Mr. Batten handed out the "HCAS Data Collection Status" spreadsheet and noted that all data has been received except for the transit bus VMT and the school bus VMT. When the final 2018 VMT forecast by weight class and functional class is complete it will be sent to Roger Mingo, who will then return a set of pavement cost factors that will be used to allocate the pavement cost. A few areas of the model will need to be audited and Mr. Batten will need to assign work types and bridge types to all the projects in the project data file from ODOT. His hope is for a preliminary model run on October 3. He said there are three issues for the SRT to discuss:

1. SB 810 program
2. HB 2345 biodiesel

   This needs to be quantified in the model because it should be allocating cost based on the actual miles but attributing revenue based on taxes paid. The tax has a sunset of January 1, 2020.
3. Measure 97

   Legislative Counsel examined how the fuel piece would be interpreted and advised Legislative Revenue that the only thing it applies to is fuel, not auto sales or insurance or anything else. It will probably attribute more revenue to Light vehicles but Heavy vehicles will be paying on the gallons. This would introduce a usage tax to Heavy vehicles. It was estimated that there could be as much as $700M in revenue per biennium generated as a result of this ballot measure passing.

   The issue of credit card fees was mentioned. The Motor Carrier Division used to pay the credit card fees when truckers would use credit cards, but that practice has stopped and the customers are now charged those fees in addition to the price. The Motor Carrier Division paid $2.1M last year in credit card fees. The Department of Motor Vehicles (DMV) also implemented credit card transactions and they are going to pay the credit card fees rather than asking the customers to pay. This has caused an increase to DMV costs but is built into the DMV's budget. This may be a large enough number to have an impact on the final ratios.

Future Meetings

The next meeting will be held at 1:00 pm on October 20, 2016, at the DAS Executive Building located at 155 Cottage Street NE, Salem, Oregon.

Meeting adjourned: 2:50 p.m.

TEAM MEETING MINUTES: OCTOBER 20, 2016

1:00 p.m. to 3:00 p.m.
DAS Executive Building, First Floor 155 Cottage Street N.E. Salem, Oregon 97301-3966

Attendees:

Study Review Team Members

Jerri Bohard, Oregon Department of Transportation
Mike Eliason, Association of Oregon Counties (for Mike McArthur)
Daniel Hauser, Association of Oregon Counties (for Mike McArthur)
Gerik Kransky, Bicycle Transportation Alliance (via phone)
Mazen Malik, Legislative Revenue Office
Mike McArthur, Association of Oregon Counties
Mark McMullen, Office of Economic Analysis (Chair)
Tim Morgan, AAA Oregon/Idaho
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Carl Batten, ECONorthwest
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Craig Campbell, representing AAA Oregon/Idaho
Josh Lehner, Office of Economic Analysis
Ralph Mastromonaco, ECONorthwest
Lani Pennington, Oregon Department of Transportation
Amy Williams, Oregon Department of Administrative Services

Welcome, Introduction and Opening Remarks

The meeting began at 1:05 p.m. Mr. McMullen welcomed the Study Review Team (SRT) members and support staff. Participants introduced themselves. The minutes from the September 8, 2016 meeting received unanimous approval pending one correction.

Preliminary Results

Mr. Batten presented the preliminary study results. The light vehicle equity ratio is .955. The key difference between the 2015 study and the study underway currently is in the allocation of the expenditure of federal funds. The federal fund expenditures allocated to light vehicles in the 2015 study was 57%, and in the current study is 69%. Mr. Batten is carefully reviewing all of the assignments to work types. The nature of the construction expenditures has changed somewhat since the last study, when there was more load-related bridge expenditure than this time. This time there is more culvert replacement, which is allocated in proportion to VMT since the cost of replacing the culvert is determined by the topography, streambed, etc. After the culvert is in place, the weights of the vehicles on the road do not matter. He noted that if 50 million federal dollars moved from light vehicles to the 78,000 to 80,000 pound weight class, a near-perfect equity would be reached.

There are approximately three billion more miles forecasted for 2018 than there were for 2016. The percentage attributed to light vehicles was 92.2% in the prior study but now it is 92.6%, indicating the number of light vehicles will grow faster than heavy vehicles. Analyzing weight-mile tax receipts and the number of trucks on the road indicates there is substantial truck traffic between California and Washington. The number of trucking companies and number of trucks located out of state have been consistent since 2008, but the number of trucking companies in Oregon has dropped from 9,500 to 7,500, and the number of trucks for in-state companies has also decreased.

Report Content and Format

Mr. Batten asked if anyone had comments or suggestions on the report based on previous reports. Mr. McMullen asked that the previous white paper on other states' HCAS be included as an appendix. Mr. Batten said the glossary will be updated, and the white paper on efficient fee pricing done for the previous study is still valid and may be useful to the legislature. The model methodology will need to be validated as changes are made and a new revenue instrument is added in order to factor in Measure 97, should it pass. The input and output templates and user manual will be updated to reflect easier ways of using the model.

Measure 97

The SRT noted that $500 million per biennium is required to be in the highway fund, with the vast majority of this coming from light vehicles due to the retail fuel tax. The SRT discussed various recommendations that could be made to the Legislature if Measure 97 passes. The weight-mile tax could be increased to a $700 million tax to make it equitable again, or lower the gas tax until the Measure 97 gross receipts tax is offset.

It was noted that there have been a number of recent opinions from the Attorney General and Legislative Counsel regarding the highway fund, some addressing Measure 97 and others addressing the use of highway fund dollars to clean up vehicle emissions. Measure 97 might also call attention to corporations that deal with fuel and should have had a portion of their tax revenue going into the highway fund as well. The opinion from Legislative Counsel said the Measure 97 tax on the sale of vehicles and car insurance would not be dedicated to the highway fund. Providing the Legislature with information about how the HCAS works might be helpful. Any revenue will be impacted by how the money is allocated between cars and trucks. The possible solutions include either decreasing automobile taxes, increasing truck taxes, or a combination of the two. Providing the Legislature with scenarios may also be useful. It was added that Measure 97 is not subject to the split between cities, counties and state.

Regarding gasoline sales in Oregon, 85% occurs at gas stations and the other 15% at grocery stores. The share of grocery store receipts that are gas-related is unknown at this time. It would need to be determine how to require grocery stores to account for what percent of sales is gas or diesel. It also needs to be determined how the minimum payment for C corporations that sell fuel today will be handled if Measure 97 does not pass. It would need to go to the highway fund.

If Measure 97 fails, there will be a $1.5 billion budget shortfall and the Legislature will need to do something about it, so flexibility in the model is necessary. There could be a gross receipts tax or value added tax. As long as it could be converted to a per-gallon rate that would apply to all gallons, the change in the model would handle it. Mr. Batten is adding a new column in the instruments table where a cents-per-gallon tax equivalent would be specified and then that would be applied to all gallons based on weight categories.

Credit Card Fees

Motor Carrier had been paying $2.1 million per year in customer credit card fees, but then changed its policy and now passes the fee on to the customer. The Department of Motor Vehicles also implemented credit card transactions but decided to absorb the fee. Dan Porter will need to explain how that is shown in his numbers.

Future Meetings

The next meeting will be held at 1:00 pm on November 17, 2016, at the ECONorthwest offices located at 222 SW Columbia in Portland, Oregon.

Meeting adjourned: 2:28 p.m.

TEAM MEETING MINUTES: NOVEMBER 17, 2016

1:00 p.m. to 3:00 p.m.
DAS Executive Building, First Floor 155 Cottage Street N.E. Salem, Oregon 97301-3966

Attendees:

Study Review Team Members

Jerri Bohard, Oregon Department of Transportation
Mazen Malik, Legislative Revenue Office
Mark McMullen, Office of Economic Analysis (Chair)
Don Negri, Willamette University (via phone)
Bob Russell, Oregon Trucking Association

Support Staff and Friends of the SRT

Carl Batten, ECONorthwest
Waylon Buchan, Oregon Department of Transportation (via phone)
Craig Campbell, representing AAA Oregon/Idaho
Ralph Mastromonaco, ECONorthwest
Lani Pennington, Oregon Department of Transportation
Amy Williams, Oregon Department of Administrative Services

Welcome, Introduction and Opening Remarks

The meeting began at 1:00 p.m. Mr. McMullen welcomed the Study Review Team (SRT) members and support staff. Participants introduced themselves. The minutes from the October 20, 2016 meeting received unanimous approval pending one correction.

Discuss Final Model Results and Recommendations

Mr. Batten discussed the final model and the changes made. He increased the assumed percentage of empty log truck miles from 50% to 55% to be consistent with ODOT's flat-fee study. He also changed the allocator for work type number 24, which had been an "other construction" work type to an "other construction" allocator. He also applied updated pavement cost factors from Roger Mingo and verified the credit card fees were being handled appropriately for both motor carrier and the DMV. In addition, he fixed the effective use fuel tax credit for vehicles under 26,000 pounds so B-20 biodiesel is exempt from the fuel tax for those vehicles, and Dan Porter explained how many gallons that represented out of the total gallons. Mr. Batten and his team determined that means those vehicles are paying 27.6 cents per gallon for diesel. He also built into the model the capability to handle a gross receipts tax that affects motor fuels, which could be used if a sales tax is ever applied to motor fuels.

In comparison to the 2015 Study, the two items that made a difference were the "other construction" allocator on work type 24, and replacing culverts where the project description did not indicate it was due to fish.
It was observed that a size and weight component had been interjected into culverts, but culverts are not built any differently because they are being used by trucks. Culverts are becoming a large expense, and this is the first time culverts are being allocated based on something other than VMT. By categorizing them as "other construction," it implies culverts are designed and built differently because there are trucks on the roadway. Ms. Bohard offered to have Paul Wirfs, ODOT's geo-environmental manager, write a paper explaining how culverts are designed. She might also have him attend the next meeting of the SRT. The SRT also asked that Roger Mingo explain the changes in the Highway Performance Monitoring System data and Weigh-in-Motion data provided to him, which lets him see the number of axles in each operating weight class and the different axle spacing.

SRT's Recommended Improvements for HCAS Report Based on 2015 Report

The SRT would like to include the 2015 white paper on comparative HCAS studies in other states. They would also like to see a short explanation of the differences between the 2015 and 2017 studies.

Future Meetings

The next meeting will be held at 10:00 am on December 22, 2016, at the DAS Executive Building located at 155 Cottage Street NE, Salem, Oregon.

Meeting adjourned: 2:05 p.m.

TEAM MEETING MINUTES: DECEMBER 22, 2016

10:00 a.m. to 12:00 p.m.
DAS Executive Building, First Floor 155 Cottage Street N.E. Salem, Oregon 97301-3966

Attendees:

Study Review Team Members

Jerri Bohard, Oregon Department of Transportation
Mike Eliason, Association of Oregon Counties (for Mike McArthur) Daniel Hauser, Association of Oregon Counties (for Mike McArthur) Gerik Kransky, Bicycle Transportation Alliance
Mazen Malik, Legislative Revenue Office
Mark McMullen, Office of Economic Analysis (Chair)
Tim Morgan, AAA Oregon/Idaho
Don Negri, Willamette University
Bob Russell, Oregon Trucking Association

Support Staff and Friends of the SRT

Carl Batten, ECONorthwest
Waylon Buchan, Oregon Department of Transportation
Josh Lehner, Office of Economic Analysis
Lani Pennington, Oregon Department of Transportation
Amy Williams, Oregon Department of Administrative Services

Guests

Gregory Jolivette, Legislative Fiscal Office
Patrick Brennan, House Transportation Policy Committee and Senate Business and Transportation Committee

Welcome, Introduction and Opening Remarks

The meeting began at 10:05 a.m. Mr. McMullen welcomed the Study Review Team (SRT) members, guests and support staff. Attendees introduced themselves. The minutes from the November 17, 2016 meeting received unanimous approval.

Final Results

Mr. Batten presented the final results to the SRT and stated the equity ratio for light vehicles is 1.0076. It had been previously agreed upon that if the final result is between .95 and 1.05, it is within the margin of error for the various forecasts included in this process.

Two issues that arose at the last SRT meeting, which Mr. Batten addressed via email, related to culverts and the share of local government expenditures allocated to heavy vehicles. Regarding culverts, ODOT confirmed that the weight of the vehicles traveling on the roadway over the culvert does not influence the cost of the culvert itself, but in order to replace the culvert they have to remove the roadway above it. Based on the bid breakdowns on culvert projects since 2012, 12% of the cost of a culvert project goes toward pavement. As a result, Mr. Batten recommends allocating 12% of culvert costs to “Pavement” and the rest to “All VMT.”

Regarding the issue of the share of local government expenditures allocated to heavy vehicles, 33% of state expenditures, 35% of federal expenditures, and almost 51% of local expenditures were allocated to heavy vehicles. When the VMT is distributed to the different ownerships and functional classes, the roads owned by local governments do not receive a very large share of heavy vehicle traffic. However, local governments spend a much higher portion of their budgets on pavement than the state does (69% vs. 22%), and the roads owned by local governments are typically less durably constructed than the interstate freeways and highways owned by the state. As a result, when heavy trucks use them, they impose a higher share of wear and tear. It was suggested that this should receive further exploration during the 2019 HCAS since the amount of local expenditures allocated to heavy vehicles rose from 41% during the 2015 study to almost 51% during the current study. ODOT could perform some analysis on the HPMS data. Ms. Bohard requested that a meeting to discuss additional research needs occur soon to allow ODOT time to plan for them.

Before finalizing the HCAS report, Mr. Malik and Ms. Pennington will test the model to ensure its accuracy. In addition, the 2015 white paper on studies in other states will be included as an appendix to the report, and the model documentation and glossary will be updated.

ODOT requested that Chapter 7 of the report include the recommendations they will be making for flat fee rate adjustments. These recommendations are the rates that would have achieved equity in 2015 had they been charged to flat fee paying vehicles, so the data is actual and therefore slightly different than the forecasted data typically used in the HCAS report. Mr. Batten asked the SRT whether to omit the forecasted data in this section to eliminate any confusion for those reading the report. The SRT recommended explaining in the report that the figures were provided by ODOT and include a footnote on the same page indicating what the flat fee rates would be if the Schedule A and B rates were changed as the SRT recommends.

Mr. Batten indicated the final draft of the report should be ready during the first week of January, which would allow distribution to the Transportation Commission before its meeting on January 19.

Mr. Batten reviewed the slides reviewing the history, purpose and methodology of the HCAS, which will be shown to the legislative committees, and discussed what is typically explained to the committees. There are seven new members on the House Transportation Committee and it will likely be March or later before it is prepared to hear about this study. The next meeting of the SRT is tentatively scheduled for January 17. It will be determined within the next few weeks whether that meeting needs to take place.

It was suggested there be a white paper on implications associated with self-driving vehicles during the 2019 HCAS. Transportation services such as Uber and Lyft could also be included. Mr. Batten requested that any potential white papers be included in the RFP to help consultants line up sub-consultants with expertise in those areas.

Future Meetings

A final meeting of the SRT will be held, if necessary, at 10:00 am on January 17, 2017, at the ECONorthwest offices located at 222 SW Columbia in Portland, Oregon.

Meeting adjourned: 11:03 a.m.

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Appendix D: Model User Guide

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1. INTRODUCTION

The 2017 Oregon Highway Cost Allocation Study (HCAS) Model User Guide describes the steps required to update and run the 2017 version of the Oregon HCAS Model. A user should be able to modify the model assumptions and update the input data and then rerun the model with the information in this user guide, along with instructions in the model tabs.

Section 2, Model Overview and Summary, provides a general overview of the HCAS model and describes the input data structure.

Section 3, System and Software Requirements, describes the computer system requirements and software required to run the model.

Section 4, Initial Model Setup, describes the model distribution and its folder and file setup.

Section 5, Install Python and Openpyxl, describes how to install Python 2.7 and Openpyxl on a Windows operating system.

Section 6, Set Up a New Scenario, describes how to set up a new scenario to run the Python HCAS model on (e.g., if the user wants to use different inputs and/or assumptions).

Section 7, Run the HCAS Python Model describes how to run the HCAS Python model using a Graphic User Interface (GUI) for Python.

Section 8, Input Data and Data Preparation, describes the data and any data pre-processing required to update the HCAS model.

Section 9, Input Text Files, describes the input text files. Each input file is described in terms of the file contents and the data required to update the input text file.

Section 10, Inputs Workbook, describes the inputs workbook. The tab-by-tab explanation of the model displays a screen shot of the model tab, and then describes the contents of the tab, how the data on the tab are used in the model, and the process for updating the data and other user-specified assumptions.

Section 11, Output Files, guides the user through the outputs workbook and output text files.

Section 12, Policy Analysis of Alternative Rates, is a user guide for an alternative rate analysis using the HCAS model. This section describes the various revenue instruments of the model, along with how alternative rates for each instrument will affect the HCAS model results. The *Alt. Rates* input tab and *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary* output tabs are explained in a tab-by-tab fashion. This section also has case studies that provide step-by-step examples of how to conduct an alternative rates analysis for different revenue instruments.

2. MODEL OVERVIEW AND SUMMARY

The purpose of the HCAS is to determine whether each class of highway users is paying its fair share. Paying one's fair share is defined as contributing the same share of total revenues as the share of costs that one imposes.

The HCAS model calculates each user class's share of costs and then the user class's share of revenues to calculate equity ratios for each user class. Equity ratios close to one indicate that the user class is paying its fair share of costs. An equity ratio less than one indicates the user class is paying less than its share of costs, and an equity ratio greater than one indicates the user class is paying more than its share of costs.

The 2017 Oregon HCAS model is written in Python and requires data inputs in the form of an input Excel workbook and input text files. The input workbook is the user interface for updating data and assumptions used in the model calculations. An output workbook and text files are the result of running the HCAS model.

The 2017 Oregon HCAS model differs from the model structure used in the 2013 HCAS in terms of how the HCAS Python model is actually run and how the folders and files are structured. However, the core of the HCAS Python model and the required inputs and outputs remain unchanged. In the 2013 HCAS, there was one Excel workbook that had both input and output workbook tabs and had Visual Basic Application (VBA) code that called the HCAS Python model code.

Since the 2015 HCAS, the user runs the HCAS Python model through a Python Graphic User Interface (GUI) (steps to run a Python file are discussed in-depth in Section 7, Run the HCAS Python Model). This allows the model to be more interchangeable between operating systems and improves reliability of outputs. Another change is that instead of one large workbook with input and output tabs, there are two separate workbooks; one for the inputs (*"HCAS Inputs.xlsx",* oftentimes referred to as the "inputs workbook") and one for the outputs (*"HCAS Outputs.xlsx",* often referred to as the

"outputs workbook"). The change from one workbook to two workbooks provides more clarity on the model input-output process.

Model assumptions and many data inputs are located in the inputs workbook. The workbook is described in detail in Section 10, Inputs Workbook. The rest of the input data are in the input text files. These files are described in detail in Section 9, Input Text Files.

The tabs in the inputs workbook are oriented from left to right, with the main control and assumption tab (*General*) at the far left, followed by the tabs for VMT inputs, cost inputs, revenue inputs, and other inputs (e.g., *MPG*, *Policy*).

To update and run the model, the user edits the model input data, parameters and assumptions as needed, saves the inputs workbook and then runs the Python HCAS model code. Instructions to run the Python HCAS model code are provided in Section 7, Run the HCAS Python Model.

Running the HCAS Python model code will read in the data from the inputs workbook and the input text files. Using these data, the HCAS model will perform the VMT analysis, cost allocation, revenue attribution, and alternative rates revenue attribution calculations. The HCAS model will then generate a set of output text files in an outputs folder and populate an outputs Excel workbook with the HCAS model results. Section 11, Output Files, describes these output files. The structure of the Python code and model calculations are provided in Appendix E.

3. SYSTEM AND SOFTWARE REQUIREMENTS

This section describes the computer system and software requirements to update and run the HCAS model.

As noted in Section 2, Model Overview and Summary, the 2017 Oregon HCAS model is a model written in Python that requires data inputs in the form of an input Excel workbook and input text files. The model also requires these input files along with an output template Excel workbook to be in a particular folder setup. This section discusses the system and software requirements for the model. The following section discusses the distribution format of the model and the folder and file setup for the model.

SYSTEM AND SOFTWARE REQUIREMENTS

The HCAS model can be updated and run using standard computer software and available open-source programming software. The user must install the requirements listed below prior to implementing the HCAS model.

System Requirements

The HCAS model works on Windows and Macintosh Operating Systems. The steps outlined in Section 5, Install Python and Openpyxl, provide screenshots of the process to install Python on a computer running Windows 7. The process may look different if the user is running a different version of Windows.

Excel

The HCAS model requires Excel input and output workbooks using a version of Microsoft Office Excel 2007 or later. The file extension format of all Excel workbooks is ".xlsx."

Python

Python is an open-source, object-oriented programming language. The user must download and install the Python software maintained by the Python Software Foundation.[1] The user must also install the Python package Openpyxl that is used to read and write Excel workbooks.[2] (See Section 5, Install Python and Openpyxl.)

Text Editor

A text editor or Excel can be used to view input and output tab-deliminated text files.

Database Software

Pre-processing of some of the original data files must be done outside of the HCAS model due to the size of the data sets or the type of data tabulations. The pre-processing can be done using desktop database software such as PostgreSQL or Microsoft Access. PostgreSQL is an open-source object-relational database management system (DBMS) that supports the SQL programming language.

[1] Python can be downloaded from: http://www.python.org/download. The Python Software Foundation website also contains documentation and other related material. Instructions on how to install Python 2.7 are provided in Section 5, Install Python and Openpyxl. The user should consult the Python documentation for additional information on how to install the program and open the Python editor.

[2] Openpyxl can be downloaded using Pip, a Python package installer or can be downloaded directly from https://pypi.python.org/pypi/openpyxl. Pip is automatically installed in the default installation of Python 2.7.9 from the Python Software Foundation. More detailed instructions on how to install Openpyxl are provided in Section 5, Install Python and Openpyxl and the model distribution's README.rtf.

4. INITIAL MODEL SETUP

MODEL DISTRIBUTION

The 2017 HCAS model is available to download in a ZIP archive file format ("2017 Oregon HCAS Model.zip"). Unzipping this file will automatically set up the correct folder structure and includes all of the 2017 HCAS input files that are required to run the model.

INITIAL FOLDER AND FILE SETUP

First, the user must unzip the model distribution file, "2017 Oregon HCAS Model.zip." This can usually be done by double clicking on the file. Doing this will create a new folder, "2017 Oregon HCAS Model." Figure 1 shows the original ZIP file and the result of unzipping the ZIP file.

Figure 2 shows the first level folders of the "2017 Oregon HCAS Model" folder (this may be referred to as the "base model folder"). The base model folder has four first level folders: *src*, *processed scenarios, scenarios*, and *template_outputs*. There is also a README.pdf text file that has general instructions on how to run the model on a Windows Operating System. Figure 3 shows the contents of these four folders.

src

The src folder contains "HCASModule.py", a Python file that contains the HCAS model code and is what the user will open to run the HCAS model. Executing this file will run the HCAS model code that performs the model calculations (e.g., VMT analysis, cost allocation and revenue attribution). Section 7, Run the HCAS Python Model, describes how to open this file and run the HCAS model in Python. The user should not make any modifications to files in the src folder.

scenarios

The *scenarios* folder is a place to put scenarios that the user is actively working on (i.e., scenarios the user wants to run through the HCAS model). Each scenario will have its own folder in the *scenarios* folder (this folder can be named whatever the desired scenario name is).

The 2017 HCAS scenario is provided in the standard model distribution in the folder entitled "*2017_final*." The contents of this folder are illustrated in Figure 4. As illustrated in the 2017 final scenario, the scenario folder must have an inputs folder. The *inputs* folder must have an Excel inputs workbook and a folder entitled *txt_2015*. All of the input text files should be placed in the *txt* folder.

Figure 4 shows the required structure for the *inputs* folder along with the required filenames. The Excel inputs workbook should be entitled "HCAS Inputs.xlsx" and the input text files must have specific names (see names listed in the *txt_2015* folder in Figure 4).

The *2017_final* folder and its inputs folder also serves as a template that the user may use as a starting point to create the scenario the user wants to run. The primary HCAS model user interface to change assumptions and input data is the Excel inputs workbook, "HCAS Inputs.xlsx". (See Section 6, Set Up a New Scenario for more information).

Figure 1. Model Distribution Files

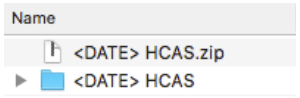


Figure 2. Model Base Folders

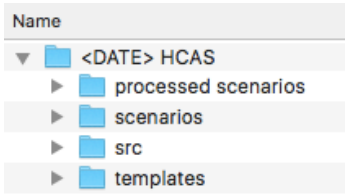


Figure 3. Model Base Folder Contents

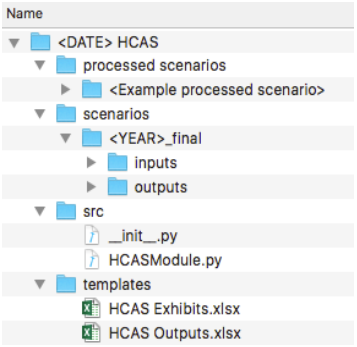
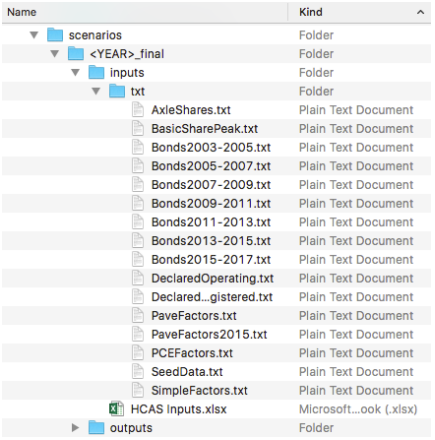


Figure 4. Scenario Input Files



processed scenarios

Once the user runs a scenario through the HCAS Python model and is satisfied with the model results, the user should move the scenario's folder from the *scenarios* folder to the *processed scenarios* folder. The user may click on the folder and drag it from the *scenarios* folder to the *processed scenarios* folder. Alternatively, the user may open the *scenarios* folder, right click on the scenario's folder and select "Cut." The user should then open the *processed scenarios* folder, right click and select "Paste." (See Section 6, Set Up a New Scenario for more information).

template outputs

The *template outputs* folder has one file, an Excel workbook "HCAS Outputs.xlsx." This workbook serves as a template workbook with some basic text and header formatting, but does not have HCAS model output data. The user should not make any modifications to template Excel workbook in the *template outputs* folder.

When the user runs the HCAS Python model for a scenario, this template workbook, "HCAS Outputs.xlsx", is copied into the scenario's *outputs* folder and is filled with the results of the HCAS model for that scenario.

The scenario's name is added to the filename. For example, if the scenario's folder name is "Final", a result of running the model is the creation of a new workbook in the *outputs* folder entitled, "HCAS Outputs Final.xlsx." Similarly, if the scenario's folder name is "Scenario 1", the result of running the model is the creation of a new workbook entitled "HCAS Outputs Scenario 1.xlsx."

5. INSTALL PYTHON AND OPENPYXL

The user should complete the steps outlined in this section to install Python 2.7 and Openpyxl on the user's operating system.

These instructions are for a Windows 7 operating system. The general steps should be the same for other Windows operating systems, but some things may differ. For example, the way to search for a program or the way the window screen looks may differ from the directions provided in this user guide.

1. INSTALL PYTHON 2.7

This sub-section describes the steps to install Python 2.7. If the user already has Python 2.7 installed, the user may try to skip to the following sub-section, 2. Install Openpyxl.

If the user runs into issues later on when trying to install Openpyxl or running the HCAS Python model, reinstalling a new, clean version of Python 2.7 by following these steps may resolve those issues.

Steps:

- Step 1.1: Go to "https://www.python.org/downloads/windows/" and download the latest Python 2 Release. This will lead you to a page with a list of files. Download the Windows x86 MSI installer. This should download a file entitled, "python-2.7.13.msi. Open this file.
- Step 1.2: A Python 2.7.9 Setup window (similar to the one displayed in Figure 6, on the previous page) should open up. In the Python 2.7.9 Setup window, select the option "Install for just me (not available on Windows Vista)." Click "Next."

Figure 5. Step 1.1: Open python-2.7.9.msi

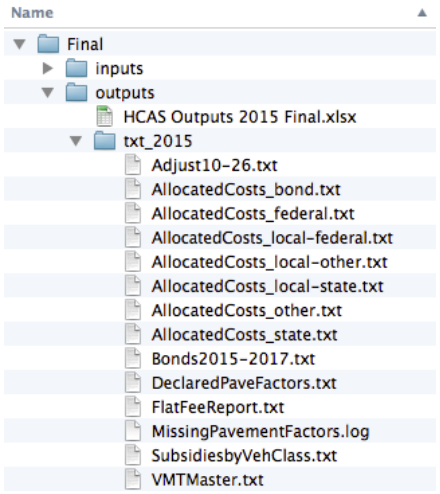
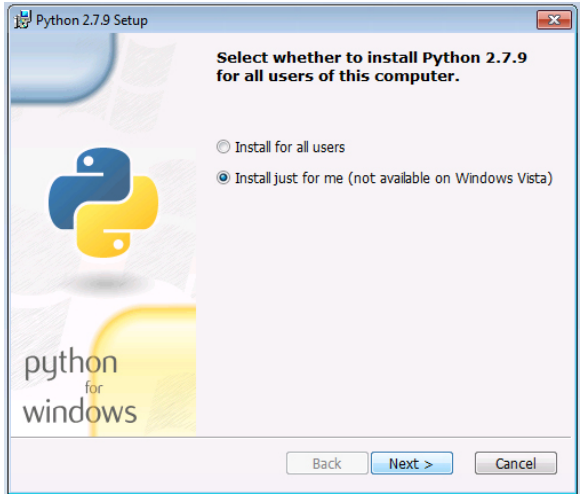
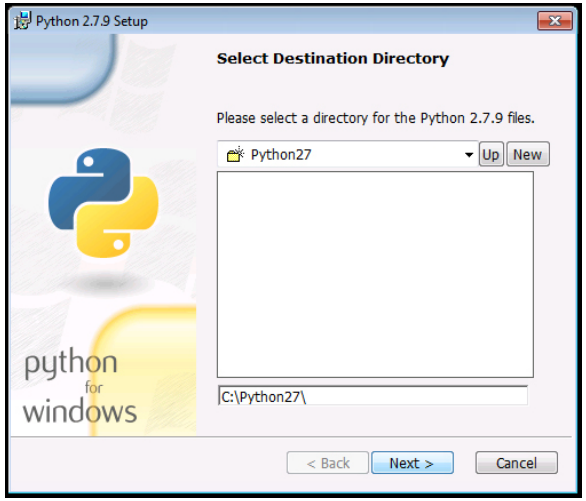


Figure 6. Step 1.2: User Install Options



- Step 1.3: The next window sets up the installation directory for Python 2.7 (see Figure 7). The installer should automatically select the correct folder to install Python 2.7 in. The default installation location is "C:\Python\27". If the text in the bottom-most white text box does not say "C:\Python\27", modify the text in the box so that it says "C:\Python\27". Click "Next."

Figure 7. Step 1.3: Directory Install Options



- Step 1.4: The next window will start the installation of Python 2.7 (see Figure 8). Wait until the installation finishes. This may take a couple minutes, and there may be some additional windows that pop up during the process. If a window pops up asking whether the user wishes to continue with the installation, the user should click "Yes" to continue. An example of what this type of window might look like is illustrated in Figure 9. Another window that looks similar to the window illustrated in Figure 10 (on the following page) may also pop up - this window will open and close automatically, the user should not try to close this window.

Figure 8. Step 1.4: Start Installation

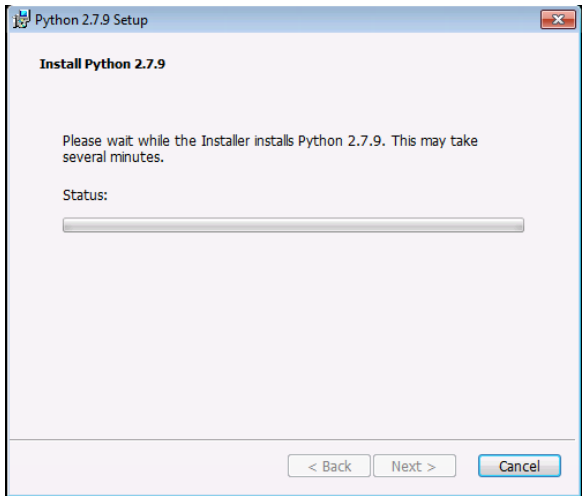


Figure 9. Step 1.4 (Example): Popup Window

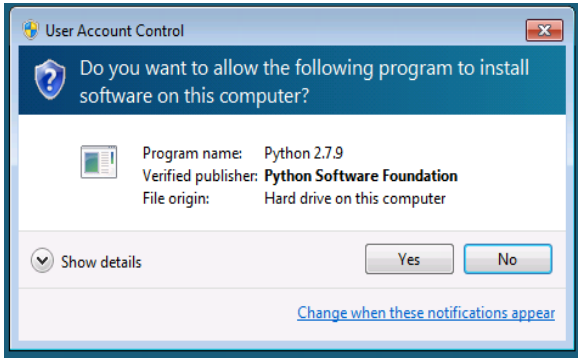


Figure 10. Step 1.4 (Example): Popup Window

- Step 1.5: The installation has finished when the "Finish" button option becomes an available option to click on (see Figure 11). Click "Finish."

Figure 11. Step 1.5: Finish Installation

2. INSTALL OPENPYXL

The following steps walk the user through installing Openpyxl. Openpyxl is a Python package that reads and writes Excel files. It is easiest to install through Pip, a Python package manager that is automatically installed when the user installs Python 2.7 using the default installation options. The steps provided in the previous sub-section, 1. Install Python 2.7, install the default version of Python 2.7.

It is recommended to try to install Openpyxl using Pip. Installing Openpyxl through Pip requires the user to use a Windows program called Command Prompt.

If the user already had an existing version of Python 2.7 and did not do a new installation, the existing version of Python may not have Pip installed. If the existing version does not have Pip installed, the user will run into an error during Step 2.5. If this occurs, the user should try installing the default version of Python 2.7 using the directions provided in the previous sub-section, 1. Install Python 2.7.

Steps:

- Step 2.1: Click on the Start menu (e.g., the Windows Logo Icon in the bottom-left corner of the computer screen, see Figure 12). In the Start menu, click on "Search for programs and files" (see Figure 13). In this box, type "Command Prompt".
- Step 2.2: Typing "Command Prompt" into the search box should change the menu to look similar to Figure 14. Click on the listing for "Command Prompt" under "Programs".
- Step 2.3: Clicking on Command Prompt should open a window that looks similar to the one illustrated in Figure 15 (on the previous page). What is printed in the window when the user opens it may vary by computer. For the purposes of installing Openpyxl, it should be fine if what is displayed in the user's window differs from what is illustrated in the figure.

Figure 12. Step 2.1: Windows Start Menu Icon

Figure 13. Step 2.1: Search for Program

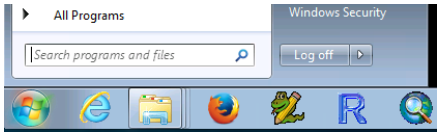
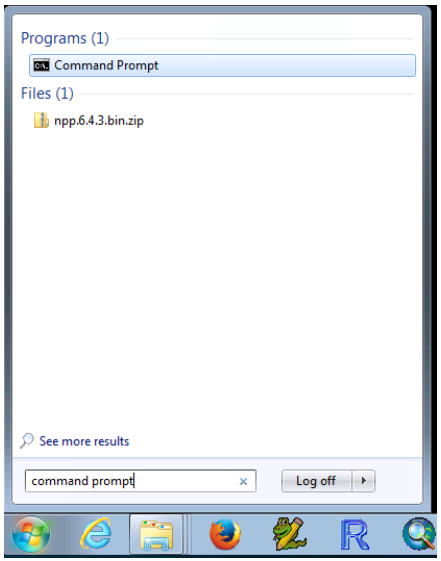


Figure 14. Step 2.2: Search Results



- Step 2.4: In the Command Prompt window, the user should type the following:

  C:\Python27\Scripts\pip.exe install openpyxl==2.4.2

  Note: The only spaces are between "exe" and "install", and between "install" and "openpyxl".

  Figure 16 illustrates how this command looks on the Windows computer used for this guide. Once the user has typed the command, the user should press Enter (or Return).
- Step 2.5: After the user presses Enter, Openpyxl should start to download. If the user installed Python 2.7 following the steps in the previous sub-section, this command should work and the result of pressing Enter should look something like the output in Figure 17 (on the following page), with the end result being the successful installation of Openpyxl.

Figure 15. Step 2.3: Open Command Prompt

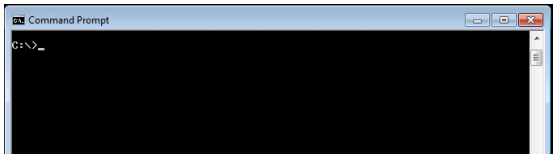


Figure 16. Step 2.4: Command to Install Openpyxl

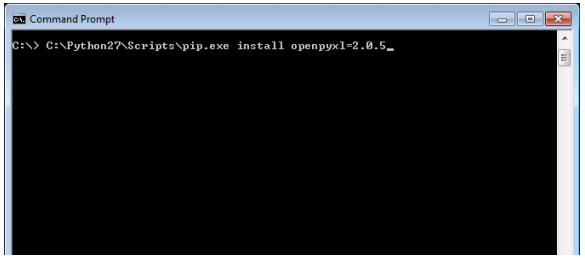
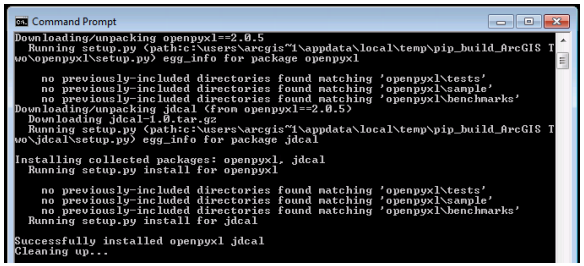


Figure 17. Step 2.5: Installation of Openpyxl



Troubleshooting: If the output in the Command Prompt window does not look like that displayed in Figure 17, (e.g., the user does not see something along the lines of "Successfully installed openpyxl", "Cleaning up..."), the user may need to reinstall the default installation of Python 2.7. The user should try deleting their current version of Python 2.7, located in the "My Computer" folder (i.e., the "C" folder), and then reinstalling a new, default installation of Python 2.7 by following the steps listed in the previous sub-section, 1. Install Python 2.7. However, if the user uses Python for a different project, the user should contact the appropriate parties to make sure deleting the version of Python the user has installed doesn't cause other problems.

6. SET UP A NEW SCENARIO

If the user wants to run a new scenario (e.g., entitled "Scenario 1" in this guide) where the user may see what happens under different model assumptions, the user may create a new folder in the *scenarios* folder. This guide uses the name "Scenario 1" as an example. The user may rename this folder any name they want. Figure 18 shows where in the folder structure the user should create the new folder. The easiest way to set up a new scenario is to copy the *2017_final* folder and then rename the copy *Scenario 1* (or any other scenario name). The user may then open "HCAS Inputs.xlsx" in the *inputs* folder and change assumptions and inputs in that workbook. The user should then resave it, and run the HCAS Python model. Figure 19 shows all of the required input files and their placement within the *Scenario 1* folder. While the actual folder names in the *scenarios* folder may change (e.g., the folder names in the *scenarios* folder in Figure 18 could just as easily be "Final" or "Scenario One"), it is important that the user does not change the file names in the *inputs* folder (i.e., the user should not change the names of the input text files or the name of the inputs Excel workbook).

Figure 18. Add a New Scenario Folder

Name	Kind
2015 Oregon HCAS Model	Folder
code	Folder
processed scenarios	Folder
scenarios	Folder
Example Scenario	Folder
Scenario 1	Folder
template_outputs	Folder
README.rtf	Rich Text Document

Figure 19. Add New Scenario Input Files

Name	Kind
Example Scenario	Folder
Scenario 1	Folder
inputs	Folder
HCAS Inputs 2015.xlsx	Microsoft Excel workbook
txt_2015	Folder
AxleShares.txt	Plain Text Document
BasicSharePeak.txt	Plain Text Document
Bonds2003-2005.txt	Plain Text Document
Bonds2005-2007.txt	Plain Text Document
Bonds2007-2009.txt	Plain Text Document
Bonds2009-2011.txt	Plain Text Document
Bonds2011-2013.txt	Plain Text Document
Bonds2013-2015.txt	Plain Text Document
DeclaredOperating.txt	Plain Text Document
DeclaredRegistered.txt	Plain Text Document
PaveFactors.txt	Plain Text Document
PCEFactors.txt	Plain Text Document
SeedData.txt	Plain Text Document
SimpleFactors.txt	Plain Text Document

When the user runs the HCAS Python model, the model will create an outputs folder that it will fill with all of the model outputs. Figure 20 shows the file structure and files that will be created when the model is run. Section 7, Run the HCAS Python Model describes how to run the model.

Once the user is satisfied with the model outputs, the user may move the *Scenario 1* folder from the *scenarios* folder to the *processed scenarios* folder. Figure 21 shows the result of moving the *Scenario 1* folder to the *processed scenarios* folder.

Figure 20. New Scenario Output Files

Name	Kind
Example Scenario	Folder
Scenario 1	Folder
inputs	Folder
outputs	Folder
HCAS Outputs 2015 Scenario 1.xlsx	Microsoft Excel workbook
txt_2015	Folder
Adjust10-26.txt	Plain Text Document
AllocatedCosts_bond.txt	Plain Text Document
AllocatedCosts_federal.txt	Plain Text Document
AllocatedCosts_local-federal.txt	Plain Text Document
AllocatedCosts_local-other.txt	Plain Text Document
AllocatedCosts_local-state.txt	Plain Text Document
AllocatedCosts_other.txt	Plain Text Document
AllocatedCosts_state.txt	Plain Text Document
Bonds2015-2017.txt	Plain Text Document
DeclaredPaveFactors.txt	Plain Text Document
FlatFeeReport.txt	Plain Text Document
SubsidiesbyVehClass.txt	Plain Text Document
VMTMaster.txt	Plain Text Document
MissingPavementFactors.log	Log File

Figure 21. Move New Scenario Folder

Name	Kind
code	Folder
processed scenarios	Folder
Scenario 1	Folder
scenarios	Folder
Example Scenario	Folder
template_outputs	Folder
README.rtf	RTF Document

7. RUN THE HCAS PYTHON MODEL

The steps outlined in this section may need to be repeated each time the user wants to run a scenario through the 2017 Oregon HCAS Model.

If the user does not have an IDLE window open, the user should start at 1. Open IDLE. If the user already has an IDLE window open, the user should start at 2. Run the HCAS Python Model.

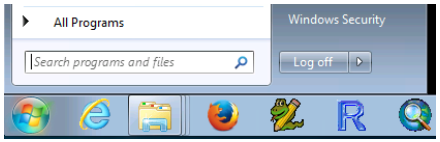
1. OPEN IDLE

Once the user has Python and Openpyxl installed, the user is ready to run the HCAS Python model. The most straightforward way to run the HCAS Python model is through a graphical user interface (GUI) for Python. IDLE is a standard Python GUI that works on Windows, Mac OS X, and Unix.[3] IDLE should be automatically installed when the user installed a new version of Python 2.7 by following the steps in Section 5, Install Python and Openpyxl.

Steps:

- Step 1.1: Click on the Start menu (e.g., the Windows Logo Icon in the bottom-left corner of the computer screen). In the Start menu, click on "Search for programs and files" (see Figure 22). In this box, type "IDLE".

Figure 22. Step 1.1: Search for IDLE



- Step 1.2: Typing "IDLE" into the search box should change the menu to look something like what is illustrated in Figure 23. There may be more than one listing for IDLE, as illustrated in the figure. Click on any one of the listings for "IDLE" under "Programs".
- Step 1.3: Clicking on IDLE should open a window that looks similar to the one illustrated in Figure 24.

Figure 23. Step 1.2: Search Results for IDLE

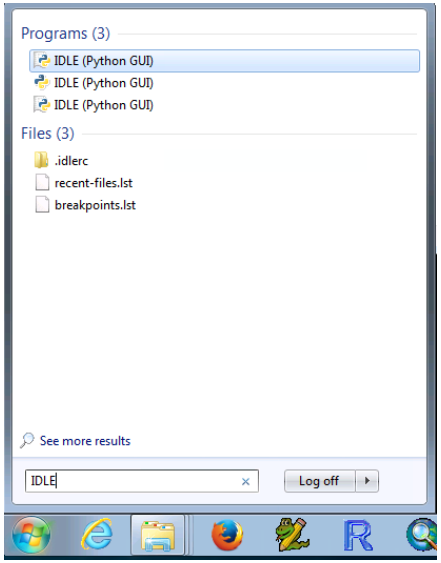
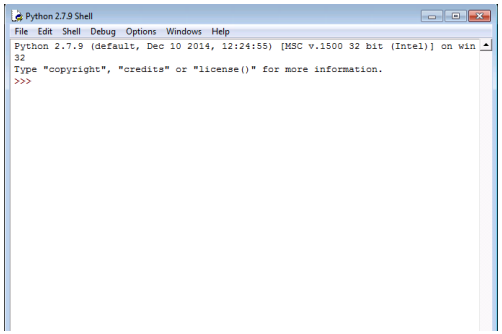


Figure 24. Step 1.3: Open IDLE



2. RUN THE HCAS PYTHON MODEL

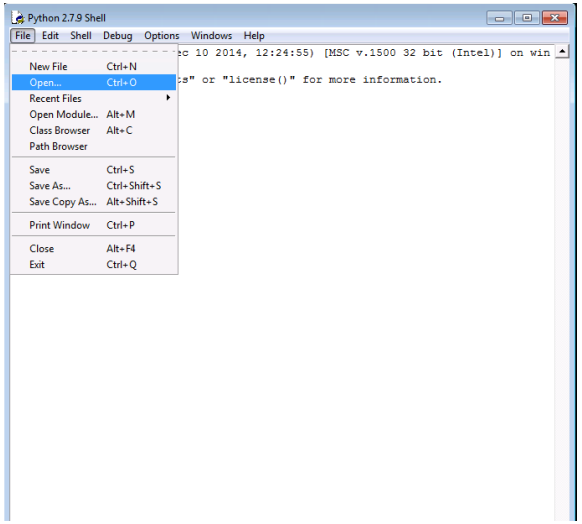
Once the user has an IDLE window open (the result of completing the steps in the previous sub-section, 1. Open IDLE) the user is ready to run the HCAS Python model.

Make sure there is a window open like the one displayed in Figure 24 (if there is not, go back to the previous sub-section, 1. Open IDLE , and follow those steps). The following lists steps to run the HCAS Python model, HCASModule.py, using IDLE.

Steps:

- Step 2.1: As illustrated in Figure 25, click on the "File" menu icon in the top-right corner of the IDLE window. In the File drop down menu, click on "Open."

Figure 25. Step 2.1: Open a File in IDLE



[3]Documenation and more in-depth instructions on how to use IDLE are avaialbale at: https://docs.python.org/2/library/idle.html.

- Step 2.2: Clicking on Open will make a new window pop up similar to the one illustrated in Figure 26. In this window, find the location on the user's computer with the "2017 Oregon HCAS Model" folder (i.e., the unzipped model distribution folder, see Figure 1). Within this folder, click on the *code* subfolder, and then select "HCASModule.py". In the window, click on "Open" in the bottom-left corner of the window (see Figure 26).

Figure 26. Step 2.2: Select File to Open

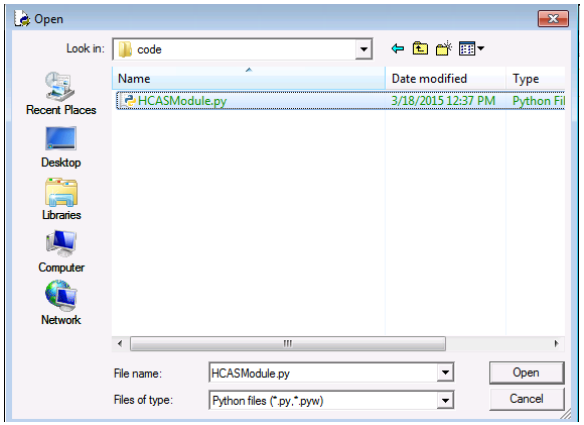
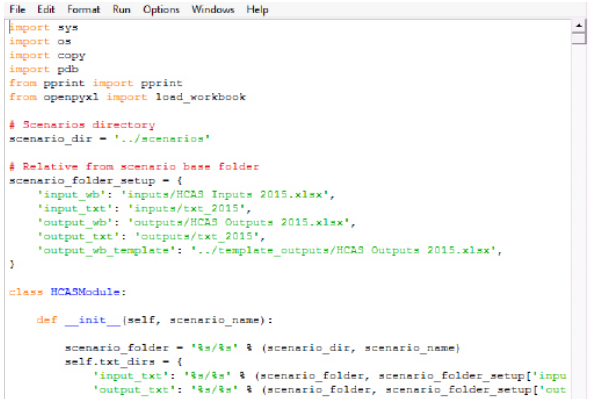


Figure 27. Step 2.3: Open the HCAS Python Model



- Step 2.3: Opening "HCASModule.py" will open a new window with the HCAS Python model code displayed. This window will look similar to the window illustrated in Figure 27. The user should not make any changes to the code displayed in this window.
- Step 2.4: Figure 28 illustrates how to run the HCAS Python model in IDLE. In the menu bar in the top of the IDLE window, click on the "Run" menu icon in the top-center of the IDLE window. In the Run drop down menu, click on "Run Module."
- Step 2.5: Clicking on "Run Module" will open up a new IDLE window similar to the one illustrated in Figure 29. Initially, only the black text at the top of the window will show up.

  As the HCAS Python model runs, text in blue will gradually appear. The lines in blue tell the user the progress of the HCAS Python model and what point it is at in the calculations and model process.

  The blue text may also provide some troubleshooting instructions for the user in case the HCAS Python model tries to open a file or folder and cannot find it.
- Step 2.6: The model has finished running shortly after ">>>" shows up in black text (see the last line in Figure 29). At this point, the user may go to the scenario's folder (e.g., *Scenario 1*). In this folder, there will be an *outputs* folder where the user may examine the model outputs. If the user is satisfied with the model outputs, the user should move the scenario's folder (*Scenario 1*) from the *scenarios* folder to the *processed scenarios* folder.

  Note: If the user moves the scenario's folder to the *processed scenarios* folder, but then wants to make other modifications to the scenario's inputs and re-run the scenario, the user should move the scenario's folder back to the *scenarios* folder and then repeat the steps in this section.

Figure 28. Step 2.3: HCAS Python Model

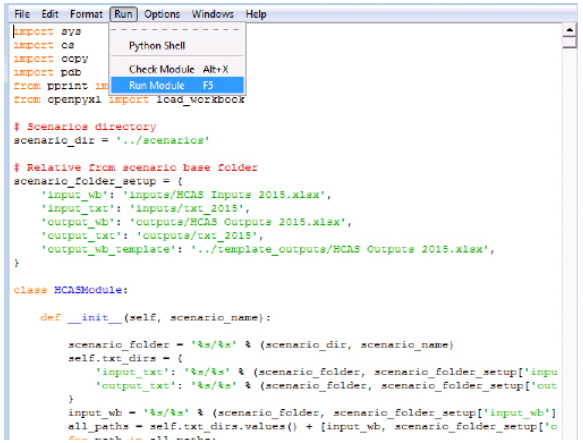
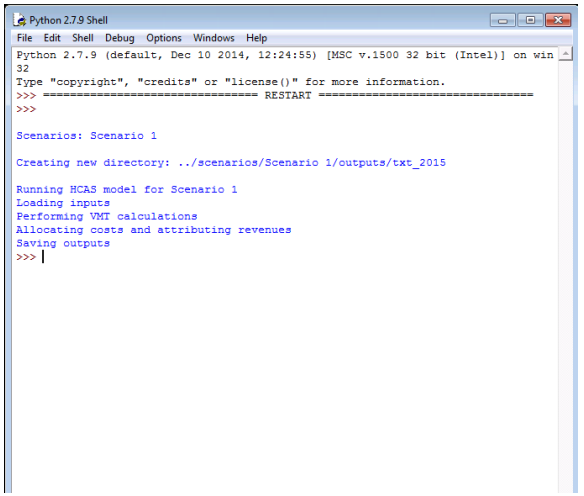


Figure 29. Step 2.5: IDLE Run Window



8. INPUT DATA AND DATA PREPARATION

This section describes the original data files and the data sources required to update the HCAS model. Many of these data files are obtained from sources within the Oregon Department of Transportation (ODOT) and are produced or adapted specifically for the Oregon HCAS. For each data set, the data files, sources for the data, and any pre-processing of the data outside of the model are described.[4] Appendix F provides a full list of the data sources and the original filenames.

WEIGH-IN-MOTION DATA

Source: Portland State University/ODOT

Weigh-in-motion (WIM) sensors weigh every truck passing over multiple points on Oregon's freeway system and at other, non-freeway locations. WIM data provide a good description of the distribution of operating weights.

Pre-Processing of WIM Data

The WIM data are used to calculate distributions of operating weight classes and numbers of axles for each declared weight (and number of axles for declared weights over 80,000 pounds). For each declared weight and axle category, calculate the distribution of WIM observations among vehicle operating weight classes and number of axles (coding 9 or more axles as 9). These data are used to create the *DeclaredOperating.txt* input text file.

The input file should have four columns: Declared (declared weight category identified by the lowest weight in the category, e.g., 1, 10001, 12001, 14001,…), DeclaredAxles (declared number of axles; zero for declared weights up to 80,000 pounds), Operating (operating weight class), OperatingAxles (actual number of axles, but not more than 9), and Share (share of vehicles for the declared weight and declared axles category by operating weight and operating axles). For each declared weight and axles category, the sum of the shares in the table should equal one.

HPMS DATA

Source: ODOT

The Highway Performance Monitoring System (HPMS) is a federal program that collects data from each state every year. Over the years, the number of data elements that must be reported has changed, but the data are still extremely useful in highway cost allocation and in developing pavement factors.

Pre-Processing of HPMS Data

The entire HPMS data set is an input file for the NAPCAS model. The HPMS data are also used in the process of estimating distributions of VMT by functional class and ownership in the *VMT by FC* tab in the inputs workbook.[5]

To perform the data tabulation of the HPMS data for the *VMT by FC* tab, divide the HPMS section average annual daily traffic (AADT) by the section length in miles and multiply by 365 days to calculate the section VMT. Since HPMS is a sample, each sample section VMT is expanded by multiplying it by its section weight. A summary table of VMT by functional system and ownership is tabulated and pasted into the *VMT by FC* tab such that the rows are the functional system, the column headings are ownership, and the cell entries are the sum of VMT.

FEDERAL AND TRANSIT VMT DATA

FHWA *Highway Statistics* Data

Source: Office of Highway Policy Information, Federal Highway Administration, http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.cfm

The Federal Highway Administration (FHWA) publishes an annual report called *Highway Statistics*. Data from tables VM-1 and VM-2 from Highway Statistics are used in the HCAS model for the base year VMT and VMT by FC. The Oregon row from Table VM-2, Functional Travel System Travel (Year) 1/Annual Vehicle-Miles, is pasted into the *VMT by FC* tab in the appropriate row. The Oregon row from Table MV-7, Publicly Owned Vehicles, is used in the *Federal VMT* tab. FHWA usually begins to release tables and chapters from *Highway Statistics* in late fall or winter of the following year. Use the *Highway Statistics* report corresponding to the study base year. If base year statistics are unavailable, use the most recent data that are available.

The appropriate rows from these tables should be pasted into the yellow-shaded cells in the inputs workbook where indicated on the *Federal VMT* and *VMT by FC* tabs.

GSA Federal Fleet Report Data

Source: U.S. General Services Administration, www.gsa.gov/vehiclepolicy

The *Federal Fleet Report* is an annual publication produced by the U.S. General Services Administration (GSA). The *Federal*

[4]VMT by FC is the vehicle miles traveled (VMT) by the facility class (FC), where each facility class is defined by a functional class and ownership.

Fleet Report provides data on the number of federal vehicles and vehicle miles traveled by vehicle type and department or agency in the base year. These data are used in the *Federal VMT* tab as part of the federal vehicle class VMT calculations which help develop the *Base VMT* tab. The tables from the *Federal Fleet Report* used in the study are Table 2-5 (Passenger Vehicles), Table 2-6 (Trucks and Other Vehicles), and Table 4-2 (Average Miles Per Vehicle).

The *Federal VMT* tab lists the tables and rows from the *Federal Fleet Report* that should be pasted into the yellow-shaded cells on the tab.

Transit VMT Data

Source: Tri-Met, Lane Transit District, Salem-Keizer Cherriots Transit District

Transit bus VMT is updated on the *Transit VMT* tab with VMT information obtained by calling the three largest transit agencies in Oregon: Tri-Met, Lane Transit District, and Salem-Keizer Cherriots Transit District. Call each transit district to request information on the total calendar year VMT for buses by bus weight class for the base year. Enter this data directly into the yellow-shaded cells in the *Transit VMT* tab.

MOTOR CARRIER DATA

The Motor Carrier Transportation Division (MCTD) of ODOT produces data on truck registrations, WMT collections, and flat-fee collections. These data are cleaned and consolidated into a set of reports called Highway Use Statistics. The cleaned, unconsolidated data are used in the study.[6]

Motor Carrier Registrations Data

Source: MCTD, ODOT

The Motor Carrier Registrations data are used to develop distributions of registered weights by declared weights for the *DeclaredRegistered.txt* input text file. For each declared weight category, the text file contains the share of vehicle registrations at a registered weight.

Pre-Processing of the Motor Carrier Registrations Data

The Motor Carrier Registrations data are used to develop the *DeclaredRegistered.txt* input text file. The share of vehicle registrations for the distribution of registered weights for each declared weight should be calculated from the count of registrations. The final processed table for the *DeclaredRegistered.txt* input text file should contain the declared weight, the registered weight, and the share of registrations at that declared weight.

Flat Fee Collections Reports

Source: MCTD, ODOT

The Flat Fee Collections Reports are used to calculate the Flat Fee VMT for the *MCTD VMT* tab which links to the *Base VMT* tab. The data are also used to estimate VMT per month and axle shares for the *Rates* tab.

Pre-Processing of the Flat Fee Collections Reports

A summary table of the monthly miles and count of the monthly reports from the Flat Fee Collections Reports should be created using a series of pivot tables. The pivot table rows are commodity, weight class, and axle count. A "mile_non_zero" indicator can be created and used in the page fields so that the pivot table can produce results for all observations or for records where miles are non-zero. In the model calculation, the log truck flat fee analysis includes an adjustment for log truck empty miles to account for the log hauler option of declaring a lower weight when their trailer is empty and stowed above the tractor unit. Because the analysis will account for the empty log truck

Figure 30. Flat Fee

A	I	J	K
	Flat Fee Miles		
Weight	Logs	Dump	Chip
26,001	0	289	0
28,001	0	0	0
30,001	0	0	0
32,001	0	0	0
34,001	0	0	0
36,001	0	0	0
38,001	0	0	0
40,001	0	0	0
42,001	0	0	0
44,001	0	985	0
46,001	0	82,043	0
48,001	0	14,251	0
50,001	0	12,367	0
52,001	0	10,984	0
54,001	0	40,341	0
56,001	0	13,594	0
58,001	0	0	0
60,001	0	0	0
62,001	0	0	0
64,001	0	9,260	0
66,001	0	0	0
68,001	0	0	0
70,001	0	0	0

[6] Weight class and axle class are two important variables used in the HCAS model for defining vehicle classes. HCAS weight classes are shown in the *Codes* tab in the inputs workbook. Basic vehicles are those vehicles weighing less than 10,001 pounds. For vehicles from 10,001 to 200,001 pounds, weight classes are defined in 2,000-pound increments, (e.g. 10,001, 12,001, ...80,001, 82,001...200,001). The vehicle weight recorded in the original data source is used to assign the record to a HCAS weight class. For a weight recorded in pounds, subtract one from the entered weight, divide by 2,000, truncate or round to the decimal point, then multiply by 2,000 and add one (e.g., Round((Weight-1)/2000,0)*2000+1 in Excel).
HCAS axle classes are zero, five, six, seven, eight or nine (or more). If the weight class is under 80,001, the axle class is zero. For 80,001 and above, a record with five or fewer reported axles is assigned to axle class five, and nine or more axles are assigned to axle class nine. If the reported axle count is six, seven, or eight, the axle class is set equal to the reported number of axles.

VMT, the input log truck VMT must be correctly entered at their fully loaded weights. Log trucks reported at weights under 56,000 pounds are assumed to be a data entry or report error (i.e., reported as the empty or average operating weight when the weight reported should be the loaded weight). Thus, log trucks with a reported weight under 56,000 pounds should be reassigned to a higher weight class. If the plate number for the under-56,000-pounds record is also reported at a higher weight, the lower weight record is entered at the higher weight class. Log truck records entered at weights under 56,000 pounds that are not reassigned to a higher weight class are excluded.

For the Flat Fee Miles table (see Figure 30 on the previous page) in the *MCTD VMT* tab, the miles reported in the Flat Fee Collections Reports are summed for each commodity and axle class and then the number of non-zero records and total number of records are counted.

For the *Rates* tab, create a pivot table or summary table results using the Flat Fee Collections Reports data. The records where miles are non-zero ("non-zero miles") are used to calculate the average VMT per month and the axle share of VMT for each weight class.

Figure 31. RUAF

RUAF	
Weight	Miles
26,001	0
28,001	0
30,001	0
32,001	0
34,001	0
36,001	0
38,001	0
40,001	0
42,001	0
44,001	0
46,001	0
48,001	0
50,001	0
52,001	0
54,001	0
56,001	0
58,001	0
60,001	0
62,001	0
64,001	0
66,001	0
68,001	0
70,001	0
72,001	0
74,001	0
76,001	0
78,001	0
80,001	0
82,001	0
84,001	0
86,001	0

Figure 32. WMT

A	B	C	D	E	F	G
	Weight-Mile Tax					
Weight	Any Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles
26,001	2,866,691	0	0	0	0	0
28,001	4,559,806	0	0	0	0	0
30,001	9,552,825	0	0	0	0	0
32,001	22,592,747	0	0	0	0	0
34,001	4,688,468	0	0	0	0	0
36,001	2,708,640	0	0	0	0	0
38,001	3,864,649	0	0	0	0	0
40,001	2,987,501	0	0	0	0	0
42,001	3,352,060	0	0	0	0	0
44,001	31,943,364	0	0	0	0	0
46,001	13,430,413	0	0	0	0	0
48,001	15,961,987	0	0	0	0	0
50,001	14,865,875	0	0	0	0	0
52,001	22,155,684	0	0	0	0	0
54,001	25,661,091	0	0	0	0	0
56,001	10,429,474	0	0	0	0	0
58,001	8,389,532	0	0	0	0	0
60,001	1,671,415	0	0	0	0	0
62,001	2,499,763	0	0	0	0	0
64,001	11,310,374	0	0	0	0	0
66,001	2,698,457	0	0	0	0	0
68,001	5,545,025	0	0	0	0	0
70,001	3,921,367	0	0	0	0	0
72,001	2,321,225	0	0	0	0	0
74,001	4,976,077	0	0	0	0	0
76,001	1,156,997	0	0	0	0	0
78,001	1,065,472,974	0	0	0	0	0
80,001	0	6,488,201	243,509	272,535	2,988	1,813
82,001	0	7,624,312	1,075,976	59,738	50,080	2,469
84,001	0	8,543,751	3,832,396	248,029	96,586	4,843
86,001	0	1,413,626	11,233,666	904,514	92,527	9,692

Road Use Assessment Fee Data

Source: MCTD, ODOT

The road use assessment fee (RUAF) data are the records from the vehicles paying the RUAF at weight classes of 96,001 pounds and above. Each RUAF record contains an ID number, issue date, axles, weight, miles, and tax. The RUAF data are tabulated to determine the VMT by RUAF vehicles by weight and axle class, which are then pasted into RUAF table in the *MCTD VMT* tab (see Figure 31).

WMT Collections Reports

Source: MCTD, ODOT

The WMT Collections (or Payments) Reports are pre-processed and used to develop the M*CTD VMT* tab and determine the VMT for the various WMT vehicle classes.

Pre-Processing of the WMT Collections Reports

The size of the WMT Collections Report data set requires that the data pre-processing take place outside of the HCAS model.

Assign all of the records in the WMT Collections Report data to a weight class and axle class using the HCAS weight class and axle class categories. Then, create a summary table that has the sum of the miles traveled for the HCAS weight and axle class categories from the WMT Collections Report data. This summary table is then pasted into Weight-Mile Tax table in the *MCTD VMT* tab (see Figure 32).

VMT ESTIMATES AND FORECAST

Source: Financial and Economics Analysis Unit, ODOT Financial Service Branch

The Financial and Economic Analysis Unit of ODOT's Financial Services Branch produces VMT estimates for use in its estimation of revenues for budgeting. These become available at the same time as the Agency Request Budget, which has been at the end of August.

The ODOT VMT estimates and forecast are used to determine the base year to model year VMT growth rate for light, medium-heavy, and heavy vehicle groups. The data do not require pre-processing and should be pasted into the yellow-shaded cells on the *VMT Growth* tab so that the new base year and forecast year match the base year and forecast year labels. The base-year VMT from the ODOT forecast are used to control total VMT for light and medium-heavy vehicle classes in the *Base VMT* tab.

DMV VEHICLE REGISTRATIONS

Source: Department of Motor Vehicles, Request by ODOT Financial Services

The DMV registrations data are used to build the estimates of VMT by weight class and tax class for the base year for certain vehicle tax classes. For the 2017 HCAS, ODOT Financial Services was granted permission to obtain de-identified registration records from DMV.

Pre-Processing of the DMV Registrations Data

Due to the size of the DMV registrations data, pre-processing of the registrations takes place outside of the HCAS model.

Two summary tables created from the DMV registrations are used to update the model: a summary table of motor home registrations by vehicle length, and a summary table of other, special categories of vehicle registrations by fuel type and weight class.

The DMV registrations data are used to create a summary table of vehicle registrations by fuel type and weight class for the following vehicle tax classes: Commercial Trucks (10,001 to 26,000 pounds), Tow Trucks, Farm Vehicles, Charitable Non-profit, and E-Plate (exempt). For this table, a weight class is assigned to each registration record by converting the registered vehicle weight to the corresponding HCAS weight class. Fuel type is available from the "motive power" field.

The license plate string is used to identify the vehicle tax class using the plate vehicle class designations (T for commercial truck, TW for tow truck, F for farm, CN for charitable/non-profit, or E for exempt; followed by numerals).

The summary table of DMV registrations data should be pasted into the yellow-shaded cells (columns B through M) in the left-most table on the DMV VMT tab (see Figure 33).

Figure 33. DMV-Other

	Gas						Diesel & Other						Assumed Miles per Registration				
Weight	CN	E	F	T	TOW	MH	CN	E	F	T	TOW	MH	CN	E	F	T	TOW
1	114	29,452	1,869	927	86	0	40	10,929	568	766	315	0	10,000	13,000	3,000	0	15,00
10,001	128	34	428	1,836	21	12,213	70	31	391	2,112	70	1450	10,000	12,000	3,000	19,000	15,00
12,001	97	33	209	911	22	2,847	41	27	251	1,533	86	373	10,000	12,000	3,000	19,000	15,00
14,001	223	52	383	1,212	29	7,886	93	134	508	3,242	160	355	10,000	12,000	3,000	19,000	15,00
16,001	21	6	229	482	11	4,905	28	33	398	1,944	104	360	10,000	12,000	3,000	19,000	15,00
18,001	16	5	423	391	15	3,263	64	55	765	2,224	186	750	10,000	12,000	3,000	19,000	15,00
20,001	7	2	157	144	2	0	18	37	275	491	30	0	10,000	12,000	3,500	19,000	15,00
22,001	8	6	319	172	1	1,455	22	10	420	693	43	455	10,000	12,000	3,500	19,000	15,00
24,001	20	7	699	650	19	1,109	141	63	1,503	6,026	661	1177	10,000	12,000	3,500	19,000	15,00
26,001	4	3	310	5	0	572	37	11	241	31	0	621	10,000	11,000	3,500		15,00
28,001	3	5	279	4	0	287	21	80	364	30	0	912	10,000	11,000	3,500		15,00
30,001	4	2	187	0	0	447	34	47	325	11	0	3539	10,000	11,000	3,500		15,00
32,001	1	1	51	4	0	0	40	39	288	34	0	0	10,000	11,000	3,500		15,00
34,001	0	1	37	2	0	0	10	25	131	18	0	0	10,000	11,000	3,500		15,00
36,001	1	2	17	0	0	0	10	80	56	9	0	0	10,000	11,000	3,500		15,00
38,001	0	1	31	2	0	0	5	19	153	11	0	0	10,000	11,000	3,500		15,00
40,001	2	0	30	1	0	0	1	1	53	6	0	0	10,000	11,000	4,000		15,00
42,001	1	3	77	0	0	0	3	4	128	3	0	0	10,000	11,000	4,000		15,00
44,001	1	0	104	0	0	0	4	4	581	11	0	0	10,000	11,000	4,000		15,00
46,001	0	1	71	1	0	0	7	6	591	19	0	0	10,000	11,000	4,000		15,00
48,001	0	0	39	1	0	0	4	5	583	9	0	0	10,000	11,000	4,000		15,00
50,001	0	0	5	0	0	0	3	3	206	11	0	0	10,000	11,000	4,500		15,00

Motorhome registrations data do not include vehicle weight, so registrations are tabulated by vehicle length and assigned a HCAS weight class based on their reported vehicle length.

PAVEMENT FACTORS

Source: RD Mingo & Associates

RD Mingo & Associates produce Oregon-specific pavement factors using the Oregon HPMS submittal data in the new 2010 National Pavement Costs Model (NAPCOM). Pavement factors are used to update *PavementFactors.txt* input file and the pavement allocators in the *Policy* tab. Minimal processing of the pavement factors data may be necessary to get the pavement factors into the correct format for *PavementFactors.txt*.

ESTIMATED AVERAGE BASIC-VEHICLE MPG

Source: Financial and Economics Analysis Unit, ODOT Financial Services Branch

The ODOT revenue forecast and budget-development process incorporates assumptions about fuel consumption per mile that are developed from data from Global Insight and other sources. These fuel consumption assumptions are used to inform the user choice of parameters on the *Gas and Diesel* table in the *General* tab in the inputs workbook. While the fuel consumption per mile assumptions provided by ODOT are not direct inputs into the model, the user-specified assumptions regarding the implied MPG on the *Gas and Diesel* table in the *General* tab should be generally consistent with the assumptions made by ODOT.

EXPENDITURE AND REVENUE DATA

Local Government Revenues and Expenditures

Source: ODOT-conducted Local Roads and Streets Survey

Prior-fiscal-year (corresponding to the model year) revenues and expenditures by local governments come from the Local Roads and Streets Survey (LRSS) compiled by ODOT.

Paste the LRSS data into the *Local Costs* tab and the formulas in that tab will produce estimates of future expenditures by work type and funding source.

Budgeted Non-Project Expenditures

Source: ODOT Agency Request Budget

Budgeted non-project expenditures come from spreadsheets used to develop the Agency Request Budget and are required to update the *Non-Project Costs* tab. These data are available around the end of August and are completed by the ODOT Finance Section. The Highway Programs Office provides the breakdown of non-project maintenance costs by maintenance work type. The non-project expenditure data do not require any pre-processing. The non-project expenditure data are pasted into the *Non-Project Costs* tab.

Project Expenditure Data

Source: ODOT Financial Services

Project cost information is collected from several sources. The ODOT Cash Flow Projection system tracks expenditures by work category for each project per month. Upon request, project expenditure files are produced that contain data for all projects with expected expenditures in the upcoming biennium. ODOT Finance then matches these projects to the Project Control System (PCS) to obtain additional data about the nature of the projects, particularly the project funding sources and project work types. For bridge projects, additional research is conducted using information in the PCS files, the Oregon Bridge Log, or correspondences with ODOT bridge section staff to determine relevant characteristics of the bridges involved so that the expenditures may be assigned to bridge types. Expenditures on different bridge types are allocated using different factors. Project expenditures data are requested when the Agency Request Budget data become available (generally in August or September) so that the project data are consistent with the budget.

Pre-Processing of Project Expenditure Data

Given the number of different sources, some in non-standardized formats, used to create the project expenditures input data, there is no formalized method for processing and developing the project costs table. The general steps for processing and creating the project costs table are the following:

1. Identify projects with expenditures during the study period from Cash Flow Projections
2. Assign a functional class to the project using information in the PCS.
3. Determine the share of project funding from each funding source
4. Determine the project HCAS work type(s) using the project information and/or the ODOT-specified work types

5. If the project has more than one work type, determine the share of project expenditures by work type

6. For each bridge project work type, assign a bridge type

Using the list of projects in the Cash Flow Projection and PCS, create a list of projects with expenditures in the study period.

Assign a functional class to each project. If a functional class is included in the project location information, validate that the functional system is a valid FHWA functional system or HCAS facility class. Projects are assigned a functional class based on the project funding sources if functional class is not provided. Functional system of zero is the default for an unknown functional system.

For each project, determine the share of project expenditures by funding source. Project expenditure shares by funding source reflect the total project funding, not necessarily the expenditures during the study period. Shares or dollar amounts by funding source are provided in the PCS data. Funding source should be entered as federal, state, bond, or other. Make sure the funding source is spelled correctly and is not capitalized.

Use the PCS project work type(s) and project description (SXYR Work Description) to assign HCAS work type(s) to the project. The project may have up to three work types. ODOT may have already listed three project work types and the work type funding shares in PCS. The analyst should review the ODOT-assigned work types and then assign the appropriate HCAS work type. The share of total project costs associated with each work type must be entered when multiple work types are assigned. Only assign multiple work types when the share of total project costs can be identified for each work type.

Bridge types are assigned to all projects. If the project is not a bridge project, then the bridge type can be entered as zero. Zero is also used when the bridge type is unknown. The bridge length and number of spans determine the bridge type. When multiple bridge types are being built or replaced in a single project, the bridge types may be entered separately, as if they were different work types, but using the same work type code. For example, if a project is a bridge bundle project replacing a single span bridge and a multi-span bridge, the bridge replacement work type would be assigned twice to the project, once for the single span bridge type and once for the multi-span bridge type. Again, the project can only have up to three work type/bridge type combos, and the share of total project funding must be identified for each work type/bridge type when broken out separately. Lists of work types and bridge types are located in the *Codes* tab in the inputs workbook.

The bridge length and spans may be reported in the PCS files, or the bridge number can be used to look up the bridge characteristics in the Oregon Bridge Log. The Oregon Bridge Log[7] will likely display the former bridge type in the case of bridge replacements. If the project is a bridge replacement, it may be necessary to contact the ODOT Bridge Section to find out information on the new bridge type.

For the 2017 HCAS, the project expenditure file was first created by working in a file where each project was a single record with columns for funding sources, funding source project cost share, functional class, work types, work type project cost share, bridge types, and total project amount. Once all of the funding source, work type, and bridge type data are entered, make sure that the entered data are valid and that the funding source and work type shares sum to 100 percent. Also make sure that the project expenditure is positive.

[6]The Oregon Bridge Log is an annual ODOT publication. The Oregon Bridge Log does not contain information on covered bridges. Most covered bridge projects are maintenance projects (on the covered structure); most covered bridges are single spans less than 125 feet.

The project expenditure data are then used to create the table of project expenditures by funding source and work type for the *Project Costs* tab. Because a project may have up to four funding sources and up to three work types, each project can potentially be turned into twelve separate entries in the *Project Costs* table. Paste the final project costs table into the *Project Costs* tab in the inputs workbook using the format shown in Table 1.

Table 1 displays an example of the *Project Costs* tab entries for a project that has three funding sources (state, federal, and other) and three work types (20, 21, and 41). The "Dollars" column is produced by multiplying the total project expenditures in the biennium by the fund source share and work source share. The key number is included for project identification but is not read into the model.

Budgeted Revenue Control Totals

Source: Financial and Economics Analysis Unit, ODOT Financial Services Branch

Budgeted revenue control totals come from spreadsheets used to develop the Agency Request Budget by the Financial and Economics Analysis Unit of the ODOT Financial Services Branch. These data are usually available at the end of August before the upcoming biennium.

The data in these spreadsheets are pasted into the yellow-shaded cells on the *Revenue Forecast* tab in the inputs workbook. Gross revenue amount by revenue source is linked to the appropriate revenue control total on the *Revenue Forecast* tab.

Current-Law Tax Rates and Fee Schedules

Source: Oregon Revised Statues, or the ODOT DMV and MCTD websites

Current-law fuel tax rates, WMT rates, registration and title fees, and other vehicle- and road-use-related fees may be obtained from Oregon Revised Statutes and Oregon Administrative Rules. The rates and fee schedules can also be found at the ODOT Department of Motor Vehicles (DMV) and Motor Carrier Transportation Division (MCTD) websites. The WMT Schedule A and B tables can be found at the MCTD website, where the WMT rates are calculated for each weight class and axle combination for Table B.

Rates must be converted to the proper unit for each revenue instrument, otherwise no calculations or processing is required. Update the current tax rates if changes have been made in the Oregon Revised Statutes in the *Rates* tab in the inputs workbook.

9. INPUT TEXT FILES

This section describes the input text files used to recalculate the model. The user may update some of the input text files, however some files are carried forward to future studies without modification. Each input text file is listed below, followed by a description of how the file is used, the file contents, and how to update the file.

AxleShares.txt

This file contains the distribution of VMT by number of axles for each weight class. These shares change little from year to year and do not need to be updated every biennium. The source is the weigh-in-motion data.

BasicSharePeak.txt

This file contains the share of VMT during the peak hour of the day by functional class that are by basic vehicles.[8] These shares change little from year to year and do not need to be updated every biennium. The source is 24-hour automatic traffic recorder data from ODOT.

Table 1. Example of Project With Multiple Work Types and Funding Sources

Funding	Work Type	Functional Class	Bridge Type	Dollars	Key Number
state	20	0	0	164,498	K16239
state	21	0	0	65,178	K16239
state	41	0	0	80,697	K16239
federal	20	0	0	307,266	K16239
federal	21	0	0	121,747	K16239
federal	41	0	0	150,734	K16239
other	20	0	0	190,733	K16239
other	21	0	0	75,573	K16239
other	41	0	0	93,567	K16239

Bonds

- *Bonds2003-2005.txt*
- *Bonds2005-2007.txt*
- *Bonds2007-2009.txt*
- *Bonds2009-2011.txt*
- *Bonds2011-2013.txt*
- *Bonds2013-2015.txt*
- *Bonds2015-2017.txt*

These files contain the prior allocated bonds from the 2003, 2005, 2007, 2009, 2011, and 2013 studies. The prior allocated bonds are read into the model and used in the class method that performs the bond cost allocation calculations. The file contents are the prior allocated bond expenditures (dollars) by weight class and axles. These files are not updated.

DeclaredOperating.txt

This file contains a distribution of operating weights for each declared weight from the weigh-in-motion data. The *DeclaredOperating.txt* data are used to build the pavement factors for each row of the VMT data in the VMT calculations of the model.

DeclaredRegistered.txt

This file contains a distribution of registered weights for each declared weight from the Motor Carrier Registrations data. The *DeclaredRegistered.txt* data are used to attribute registration and title fee revenues.

PaveFactors.txt

Contains the responsibility shares for flexible and rigid pavement costs by weight class and number of axles. This file is produced by Roger Mingo using the HPMS submission and weigh-in-motion data in the NAPHCAS-OR model.

PCEFactors.txt

This file contains the passenger-car equivalents (by weight class and number of axles) on regular, uphill, and congested roadways as estimated by Battelle for the most recent (1997) federal HCAS. This file is not updated.

SimpleFactors.txt

This file contains vectors of ones and zeros that help the model select the appropriate VMT for cost allocation. For example, for a cost allocated on over-106,000-pound VMT, the model will isolate the proper VMT records by applying a simple factor. In this case, a vector containing zeros for all weight classes except those above 106,000 pounds is applied to the VMT master. This file does not need to be updated for new studies unless the allocators are changed.

SeedData.txt

This file contains an initial guess as to the distribution of VMT by weight class, functional class, ownership, and number of axles. It does not need to be updated.

10. INPUTS WORKBOOK

This section provides a tab-by-tab explanation of the tabs in the input workbook. One input Excel workbook must be included in the scenario's *inputs* folder ("HCAS Inputs.xlsx") for the processing of input data. The input workbook is read in when the HCAS model is run in Python. The majority of the required calculations and data tables are automatically updated when the yellow-shaded input cells are modified.

After updating the data and assumptions in the input tabs, check that the named ranges in the HCAS Model workbook are defined to include the full range of input data. To view and change a named range, go to the *Insert* menu, and select the *Name* option. From the *Name* menu, select the *Define* option. In the window that pops up, select the named range, and review and change (if necessary) the *Refers to* cell references.

SET UP BASE VMT

In the 2013 HCAS study, the *Base VMT* tab in the primary inputs workbook was developed using a supplemental Base VMT workbook. Starting with the 2015 HCAS study, the *Base VMT* tab and the tabs that it links to it are consolidated in the main inputs workbook, "HCAS Inputs.xlsx". *The Base VMT* tab is built using *DMV VMT, MCTD VMT, Federal VMT*, and *Bus VMT* tabs.

Since the 2015 HCAS study, the approach for calculating the base VMT has been formalized with the intermediate calculations performed in other VMT tabs in the main inputs workbook. To the extent possible, this allows the user to see the steps from the raw, original data to the detailed base-year VMT table. The following is a tab-by-tab explanation of the data and calculations that build the *Base VMT* tab. Some tabs were already discussed in the section, Section 8, Input Data and Data Preparation.

MCTD VMT

The *MCTD VMT* tab contains calculations and data related to flat fee VMT, WMT VMT, and RUAF. The pre-processing steps for those data are described and illustrated in Section 8, Input Data and Data Preparation.

Bus VMT

The *Bus VMT* tab contains transit bus VMT and school bus VMT.

Transit

The columns B through H in the *Bus VMT* tab provide estimates of transit bus VMT in Oregon. Transit VMT estimates developed in 2005 are updated by scaling the transit district VMT by the change in the VMT for the three largest transit districts in Oregon.

Transit bus VMT is updated on the *Transit VMT* tab with VMT information from the three largest transit agencies in Oregon: Tri-Met, Lane Transit District, and Salem-Keizer Cherriots Transit District. To update this tab, the transit bus VMT by weight class for Tri-Met, Lane Transit District, and Salem-Keizer Transit District are collected for the base year (yellow-shaded input cells). The change in VMT for these three transit districts is used to adjust the 2005 transit VMT estimates.

School Bus

The Bus VMT tab contain the estimates of school bus VMT in Oregon. School bus VMT by weight class and fuel type from 1999 is the base VMT distribution for the school bus VMT estimates. The Department of Education (DOE) estimate of total school bus VMT for 2006 is used as the control total for updating the VMT. The 2006 school bus VMT is distributed across weight classes using the school bus VMT distribution from 1999. School bus registrations by fuel type (gasoline or diesel) from the DMV-Other table is applied to the 2006 school bus VMT to determine the fuel-type split for the school bus VMT.

Federal VMT

The Federal VMT tab has three primary tables: *Federal*, *Federal VMT Spread*, and *Federal Summary VMT*.

Federal

Paste the indicated table rows from the FHWA *Highway Statistics* (Table MV-7) and the GSA *Federal Fleet Report* into the yellow-shaded cells in the Federal table on the *Federal VMT* tab (see Figure 36 on the following page). The input data the *Federal* table are used with the *Federal VMT Spread* table to calculate the *Federal Summary VMT* table. It is important that the input data are pasted into the exact cells as indicated by the row and column headings because the cells are referenced in the VMT calculations at the bottom of the *Federal VMT tab*. The calculations at the bottom of the tab aggregate the various reported vehicle types and classes to calculate total federal VMT for buses, medium heavy trucks, and heavy trucks.

Figure 34. Bus VMT

Bus VMT by Area and Assumed Shares									Bus VMT by Type		
Weight	TriMet	LTD	Salem-Keizer	Rogue Valley	Lincoln	Sunset Empire	Klamath Basin	Assumed School Shares	Gas School Buses	Diesel School Buses	Diesel Transit Buses
10,001	0	0						0.0030	45,757	153,186	0
12,001	0	0		0				0.0656	1,006,649	3,370,085	0
14,001	0	0		0				0.0048	73,211	245,098	0
16,001	0	0		0				0.0036	54,908	183,823	0
18,001	0	0		0				0.0042	64,059	214,459	0
20,001	0	0		0				0.0418	640,594	2,144,598	0
22,001	0	0		0				0.0585	896,832	3,002,439	0
24,001	486,853	0		0				0.2649	4,063,200	13,602,886	486,853
26,001	11,750,261	2,693,832		0				0.1259	1,930,935	6,464,435	14,444,093
28,001	6,948,648	0		0				0.1169	1,793,665	6,004,878	6,948,648
30,001	234,138	0		0				0.1712	2,626,438	8,792,856	234,138
32,001	0	0		0				0.0477	732,108	2,450,971	0
34,001	0	0		0				0.0901	1,381,854	4,626,207	0
36,001	0	0		794,667				0.0012	18,303	61,275	794,667
38,001	0	0	1,514,679	0				0.0006	9,151	30,637	1,514,679
40,001	0	877,106	872,528	0				0.0000	0	0	1,749,634
	School bus VMT	66,685,496									
	% Diesel	77%									

Federal VMT Spread

The *Federal VMT Spread* table uses the share of VMT for school buses and transit buses (*Bus VMT* tab) by weight classes to spread the federal bus VMT across vehicle weight classes. Similarly, the State and Local Government (SLG) VMT are used to spread the federal heavy vehicle VMT across weight classes. This table essentially creates the shares or weights for each weight class, which are then applied to the federal VMT input from the Federal table.

All of the calculations on this tab are linked to other tabs that help develop the *Base VMT* tab. The user may check that the shares are properly calculated and applied to the federal VMT such that the total federal VMT is still equal to the VMT on the *Federal VMT* tab.

Federal Summary VMT

The *Federal Summary VMT* table sums the federal VMT by weight class from the *Federal* table and the Federal VMT Spread table.

Federal VMT for basic vehicles is the sum of the basic VMT from the Federal table and the federal bus VMT from the Federal VMT Spread table. Federal VMT for vehicles 10,001 pounds and above are the federal bus and truck VMT from the Federal VMT Spread table. Federal Gas VMT is derived by applying the percent gasoline from the SLG vehicles to the Federal VMT; Federal Diesel VMT is total Federal VMT less Federal Gas VMT.

Figure 35. Federal

A	B	C	D	E	F	G	H	I	J	K	L	M	N
						Federal Vehicle VMT							
Sources:													
2014 FHWA Highway Statistics, Table MV - 7, Publicly Owned Vehicles 2014.					http://www.fhwa.dot.gov/policyinformation/statistics/2014/mv7.cfm								
2015 Federal Fleet Report. US General Services Administration (GSA).					http://www.gsa.gov/portal/category/102859								
2014 FHWA Highway Statistics													
Table MV - 7, Publicly Owned Vehicles 2012, Federal - Motor Vehicles (1)													
State	Automobiles	Buses	Trucks & Truck Tractors	Total									
Oregon	2,494	59	6,168	8,721									
2015 Federal Fleet Report													
*Table 2-5: Passenger Vehicles**													
Department or Agency	Low-Speed	Sub-Compact	Compact	Midsize	Large	Limousines	Light SUVs	Medium SUVs	Light Pass Vans	Medium Pass Vans	Total		
Total Civilian Agencies	737	11,470	21,027	19,220	6,751	77	62,483	7,571	17,330	5,347	152,013		
U.S. Postal Service Agencies	0	120	4,068	2,725	120	0	1,294	0	689	2	9,018		
Table 2-6: Trucks and Other Vehicles*													
Department or Agency	Light Duty 4x2	Light Duty 4x4	Medium Duty	Heavy Duty	Ambulances	Buses	Total						
Total Civilian Agencies	15,162	35,770	32,281	11,738	452	3,006	98,409						
U.S. Postal Service Agencies	188,708	1,777	7,958	4,897	0	2	203,342						
Table 4-2: Average Miles Per Vehicle													
Department or Agency	Low-Speed	Sedans	Pass Vans	SUVs	Pass Subtotal	Light Trucks	Medium Trucks	Heavy Trucks	Truck Subtotal	Ambulances	Buses	Other Subtotal	Total
Total Civilian Agencies	1,064	10,170	8,702	9,872	9,770	8,864	7,638	4,659	7,928	9,024	13,464	12,832	9,113
Total U.S. Postal Service	0	7,250	6,401	6,208	7,035	6,085	5,764	25,150	6,932	0	1,893	1,893	6,553

Figure 36. Federal VMT Spread

Federal VMT Spread Table													
Spread Federal VMT across Weight Classes using the Distribution of Bus and SLG VMT													
Weight Class	Gas School Buses	Diesel School Buses	Diesel Transit Buses	Bus Total	Percent of Buses	Spread Federal Buses	Gas SLG	Diesel & Other SLG	SLG Totals	SLG Medium Percent	SLG Heavy Percent	Spread Federal Trucks	SLG Gas Percent
1	0	0	0	0	0.00%	0	382,876,000	142,077,000	524,953,000			0	72.94%
10,001	45,757	153,186	0	198,943	0.21%	1,693	408,000	372,000	780,000	20.90%		6,628,400	52.31%
12,001	1,006,649	3,370,085	0	4,376,733	4.71%	37,254	396,000	324,000	720,000	19.29%		6,118,523	55.00%
14,001	73,211	245,098	0	318,309	0.34%	2,709	624,000	1,608,000	2,232,000	59.81%		18,967,423	27.96%
16,001	54,908	183,823	0	238,731	0.26%	2,032	72,000	396,000	468,000		7.00%	1,351,081	15.38%
18,001	64,059	214,459	0	278,518	0.30%	2,371	60,000	660,000	720,000		10.78%	2,078,586	8.33%
20,001	640,594	2,144,598	0	2,785,193	3.00%	23,707	24,000	444,000	468,000		7.00%	1,351,081	5.13%
22,001	896,832	3,002,439	0	3,899,271	4.20%	33,190	72,000	120,000	192,000		2.87%	554,289	37.50%
24,001	4,063,200	13,602,886	486,853	18,152,939	19.56%	154,513	84,000	756,000	840,000		12.57%	2,425,016	10.00%
26,001	1,930,935	6,464,435	14,444,093	22,839,463	24.60%	194,403	33,000	121,000	154,000		2.31%	444,586	21.43%
28,001	1,793,665	6,004,878	6,948,648	14,747,191	15.88%	125,624	55,000	880,000	935,000		13.99%	2,699,274	5.88%
30,001	2,626,438	8,792,856	234,138	11,653,431	12.55%	99,191	22,000	517,000	539,000		8.07%	1,556,052	4.08%
32,001	732,108	2,450,971	0	3,183,079	3.43%	27,094	11,000	429,000	440,000		6.59%	1,270,247	2.50%
34,001	1,381,854	4,626,207	0	6,008,062	6.47%	51,139	11,000	275,000	286,000		4.28%	825,660	3.85%
36,001	18,303	61,275	794,667	874,245	0.94%	7,441	22,000	880,000	902,000		13.50%	2,604,006	2.44%
38,001	9,151	30,637	1,514,679	1,554,467	1.67%	13,231	11,000	209,000	220,000		3.29%	635,123	5.00%
40,001	0	0	1,749,634	1,749,634	1.88%	14,892	0	11,000	11,000		0.16%	31,756	0.00%
42,001	0	0	0	0	0.00%	0	33,000	44,000	77,000		1.15%	222,293	42.86%
44,001	0	0	0	0	0.00%	0	0	44,000	44,000		0.66%	127,025	0.00%
46,001	0	0	0	0	0.00%	0	11,000	66,000	77,000		1.15%	222,293	14.29%
48,001	0	0	0	0	0.00%	0	0	55,000	55,000		0.82%	158,781	0.00%
50,001	0	0	0	0	0.00%	0	0	33,000	33,000		0.49%	95,269	0.00%
52,001	0	0	0	0	0.00%	0	0	44,000	44,000		0.66%	127,025	0.00%

Figure 37. Federal Summary VMT

Federal VMT Summary for Gas and Diesel Vehicles			
	Federal VMT	Federal Gas	Federal Diesel
1	19,577,617	14,278,992	5,298,625
10,001	6,630,094	3,468,049	3,162,045
12,001	6,155,777	3,385,677	2,770,100
14,001	18,970,132	5,303,478	13,666,654
16,001	1,353,113	208,171	1,144,941
18,001	2,080,956	173,413	1,907,543
20,001	1,374,787	70,502	1,304,285
22,001	587,479	220,305	367,174
24,001	2,579,529	257,953	2,321,576
26,001	638,990	136,926	502,063
28,001	2,824,798	166,165	2,658,634
30,001	1,655,243	67,561	1,587,682
32,001	1,297,340	32,434	1,264,907
34,001	876,799	33,723	843,076
36,001	2,611,447	63,694	2,547,753
38,001	648,355	32,418	615,937
40,001	46,649	0	46,649
42,001	222,293	95,269	127,025
44,001	127,025	0	127,025
46,001	222,293	31,756	190,537
48,001	158,781	0	158,781
50,001	95,269	0	95,269
52,001	127,025	0	127,025
54,001	158,781	0	158,781
56,001	31,756	0	31,756
58,001	31,756	0	31,756
60,001	0	0	0
62,001	31,756	0	31,756
64,001	95,269	0	95,269
66,001	0	0	0
68,001	31,756	0	31,756
70,001	0	0	0
72,001	0	0	0
74,001	0	0	0
76,001	63,512	31,756	31,756
78,001	63,512	0	63,512
80,001	0	0	0
82,001	0	0	0
84,001	0	0	0
86,001	0	0	0
88,001	0	0	0
90,001	0	0	0

BASE VMT

The *Base VMT* tab contains the base-year VMT by weight class and vehicle tax class. The base-year VMT are used in the model to calculate the model-year VMT. The base-year VMT are used to allocate costs and attribute revenues by vehicle tax and weight class. The *Base VMT* tab is built using the *General, DMV VMT, MCTD VMT, Federal VMT*, *Bus VMT,* and *VMT Growth* tabs.

The *Base VMT* tab adjusts the basic and medium-heavy VMT so that the total for these two weight groupings equals their corresponding VMT forecast from the ODOT Economic and Revenue Forecast (for the base year). The VMT estimates for the base year from the ODOT Transportation and Revenue forecast are pasted into the yellow-shaded cells to the right of the VMT table on the *VMT Growth* tab (see Figure 44 on page D26). The VMT estimates for the base year are the control totals for the basic vehicle and medium-heavy vehicle classes. The *Base VMT* and *DMV VMT* tabs both reference these control totals and use the medium vehicle control total to calculate the scaling factor used to adjust the medium-heavy VMT for each vehicle tax class. A more detailed discussion of the *VMT Growth* tab is provided later on in this section.

The VMT for the tax classes calculated separately (transit, school bus, etc.) are subtracted from the light-vehicle control total to determine the Private Passenger basic VMT. The medium-heavy vehicle VMT are scaled such that the total medium-heavy vehicle VMT equals the control total. The medium-heavy control total adjustment factor is applied to the VMT for medium-heavy vehicle classes (vehicles between 10,001 and 26,000 pounds).

The WMT VMT reflect the WMT VMT reported in the WMT Collection Reports. The WMT VMT are adjusted to include an assumed WMT evasion factor. The WMT evasion factor[9] adjusts the WMT VMT to account for the additional VMT not reported for WMT payments. The WMT evasion factor is a user-specified assumption located on the *General* tab in the Control table.

Since the 2015 HCAS, all inputs that build the *Base VMT* tab are linked to it and the tab automatically updates. Similarly, a number of other tabs reference the *Base VMT* tab and also update automatically (e.g., development of growth factors on the *VMT Growth* tab for weight classes 26,001 to 104,001 pounds).

Figure 38. Base VMT

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Weight Class	Private Passenger	Gas Commercial 10-26	Diesel & Other Commercial 10-26	Gas Tow Trucks	Diesel & Other Tow Trucks	RUAF Vehicles	Flat Fee Vehicles Log	Flat Fee Vehicles S&G	Flat Fee Vehicles Chip	WMT Vehicles 26-80 Any Axle	WMT Vehicles 80+ 5 Axle	WMT Vehicles 80+ 6 Axle	WMT Vehicles 80+ 7 Axle	WMT Vehicles 80+ 8 Axle	WMT Vehicles 80+ 9+ Axle	Gas Farm
2	WC	Cars	GasComm	DieselComm	GasTow	DieselTow	RUAF	FlatFeeLog	FlatFeeSG	FlatFeeChip	WMTA	WMTB5	WMTB6	WMTB7	WMTB8	WMTB9	GasFarm
3	1	30,421,163,637	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	10,001	18,225,160	42,402,635	48,822,431	420,000	1,110,000	0	0	0	0	0	0	0	0	0	0	1,374,000
5	12,001	12,079,652	17,797,227	35,662,992	345,000	1,380,000	0	0	0	0	0	0	0	0	0	0	669,000
6	14,001	33,084,448	25,907,645	74,592,998	510,000	2,415,000	0	0	0	0	0	0	0	0	0	0	1,212,000
7	16,001	20,526,236	9,115,653	44,367,413	135,000	1,620,000	0	0	0	0	0	0	0	0	0	0	798,000
8	18,001	16,697,756	7,196,568	44,710,106	135,000	2,580,000	0	0	0	0	0	0	0	0	0	0	1,386,000
9	20,001	0	2,535,933	10,760,583	45,000	465,000	0	0	0	0	0	0	0	0	0	0	637,000
10	22,001	7,684,876	4,249,402	15,421,217	15,000	765,000	0	0	0	0	0	0	0	0	0	0	1,235,500
11	24,001	9,311,980	15,421,217	132,805,237	405,000	9,885,000	0	0	0	0	0	0	0	0	0	0	2,684,500
12	26,001	4,709,828	0	0	0	0	0	0	10,935	0	2,391,059	0	0	0	0	0	1,218,000
13	28,001	4,949,108	0	0	0	0	0	0	0	0	3,995,673	0	0	0	0	0	1,102,500
14	30,001	15,728,672	0	0	0	0	0	0	0	0	9,726,469	0	0	0	0	0	735,000
15	32,001	0	0	0	0	0	0	0	0	0	22,936,441	0	0	0	0	0	196,000
16	34,001	0	0	0	0	0	0	0	0	0	4,679,480	0	0	0	0	0	154,000
17	36,001	0	0	0	0	0	0	0	0	0	2,514,291	0	0	0	0	0	56,000
18	38,001	0	0	0	0	0	0	0	0	0	3,537,992	0	0	0	0	0	147,000
19	40,001	0	0	0	0	0	0	0	0	0	3,564,333	0	0	0	0	0	124,000
20	42,001	0	0	0	0	0	0	0	0	0	3,423,305	0	0	0	0	0	400,000
21	44,001	0	0	0	0	0	0	0	300	0	32,983,660	0	0	0	0	0	520,000
22	46,001	0	0	0	0	0	0	0	105,713	0	12,898,123	0	0	0	0	0	324,000
23	48,001	0	0	0	0	0	0	0	0	0	14,930,438	0	0	0	0	0	288,000
24	50,001	0	0	0	0	0	0	0	14,124	0	14,215,658	0	0	0	0	0	31,500
25	52,001	0	0	0	0	0	0	0	0	0	25,372,851	0	0	0	0	0	67,500
26	54,001	0	0	0	0	0	0	0	42,344	0	24,570,818	0	0	0	0	0	27,000
27	56,001	0	0	0	0	0	0	0	73,174	0	8,615,805	0	0	0	0	0	0
28	58,001	0	0	0	0	0	0	0	0	0	8,154,367	0	0	0	0	0	18,000
29	60,001	0	0	0	0	0	0	0	0	0	1,505,577	0	0	0	0	0	0
30	62,001	0	0	0	0	0	0	0	0	0	2,531,394	0	0	0	0	0	4,500
31	64,001	0	0	0	0	0	0	0	12,960	0	10,622,171	0	0	0	0	0	13,500
32	66,001	0	0	0	0	0	0	0	0	0	2,624,002	0	0	0	0	0	4,500
33	68,001	0	0	0	0	0	0	0	0	0	5,319,462	0	0	0	0	0	0
34	70,001	0	0	0	0	0	0	0	0	0	3,222,945	0	0	0	0	0	10,000
35	72,001	0	0	0	0	0	0	0	0	0	2,297,238	0	0	0	0	0	0
36	74,001	0	0	0	0	0	0	0	0	0	5,445,831	0	0	0	0	0	10,000
37	76,001	0	0	0	0	0	0	0	0	0	989,228	0	0	0	0	0	0
38	78,001	0	0	0	0	0	0	31,303,827	185,984	0	1,026,162,913	0	0	0	0	0	150,000
39	80,001	0	0	0	0	0	0	2,638,939	0	0	0	7,326,703	241,909	252,735	25,628	12,784	6,000
40	82,001	0	0	0	0	0	0	0	0	0	0	8,853,886	851,597	91,222	57,051	8,431	0

GENERAL

Control

Enter the biennium study period and the bond factor in the *Control* table.

To update the study biennium, enter the first year of the biennium in the yellow-shaded cell next to the "Study biennium" cell. The biennium start year should be the calendar year for the first year of the biennium.

Enter the bond factor in the yellow-shaded cell next to the bond factor label. The bond factor can be calculated by using Excel's PMT function. The bond factor should be the share of payments on bond expenditures in this biennium paid in this biennium.

The Excel PMT function calculates the bond loan payment based on the assumptions of constant repayment periods and a constant interest rate. In the 2017 HCAS and previous studies, the bond factor has been calculated using a repayment period of 20 years and an interest rate of 5 percent. The bond factor is used in the model to calculate the portion of bond expenditures allocated to the current study.

Assumptions located in the bottom of the portion of the *Control* table include user-specified assumptions for the gas, diesel, and WMT avoidance or evasion rates; the percent of basic VMT by diesel-fueled vehicles; the RUAF registration revenue allocation; empty log truck miles and weight; and the percentage of taxed gallons that are diesel.

The gas tax avoidance rate and the diesel tax avoidance/evasion rate are both expressed as the percent of total taxable VMT that avoids the gas tax by purchasing fuel out-of-state. The avoidance/evasion rates are applied to their respective gas and diesel VMT to calculate gas and diesel tax revenues. Change these assumptions by entering a percentage in the yellow-shaded evasion cells.

Similarly, the WMT evasion rate is expressed as the percent of total WMT VMT that evades the WMT. The WMT evasion rate is applied to WMT vehicle class VMT to calculate WMT revenues. The WMT evasion rate is also used to adjust the WMT base VMT in the *Base VMT* tab because the base VMT data are calculated from the WMT tax collection reports. Change the WMT evasion rate by entering a percentage in the yellow-shaded "WMT Evasion" cell.

The percent of basic VMT by diesel-powered vehicles is used to split basic vehicle VMT into gasoline-powered VMT and diesel-powered VMT for the calculation of gasoline and diesel tax revenues. Change the assumption by entering a percentage in the yellow-shaded "Basic Diesel" cell.

RUAF vehicles are credited with a portion of the heavy vehicle registration revenues using the RUAF registration assumptions. The first RUAF registration assumption is the RUAF Registration Adjustment in dollars per mile. This assumption is the registration revenue dollars per RUAF mile credited to the RUAF vehicles class. The next three RUAF registration assumptions allocate the RUAF registration revenue across three RUAF vehicle weight groups by specifying the portion of RUAF vehicles, which register at

Figure 39. Control

	A	B	C	D	E
1					
2		**Control**			
3	**Study biennium**	2017	to 2019		
4	Base year	2015			
5	Model year	2018			
6					
7	**Bond Factor**	0.1344	(biennial repayment amount per dollar of bonded expenditure; assumes 20-year repayment)		
8					
9	**Gas Tax Avoidance**	3.53%	(percent of total that is avoided)		
10	**Diesel Tax Evasion & Avoidance**	4.53%	(percent of total that is avoided or evaded)		
11	**WMT Evasion**	5.00%	(percent of total that is evaded)		
12	**Basic Diesel**	5.00%	(percent of basic VMT by diesel-powered vehicles)		
13	**RUAF Registration Adjustment**	0.0450	(dollars per mile)		
14	**RUAF Reg. from 78,001**	14%	(percent of total)		
15	**RUAF Reg. from 96,001**	15%	(percent of total)		
16	**RUAF Reg. from 104,001**	71%	(percent of total)		
17	**Log truck miles empty**	55%	(percent of VMT empty)		
18	**Empty log truck declared weight**	42,001	(declared weight category, use valid 2,000 lb weight class)		
19	**Taxed diesel**	10.50%	(percent of taxed gallons that are diesel)		

three different registration weight classes. RUAF Reg. from 78,001, RUAF Reg. from 96,001, and RUAF Reg. from 104,001 must be entered as percentages in the yellow-shaded cells. The total of these three assumptions must equal 100 percent.

Two assumptions are used to adjust the log truck VMT for the "as if" WMT revenue calculations. The "Log truck miles empty" assumption specifies the percent of log truck VMT without a load (empty), and the "Empty log truck declared weight" is the weight class the empty log truck VMT are assigned (enter a valid HCAS vehicle weight class). Log truck VMT in the flat fee reports should be reported using the loaded weight. Since log haulers are allowed to use a lower declared weight when their trailer is empty and stowed above the tractor unit, the log truck VMT must be adjusted to take into account the empty VMT at the lower weight class for calculation of the as-if WMT tax revenues.

Gas and Diesel

The *Gas and Diesel* table uses VMT from the *Base VMT* tab and rates from the *VMT Growth* tab to determine VMT in the model year for gas and diesel vehicles. The VMT and user-specified assumptions are used to determine the implied gallons and implied MPG for basic and non-basic vehicle classes.

The middle portion of the table is the average annual gas and diesel tax revenues. Gas tax revenues and diesel tax revenues from the *Revenue Forecast* tab are added and divided by two to calculate the average annual revenue ("Total" column). This is then allocated between basic and non-basic and divided by the gas/diesel tax rate per gallon to calculate the total implied gallons.

Once the base VMT, VMT growth rates, and revenue totals have been updated, adjust the yellow-shaded assumptions until the green-highlighted implied MPG are reasonable for their corresponding vehicle class.

Reasonable MPG is about 20 for basic vehicles and about 10 for non-basic vehicles, with the gas MPG higher than the diesel MPG.

Using VMT by weight class from the *Base VMT* tab and MPG assumptions by weight class from the *MPG* tab, the "Percent of taxed gallons that are basic" is equal to the taxed gallons for vehicles under 10,000 pounds divided by the total taxed gallons.

The yellow-shaded assumptions are percent of basic gallons that are diesel and percent of RV gallons that are diesel. The user should adjust these assumptions using the values specified in the previous study as starting points.

- The "Percent of basic gallons that are diesel" is entered as a percent. A reasonable range for this assumption is between 5 and 8 percent.[10]
- The "Percent of RV gallons that are diesel" is entered as a percent. A reasonable range for this assumption is between 30 and 60 percent.[10]

Bridge Splits

The *Bridge Splits* table (see Figure 42 on the following page) contains the split of the bridge costs for the incremental allocation of bridge project expenditures. The available bridge types and the bridge reclassification work types are listed on the *Codes* tab.

Work types 60 through 65 are designated bridge reclassification codes for splitting the bridge project expenditures. Expenditures entered for bridge projects work types (work types 13, 14, 15, 16, 19, or 68) in the *Project Costs* tab are reclassified using their bridge

Figure 40. Gas and Diesel

Gas and Diesel					
VMT from Model		**Taxed Gas**	**Taxed Diesel**	**Taxed Unknown**	**Total**
	Basic	426,104,109	5,684,848	35,133,836,928	35,565,625,885
	Non-Basic	189,291,791	542,595,606	190,139,913	922,027,310
	All	615,395,900	548,280,454	35,323,976,841	36,487,653,195
Percent of basic gallons that are diesel		7.20%	Change these until the green cells look		
Percent of RV gallons that are diesel		40.00%	reasonable		
Percent of taxed gallons that are basic		94.21%			
Implied Gallons		**Gas**	**Diesel**		**Total**
Basic		1,630,401,363	126,496,658		1,756,898,021
Non-Basic		38,601,797	69,308,182		107,909,979
All		1,669,003,160	195,804,840		1,864,808,000
Implied MPG		**Gas**	**Diesel**		**Total**
Basic					20.24
Non-Basic		7.86	8.93		
All					

[10]The ranges for these user-specified rates are only guidelines; the objective should be reasonable MPG estimates.

type and work type into work types 60 through 65. This bridge splits are used by the model for the incremental bridge cost allocation approach used in the study. The user may adjust the share for each bridge type and work type, such that the sum of the shares by bridge type equals one.

Studded Tires

The *Studded Tires* table contains the state and local studded tire-related expenditures. A 2014 review of studded tires in Oregon by ODOT provided projected studded tire expenditures for state roads.[11] The 2017 HCAS uses the same distribution by work type as the 2015 HCAS.

Local studded tire costs are estimated from the state studded tire costs using the share of basic VMT on local roads compared to basic VMT on state roads. The "Speed-Adjusted Local to State Basic VMT on Urban Principal Arterials and Above" is applied to the state studded tire expenditures to calculate the local expenditures for each studded tire-related work type. The speed-adjusted local to state basic VMT should not change much between studies.

VMT GROWTH

The *VMT Growth* tab has VMT controls (base-year and model-year VMT) and VMT growth by vehicle class (light, medium, heavy) and then detailed growth rates and growth factors by weight class.

The VMT growth rates are calculated from the change in VMT from the base year to the model year in the ODOT Economic and Revenue Forecast. To update the growth rates, paste the ODOT Economic and Revenue Forecast VMT by vehicle class (light, medium, heavy) into the yellow-shaded cells in the table displayed in Figure 44 so that the base year and model year match the Base Year and Model Year columns. The compound VMT growth rates are automatically calculated for light, medium, and heavy vehicle classes.

VMT growth rates by weight class for the basic and medium vehicle classes as well as weight classes over 106,001 pounds (heavy) are set equal to their calculated compound vehicle class growth rates.

For weight classes between 26,001 and 104,001, growth factors are developed such that variation across heavy weight classes exists. The heavy vehicle growth rates for these weight classes are automatically adjusted such that the total heavy vehicle VMT growth rate matches the target VMT growth rate, but variation still exists across the weight classes within the heavy vehicles. Using the distribution of VMT from 2011, base-year VMT and model-year VMT, growth factors are automatically developed for weight classes between 26,001 to 104,001 pounds (see Figure 45).

Small modifications in the VMT growth rates for the weight classes from 78,001 and 104,001 pounds will have the greatest impact on the total heavy vehicle group VMT growth rate since a majority of the heavy vehicle VMT are in these two weight classes.

The VMT growth rates by weight class are applied to the base-year VMT data to calculate the model-year VMT.

Figure 41. Bridge Splits

	A	B	C
42			
43	Bridge Splits		
44	Bridge Type	Work Type	Share
45	0	60	0.6849
46	0	61	0.2520
47	0	62	0.0000
48	0	63	0.0000
49	0	64	0.0631
50	1	60	0.6666
51	1	61	0.2999
52	1	62	0.0000
53	1	63	0.0000
54	1	64	0.0335
55	2	60	0.6849
56	2	61	0.2520
57	2	62	0.0000
58	2	63	0.0000
59	2	64	0.0631
60	3	60	0.7221
61	3	61	0.1697
62	3	62	0.0000
63	3	63	0.0514
64	3	64	0.0568
65	4	60	0.8713
66	4	61	0.1029
67	4	62	0.0000
68	4	63	0.0000
69	4	64	0.0258

Figure 42. Studded Tires

	A	B	C	D	E
71					
72	Studded Tires				
73	Funding	Work Type	Facility Class	Dollars	Distributon by Work Type
74	state	1	0	407,453	5%
75	state	11	0	6,790,885	79%
76	state	26	0	1,372,441	16%
77	local-state	101	-2	44,820	
78	local-state	111	-2	746,997	
79	local-state	126	-2	150,968	
80					
81			Study biennium projected studded tire expenditures by road type:		
82				state	8,570,779
83				local-state	942,786
84	Speed-Adjusted Local to State Basic VMT on Urban Principal Arterials and Above				0.11

Figure 43. Oregon Transportation Economic and Revenue Forecast

	E	F	G	H	I
1	ODOT Forecast	Base 2013	Model 2016	Forecast Growth	Weighted Average
2	Light	31,058,764,544	32,927,262,617	1.97%	
3	Medium	780,033,522	843,275,225	2.63%	
4	Heavy	1,770,824,870	1,951,715,914	3.30%	3.30%

[11] The projected expenditures for the study biennium include half of the projected expenditures for 2015 and 2017 and the all of the projected expenditures for 2016.

Figure 44. Development of VMT Growth Rates for Heavy Vehicles (26,001 to 104,001 pounds)

Weight Class	Prior 2013	Scaled 2015	Shift	Shifted Again	Re-scaled	Grown 2018	Growth Factor
26,001	34,433,084	32,269,558	0.9372	31,626,109	31,434,826	33,590,098	0.9954
28,001	36,197,464	29,240,592	0.8078	24,701,870	24,552,467	26,235,862	0.8580
30,001	44,657,557	40,134,540	0.8987	37,720,486	37,492,343	40,062,938	0.9545
32,001	31,779,615	28,972,714	0.9117	27,622,651	27,455,582	29,338,025	0.9683
34,001	14,238,856	12,234,149	0.8592	10,992,794	10,926,307	11,675,449	0.9126
36,001	9,332,254	7,271,581	0.7792	5,925,251	5,889,413	6,293,210	0.8276
38,001	9,903,480	6,870,423	0.6937	4,984,421	4,954,274	5,293,955	0.7368
40,001	6,232,457	5,081,449	0.8153	4,332,629	4,306,424	4,601,686	0.8660
42,001	5,109,162	4,482,614	0.8774	4,112,904	4,088,029	4,368,317	0.9319
44,001	36,106,406	34,985,367	0.9690	35,450,655	35,236,240	37,652,150	1.0291
46,001	16,523,693	16,482,242	0.9975	17,193,374	17,089,384	18,261,086	1.0594
48,001	18,089,331	18,702,150	1.0339	20,220,701	20,098,401	21,476,412	1.0981
50,001	15,376,746	16,034,544	1.0428	17,485,757	17,379,999	18,571,627	1.1075
52,001	27,383,279	24,050,520	0.8783	22,090,173	21,956,566	23,461,979	0.9328
54,001	26,399,073	27,329,940	1.0353	29,588,594	29,409,635	31,426,053	1.0996
56,001	9,019,443	10,673,243	1.1834	13,208,355	13,128,467	14,028,597	1.2568
58,001	8,700,849	8,890,917	1.0218	9,500,951	9,443,486	10,090,962	1.0853
60,001	1,577,577	1,738,323	1.1019	2,003,117	1,991,001	2,127,511	1.1703
62,001	2,694,376	2,634,508	0.9778	2,693,868	2,677,575	2,861,158	1.0385
64,001	11,025,095	11,671,018	1.0586	12,920,246	12,842,101	13,722,596	1.1243
66,001	2,689,002	2,778,321	1.0332	3,001,990	2,983,834	3,188,415	1.0974
68,001	5,504,944	5,704,057	1.0362	6,180,882	6,143,499	6,564,716	1.1005
70,001	3,282,945	4,033,162	1.2285	5,181,594	5,150,254	5,503,372	1.3048
72,001	2,362,238	2,408,176	1.0194	2,567,369	2,551,841	2,726,803	1.0828
74,001	5,581,313	5,085,231	0.9111	4,845,300	4,815,995	5,146,195	0.9677
76,001	1,265,193	1,356,327	1.0720	1,520,574	1,511,377	1,615,002	1.1386
78,001	1,065,348,027	1,101,118,953	1.0336	1,190,179,930	1,182,981,413	1,264,090,401	1.0978
80,001	10,588,699	9,138,654	0.8631	8,248,169	8,198,282	8,760,382	0.9167
82,001	9,988,186	9,095,873	0.9107	8,662,392	8,609,999	9,200,328	0.9672
84,001	15,247,962	15,300,865	1.0035	16,056,683	15,959,568	17,053,807	1.0658
86,001	30,157,503	24,353,651	0.8075	20,566,880	20,442,486	21,844,088	0.8577
88,001	35,021,011	34,807,074	0.9939	36,177,788	35,958,975	38,424,438	1.0556
90,001	18,607,869	20,321,703	1.0921	23,209,148	23,068,773	24,650,442	1.1599
92,001	4,178,925	3,496,215	0.8366	3,058,914	3,040,413	3,248,874	0.8886

Figure 45. VMT by FC Ownership

VMT by Functional Class							
Functional System	Ownership 1	2	4	21	25	64	66
1	3,758,956,699			0	0	0	0
2	3,909,574,550	196,201,231		0	0	0	0
3	1,375,964,728	386,922,085		0	0	829,505	
4	324,323,360	1,418,850,481	19,227,609	0	0	36,525,375	40,036,657
5							
6							
1	5,537,060,044			0	0	0	0
2	1,346,423,788	28,659,800	11,908,125	0	0	0	0
3	4,259,830,178	214,145,320	1,023,114,769	3,760,960	20,193,421	0	0
4	309,033,696	1,529,325,486	2,435,632,782			0	0
5	116,282,550	760,064,248	1,777,488,954	4,147,608		0	0
6	277,839	125,571,953	136,915,961				
	State	County	City	Other State	Other Local	USFS	National Parks

Figure 46. Oregon VMT from Highway Statistics: Rural and Urban

	A	B	C	D	E	F	G	H
18								
19	Oregon VMT from Highway Statistics							
20	Rural							
21	State	Interstate	Other Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	Total
22	Oregon	4,103	4,387	2,052	2,025	508	1,456	14,531

	I	J	K	L	M	N	O	P
18								
19	Oregon VMT from Highway Statistics							
20	Urban							
21	Interstate	Other Freeways & Expressways	Other Principal Arterial	Minor Arterial	Collector	Local	Total	Total
22	4,455	1,320	4,767	3,722	2,277	2,099	18,642	33,173

VMT BY FC

The *VMT by FC* tab calculates VMT by functional system and ownership, which is used in the model with the *Base VMT* and *VMT Growth* input tabs.

Two data sources are used to update the input on this tab: Oregon's Highway Performance Monitoring System (HPMS) submission data and data from the annual Federal Highway Administration (FHWA) *Highway Statistics* report.

The Oregon HPMS submission data corresponding to the base year are pre-processed outside of the HCAS model. The summary table of VMT by functional system and ownership is pasted into the yellow-shaded cells in the table at the top of the *VMT by FC* tab (see Figure 46).

The second data source needed to update the *VMT by FC* tab is the Oregon information from the FHWA *Highway Statistics* Report Table VM-2. Paste the Oregon row from Table VM-2 into the yellow-shaded cells in the middle row of the tab (see Figure 47).

The input data are combined into a single table of VMT by functional system and ownership at the bottom right of the tab. This table is then used to create the column of VMT by facility class located at the bottom left of the tab.

NON-PROJECT COSTS

The *Non-Project Costs* tab (see Figure 48 on the following page) contains the administrative and non-project-related costs by funding source. The non-project costs are allocated to the vehicle weight classes in the model cost allocation calculations. The *Non-Project Costs* tab includes the DMV and Motor Carrier collection costs, ROW costs, and PE costs. Non-project maintenance costs are broken out by their specific maintenance work category. The data for the *Non-Project Costs* tab are based on ODOT's proposed budget. ODOT staff complete a worksheet with the same format as the tables of the *Non-Project Costs* tab. When pasting the data into the tables, it is important that the row and column headings match exactly because the non-project cost entries at the bottom of the tab are referenced by work type to the input data.

[7]The ranges for these user-specified rates are only guidelines; the objective should be reasonable MPG estimates.

Figure 47. Non-Project Costs

	A	B	C	D	E	F	G	H
1	Work Type	State Funded	Federal Funded	Bond Funded	Other Funded	OTIA Funded	JTA Funded	Category
2	2	7,111,207	25,115,052	0	7,202,369	0	2,575,754	Project Right of Way and Utilities
3	1	19,241,968	67,957,944	0	19,488,639	475,167	500,021	Other Project-Related (PE)
4	20	1,500,000	0	0	0	0	0	Safety Rest Area Improvements & Access Mgmt
5	22	13,255,613	7,700,000	0	0	0	0	Traffic Operations Centers, ITS, Incident Response & Traffic Signal Services
6	50	24,263,505	0	0	0	0	0	Local Government Support - Regional and Central (Locals may participate)
7	50	174,127,562	0	0	0	0	0	Special Programs (Central, Regional, Tech Services Construction support)
8	55	80,107,319	5,940,865	0	0	0	0	Motor Carrier (All) & Central Services Collection Costs-Trucks Only
9	58	3,846,370	0	0	0	0	0	Fuel Tax Collection Costs (includes CS)
10	56	39,849,597	0	0	0	0	0	Reg Fee Collection Costs-Basic Only (includes CS)
11	58	3,355,142	0	0	0	0	0	Reg Fee Collection Costs-Non-Basic Only (includes CS)
12	56	54,007,529	0	0	0	0	0	Title Collection Costs - Light (includes CS)
13	57	1,242,087	0	0	0	0	0	Title Collection Costs - Heavy (includes CS)
14	50	115,834,483	278,321	0	0	0	0	Central Services budget: ARB Hwy Division portion of CS assessment
15	43	5,606,754	55,823,130	0	0	0	0	Transit: STP Funds
16	42	1,400,000	22,551,911	0	0	0	0	Rail: Grade Crossing Protection Fund (from Highway Fund)
17	21	4,981,951	18,669,948	0	0	0	0	T. Safety: Highway Funded Positions & STP
18	50	98,339,786	178,980	33,976,920				Transportation Program Development
19	40	11,922,463	0	0	0	0	0	OPS/SpPgms/Permits
20	40	16,061,008	0	0	0	0	0	State Radio System
21	26	122,417,001	15,000,000	0	0	0	0	Surface/Shoulder/Contract
22	28	19,641,056	0	0	0	0	0	Drainage
23	30	60,505,518	0	0	0	0	0	Roadside & Vegetation
24	32	62,084,533	4,757,000	0	0	0	0	Traffic Services & ITS
25	29	18,576,955	0	0	0	0	0	Bridge (Structures)
26	34	122,085,856	0	0	0	0	0	Snow & Ice/Extraordinary
27	40	19,719,533	0	0	0	0	0	Risk Mgmt
28								
29		167,924,803	577,438,850	0	170,064,561	10,335,158	213,025,277	Project Construction
30		287,093,064	0	0	0	56,146,426	160,182,166	Counties
31		182,987,244	0	0	0	41,099,933	106,788,110	Cities

Figure 48. Local Costs

	A	B	C	D	E	F
3						
4			RECEIPTS FOR ROAD AND STREET PURPOSES			
5		ITEM				TOTAL RECEIPTS
6	A. RECEIPTS FROM LOCAL SOURCES					
7	1	Special Assessments				
8		a. Permanent Property Tax or Assessment				12,354,528
9		b. Limited Duration Property Tax or Assessment				12,245,821
10		c. Traffic impact fees or system development charges				40,221,282
11		d. Transportation Utility Fees				24,299,118
12		e. Local Improvement Districts (or similar)				16,326,312
13		f. Urban Renewal District				9,539,803
14						
15	2	General Fund and Non-Dedicated City/County Fund Transfers				72,316,540
16						
17	3	Local Option Road User Fees (Include only what you actually keep)				
18		a. Fuel taxes (indicate rate _____)				0
19		Less: Collection Expense				0
20		Please see instructions		Net Fuel Tax		15,670,761
21		b. Motor Vehicle Registration fees				15,933,291
22						
23	4	Other Local Receipts				
24		a. Interest income				7,535,774
25		b. Traffic fines				414,275
26		c. Parking meters and fines				32,100,587
27		d. Permits and land use fees				11,391,636
28		e. Sales of Surplus Land & Equipment and Rentals				4,792,420
29		f. Hotel/Motel taxes				7,270,422
30		g. Franchise fees				8,324,739
31		h. Other (Please specify source and amount for each source)				44,664,074
32						
33	5	Receipts from Other Local Governments				
34		a. From Cities				3,721,627
35		b. From Counties				5,056,043
36		c. Other (Please specify source and amount for each source)				45,285,075
37						
38	6	Proceeds from Sale of Bonds and Notes				
39		a. Bonds (Must equal Part III, Item B.1)				174,661,277
40		b. Notes (Must equal Part III, Item B.2)				43,415,726
41						
42	B. PRIVATE CONTRIBUTIONS					10,914,922
43						
44	C. RECEIPTS FROM STATE GOVERNMENT					
45	1.	State Highway Fund Apportionment (including 1% Bike/Pedestrian Path money)				330,742,769
46	2.	Special County Allotment				1,966,467
47	3.	State Highway Fund Exchange Program				15,635,408
48	4.	ODOT Issued Permit Fees				528,720
49	5.	Other State Highway Fund Grants (Please specify source and amount for each so				23,900,187
50	6.	State Forestry				967,799
51	7.	Other State Funds (Please specify source & amount for each source)				10,557,671
52						
53	D. RECEIPTS FROM FEDERAL GOVERNMENT					
54	1	US Forest Service Annual Distribution				37,755,072
55	2	USFS and O&C Title II				325,979
56	3	5% Distribution of BLM Land Sales				67,289
57	4	BLM Mineral Leases				168,872
58	5	U.S. Taylor Grazing Apportionment				183,569
59	6	Federal Flood Control				320,203
60	7	Housing and Urban Development				159,498
61	8	Economic Development Administration				0
62	9	Federal Receipts for FHWA Grants				3,046,416
63	10	Other Federal Fund Receipts (Please specify source & amount for each source)				28,371,575
64	11	Federal Receipts for Federally Declared Emergency Events:				
65		a. FEMA - Public Assistance				2,008,710
66		b. FHWA - Emergency Relief				393,271
67						
68	E. RECEIPTS FOR NON-JURISDICTION ROAD/STREET WORK (see instructions)					
69	1	Non-road and street work				28,195,368
70	2	Work for other jurisdictions				6,548,158
71						
72	TOTAL RECEIPTS					1,110,299,052

	H	I	J	K	L	M	N
3							
4			DISBURSEMENTS FOR ROAD AND STREET PURPOSES				
5		ITEM					DISBURSEMENT AMOUNT
6	A. LOCAL DISBURSEMENTS (Identify by footnote the application of private contributions)						
7	1	Capital Projects - Construction, Expansion and Preservation					
8		a. Right-of-way					10,537,400
9		b. Project engineering					42,764,984
10		c. Construction					23,206,426
11			-1	New Facilities			15,954,095
12			-2	Capacity Improvements			35,132,536
13			-3	Bicycle and Pedestrian Paths			7,990,422
14			-4	System Preservation			125,532,808
15			-5	System Enhancement			93,257,515
16							
17	2	Operations and Maintenance					
18		a. General maintenance of condition					258,794,039
19		b. Safety and traffic maintenance					65,674,619
20		c. Snow and ice removal					6,337,174
21		d. Extraordinary maintenance (not including Declared Emergency Events)					2,739,658
22		e. Federally declared emergency events					1,624,418
23							
24	3	Administration and General Engineering					126,730,223
25		Costs shown here should include, but not be limited to:					
26		General supervision & administration, all clerical & accounting costs,					
27		administrative fees paid to agency general funds, long range planning					
28		costs, permit issuing costs(permit acquisition should be included in					
29		construction), operations and maintenance engineering,					
30		highway planning, traffic studies, and research activities					
31							
32	4	Match Payments for Local Agency Projects					3,533,046
33							
34	B. DEBT SERVICE ON LOCAL OBLIGATIONS						
35	1	Bonds					
36		a.	Interest (including paying fees)				7,907,514
37		b.	Redemption (Must equal Item III, C.1)				38,576,374
38	2	Notes					
39		a.	Interest (including paying fees)				5,903,939
40		b.	Redemption (Must equal Item III, C.2)				73,095,997
41							
42	C. PAYMENTS TO OTHER JURISDICTIONS FOR WORK ON THEIR ROADS/STREETS						
43		1. To counties					359,185
44		2. To cities					28,210,129
45		3. To other local agencies					3,723,499
46		4. To state for state highway projects					632,337
47							
48	D. EXPENDITURES THAT ARE REIMBURSED FOR WORK DONE ON OTHERS' ROADS/STREETS						
49		1. Non-road and street work					43,556,620
50		2. Work reimbursed by another agency for their road/street work					11,742,685
51							
52	TOTAL DISBURSEMENTS						1,033,517,642

LOCAL COSTS

The *Local Costs* tab contains the local agency expenditures by project work type, facility class, and bridge type. The Local Roads and Streets Survey (LRSS) receipts and disbursements data are used to update the *Local Costs* tab. The LRSS data should be pasted in the yellow-shaded cells on the *Local Costs* tab. Make sure that the LRSS data are pasted into the correct rows because the calculations refer to specific cells for the different expenditure types.

Once the LRSS data are pasted into the *Local Costs* tab, calculations are performed to remove the non-fungible local revenue sources from the expenditures and then sum the remaining expenditures by HCAS work type. The *Local Costs* tab calculations automatically update the local costs table at the bottom of the *Local Costs* tab.

Figure 49. Project Costs

	A	B	C	D	E	F
1	Funding	Work Type	Functional Class	Bridge Type	Dollars	Key Number
2	federal	5	0	0	4,913,904	K09436
3	other	5	0	0	533,347	K09436
4	state	5	0	0	478,827	K09436
5	federal	11	0	0	47,500	K11017
6	other	11	0	0	1,159	K11017
7	state	11	0	0	452	K11017
8	state	5	0	0	60,038	K11196
9	other	5	0	0	16,056	K11196
10	state	41	0	0	168,856	K11196
11	state	41	0	0	146,342	K11196
12	other	41	0	0	45,157	K11196
13	other	41	0	0	39,136	K11196
14	federal	5	0	0	2,684,324	K11258
15	state	5	0	0	307,233	K11258
16	federal	44	0	0	2,477,837	K11258
17	state	44	0	0	283,600	K11258
18	federal	14	0	2	155,559	K12001
19	other	14	0	2	42,202	K12001
20	federal	15	0	3	120,714	K12692
21	state	15	0	3	13,816	K12692
22	federal	4	0	2	12,735,763	K12723
23	other	4	0	2	1,576,794	K12723
24	state	4	0	2	1,455,381	K12723
25	federal	15	0	2	1,107,458	K12723

PROJECT COSTS

The *Project Costs* tab contains the project costs for the biennium, which are allocated to vehicle classes in the cost allocation procedure in the model.

Project expenditures are broken out by their funding source, work type, and bridge type (if applicable). Only one functional system is assigned to the project, but the project may have up to four funding sources (federal, state, local, bond), three work types (see work type codes on the *Codes* tab), and three bridge types, which correspond to the work types (bridge types are also listed on the *Codes* tab). Thus, a single project may be listed multiple times in the *Project Costs* tab, once for each possible funding source, work type, and bridge type combination. The user may change the *Project Costs* input data by pasting project expenditures into the rows. The model ignores entries in the Key Number column and stops reading data at the first empty row, so be sure eliminate spaces between entries.

REVENUE FORECAST

The ODOT Revenue Forecast (total revenue dollars) by revenue source for the study period should be pasted into the yellow-shaded cells on the *Revenue Forecast* tab. The ODOT Revenue Forecast is provided by the Financial and Economics Analysis Unit of the ODOT Financial Services Branch. Make sure the row and column headings in the tab correspond to the new data when pasting the new revenue forecast into the yellow-shaded cells because the revenues by summary revenue source will automatically calculate the revenue control totals in the left-most summary table of the *Revenue Forecast* tab. The revenue control totals are used to attribute revenues to the vehicle classes. The Registration Fee revenues and the Other MC revenue totals are set equal to the control totals in the revenue attribution calculations.

Figure 50. Revenue Forecast

	A	B
1	**Revenue Source**	**Gross**
2	Basic/Motorcycle/Moped Light Reg	314,161,649
3	Truck Normal Reg	33,550,449
4	Bus Normal Reg	738,168
5	Farm Reg	6,258,719
6	Charitable/Non-Profit Reg	285,138
7	Tow Reg	603,028
8	Heavy Fixed Load Vehicle Reg	187,357
9	E-Plate Reg	32,693
10	School Bus Reg	4,866
11	Light Trailer Reg	14,314,240
12	Heavy/Special/Rental Trailer Reg	265,084
13	Light Titles - New/First OR/Transfer	140,733,179
14	Heavy Titles - New/First OR/Transfer	3,654,763
15	Motor Carrier Interstate Reg	58,988,864
16	Motor Carrier Intrastate Reg	24,489,529
17	Motor Carrier Trip Permits	8,688,481
18	Weight-Mile Tax (includes late fees)	595,237,237
19	Road Use Assessment Fee	4,648,781
20	Weight Receipts	7,244,413
21	Gas Tax	951,703,440
22	Use Fuel (diesel) Tax	99,554,088

RATES

The *Rates* tab contains revenue instrument rates (tax rates and fees) that are used in the revenue attribution calculations along with other revenue inputs in the *Revenue Forecast* (revenue control totals) and *General* (evasion rates, etc.) tabs.

The tax and fee rates for the revenue instruments are located in the *Rates* tab. Each of the revenue rates is used with its corresponding vehicle tax class VMT to calculate or attribute revenues to the vehicle classes. The current law rates can be found in the Revised Oregon Statutes or obtained from ODOT publications.

The gas and diesel tax rates are entered as dollars per gallon. The VMT tax, WMT tax, and RUAF are entered as dollars per mile. Oregon does not currently have a VMT tax so rates are entered as zero for this instrument. The WMT tax and RUAF will vary by weight class and should be entered following the WMT tables or by calculating the weight class rate using the mid-point weight for the weight class.

Registration fees are entered as dollars per year. Divide the two-year registration fee by two to annualize the registration fee. The Normal Reg is the passenger vehicle registration fee for basic vehicles. The Heavy Vehicle Registration Fee table is for vehicles 10,001 pounds and greater.

Public vehicles are required to pay a one-time registration fee of $2. The E-Plate Reg fee is set to $0.40 per year, using the assumption that each public vehicle has a 5-year service life.

The title fee is entered as dollars per transaction. The light vehicle title fee is used for weight classes 24,001 pounds and under, and the heavy vehicle title fee is used for weight classes 26,001 pounds and greater.

The annual flat fee rates per 100 pounds are converted to monthly rates for each weight class by dividing by 12 (months per year) and using the mid-point of the weight category to calculate the rate for the weight class.

Figure 51. Rates

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		Rates														RUAF Rate		
2	**Weight Class**	**Axles**	**Gas Tax (per gallon)**	**Use Fuel Tax (per gallon)**	**VMT Tax**	**WMT Rate**	**Normal Reg**	**Farm Reg**	**Tow Reg**	**CN Reg**	**E-Plate Reg**	**LT Reg**	**HT Reg**	**Title**		**Weight Class**	**Axles**	**RUAF Rate**
3	1	0	0.30	0.30	0.00	0.0000	43	35	43	43	0.40	43	0	77		1	0	0.0000
4	10,001	0	0.30	0.30	0.00	0.0000	391	53	122	60	0.40	43	0	77		10,001	0	0.0000
5	12,001	0	0.30	0.30	0.00	0.0000	438	68	132	65	0.40	43	0	77		12,001	0	0.0000
6	14,001	0	0.30	0.30	0.00	0.0000	485	76	153	75	0.40	43	0	77		14,001	0	0.0000
7	16,001	0	0.30	0.30	0.00	0.0000	532	91	163	80	0.40	43	0	77		16,001	0	0.0000
8	18,001	0	0.30	0.30	0.00	0.0000	593	99	183	90	0.40	43	0	77		18,001	0	0.0000
9	20,001	0	0.30	0.30	0.00	0.0000	640	114	193	95	0.40	43	0	77		20,001	0	0.0000
10	22,001	0	0.30	0.30	0.00	0.0000	703	121	214	105	0.40	43	0	77		22,001	0	0.0000
11	24,001	0	0.30	0.30	0.00	0.0000	764	137	224	110	0.40	43	0	77		24,001	0	0.0000
12	26,001	0	0.30	0.30	0.00	0.0498	375	144	244	120	0.40	0	10	90		26,001	0	0.0000
13	28,001	0	0.30	0.30	0.00	0.0528	391	159	255	125	0.40	0	10	90		28,001	0	0.0000
14	30,001	0	0.30	0.30	0.00	0.0552	422	167	275	135	0.40	0	10	90		30,001	0	0.0000
15	32,001	0	0.30	0.30	0.00	0.0576	438	182	285	140	0.40	0	10	90		32,001	0	0.0000

MPG

There are two *MPG* tabs (one in the inputs workbook and one in the outputs workbook) that contain initial assumed MPG (input) and adjusted MPG (output) by weight class.

In the inputs workbook, the assumed MPG values in the yellow-shaded cells were derived from a regression analysis of the Vehicle Inventory and Use Statistics (VIUS) 2002 data (U.S. Census Bureau). VIUS data collection was discontinued after 2002. The MPG assumptions by weight class can be updated when better information or data on MPG by weight class become available; no standardized method for updating this tab has been developed.

The assumed MPG are used in the initial allocation of fuel tax revenues by weight class in the model (see columns A and B in Figure 53). Gasoline and diesel fuel tax revenues are attributed separately because the model allows for different tax rates and different evasion/avoidance assumptions for the two fuel types. VMT by fuel type and weight class for fuel-tax paying vehicles are assembled and adjusted for evasion/avoidance. A preliminary attribution is made by dividing the adjusted VMT in each combination of weight class and fuel type by the assumed miles per gallon for that weight class from the *MPG* tab and multiplying the resulting number of gallons by the per-gallon rate for that fuel type. The attribution to vehicles between 10,001 and 26,000 pounds is then adjusted to bring those weight classes, as a group, to equity (before considering subsidies). The revenue attributed to basic vehicles is adjusted so that the total revenue attributed equals the forecast revenues from the budget. The implied miles per gallon after adjustment for each weight class is calculated and saved in *MPG* tab in the outputs workbook where it may be examined for reasonableness (see columns D and E in Figure 53). Adjusted MPG is also a set of MPG values (by weight class) adjusted to account for the wide variation in VMT for 10,000-26,000-pound vehicles. The reasons for using this approach are detailed in Issue Paper 6 of the 2007 HCAS.

POLICY

The *Policy* tab contains the allocator or allocators applied to each work type. The user may change the yellow-shaded cells in the work type-allocator table for the allocator name and the allocator share for each work type. Available allocators are listed to the right of the main table. Note that all allocators must be entered exactly as shown (spaces, spelling, etc.) for the model to function properly; the user should copy and paste allocator names into the yellow-shaded allocator name columns to avoid errors.

The user may enter the allocator share (a percent value between 0 and 100 percent) for the first allocator; the percentage for a second allocator is automatically calculated as 100 percent minus the percentage for the first allocator. Do not change this; the allocator percentages must add to exactly 100 percent.

The Preliminary and Construction Engineering and Right of Way allocators are updated using the calculations from the supplemental Split PE and ROW workbook. Pavement work type allocators are from the pavement factors developed by RD Mingo and Associates.

CODES

The *Codes* tab has Summary Work Types (SWT) and the Summary Weight Class lookup tables which are used by the model to aggregate the costs to allocate and allocated costs.

Figure 54. Initial and Adjusted MPG

Inputs Workbook

	A	B
1	Declared	MPG
2	1	20.00
3	10,001	10.85
4	12,001	10.27
5	14,001	9.77
6	16,001	9.33
7	18,001	8.94
8	20,001	8.59
9	22,001	8.27
10	24,001	7.98
11	26,001	7.15
12	28,001	7.04
13	30,001	6.94
14	32,001	6.85
15	34,001	6.76
16	36,001	6.67
17	38,001	6.59

Outputs Workbook

	D	E
1	Weight Class	Adjusted MPG
2	1	20.89
3	10,001	15.53
4	12,001	14.69
5	14,001	13.97
6	16,001	13.35
7	18,001	12.79
8	20,001	12.29
9	22,001	11.83
10	24,001	11.42
11	26,001	7.15
12	28,001	7.04
13	30,001	6.94
14	32,001	6.85
15	34,001	6.76
16	36,001	6.67
17	38,001	6.59

Figure 52. Policy

	A	B	C	D	E	F
1	Work Type Description	Work Type	Allocator 1	Share 1	Allocator 2	Share 2
2	Preliminary and Construction Engineering (and etc.)	1	CongestedPCE	0.5595	Other_Construction	0.4405
3	Right of Way (and Utilities)	2	CongestedPCE	0.7375	Other_Construction	0.2625
4	Grading and Drainage	3	CongestedPCE	1.0000	None	0.0000
5	New Pavements-Rigid	4	CongestedPCE	0.0399	Rigid	0.9601
6	New Pavements-Flexible	5	CongestedPCE	0.0543	Flex	0.9457
7	New Shoulders-Rigid	6	CongestedPCE	1.0000	None	0.0000
8	New Shoulders-Flexible	7	CongestedPCE	1.0000	None	0.0000
9	Pavement and Shoulder Reconstruction-Rigid	8	CongestedPCE	0.0399	Rigid	0.9601
10	Pavement and Shoulder Reconstruction-Flexible	9	CongestedPCE	0.0543	Flex	0.9457
11	Pavement and Shoulder Rehab-Rigid	10	All_VMT	0.0399	Rigid	0.9601
12	Pavement and Shoulder Rehab-Flexible	11	All_VMT	0.0543	Flex	0.9457
13	Pavement and Shoulder Rehab-Other	12	All_VMT	1.0000	None	0.0000
14	New Structures	13	None	1.0000	None	0.0000
15	Replacement Structures	14	None	1.0000	None	0.0000
16	Structures Rehabilitation	15	None	1.0000	None	0.0000

Figure 53. Codes

	A	B	C	D	E
1	Summary Work Types			Summary Weight Classes	
2	Work Type	Summary Work Type		Weight Class	Summary Weight Class
3	0	21		1	1
4	1	17		8,001	1
5	2	22		10,001	10,001
6	3	12		12,001	10,001
7	4	12		14,001	10,001
8	5	13		16,001	10,001
9	6	12		18,001	10,001
10	7	12		20,001	10,001
11	8	12		22,001	10,001
12	9	15		24,001	10,001
13	10	18		26,001	26,001
14	11	20		28,001	26,001
15	12	18		30,001	26,001
16	13	3		32,001	26,001
17	14	3		34,001	26,001
18	15	3		36,001	26,001
19	16	14		38,001	26,001
20	17	12		40,001	26,001

11. OUTPUT FILES

After the user has finished updating the inputs workbook for their scenario, the user must save the workbook in the *inputs* folder as specified earlier in this guide (see Section 4, Initial Model Setup and Section 6, Set Up a New Scenario). After the user has set up a new scenario, the user must run the scenario through the HCAS Python model. Steps to run the HCAS Python model are outlined in Section 7, Run the HCAS Python Model.

Once the HCAS Python model has finished running, the user may open the scenario's *outputs* folder and open the outputs workbook that will have the scenario's name in its filename (e.g., "HCAS Outputs Scenario 1.xlsx"). The outputs workbook will have detailed and summary data on the VMT analysis, allocated costs, and attributed revenues from the model. There are also detailed text output files that are saved in the *txt* folder.

AUDITING

Recalculating the model and saving the outputs should take a few minutes. Once the model results have been recalculated there are several checks that can be performed to audit the model calculations. After the model has successfully completed, review the model results to check that the VMT, cost allocation, and revenue attribution in the output tabs are reasonable.

The following are general checks that can be performed to audit the model output:

Check that the costs to allocate (the non-project costs, project costs, and local costs data entered into the model by the user) are equal to the allocated costs from the model. If costs to allocate are different from the allocated costs, go back to the non-project costs, project costs, and local costs tabs to check that all costs were entered with valid work types, funding sources, functional systems, and bridge types.

Check the reasonableness of the adjusted MPG rates compared to the initial assumed MPG by weight class on the *MPG* tab in the outputs workbook.

Check to see if any pavement factors are listed as missing by reviewing the *MissingPavementFactors.log* file in the *txt* folder. If the *MissingPavementFactors.log* file does have missing pavement factors listed, check the pavement factors input file.

Attributed Revenues for Registration fees and Other MC in the *Attributed Revenues* tab in the outputs workbook should equal their control totals from the *Revenue Forecast* tab in the inputs workbook.

OUTPUT WORKBOOK TABS

Running the HCAS Python model will produce a new outputs workbook with model outputs and summary results.

Model VMT

The *Model VMT* tab contains the projected VMT in the forecast year by vehicle weight class and vehicle tax class. This table is analogous to the table in the *Base VMT* input tab but for the model year. The VMT growth rates are applied to the Base VMT to produce the Model VMT output.

Figure 55. Model VMT

	A	B	C	D	E	F	G	H	I	J	K
2	Weight Class	Private Passenger	Gas Commercial 8-26	Diesel & Other Commercial 8-26	Gas Tow Trucks	Diesel & Other Tow Trucks	RUAF Vehicles	Flat Fee Vehicles Log	Flat Fee Vehicles S&G	Flat Fee Vehicles Chip	WMT Vehicles 26-80 Any Axle
3	1	32,251,303,582	0	0	0	0	0	0	0	0	0
4	10,001	19,702,776	45,840,455	52,780,740	454,052	1,199,994	0	0	0	0	0
5	12,001	13,059,017	19,240,148	38,554,392	372,971	1,491,884	0	0	0	0	0
6	14,001	35,766,790	28,008,123	80,640,672	551,349	2,610,798	0	0	0	0	0
7	16,001	22,190,413	9,854,710	47,964,528	145,945	1,751,343	0	0	0	0	0
8	18,001	18,051,537	7,780,034	48,335,006	145,945	2,789,175	0	0	0	0	0
9	20,001	0	2,741,536	11,633,004	48,648	502,700	0	0	0	0	0
10	22,001	8,307,932	4,593,925	16,671,502	16,216	827,023	0	0	0	0	0
11	24,001	10,066,955	16,671,502	143,572,504	437,836	10,686,433	0	0	0	0	0
12	26,001	2,516,480	0	0	0	0	0	0	5,843	0	1,277,552
13	28,001	4,587,697	0	0	0	0	0	0	0	0	3,703,887
14	30,001	14,736,282	0	0	0	0	0	0	0	0	9,112,784
15	32,001	0	0	0	0	0	0	0	0	0	24,648,877
16	34,001	0	0	0	0	0	0	0	0	0	4,348,035
17	36,001	0	0	0	0	0	0	0	0	0	4,791,243
18	38,001	0	0	0	0	0	0	0	0	0	6,813,337
19	40,001	0	0	0	0	0	0	0	0	0	6,132,121
20	42,001	0	0	0	0	0	0	0	0	0	4,290,966
21	44,001	0	0	0	0	0	0	0	333	0	36,568,868
22	46,001	0	0	0	0	0	0	0	124,810	0	15,228,160
23	48,001	0	0	0	0	0	0	0	0	0	15,187,191
24	50,001	0	0	0	0	0	0	0	15,752	0	15,854,551
25	52,001	0	0	0	0	0	0	0	0	0	30,823,833

Costs to Allocate by SWT

The *Costs to Allocate by SWT* tab (see Figure 57 on the following page) displays a summary table of the input data in the *Project Costs, Non-Project Costs,* and *Local Costs* tabs by summary work type. While the model combines the cost input data from the three tabs from the inputs workbook to produce this summary table, no other calculations are performed on the input data to produce the *Costs to Allocate by SWT* tab. The tabulated costs from all funding sources on the *Costs to Allocate by SWT* tab are compared with the output on the *Allocated Costs by SWT* tab to ensure that all input costs are allocated in the model calculations. The *Costs to Allocate by SWT* tab is also used to create exhibits in the final HCAS report.

Figure 56. Costs to Allocate by SWT

Summary Work Type	Bond	Federal	Local-Federal	Local-Other	Local-State	State
Admin	5,452,786	6,398,166	22,881,769	15,669,929	120,788,280	594,973,380
Bike and Pedestrian	0	42,791,867	175,979	120,514	928,958	11,404,562
Bridge-bridge and interchange	3,078,183	153,370,965	351,369	240,625	1,854,806	14,159,600
Bridge-bridge maintenance	0	14,922,283	0	0	0	1,707,922
Fish	153,578	21,089,803	0	0	0	2,390,897
Hwy Planning	0	285,388	0	0	0	32,664
Hwy Safety	0	22,551,911	0	0	0	1,400,000
Maintenance	0	26,211,554	1,879,759	1,287,300	9,922,871	313,067,716
Maintenance-bridge maintenance	0	4,416,020	0	0	0	19,081,840
Maintenance-other pavement	0	472,759	0	0	0	39,884
Maintenance-pavement maintenance	0	3,094,216	45,459,211	31,131,449	239,819,109	124,292,644
Modernization	15,960,855	211,953,870	13,590,144	9,306,824	71,739,650	47,953,649
Modernization-new pavement	16,974,693	66,939,718	773,750	529,881	4,084,472	8,665,319
Modernization-other pavement	0	0	0	0	0	0
Modernization-pavement and shoulde	0	54,275,120	0	0	0	3,371,592
Multimodal	0	0	0	0	0	0
PE	156,503	75,977,486	941,845	644,996	4,926,992	18,834,515
Preservation	0	0	0	0	0	0
Preservation-other pavement	0	0	0	0	942,786	8,570,779
Preservation-pavement and shoulder r	0	105,922,153	2,764,703	1,893,328	13,847,316	5,342,440
Prior Allc'td Bonds	392,009,761	0	0	0	0	0
ROW	413,370	25,115,052	232,073	158,929	1,225,067	7,111,207
Transit	0	61,383,493	0	0	0	5,888,744
Unknown	0	12,671,072	0	0	0	114,905,869
Costs to Allocate Total	**434,199,728**	**909,842,896**	**89,050,601**	**60,983,774**	**470,080,307**	**1,303,195,223**
Annual Expenditures (thousands)	**217,100**	**454,921**	**44,525**	**30,492**	**235,040**	**651,598**

Figure 57. Allocated Costs by SWT

			Summary Weight Class							
Funding	Summary Work Type	1	10,001	26,001	78,001	80,001	104,001	105,501	Total
bond	Other	4,997,797	127,995	62,269	173,970	49,007	41,271	477	5,452,786
bond	Other	0	0	0	0	0	0	0	0
bond	Bridge	1,980,035	188,694	87,399	330,140	175,599	140,668	175,647	3,078,183
bond	Bridge	0	0	0	0	0	0	0	0
bond	Other	136,884	4,107	1,902	7,185	1,935	1,550	16	153,578
bond	Other	0	0	0	0	0	0	0	0
bond	Other	0	0	0	0	0	0	0	0
bond	Maintenance	0	0	0	0	0	0	0	0
bond	Maintenance	0	0	0	0	0	0	0	0
bond	Maintenance	0	0	0	0	0	0	0	0
bond	Maintenance	0	0	0	0	0	0	0	0
bond	Modernization	4,112,318	1,252,731	740,376	4,303,537	3,180,829	1,917,306	453,757	15,960,855
bond	Modernization	2,492,838	1,402,157	943,486	5,707,248	3,566,070	2,695,857	167,035	16,974,693
bond	Modernization	0	0	0	0	0	0	0	0
bond	Modernization	0	0	0	0	0	0	0	0
bond	Other	0	0	0	0	0	0	0	0
bond	Other	108,226	6,831	4,267	19,955	8,773	7,006	1,446	156,503
bond	Preservation	0	0	0	0	0	0	0	0
bond	Preservation	0	0	0	0	0	0	0	0
bond	Preservation	0	0	0	0	0	0	0	0

Figure 58. Allocated Costs

Weight Class	Axles	Bond	Federal	Local-Federal	Local-Other	Local-State	Other	State	Total Allocated Costs
1	0	221,548,336	518,668,122	51,681,894	35,392,877	273,475,961	136,439,276	974,907,406	2,075,674,595
10,001	0	3,166,487	4,379,132	323,665	221,653	1,704,579	1,701,960	4,459,680	14,255,195
12,001	0	2,326,401	3,077,872	289,298	198,118	1,523,144	1,136,528	3,020,748	10,435,580
14,001	0	4,104,784	7,356,245	742,656	508,587	3,909,111	2,407,028	6,620,952	23,242,336
16,001	0	2,393,163	4,391,082	522,894	358,089	2,751,940	1,361,383	3,788,494	14,205,663
18,001	0	2,388,956	5,008,026	680,006	465,683	3,578,386	1,466,395	4,122,616	16,243,672
20,001	0	849,484	1,568,197	266,384	182,425	1,401,657	421,318	1,222,644	5,490,790
22,001	0	1,296,238	3,064,435	544,509	372,892	2,864,931	772,776	2,261,539	10,404,545
24,001	0	5,615,248	20,896,091	4,137,149	2,833,209	21,766,432	4,820,203	14,467,486	69,715,613
26,001	0	1,019,686	1,005,580	166,647	114,124	876,958	266,805	1,474,457	4,657,452
28,001	0	995,566	1,993,592	380,733	260,734	2,003,414	510,683	2,773,596	8,407,636
30,001	0	1,932,653	2,501,410	496,432	339,967	2,612,197	627,548	3,461,814	11,344,473
32,001	0	1,326,243	2,505,038	493,129	337,705	2,594,645	592,827	3,062,614	10,319,376
34,001	0	576,788	882,709	153,773	105,307	809,142	204,858	1,138,302	3,666,020
36,001	0	591,269	1,184,334	258,032	176,706	1,357,708	264,945	1,522,806	5,090,854
38,001	0	698,269	1,311,328	165,055	113,033	868,539	315,022	1,668,119	4,824,343
40,001	0	270,926	765,006	116,947	80,088	615,342	189,146	958,484	2,806,793
42,001	0	564,771	478,577	81,126	55,557	426,853	114,160	582,149	2,189,033
44,001	0	1,839,960	3,073,689	494,762	338,824	2,603,260	726,381	3,669,355	12,019,850
46,001	0	1,094,758	1,447,475	234,649	160,693	1,234,643	349,061	1,770,836	5,943,053
48,001	0	1,121,236	1,376,155	232,174	158,997	1,221,604	332,337	1,679,283	5,789,449
50,001	0	835,113	1,435,702	249,135	170,613	1,310,800	334,052	1,645,965	5,647,327
52,001	0	1,594,797	2,750,135	446,384	305,693	2,348,619	647,949	3,173,528	10,619,156
54,001	0	1,700,495	2,544,839	425,202	291,187	2,237,143	595,729	2,906,514	10,105,379

Allocated Costs by SWT

The *Allocated Costs by SWT* tab displays the model output of the allocated costs by summary work type, funding source, and summary weight class. The allocated costs on this tab are the same allocated costs displayed in the *Allocated Costs* tab and in the Allocated Cost output text files. Whereas the *Allocated Costs* tab contains the allocated costs for every weight class, the *Allocated Costs by SWT* tab has a summary table to create exhibits in the final HCAS report.

Allocated Costs

The *Allocated Costs* tab displays the costs allocated in the model for each funding source to each weight class and axle class. This tab does not contain any information on the work types of the allocated costs. The output on the *Allocated Costs* tab is used in the *Equity* and *Summary* tabs to determine cost responsibility by weight class and user groups.

Attributed Revenues

The *Attributed Revenues* tab displays the attributed user fees by major revenue source for each weight and axle class. The revenue totals are calculated in the Attribute Revenues calculations in the model. The output on the *Attributed Revenues* tab is used in the *Equity* tab and *Summary* tab to determine annual user fees and share of revenues for each vehicle class.

MPG

The *MPG* tab in the outputs workbook is discussed in the previous section on page D29 and illustrated in Figure 54.

Figure 59. Attributed Revenues

Weight Class	Axles	Gas Tax	Diesel Tax	WMT	Flat Fee	RUAF	Registration	Other MC	Subsidy	Full Fee VMT
1	0	919,921,791	47,184,812	0	0	0	472,349,600	0	9,186,820	32,251,303,582
10,001	0	6,000,108	4,784,631	0	0	0	4,107,359	0	256,772	118,323,971
12,001	0	3,310,392	3,719,277	0	0	0	2,668,654	0	648,072	70,853,557
14,001	0	6,534,451	8,161,236	0	0	0	6,114,082	0	1,038,081	144,415,585
16,001	0	3,267,794	5,114,430	0	0	0	3,603,323	0	322,125	80,009,652
18,001	0	2,808,177	5,609,788	0	0	0	3,904,726	0	486,274	74,166,577
20,001	0	469,800	1,413,106	0	0	0	896,170	0	686,251	14,374,539
22,001	0	1,700,247	2,164,674	0	0	0	1,927,560	0	444,297	29,573,359
24,001	0	3,989,949	18,416,572	0	0	0	10,989,563	0	2,892,046	170,310,960
26,001	0	330,619	64,201	120,882	2,173	0	132,076	10,742	1,630,931	3,799,875
28,001	0	593,991	123,986	371,574	0	0	267,852	31,144	2,837,769	8,291,584
30,001	0	1,411,923	172,255	955,749	0	0	433,880	76,624	2,357,740	23,849,066
32,001	0	81,450	121,851	2,697,573	0	0	894,582	207,259	998,196	24,648,877
34,001	0	110,742	41,475	494,850	0	0	166,556	36,560	1,099,048	4,348,035
36,001	0	43,323	46,623	573,512	0	0	166,024	40,287	1,597,969	4,791,243
38,001	0	58,417	104,152	846,625	0	0	329,379	57,290	1,694,835	6,813,337
40,001	0	36,590	31,148	788,775	0	0	246,558	51,562	669,884	6,132,121
42,001	0	77,266	58,147	572,329	0	0	216,369	36,080	136,997	4,290,966
44,001	0	53,335	229,651	5,044,310	7,514	0	2,254,130	307,488	141,504	36,569,200
46,001	0	45,420	260,601	2,167,120	33,427	0	1,001,182	128,045	238,122	15,352,970
48,001	0	27,137	214,288	2,233,428	0	0	944,523	127,701	187,664	15,187,191
50,001	0	3,286	95,446	2,418,929	8,566	0	809,436	133,312	77,768	15,870,303
52,001	0	7,743	177,206	4,878,488	0	0	1,584,617	259,181	167,772	30,823,833

SUMMARY WORKBOOK TABS

The *Equity* and *Summary* tabs summarize the model output tabs, displaying summary results and equity ratios. These tabs reference the model output tabs and do not require any user input.

Equity

The *Equity* tab contains the Annual VMT, Annual Cost Responsibility, Annual User Fees, and Subsidy and Equity Ratios for each 2,000-pound weight class. The VMT, Cost Responsibility, and User Fee Revenues are shown for All Vehicles and for Full-Fee Vehicles.

Full-Fee Costs are calculated by scaling total Cost Responsibility by the ratio of full-fee VMT to total VMT. The Full-Fee Scaled Equity Ratio is the ratio of the share of full-fee cost responsibility to the full-fee user fee share.

Figure 60. Equity

			Annual VMT			Annual Cost Responsibility			Annual User Fees			Annual Full-Fee	Full-Fee Scaled
Weight Class	Axles		All	Full-Fee	Alternative Fee	State	Federal	Local	All	Full-Fee	Subsidy	Cost Responsibility	Equity Ratio
1	0		32,927,262,617	32,251,303,582	675,959,035	596,227,871	259,334,061	180,275,366	719,728,102	709,452,020	4,593,410	1,016,531,685	0.9974
10,001	0		130,921,450	118,323,971	12,597,479	3,813,084	2,189,566	1,124,948	7,446,049	6,845,610	128,386	6,441,768	1.5187
12,001	0		85,084,647	70,853,557	14,231,090	2,673,574	1,538,936	1,005,280	4,849,161	4,307,936	324,036	4,345,073	1.4169
14,001	0		167,165,542	144,415,585	22,749,957	5,362,868	3,878,123	2,580,177	10,404,884	9,437,262	519,041	10,039,615	1.3434
16,001	0		89,089,769	80,009,652	9,080,117	3,090,829	2,195,541	1,816,462	5,992,773	5,526,630	161,062	6,378,904	1.2382
18,001	0		88,695,101	74,166,577	14,528,524	3,255,786	2,504,013	2,362,037	6,161,345	5,355,409	243,137	6,791,455	1.1269
20,001	0		23,980,956	14,374,539	9,606,416	1,036,064	784,098	925,233	1,389,538	1,038,584	343,126	1,645,630	0.9019
22,001	0		39,254,935	29,573,359	9,681,576	1,778,889	1,532,218	1,891,166	2,896,240	2,349,290	222,149	3,919,219	0.8567
24,001	0		219,082,825	170,310,960	48,771,865	10,041,367	10,448,045	14,368,394	16,698,042	14,104,863	1,446,023	27,097,818	0.7439
26,001	0		18,397,735	3,799,875	14,597,860	1,247,072	502,790	578,864	330,346	236,656	815,465	480,976	0.7032
28,001	0		33,554,128	8,291,584	25,262,544	1,884,561	996,796	1,322,441	694,273	522,184	1,418,885	1,038,808	0.7184
30,001	0		41,839,917	23,949,066	17,890,851	2,697,234	1,250,705	1,724,298	1,525,216	1,541,349	1,178,670	3,233,217	0.6813
32,001	0		34,152,283	24,648,877	9,503,406	2,194,429	1,252,519	1,712,740	2,001,358	1,804,665	499,098	3,723,924	0.6926
34,001	0		13,230,326	4,348,035	8,882,291	857,545	441,354	534,111	425,091	320,299	549,524	602,403	0.7599
36,001	0		17,783,585	4,791,243	12,992,341	1,057,038	592,167	896,222	434,884	332,428	798,984	685,788	0.6928
38,001	0		19,071,766	6,813,337	12,258,429	1,163,194	655,664	573,314	697,931	552,072	847,417	861,742	0.9156
40,001	0		10,722,394	6,132,121	4,590,274	614,705	382,503	406,189	577,316	521,719	334,942	802,600	0.9290
42,001	0		6,404,116	4,290,966	2,113,149	573,460	239,289	281,786	480,096	367,576	68,499	733,362	0.7163
44,001	0		40,031,045	36,569,200	3,461,845	2,754,668	1,536,844	1,718,423	3,948,213	3,671,409	70,752	5,490,193	0.9557
46,001	0		19,508,687	15,352,970	4,155,717	1,432,797	723,737	814,992	1,817,898	1,524,350	119,061	2,338,536	0.9316
48,001	0		18,400,406	15,187,191	3,213,215	1,400,259	688,078	806,387	1,773,539	1,541,277	93,832	2,389,226	0.9219
50,001	0		17,149,499	15,870,303	1,279,195	1,240,539	717,851	865,274	1,734,487	1,641,094	38,884	2,613,044	0.8976
52,001	0		33,268,173	30,823,833	2,442,339	2,394,163	1,375,068	1,550,348	3,453,617	3,277,787	83,886	4,919,759	0.9522
54,001	0		30,137,315	28,098,510	2,038,805	2,303,504	1,272,419	1,476,766	3,316,209	3,185,302	100,216	4,710,873	0.9663
56,001	0		10,278,133	9,901,552	376,581	774,798	499,500	692,072	1,137,817	1,119,610	24,374	1,894,323	0.8447
58,001	0		9,847,223	9,228,740	618,483	711,044	456,865	487,010	1,120,441	1,074,258	25,810	1,550,976	0.9899
60,001	0		1,788,245	1,706,630	81,615	132,029	67,040	70,253	210,467	203,421	2,683	257,031	1.1311
62,001	0		3,265,788	3,068,241	197,547	253,849	160,065	201,113	389,469	380,497	15,526	577,824	0.9411
64,001	0		9,660,071	9,318,388	341,683	868,306	505,014	635,408	1,235,507	1,217,713	26,857	1,937,677	0.8981
66,001	0		2,540,015	2,478,617	61,399	239,950	135,648	179,413	342,358	337,970	3,984	541,595	0.8918
68,001	0		4,219,781	4,077,601	142,180	426,685	215,490	230,389	594,525	587,461	13,440	843,164	0.9958
70,001	0		3,857,604	3,787,102	70,503	363,624	224,421	151,152	581,206	575,019	4,518	725,688	1.1324
72,001	0		2,713,344	2,638,683	74,661	190,444	121,761	46,307	426,941	420,351	5,304	348,647	1.7230
74,001	0		7,070,688	6,899,053	171,636	585,222	449,409	276,908	1,163,060	1,156,804	22,524	1,279,702	1.2919

Figure 61. Summary

	Declared Weight			Annual VMT			Annual Cost Responsibility				Annual User Fees			Scaled Equity Ratio	
				All	Full-Fee	Alternative Fee	State	Federal	Local	Full-Fee	All	Full-Fee	Subsidy	All	Full-Fee
1	to	10,000		32,927,262,617	32,251,303,582	675,959,035	598,227,871	259,334,061	180,275,366	1,016,531,685	719,728,102	709,452,020	4,593,410	1.0091	0.9974
10,001	to	26,000		843,275,225	702,028,201	141,247,024	31,052,459	24,870,540	26,073,697	66,659,482	55,838,035	48,965,588	3,386,959	0.9909	1.0498
26,001	to	78,000		410,249,237	283,034,270	127,214,967	28,510,092	15,548,136	18,259,315	44,777,532	30,610,934	28,296,277	7,198,701	0.7148	0.9031
78,001	to	80,000		1,146,174,981	1,137,895,842	8,279,139	112,192,456	76,500,581	32,871,965	219,964,576	207,267,503	206,601,899	837,597	1.3612	1.3423
80,001	to	104,000		322,878,314	319,963,924	2,912,390	50,956,136	40,921,724	25,456,440	116,210,493	56,592,874	56,344,132	261,800	0.7018	0.6929
104,001	to	105,500		271,908,389	265,622,107	6,286,282	44,660,687	30,885,600	23,975,266	97,221,086	50,456,970	49,828,437	550,814	0.7377	0.7325
105,501	and	up		3,145,854	3,145,854	0	3,097,773	6,860,806	3,145,293	13,101,662	2,205,308	2,205,301	0	0.2449	0.2406
	Total			35,924,894,615	34,962,995,779	961,898,836	868,697,476	454,921,448	310,057,342	1,574,466,517	1,122,699,726	1,101,693,653	16,829,281	1.0000	1.0000
10,001	and	up		2,997,631,998	2,711,692,197	285,939,801	270,469,605	195,587,387	129,781,976	557,934,832	402,971,624	392,241,634	12,235,871	0.9841	1.0047
26,001	to	80,000		1,556,424,218	1,420,930,112	135,494,106	140,702,549	92,048,717	51,131,279	264,742,109	237,878,437	234,898,176	8,036,298	1.2193	1.2680
80,001	to	105,500		594,786,702	585,588,031	9,198,671	95,616,823	71,807,324	49,431,706	213,431,579	107,049,845	106,172,569	812,615	0.7183	0.7109
26,001	to	105,500		2,151,210,920	2,006,518,143	144,692,777	236,319,372	163,856,041	100,562,986	478,173,688	344,928,281	341,070,745	8,848,912	1.0024	1.0194
26,001	and	up		2,154,356,774	2,009,663,996	144,692,777	239,417,145	170,716,847	103,708,279	491,275,350	347,133,590	343,276,046	8,848,912	0.9830	0.9986

	Declared Weight			Annual VMT			Annual Cost Responsibility				Annual User Fees			Share of Cost	
				All	Full-Fee	Alternative Fee	State	Federal	Local	Full-Fee	All	Full-Fee	Subsidy	All	Full-Fee
1	to	10,000		91.7%	92.2%	70.3%	68.9%	57.0%	58.1%	64.6%	64.11%	64.40%	27.3%	63.5%	64.6%
10,001	to	26,000		2.3%	2.0%	14.7%	3.6%	5.5%	8.4%	4.2%	5.0%	4.4%	20.1%	5.0%	4.2%
26,001	to	78,000		1.1%	0.8%	13.2%	3.3%	3.4%	5.9%	2.8%	2.7%	2.6%	42.8%	3.8%	2.8%
78,001	to	80,000		3.2%	3.3%	0.9%	12.9%	16.8%	10.6%	14.0%	18.5%	18.8%	5.0%	13.6%	14.0%
80,001	to	104,000		0.9%	0.9%	0.3%	5.9%	9.0%	8.2%	7.4%	5.0%	5.1%	1.6%	7.2%	7.4%
104,001	to	105,500		0.8%	0.8%	0.7%	5.1%	6.8%	7.7%	6.2%	4.5%	4.5%	3.3%	6.1%	6.2%
105,501	and	up		0.0%	0.0%	0.0%	0.4%	1.5%	1.0%	0.8%	0.2%	0.2%	0.0%	0.8%	0.8%
	Total			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
10,001	and	up		8.3%	7.8%	29.7%	31.1%	43.0%	41.9%	35.4%	35.9%	35.60%	72.7%	36.5%	35.4%
26,001	to	80,000		4.3%	4.1%	14.1%	16.2%	20.2%	16.5%	16.8%	21.2%	21.3%	47.8%	17.4%	16.8%
80,001	to	105,500		1.7%	1.7%	1.0%	11.0%	15.8%	15.9%	13.6%	9.5%	9.6%	4.8%	13.3%	13.6%
26,001	to	105,500		6.0%	5.7%	15.0%	27.2%	36.0%	32.4%	30.4%	30.7%	31.0%	52.6%	30.7%	30.4%
26,001	and	up		6.0%	5.7%	15.0%	27.6%	37.5%	33.4%	31.2%	30.9%	31.2%	52.6%	31.5%	31.2%

Summary

The *Summary* tab summarizes the model results for the major vehicle weight classes. The Annual VMT, Annual Cost Responsibility, and Annual User Fees are linked to the *Equity* tab. The VMT, Cost Responsibility and User Fee shares and the equity ratios are also located on the *Summary* tab.

The *Summary* tab calculates the different Scaled Equity Ratios as follows:

- All: Ratio of the share of All User Fees to the share of all State, Federal, and Local Cost Responsibilities.
- Full-Fee: Ratio of the share of Full-Fee User Fees to the share of Full-Fee Cost Responsibility.

OUTPUT TEXT FILES

Allocated Costs

The following allocated costs text files are generated with each model run:

- *AllocatedCosts_bond.txt*
- *AllocatedCosts_federal.txt*
- *AllocatedCosts_state.txt*
- *AllocatedCosts_local-federal.txt*
- *AllocatedCosts_local-state.txt*
- *AllocatedCosts_local-other.txt*
- *AllocatedCosts_other.txt*

For each funding source, the text file contains allocated costs by work type for each vehicle weight and axle class. The size of these files requires that output text files be generated instead of including this disaggregated output as tabs in the outputs workbook. Since there are just over 100 different weight and axle classes and more than 100 work types, each of these seven text files could contain up to roughly 10,000 records.

The format of the *AllocatedCosts* text files is the same for all funding sources. The columns in the files are: funding, work type, weight class (WC), axles, and dollars.

Since allocated costs by funding source are summarized in the *Allocated Costs by SWT* tab in the outputs workbook, the *AllocatedCosts* text files are only required when the user is interested in looking at allocated costs for a particular work type or specific weight and axle class.

Bonds2017-2019.txt

Bond expenditures allocated during the 2017-2019 study. It is important to keep the bond allocation output file because this file becomes an input file for future studies. Running the 2017 model generates the bond file for 2017-2019 that will be used in the 2019 HCAS study, along with the prior bond files from the previous three studies.

DeclaredPaveFactors.txt

The *DeclaredPaveFactors.txt* file contains the pavement factors by declared operating weight.

FlatFeeReport.txt

FlatFeeReport.txt contains a summary of the flat fee revenues and as-if revenues for each flat fee commodity by weight class and axle class.

MissingPavementFactors.log

MissingPavementFactors.log is an output file that will list any missing pavement factors. This file should be checked during the auditing of the model run. If this file lists missing pavement factors, the weight classes and pavement factor input file should be checked for completeness.

SubsidiesbyVehClass.txt

SubsidiesbyVehClass.txt is an output file that contains the calculated subsidies by weight class and axle class.

VMTMaster.txt

The *VMTMaster.txt* file contains the most disaggregated output of the calculated VMT. VMT are reported for each facility class by ownership, weight class, and axle class. This file is used to report the VMT by county and city ownership.

12. POLICY ANALYSIS OF ALTERNATIVE RATES

The HCAS model includes the option to analyze changes in revenue instrument taxes or fees. The Alternative Rate Analysis is an optional analysis; if alternative rates have not been specified in the model, the user should ignore the alternative rate analysis output tabs. This section provides an explanation of the alternative rate analysis, a detailed description of the revenue instruments and three alternative rate case studies to illustrate the alternative rate analysis.

The Alternative Rate Analysis allows the user to estimate the effects of different road user tax rates and fees by entering the alternative rates in the *Alt. Rates* tab and rerunning the Python file, HCASModule.py. In the model calculations, the program calibrates the model to the rates and control totals in the *Rates* and *Revenue Forecast* input tabs, and then evaluates the effect of the modified rates specified by the user in the *Alt. Rates* input tab. The model reports the output from the current rates and alternative rates analyses in separate output tabs.

The HCAS model compares the share of costs for each vehicle class to their share of revenues to calculate the equity ratios. Altering the tax rates does not affect the allocation of costs to user groups.

The HCAS model does not contain any travel demand price elasticities, thus changing the use-related tax rates does not affect the underlying VMT used in the model. Nor does changing the fixed costs associated with owning a vehicle alter the assumed vehicle registrations or vehicle miles traveled.

The process for conducting an alternative rate analysis is straightforward. The general procedure is to:

- Enter the alternative rates in the *Alt. Rates* tab in the inputs workbook and re-save the inputs workbook.
- Run HCASModule.py (see Section 7, Run the HCAS Python Model).
- View the alternative rate results on the *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary* tabs in the outputs workbook.

ALTERNATIVE RATES INPUT TABS

Alt. Rates

The *Alt. Rates* tab in the inputs workbook contains the revenue instrument tax rates for gas, diesel, VMT, WMT, and registration fees, the RUAF and flat fee monthly rates, and VMT per month and axle shares. The setup of this tab is the same as the *Rates* tab (see Figure 51 on page D28).

Revenue Instruments

In Oregon's current highway finance system, vehicles under 26,001 pounds pay registration fees and the gas or diesel tax, and vehicles over 26,000 pounds pay registration fees and a weight mile tax (WMT).

Other special vehicles classes pay the following combination of use-related taxes and registration fees:

- Charitable non-profit vehicles: pay the charitable non-profit registration and gas or diesel tax.
- E-Plate (publicly owned) vehicles: pay the E-Plate registration fee.
- Tow trucks: Tow-Truck Registration Fee (excludes Tow Truck Certificate Cost), and gas or diesel tax. Tow trucks under 26,000 pounds have their own registration fee schedule; tow trucks over 26,000 pounds register with the MCTD and follow the normal heavy vehicle registration fee schedule.
- Farm vehicles: Farm vehicles have their own Farm Registration Fee Schedule and pay the gas or diesel tax (farm vehicles do not pay the weight-mile tax).
- Flat fee vehicles: Carriers hauling logs, sand and gravel, or wood chips have the option of paying a flat monthly fee based on vehicle weight instead of the weight mile tax. Flat fee vehicles are registered using the Motor Carrier Division registration schedule for tractors, trucks, and buses (normal registration fees).
- Road user assessment fee (RUAF) vehicles: Vehicles operating with single-trip permits at a gross weight above 98,000 pounds pay a RUAF of 5.7 cents per equivalent single-axle load for the loaded portion of their trip and pay a WMT tax for the unloaded portion. These vehicles pay regular registration fees according to their normally declared weight.
- Title fees are one-time fees for new vehicles and title transfers.

Tax rates for each of the unique revenue instruments can be copied from the *Rates* tab into the *Alt. Rates* tab and then modified by the user.

Gas Tax: Dollars per Gallon

The gas tax rate specified in the *Alt Rates* tab is applied to the imputed gallons of taxed gasoline, which is calculated in the model as the gas tax VMT divided the adjusted MPG.

The gas tax VMT is the sum of the VMT from the following vehicle classes: Gasoline-fueled Basic cars (car VMT minus the portion of basic car minus the assumed diesel share of basic VMT), Gas Commercial (GasCOMM) VMT, Gas Tow Trucks (GasTow) VMT, GasFarm VMT, GasCN VMT, GasSLG, GasFed, and GasSchool.

The total gasoline VMT is adjusted by the gas tax avoidance assumption to determine the total taxed gasoline VMT. The gas tax evasion factor is an assumption specified in the *General* tab.

Key assumptions and data used in the calculation of the gas tax revenues are the percent of basic VMT by diesel-powered vehicles, the gas tax avoidance rate, MPG, VMT and the gasoline tax rates.

The adjusted MPG is calculated by fuel type for each weight class and used in the revenue attribution for the HCAS model is also used in the alternative rate revenue attribution. Thus the revenues from an increase (or decrease) in the gas tax rates is adjusted appropriately so that the gas tax revenues from each vehicle weight class reflect their adjusted MPG and the specified alternative gas tax rate.

A majority of gasoline-powered (and taxed) vehicle miles are basic vehicles. Since the majority of the gas tax vehicle miles are by basic vehicles, increasing the gas tax rate will increase the revenue share paid by basic vehicles and increase the basic vehicle equity share. Similarly, a decrease in the gasoline tax rate will have the opposite effect, decreasing the gasoline tax revenues, which will decrease the basic vehicle share of revenues and the basic vehicle equity ratio.

Diesel Tax: Dollars per Gallon

The diesel tax rate specified in the *Alt. Rates* tab is applied to the imputed gallons of taxed diesel fuel to determine the diesel tax revenues. The imputed gallons of taxed diesel fuel is calculated as the diesel tax VMT divided by the adjusted MPG.

Diesel tax VMT is calculated as diesel tax evasion and avoidance-adjusted sum of the following vehicle class VMT: Car-Diesel (basic vehicle VMT multiplied by the percent of basic VMT by diesel-powered vehicles), Diesel Comm, DieselTow, DieselFarm, and DieselCN.

The diesel tax, paid by diesel-fueled vehicles, like the gasoline tax, affects both basic and non-basic vehicles; however the majority of diesel-fuel-taxed VMT are by heavy vehicles. In addition to having a higher share of diesel VMT, heavy vehicles also have lower MPG fuel efficiency, which means that heavy vehicles use more fuel per mile. Both of these factors imply that an increase in the diesel tax rate will result in a higher share of revenues for heavy vehicles, all other rates and assumptions held constant.

VMT Tax: Dollars per Mile

As of January 2017, no VMT tax exists in Oregon, however the VMT tax is a potential future revenue instrument and the model has included the VMT tax instrument as a possible policy option for the alternative rate analysis.

The VMT tax is entered as dollars per mile, similar to the current WMT tax. The VMT tax is applied to all full-fee basic vehicles and non-basic vehicles that do not pay the WMT, Flat Fee, or RUAF tax (e.g., VMT tax is applied to vehicles currently paying either the gasoline or diesel tax).

VMT tax revenues are calculated by applying the VMT tax rates to gas and diesel VMT. A VMT tax can be entered instead of, or in addition to, gas and diesel tax rates. Flat Fee, RUAF, and WMT vehicle classes continue to be taxed using their respective tax instruments and rates.

The impact of a VMT tax on the basic and heavy revenue shares and equity ratio will depend on the VMT tax rates specified for the different weight classes.

Weight Mile Tax (WMT): Dollars per Mile

The WMT is measured in dollars per mile. The ODOT WMT Table A lists the WMT rates for heavy vehicles between 26,000 and 80,000 pounds and the ODOT WMT Table B contains the per mile rates for heavy vehicles between 80,000 and 105,500 pounds. Vehicles weighing more than 105,500 pounds pay the RUAF.

The WMT revenues and revenue attribution are calculated by multiplying the WMT tax by the WMT evasion-adjusted WMT VMT. Increasing the WMT tax rates will increase the share of revenue for heavy vehicles (vehicles over 26,000 pounds) and increase the heavy vehicle equity ratio. The WMT tax structure will affect the equity ratios for individual weight classes within the heavy vehicle group.

Vehicle Registration Fees: Dollars per Year

The Oregon DMV registers most vehicles, with the exception of heavy vehicles (over 26,000 pounds), which must register with the MCTD. Vehicle registration fee schedules can be found at the DMV website and the Tractor, Truck, and Buses Registration Fee Schedule can be found at the MCTD website. All registration fees are entered as dollars per year on the *Rates* and *Alt Rates* tabs.

- Normal Vehicle Registration (Normal Reg): Current normal registration for basic vehicles (under 8,000 pounds) is $84 for a two-year registration ($43 per year). The MCTD Registration Fee Schedule is used for vehicles 10,000 pounds and up.
- Farm Vehicle Registration (Farm Reg): Certified farm operation vehicles have their own registration schedule ("Fee Schedule: Trucks Registered as Farm Vehicles").
- Tow Truck Registration (Tow Reg): The fee schedule for tow/recovery vehicles is used for tow trucks under 26,000 pounds, and the registration fee entered in the *Rates* and *Alt Rates* tabs should exclude the tow truck certificate fee. Tow trucks weighing more than 26,000 pounds must register with and pay registration fees according to the MCTD.
- Charitable Non-Profit Registration (CN Reg): per year registration fee. Charitable Non-Profits pay registration fees following the DMV "Fee Schedule For Charitable, Non-Profit and Manufactured Structure Motor Vehicles." This fee schedule includes vehicles up to 105,500 pounds.
- E-Plate Registration (E-Plate Reg) per year registration fee. Publicly owned vehicles pay a one-time registration fee of $2. It is assumed that the life of a publicly owned vehicle is five years, thus the annual amount for registration fees is set equal to $0.40 per year in the 2017 HCAS.

- Light Trailer Registration (LT Reg): The per year registration fee paid by light trailers weighing less than 26,001 pounds.
- Heavy Trailer Registration (HT Reg): The per year registration fee paid by heavy trailers weighing more than 26,000 pounds.

Title Fee: Dollars per Title Transaction

A title fee is paid upon first-time purchase and registration of a vehicle in Oregon. As of January 2017 there were two different title fees depending on vehicle class. The title fee for vehicles weighing under 26,000 pounds was $77 and the fee for vehicles above 26,000 pounds was $90. The title fee revenue control total amount is attributed to the vehicle classes based on VMT at each weight class and the title fee.

RUAF: Dollars per Mile

The Road Use Assessment Fee (RUAF) is a flat rate entered as dollars per equivalent single-axle load (ESAL) by weight class from the RUAF fee schedule. The RUAF rate is applied to the RUAF VMT by weight class, which are tabulated from the base year RUAF collection reports. For a given weight class, the RUAF rates decrease as the number of axles increases because the vehicle weight is being distributed over more axles, causing less road damage.

Flat Fee: Monthly Fee

A flat fee is a monthly fee paid by a flat fee commodity hauler. Flat fee rates apply to carriers hauling chips, sand and gravel, or logs. These carriers pay per month according to their loaded operating weight. The Flat Fee rates are entered as dollars per month. The VMT per month and axle share are based on the base year flat fee report data and are used to determine the WMT revenue from flat fee haulers in the "as-if" revenue calculation.

Under the current flat fee rates, log haulers may pay $7.59 per 100 pounds, sand and gravel haulers may pay $7.53 per 100 pounds, and wood chip haulers may pay $30.65 per 100 pounds. Flat fee rates apply to vehicles hauling log, sand and gravel, or chips that are over 26,000 pounds, with the monthly rate calculated as the flat fee rate paid by a hauler operating at the mid-point for the weight category (weight class plus 999 pounds).

ALTERNATIVE RATES OUTPUT TABS

The alternative rate analysis results are displayed in three tabs in the outputs workbook: *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary.*

Alt. Attributed Revenues

The *Alt. Attributed Revenues* tab contains model output of the attributed revenues by major revenue instrument for each weight and axle class. The *Alt. Attributed Revenues* are summed to produce Annual User Fees in the *Alt. Equity* and *Alt. Summary* tabs.

Alt. Equity

The *Alt. Equity* tab displays the Annual VMT, Annual Cost Responsibility, Annual User Fees, and Scaled Equity Ratio by weight and axle class for the alternative rate analysis. The *Alt. Equity* tab refers to the *Alt. Attributed Revenues*, and *Allocated Costs* tabs.

Alt. Summary

The *Alt. Summary* tab displays the summary results of the annual model VMT, annual cost responsibility, annual user fees, the subsidy and allocated subsidy, and the equity ratios by aggregated major vehicle weight class for the alternative rate analysis.

ALTERNATIVE RATES ANALYSIS CASE STUDIES

This section illustrates three different alternative rate analyses. For each case study, a step-by-step explanation of how to conduct the analysis is provided, followed by a description of the impact of the changes on vehicle equity ratios.

The first case study increases the gas and diesel tax from $0.30 per gallon to $0.36 per gallon. The second case study increases the basic vehicle registration fee by $11, or roughly 25 percent. The third case study imposes a new VMT tax of $0.0293 per mile, repealing the state fuel tax. The second case study illustrates the effect of a change in a single revenue instrument, while the first and third case studies involve changes to more than one revenue instrument. The net effect of an analysis of two or more revenue instrument rate changes will depend on the relative magnitude of the change to each revenue instrument rate and which vehicle class revenues are affected.

Case Study A: Change in Gas and Diesel Rates

The first case study considers an increase in the gas and diesel tax from the current rate of $0.30 per gallon to $0.36 per gallon—a six-cent increase. Only the gas and diesel tax rates are increased; other revenue instrument rates remain at their 2011 HCAS rates.

Perform an analysis of an increase in the gas and diesel tax rates by following these steps:

- In the *Alt. Rates* tab, copy the current rates from the *Rates* tab.
- In the Gas Tax column (column "C" beginning in row 3) enter 0.36 for each weight class. This step specifies the alternative gas tax rate of $0.36 per gallon.
- In the Diesel Tax column (column "D" beginning in row 3) enter 0.36 for each weight class. This step specifies the alternative diesel tax rate of $0.36 per gallon.
- Run HCASModule.py.
- View the alternative rate analysis results in the *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary* tabs in the outputs workbook.

The revenue in the *Alt. Attributed Revenues* tab will now reflect the increase in the gas and diesel tax rates.

Table 2. Comparison of Annual Revenues for Gas and Diesel Rates Case (thousands of dollars)

Revenue Source	2011 Rates	Alt. Rates	Revenue Difference	% Change in Revenues
Gas Tax	493,090	591,708	98,618	20%
Diesel Tax	42,798	51,357	8,560	20%
Other	590,345	590,345	0	0%
Total Revenue	1,126,232	1,233,410	107,178	9.5%

Table 3. Comparison of Revenue Shares and Equity Ratios for Gas and Diesel Rates Case

Weight Class	Share of Annual User Fees		FF Subsidy-Adjusted Equity Ratios	
	2011 Rates	Alt. Rates	2011 Rates	Alt. Rates
1 to 10,000	65.73%	68.42%	0.9954	1.0363
10,001 and up	34.27%	31.58%	1.0089	0.9295

A comparison of the *Equity* tab to the *Alt. Equity* tab shows that the VMT and Cost Responsibility for each weight class have not changed. Only the Attributed Revenues (Annual User Fees) have changed. Because the change in the attributed revenues has also changed the revenue shares, the equity ratios will reflect the shift in the share of revenues attributed to the vehicle classes.

Table 2 compares the gas tax revenue, diesel tax revenue, and other revenue for the 2011 HCAS model ("2011 Rates") and the alternative gas and diesel rates ("Alt. Rates"). Both the gas tax and diesel tax revenues have increased by 20 percent (a six-cent increase in the $0.30 per gallon fuel tax rate is a 20 percent increase) in the alternative rate analysis, and total revenues have increased by 9.5 percent as a result of the gas and diesel tax rate increases.

In the 2011 HCAS, the basic vehicle equity share is 0.9954. The basic vehicle equity share in the alternative rate analysis (found in the *Alt. Summary* tab after recalculating the model with the alternative rates) is 1.0363 (see Table 3). The basic vehicle equity share increases because the net effect of the gas and diesel tax increase is an increase in the basic vehicle revenue share, which in turn increases the basic vehicle equity ratio.

Case Study B: Change in Registration Fee

The second case study, a change in registration fees, considers increasing the normal registration fee for basic vehicles from $43 to $54 per year. Only the normal registration fee for basic vehicles is increased; other revenue instrument rates remain at their 2011 HCAS rates.

Perform an alternative rate analysis of a change in the Normal Registration Fee by following these steps:

- In the *Alt. Rates* tab, copy the current rates from the *Rates* tab.
- In the Normal Reg column (column "G" beginning in row 2), enter 54 for Weight Class 1. This step specifies the alternative registration fee of $54 per year for basic vehicles (vehicles under 10,000 pounds).
- Run HCASModule.py.
- View the alternative rate analysis results in the *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary* tabs in the outputs workbook.

Because the registration fee paid by basic vehicles increases while all other rates are held constant, the basic vehicle share of revenues increases, in turn increasing the basic vehicle equity ratio. Because the heavy vehicle class revenues remain unchanged, the heavy vehicle revenue share declines from 34.3 percent to 33.2 percent, as shown in Table 4.

Case Study C: Implementation of VMT Tax

The third case study evaluates the impact of the implementation of a vehicle-mile-traveled (VMT) tax and the repeal of the gas and diesel taxes. Only the gas and diesel taxes and VMT tax are changed; other revenue instrument rates remain at their 2011 HCAS rates.

Perform an alternative rate analysis of a new VMT tax and repeal of the gas and diesel tax by following these steps:

- In the *Alt. Rates* tab, copy the current rates from the *Rates* tab.
- In the Gas Tax and Diesel Tax columns (columns "C" and "D" beginning in row 3), enter 0 for all weight classes. This step sets the gas and diesel tax rates to zero.
- In the VMT Tax column (column "E", beginning in row 3), enter 0.0293 for all weight classes. This step sets the VMT tax rate to $0.0293 per mile (2.93 cents per mile).
- Run HCASModule.py.
- View the alternative rate analysis results in the *Alt. Attributed Revenues, Alt. Equity,* and *Alt. Summary* tabs in the outputs workbook.

A VMT tax rate of $0.0293 per mile produces average annual revenues of approximately $563.1 million. Basic vehicle full-fee revenue share increases to 75.8 percent in the alternative rate analysis from 65.7 percent in the current model.

A VMT tax rate of $0.0293 per mile is roughly equal to the effective fuel tax rate paid for vehicles with fuel efficiency of 10.5 MPG. Since the majority of the vehicle miles traveled by vehicle tax classes paying the gas and diesel tax are by basic vehicles, in the model assumed to have closer to 20 MPG, the revenues from a VMT tax of $0.0293 per mile are greater than the fuel taxes generated from a $0.30 per gallon fuel tax. Thus, the basic vehicle revenues and equity share increase as shown in Table 5.

Table 4. Comparison of Revenue Shares and Equity Ratios for Basic Vehicle Registration Fee Case

Weight Class	Share of Annual User Fees		FF Subsidy-Adjusted Equity Ratios	
	2011 Rates	Alt. Rates	2011 Rates	Alt. Rates
1 to 10,000	65.73%	66.85%	0.9954	1.0123
10,001 and up	34.27%	33.15%	1.0089	0.9761

Table 5. Comparison of Revenue Shares and Equity Ratios for VMT Tax Case Study

Weight Class	Share of Annual User Fees		FF Subsidy-Adjusted Equity Ratios	
	2011 Rates	Alt. Rates	2011 Rates	Alt. Rates
1 to 10,000	65.73%	75.88%	0.9954	1.1494
10,001 and up	34.27%	21.12%	1.0089	0.7098

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Appendix E: Model Documentation

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MODEL OVERVIEW

The full source code for the 2017 Oregon Highway Cost Allocation Model is included with the model distribution. The model is written in Python and is implemented by running HCASModule.py. The process for running the model is described in depth in Appendix D, the Model User Guide.

As described in the Model User Guide in Appendix D, the user runs the HCAS Model with using a Graphic User Interface (GUI) in which the user can open and run the Python model. The HCAS Python code is centered on a class, HCASModule, that calls a series of methods when the Python file is executed.

This appendix provides a detailed description of each of the class methods that are called in the HCAS Python model, explaining the calculations and describing the internal data structures they use. Figure 1 shows a graphical representation of the overall model process, including the Excel workbooks, the HCAS model, and the external data files. Figure 1 shows the required inputs, templates and outputs of the model. Each box shows the general filepath from the base folder where the file(s) is located. Appendix D provides a detailed overview of how these files are setup and where they are located in the HCAS model folder.

Table 1 describes the input ranges in various tabs of the "HCAS Inputs.xlsx" workbook, listing the input range name, the tab it is located in, the data it contains, the units those data are in, the class method that loads the data into the HCAS model code, and the name of the data structure in the HCAS model code that accepts the data.

Table 2 describes the tab-delimited text files that contain input data for the HCAS model, listing the file name, what data it contains, the units those data are in, and the data structure in the HCAS model that accepts the data.

Figure 1. Oregon Highway Cost Allocation Model

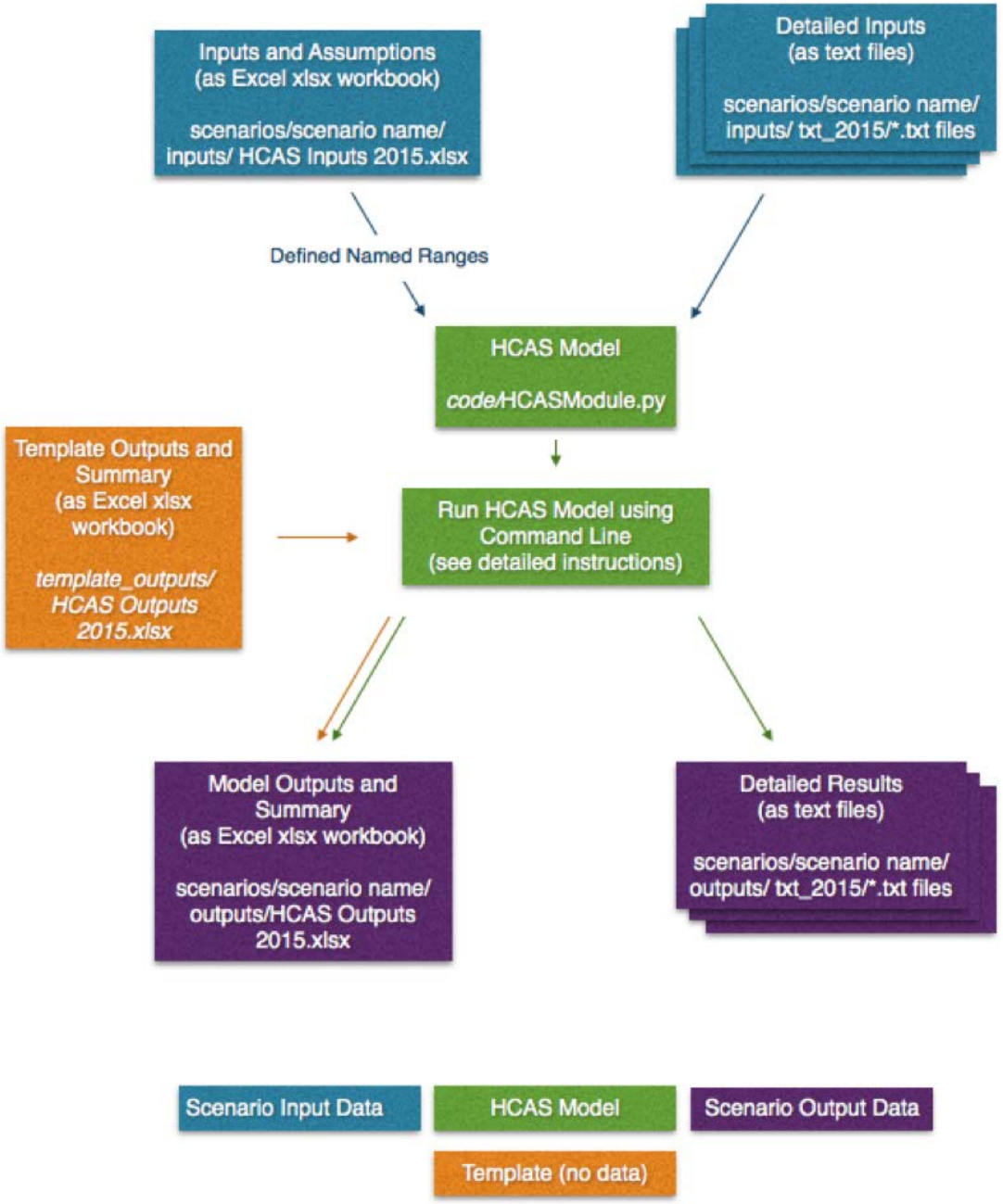

Table 1. Input Ranges

Named Range	Tab	Model Function	Model Variable Name	Units	Contains
GrowthRates	VMT Growth	simpleSetup(xls_inputs['GrowthRates'])	self.growthRates	Annual growth rate (e.g., 0.05 means 5% per year)	VMT growth rates
VMTByFC	VMT by FC	simpleSetup(xls_inputs['VMTByFC'])	self.VMTbyFC	Base-year vehicle-miles traveled	VMT by functional class and ownership
BaseVMT	Base VMT	setBaseVMT(xls_inputs['BaseVMT'])	self.baseVMT	Base-year vehicle-miles traveled	Base-year VMT by weight class and tax class
Evasion	General	setEvasion(xls_inputs['Evasion'])	self.gasEvasion, self.dieselEvasion, self.wmtEvasion, self.basicDiesel, self.ruafRegRate, self.ruafReg78, self.ruafReg96, self.ruafReg104, self.emptyLogPercent, self.emptyLogWeight	All are shares (e.g., 0.05 means 5%) except RUAF Registration Rate is in dollars per mile traveled and Empty Log Weight is in pounds	Assumptions for gas-tax avoidance, use-fuel tax evasion & avoidance, weight-mile tax evasion, share of basic VMT that burn diesel, registration rate per mile for RUAF vehicles, share of RUAF vehicles registered at 78,001-80,000 lbs, share of RUAF vehicles registered at 96,001-98,000 lbs, share of RUAF vehicles registered at 104,001-105,500 lbs, percent of flat-fee log truck miles that are empty, declared weight for empty log trucks
Path	Policy	setPath(xls_inputs['Path'])	self.path	Names of allocators and shares	Allocator(s) to use for each work type
ProjectCosts	Project Costs	setProjectOrLocalCosts(xls_inputs['ProjectCosts'])	self.projectCosts	Biennial dollars	Costs to allocate for construction projects
NonProjectCosts	Non-Project Costs	setNonProjectOrStuddedTire(xls_inputs['NonProjectCosts'])	self.nonProjectCosts	Biennial dollars	Other costs to allocate
LocalCosts	Local Costs	setProjectOrLocalCosts(xls_inputs['LocalCosts'])	self.localCosts	Biennial dollars	Local-government costs to allocate
StuddedTire	General	setNonProjectOrStuddedTire(xls_inputs['StuddedTire'])	self.studdedTire	Biennial dollars	Studded-tire adjustments
BridgeFactors	General	setBridgeFactors(xls_inputs['BridgeFactors'])	self.bridgeFactors	Shares	Incremental factors for bridge work types
BondFactor	General	float(xls_inputs['BondFactor'][0][0])	self.bondFactor	Share	Proportion of bonded expenditures to allocate in a biennium
Biennium	General	int(xls_inputs['Biennium'][0][0])	self.biennium	Four-digit year	First year of model biennium
SWT	Codes	setSummaryTypesClasses(xls_inputs['SWT'])	self.summaryWorkTypes	Work type codes	Definitions of summary work types
SWC	Codes	setSummaryTypesClasses(xls_inputs['SWC'])	self.summaryWeightClasses	Pounds	Definitions of summary weight classes

Table 3 describes the outputs from the model code that populate the tabs in the "HCAS Outputs 2017.xlsx" workbook, listing the data structure in the HCAS model from which the data are extracted, the method called to calculate and retrieve the data, the tab into which the data are written, and the contents of the data.

Table 4 describes the tab-delimited text files that are written when the HCAS model runs, listing the data structure in the HCAS model from which the data are extracted, the method called to calculate and write the data, the file names, and the contents of the data.

Table 1 (continued). Input Ranges

Named Range	Tab	Model Function	Model Variable Name	Units	Contains
RevenueTotals	Revenue Forecast	setRevenueTotals(xls_inputs['RevenueTotals'])	self.revenueTotals	Biennial dollars	Control totals for revenues by instrument
Rates	Rates	setRates(xls_inputs['Rates'])	self.rates	Dollars per whatever	Current-law rates except RUAF and flat fee
RUAFRates	Rates	setRUAFRates(xls_inputs['RUAFRates'])	self.RUAFRates	Dollars per mile	Current-law RUAF rates
FFRates	Rates	setFFRates(xls_inputs['FFRates'])	self.flatfee	Dollars per month, miles per month, and shares	Current-law flat fee rates
MPG	MPG		self.MPG	Miles per gallon	Assumed miles per gallon
AltRates	Alt Rates	setRates(xls_inputs['AltRates'])	self.altRates	Dollars per whatever	Alternative rates except RUAF and flat fee
AltRUAFRates	Alt Rates	setRUAFRates(xls_inputs['AltRUAFRates'])	self.altRUAFRates	Dollars per mile	Alternative RUAF rates
AltFFRates	Alt Rates	setFFRates(xls_inputs['AltFFRates'])	self.altFlatfee	Dollars per month, miles per month, and shares	Alternative flat fee rates

See: HCAS Inputs 2015.xlsx

Table 2. Input Text Files

File Name	Model Data Structure	Units	Contains
SeedData.txt	self.seedData	Unitless numbers	Used to populate a preliminary VMT Master table (VMTdata) for iterative proportional fitting (see below). Any seed values (except zeros) could be used to generate fitted results, but this particular set already contains data that reflect the relative proportions of different vehicle types on different functional classes, and so will produce a distribution that not only adds up to the correct totals for each weight class and each combination of functional class and ownership, but also reflects the fact that some functional classes carry higher proportions of heavy vehicles than others. There are five columns: facility class (combines functional class and ownership), functional class, ownership, weight class, axles, and VMT. The first four are keys.
AxleShares.txt	self.shares	Shares (e.g. 0.5 means 50%)	Contains the shares of vehicles weighing more than 105,500 pounds with each number of axles (5 to 9+) by weight class. These data are developed from Special Weighings data. There are three columns: weight class, axles, and share. The first two are keys
SimpleFactors.txt	self.simpleFactors	Shares	Contains vectors of factors to be multiplied by VMT for simple allocators (different weight groupings of VMT). These factors are mostly zeros and ones, reflecting the definition of the allocator. For example, the Under26 factor is one for all weight classes up to 26,000 pounds and zero for all weight classes over 26,000 pounds. There are ten columns: weight class, axles, AllVMT, BasicVMT, Over10VMT, Over26VMT, Over50VMT, Under26VMT, Over80VMT, Over106VMT, Snow, and AllAMT. The first two are keys; the rest are allocators.
PaveFactors.txt	self.paveFactors	Shares	Contains cost responsibility factors (by weight class, functional class, and number of axles) for wear and tear of flexible and rigid pavement projects. These factors are produced by the NAPHCAS-OR model (the Oregon version of the National Pavement Cost Model for Highway Cost Allocation developed by Roger Mingo). There are five columns: facility class (combines functional class and ownership), weight class, axles, flexible, and rigid. The first three are keys.
PCEFactors.txt	self.pceFactors	Shares	Contains passenger car equivalents (PCEs) by weight class, functional class, and number of axles for vehicles on regular, uphill, and congested roadways. These factors represent the amount of roadway capacity a single vehicle of a particular weight class takes up as a proportion of the capacity consumed by a basic vehicle. These factors were developed from a study conducted as a part of the 1997 federal highway cost allocation study. There are six columns: facility class (combines functional class and ownership), weight class, axles, regularPCE, UphillPCE, and congestedPCE. The first three are keys.
DeclaredRegistered.txt	self.declaredRegistered	Shares	Contains shares of vehicles in each declared weight class that are registered in each registered weight class. These data were developed from Motor Carrier registration data. There are three columns: declaredWeight, registeredWeight, and share. The first two are keys.
DeclaredOperating.txt	self.declaredOperating	Shares	Contains shares of vehicles in each declared weight class operating at each operating weight class. These data were developed from the Special Weighings data. There are five columns: declared, declaredAxles, operating, operatingAxles, and Share. The first four are keys.
BasicSharePeak.txt	self.peakShares	Shares	Contains the basic-vehicle share of peak-hour VMT for each functional class. These data were developed from automatic traffic recorder data. There are two columns: functionalClass and share. The first is the key.
BondsYYYY-YYYY.txt	self.priorBondAmount	Biennial dollars	Contains allocated bonded expenditures from prior studies. Uses such files, if they exist, from the nine most recent prior biennia. Columns are declared weight class, declared number of axles, and dollars. The first two are keys. Actual files will have biennium beginning and ending years in place of “YYYY”.

Table 3. Outputs

Tab	Model Data Structure	Method to Create	Units	Contains
Model VMT	self.vmtByVehicles	makeVMTByVehicles()	Annual vehicle-miles traveled	Model year VMT by weight class and tax class
Allocated Costs	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Allocated costs by declared weight class, declared number of axles, and funding source
Allocated Costs by SWT	self.fullAllocatedCosts	getAllocatedCostsByWorkType()	Biennial dollars	Allocated costs by funding source, summary work type, and summary weight class
Costs to Allocate by SWT	self.projectCosts, self.nonProjectCosts, self.bondCosts, self.priorBondAmount	getCoststoAllocate()	Biennial dollars	Costs to allocate by funding source and summary work type
Attributed Revenues	attributedRevenues	attributeRevenues()	Biennial dollars	Attributed revenues by declared weight class, declared number of axles, and revenue instrument
Alt. Attributed Revenues	attributedRevenues	attributeAltRevenues()	Biennial dollars	Attributed alternative revenues by declared weight class, declared number of axles, and revenue instrument
MPG	self.adjustedMPG	getAdjustedMPG()	Miles per gallon	Calibrated estimates of miles per gallon by weight class

See: HCAS Outputs 2015.xlsx

Table 4. Output Text FIles

File Name	Model Data Structure	Method to Create	Units	Contains
AllocatedCosts_bond.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from current and prior bonded expenditures. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.
AllocatedCosts_federal.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from the expenditure of federal funds by state government. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.
AllocatedCosts_local-federal.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from the expenditure of federal funds by local government. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.
AllocatedCosts_local-other.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from the expenditure of local funds by local government. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.

Table 4 (continued). Output Text FIles

File Name	Model Data Structure	Method to Create	Units	Contains
AllocatedCosts_local-state.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from the expenditure of state funds by local government. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.
AllocatedCosts_other.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Not used. This may be ignored.
AllocatedCosts_state.txt	self.fullAllocatedCosts	allocateCosts()	Biennial dollars	Contains allocated costs from the expenditure of state funds by state government. Columns are funding source, work type, declared weight class, declared number of axles, and dollars. The first four are keys.
BondsYYYY-YYYY.txt	allocatedBonds	allocateCosts()	Biennial dollars	Contains allocated bonded expenditures from this study. Will be used for the next nine biennia as an input file. Columns are declared weight class, declared number of axles, and dollars. The first two are keys. Actual file name will have beginning and ending years of the model biennium in place of "YYYY".
DeclaredPaveFactors.txt	self.pavement	makeVMTMaster()	Unitless factors	Contains pavement factors by facility class, declared weight class, and declared number of axles that are constructed from the raw pavement factors, which are by functional class, operating weight class, and actual number of axles. Columns are facility class, functional class, ownership, declared weight class, declared number of axles, flexible factor, and rigid factor. The first five are keys.
FlatFeeReport.txt	ffRevenue, asifWMTRevenue	allocateCosts()	Biennial dollars	Reports fees paid by flat-fee vehicles and the fees they would pay if they paid weight-mile tax. The 'as-if' revenue is to determine the flat fee difference. As of the 2011 study, flat-fee vehicles are not considered alternative fee-paying vehicles. Columns are declared weight class, declared number of axles, log revenue, as-if log revenue, dump revenue, as-if dump revenue, chip revenue, and as-if chip revenue. The first two are keys.
MissingPavementFactors.log	N/A	makeVMTMaster()	N/A	Lists any errors encountered while attempting to make pavement factors by facility class, declared weight class, and declared number of axles from raw pavement factors, which are by functional class, operating weight class, and actual number of axles.
VMTMaster.txt	self.VMTMaster	makeVMTMaster()	Annual vehicle-miles traveled	Contains annual VMT. Columns are functional class, ownership, declared weight class, declared number of axles, and vehicle-miles traveled. The first four are keys.
SubsidiesbyVehClass.txt	ffRevenue, regRevenue, ruafRevenue, wmtRevenue, gasTaxRevenue, dieselTaxRevenue, asifWMTRevenue	allocateCosts()	Biennial dollars	Contains calculated subsidies by subsidy type for WMT, Farm Registration, Tow Registration, Charitable Non-Profit Registration and E-Plate Registration for each weight class, and actual number of axles.

DESCRIPTION OF MODEL CALCULATION OPERATIONS

The following describes what happens when the Python HCAS model, HCASModule.py, is run. Figure 1 on page E3 illustrates the overarching process of the model. The model loads text files and tabs from the HCAS Inputs Excel workbook, performs calculations in Python, and then populates tabs with the results into the HCAS Outputs Excel workbook and saves output text files with detailed results.

SEND BASE-YEAR VMT DATA AND RETRIEVE MODEL-YEAR VMT DATA

Growth rates, from the *VMT Growth* tab, tell the model how fast VMT in each weight class is expected to grow between the base year (the most recent calendar year for which data are available) and the model year (the calendar year in the middle of the fiscal biennium being modeled).

VMT by functional class, from the *VMT by FC* tab, provides control totals for base-year VMT in each functional class. Base VMT, from the *Base VMT* tab, provides base-year VMT by weight class and tax class.

Evasion rates, from the *General* tab, tell the model what evasion and avoidance rates to assume. Evasion and avoidance are combined.

The call to **makeVMTMaster()** tells the model to do its VMT calculations. The call to **makeVMTByVehicles()** tells the model to calculate model-year VMT by weight and tax class and populate the *Model VMT* tab in the outputs workbook.

SEND COSTS TO ALLOCATE AND RETRIEVE ALLOCATED COSTS

The path, defined in the *Policy* tab, defines the set of allocators to be applied to each work type. Each work type may have up to two allocators. If there are two, the proportion of costs in that work type to which each will be applied is also defined in the path. The proportions must add up to one.

The model obtains costs to allocate from the *Project Costs*, *Non-Project Costs*, and *Local Costs* tabs. Items (rows) in the lists of costs to allocate include information about the funding source, work type, functional class, and dollar amount. Project costs also include the bridge type, which is zero if the project is not a bridge project.

The model obtains studded-tire adjustments from the Studded Tires table in the *General* tab. These move costs from their original combination of funding source and work type into the studded tire work type with the same funding source.

The model obtains bridge factors from the Bridge Splits table in the *General* tab. These factors are used to reassign bridge costs from their original work types to incremental cost work types so that incremental allocators may be applied. There will be a set of factors for each bridge type.

The model obtains the information necessary for the proper treatment of the expenditure of bond revenues from the *General* tab.

The *Codes* tab allows the model to tabulate allocated costs by summary work type and summary weight class for the report tables. These tabulations are done in the model, rather than in workbook, since it is faster, more reliable, and keeps the workbook size reasonable.

The allocateCosts() method allocates costs and returns the allocated costs by weight class and funding source, which then populate the *Allocated Costs* tab in the outputs workbook.

SEND REVENUES AND RATES AND RETRIEVE ATTRIBUTED REVENUES

The model obtains revenue totals that are the control totals by instrument from the budget. Revenues are located in the *Revenue Forecast* tab in the inputs workbook. Rates are located in the *Rates* tab in the inputs workbook. Rates are for instruments that vary by weight class (e.g., weight-mile tax rates) or not at all (e.g., fuel taxes). The two other types of rates have different dimensions, so are sent separately. RUAF rates extend to a much longer list of weight classes. Flat-fee rates are by commodity and include information about the average miles per month for each weight class and the distribution of VMT in each weight class to numbers of axles for weights over 80,000 pounds. The model obtains estimated miles per gallon by operating weight class from the *MPG* tab in the inputs workbook.

The **attributeRevenues()** method attributes revenues and returns the attributed revenues by weight class and revenue instrument, which then populate the *Attributed Revenues* tab in the outputs workbook.

The call to **getAdjustedMPG()** tells the model to return the adjusted miles per gallon (already calculated as part of the revenue attribution calculations), which then populate the *MPG* tab of the outputs workbook to the right of the initial MPG estimates. The initial estimates are adjusted to allow fuel tax revenues to add up the revenue control totals for fuel taxes.

RETRIEVE SUMMARY TABULATIONS FOR REPORT TABLES

The **getAllocatedCostsByWorkType()** method gets allocated costs by summary work type, funding source, and summary weight class, which then populate *Allocated Costs by SWT* tab in the outputs workbook.

The **getCostsToAllocate()** method returns costs to allocate by summary work type and funding source, which then populate the *Costs to Allocate by SWT* tab in the outputs workbook.

SEND ALTERNATIVE RATES AND RETRIEVE ATTRIBUTED ALTERNATIVE REVENUES

The model obtains alternative rates from the *Alt Rate*s tab. These alternative rates are used for policy analysis to test the effect on equity of proposed changes to revenue instruments. They do not require changes to revenue control totals, because they use the calibrated miles per gallon and miles per registration from the original revenue attribution calculations, which were calculated from the control totals and rates provided there.

The **attributeAltRevenues()** method attributes revenues using alternative rate schedules and returns results by weight class and revenue instrument, which populate the *Alt. Attributed Revenues* tab in the outputs workbook.

DESCRIPTION OF MODEL CLASS METHODS

The following sections of the documentation serve two purposes: they describe in detail how the model does what it does and they provide a guide for following the source code. The class methods are described in the order they appear in the source code, which is the order in which they are called in running the model. The first section describes the class methods that load the input data into the model. The subsequent sections describe the way the model analyzes VMT, allocates costs, and attributes revenues

METHODS TO LOAD DATA

The class methods described in this section serve to get data into the HCAS model. Data that are not expected to be changed by the user are read in from tab-delimited text files. Data and assumptions that an analyst is more likely to want to change between model runs are loaded from the HCAS Inputs Excel workbook. Other class methods, described in later sections, make use of the data and return results to the HCAS Outputs Excel workbook and additional, more-detailed data to tab-delimited text files.

Note that variables beginning with "self." belong to the class object and are available to any class method to which the self reference has been passed. Other variables are available only within the method that creates them.

LOAD TEXT INPUT DATA

The **readData()** method imports the following data sets from tab-delimited text files, which are expected to be in the inputs text folder:

- **AxleShares.txt** is read into self.shares and contains the shares of vehicles weighing more than 105,500 pounds by number of axles (5 to 9+) by weight class. These data are developed from Special Weighings data to describe the share of each weight class with each possible number of axles (nine or more axles are coded as nine-plus). There are three columns: weight class, axles, and share. The first two are keys.
- **BasicSharePeak.txt** is read into self.peakShares and contains the basic-vehicle share of peak-hour VMT for each functional class. These data were developed from automatic traffic recorder data. There are two columns: functionalClass and share. The first is the key.
- **DeclaredOperating.txt** is read into self.declaredOperating and contains shares of vehicles in each declared weight class operating at each operating weight class. These data were developed from the Weigh-in-Motion data. There are five columns: declared, declaredAxles, operating, operatingAxles, and share. The first four are keys.
- **DeclaredRegistered.txt** is read into self.declaredRegistered and contains shares of vehicles in each declared weight class that are registered in each registered weight class. These data were developed from Motor Carrier and DMV registration data. There are three columns: declaredWeight, registeredWeight, and share. The first two are keys.

- **PaveFactors.txt** is read into self.paveFactors and contains cost responsibility factors (by weight class, functional class, and number of axles) for wear and tear of flexible and rigid pavement projects. These factors are produced by the NAPHCAS-OR model (the Oregon version of the National Pavement Cost Model for Highway Cost Allocation developed by Roger Mingo). There are five columns: facility class (combines functional class and ownership), weight class, axles, flexible, and rigid. The first three are keys.
- **PCEFactors.txt** is read into self.pceFactors and contains passenger car equivalents (PCEs) by weight class, functional class, and number of axles for vehicles on regular, uphill, and congested roadways. These factors represent the amount of roadway capacity a single vehicle of a particular weight class takes up as a proportion of the capacity consumed by a basic vehicle. These factors were developed from a study conducted as a part of the 1997 Federal Highway Cost Allocation Study. There are six columns: facility class (combines functional class and ownership), weight class, axles, regularPCE, uphillPCE, and congestedPCE. The first three are keys.
- **SeedData.txt** is read into self.seedData and used to populate a preliminary VMT Master table (VMTdata) for iterative proportional fitting (see below). Any seed values (except zeros) could be used to generate fitted results, but this particular set already contains data that reflect the relative proportions of different vehicle types on different functional classes, and so will produce a distribution that not only adds up to the correct totals for each weight class and each combination of functional class and ownership, but also reflects the fact that some functional classes carry higher proportions of heavy vehicles than others. There are five columns: facility class (combines functional class and ownership), functional class, ownership, weight class, axles, and VMT. The first four are keys.
- **SimpleFactors.txt** is read into self.simpleFactors and contains vectors of factors to be multiplied by VMT for simple allocators (different weight groupings of VMT). These factors are mostly zeros and ones, reflecting the definition of the allocator. For example, the Under26 factor is one for all weight classes up to 26,000 pounds and zero for all weight classes over 26,000 pounds. There are twelve columns: weight class, axles, AllVMT, BasicVMT, Over10VMT, Over26VMT, Over50VMT, Under26VMT, Over80VMT, Over106VMT, Snow, and AllAMT. The first two are keys; the rest are allocators.

LOAD EXCEL INPUT DATA

Input data from the HCAS Inputs Excel workbook are loaded from the workbook using **loadExcelInputData()** method. This function takes the filename of the input workbook as an argument. In the 2017 HCAS, the model expects the HCAS Inputs Excel workbook to be in the inputs folder and have the filename 'HCAS Inputs 2015.xslx'. A more detailed explanation of the inputs workbook setup is provided in Appendix D.

Load Data for VMT Analysis

The following class methods process the loaded data for the VMT calculations. The HCAS model calls these methods to process data for the model before it calls the **makeVMTMaster()** method.

- **simpleSetup** sets up data (in this case, self.growthRates and self.VMTbyFC) that has a shared format.

  Captures VMT growth rates by weight class and puts them into self.growthRates. The key is weight class and values are annual growth rates for VMT.

  Captures base-year VMT by functional class and ownership and puts them into self.VMTbyFC. The key is facility class (combination of functional class and ownership) and the values are base-year VMT. These data are developed from the state's HPMS submission and FHWA Highway Statistics reports.
- **setBaseVMT()** captures base-year VMT by weight class and tax class and puts them into self.baseVMT. self.baseVMT is a nested dictionary. The outer keys are weight classes (from the first column of the second and greater rows of the input data). The inner keys are vehicle tax classes from the contents of the second and greater columns of the first row. Values are base-year VMT in that combination of weight class and tax class. These data are typically developed from a variety of sources, including the ODOT Revenue Forecast, DMV registrations data, Motor Carrier registrations data, weight-mile tax reports, flat-fee reports, and road-use assessment fee reports.

- **setEvasion()** captures evasion and avoidance rates, along with some other assumptions used in revenue attribution. These assumptions are specified by the analyst. The function puts the assumptions into:
  - self.emptyLogWeight (the assumed declared weight of an empty log truck with its trailer decked)
  - self.emptyLogPercent (the assumed share of log-truck VMT that are driven while empty and with the trailer decked)
  - self.ruafReg104 (the assumed share of RUAF VMT by trucks with a registered weight of 104,001 to 105,500 pounds)
  - self.ruafReg96 (the assumed share of RUAF VMT by trucks with a registered weight of 96,001 to 98,000 pounds)
  - self.ruafReg78 (the assumed share of RUAF VMT by trucks with a registered weight of 78,001 to 80,000 pounds)
  - self.ruafRegRate (the assumed per-mile registration fee paid by trucks that pay the RUAF)
  - self.basicDiesel (the assumed proportion of basic VMT by diesel-powered cars and light trucks)
  - self.wmtEvasion (the assumed percent of total miles traveled by WMT vehicles upon which taxes are not paid)
  - self.dieselEvasion (the assumed percent of VMT by use-fuel-tax-paying vehicles for which the use-fuel tax was not paid; includes evasion and avoidance)
  - self.gasEvasion (the assumed percent of VMT by gas-tax-paying vehicles for which the gas tax was not paid; probably is entirely avoidance)

Load Data for Cost Allocation

The following class methods capture data from the inputs workbook for the cost allocation calculations and are called before the model calls the **allocateCosts()** method.

- **setPath()** captures allocation rules to be applied to each expenditure category (work type) and puts them into self.path. self.path is a nested dictionary. Outer keys are work-type codes and inner keys are allocator names. Values are shares of costs in that work type to which that allocator should be applied. These assumptions are specified by the analyst in conformance with the approach agreed upon by the Study Review Team.
- **setProjectOrLocalCosts()** sets up data (e.g., self.projectCosts and self.localCosts) that has a shared format.

  Captures project costs to be allocated and puts them into self.projectCosts. The key is a tuple consisting of funding source, work type, facility class (combination of functional class and ownership), and bridge type. The values are biennial dollars of costs to allocate. These are typically derived from the ODOT Cash Flow Model and Project Control System.

  Captures local government costs to be allocated and puts them into self.localCosts. The key is a tuple consisting of funding source, work type, facility class (combination of functional class and ownership), and bridge type. The values are biennial dollars of costs to allocate. These are typically derived primarily from Local Roads and Streets Survey reports.
- **setNonProjectOrStuddedTire()** sets up data (e.g., self.nonProjectCosts and self.studdedTire) that has a shared format.

  Captures non-project costs to be allocated and puts them into self.nonProjectCosts. The key is a tuple consisting of funding source, work type, facility class (combination of functional class and ownership), and bridge type (always zero). The values are biennial dollars of costs to allocate. These are typically derived from the Agency Request Budget.

  Captures studded tire costs to be allocated and puts them into self.studdedTire. The key is a tuple consisting of funding source, work type, facility class (combination of functional class and ownership), and bridge type (always zero). The values are biennial dollars of costs to allocate, which will later be moved from the work types specified here into the work type for studded tire damage. These assumptions are supplied by the analyst.
- **setBridgeFactors()** captures cost shares used to distribute bridge expenditures for incremental cost allocation and puts them into self.bridgeFactors, a nested dictionary. The outer key is the bridge type and the inner key is a bridge-reclassification work type. Values are shares of costs for that bridge type to be allocated according to that work type. Shares for each bridge type must add up to one. The default values for these assumptions were developed from the 2002 OBEC Bridge Cost Allocation Study.

- **self.bondFactor** is defined as the proportion of bond-funded expenditures that will be repaid in a single biennium. This assumption is specified by the analyst. It represents the biennial repayment amount as a proportion of the principal amount.
- **self.biennium** is defined as the starting year of the model biennium. Specified by the analyst.

Load Data for Revenue Attribution

The following class methods capture data from the inputs workbook for the revenue attribution calculations. The HCASModule calls these methods to give data to the model before calling the standard implementation **attributeRevenues()** method or the alternative implementation **attributeAltRevenues()** method. The alternative rates are specified by the analyst to test changes in policy.

- **setRevenueTotals()** captures revenue control totals and puts them into self.revenueTotals. The key is the name of the revenue instrument and the value is biennial dollars of revenue to attribute. These are typically derived from the Agency Request Budget and must be consistent with current-law rates and the VMT data and assumptions specified elsewhere.
- **simpleSetup** sets up data (in this case, self.MPG) that has a shared format.
- Captures initial MPG assumptions by weight class and puts them into self.MPG. The key is operating weight class and values are miles per gallon. The default values for these assumptions were derived from a regression analysis of Vehicle Inventory and Use Statistics (VIUS) data.
- **setRates()** captures current-law (or alternative) rates for each of gas tax, use-fuel tax, VMT tax, weight mile tax, normal registration, farm registration, tow registration, charitable/nonprofit registration, e-plate registration, light-trailer registration, heavy-trailer registration, and title fees and puts them into self.rates (or self.altRates). self.rates (or self.altRates) is a nested dictionary. The outer keys are revenue instruments and the inner keys are tuples of weight class and number of axles. Values are rates in dollars per VMT, gallon, or year, as appropriate. For the standard implementation, these are specified by the analyst based on current law and must match the assumptions used to develop the revenue control totals. For the alternative implementation, these are specified by the analyst to test proposed changes to rates.
- **setRUAFRates()** captures current-law (or alternative) road-use assessment fee rates and puts them into self.RUAFRates (or self.altRUAFRates). The key is a tuple consisting of weight class and number of axles and values are dollars per mile. For the standard implementation, these are specified by the analyst based on current law. For the alternative implementation, these are specified by the analyst to test proposed changes to rates.
- **setFFRates()** captures current-law (or alternative) monthly flat-fee rates, average monthly miles, and axle distribution and puts them into self.flatfee (or altFlatfee). The key is one of 'Log Rate', 'Dump Rate', 'Chip Rate', 'Log VMT', 'Dump VMT', 'Chip VMT', 'Log Axles', 'Dump Axles', or 'Chip Axles' and the values are rates in dollars per month, average miles per month, or shares of VMT in that weight class accounted for by trucks with that number of axles, as appropriate. For the standard implementation, rates are specified by the analyst based on current law and the assumptions about average miles per month and distribution of miles among numbers of axles are derived from flat-fee reports from MCTD. For the alternative implementation, rates are specified by the analyst to test proposed changes to rates.

Load Data for Summary Tables

The following class methods capture data from the inputs workbook and use it to tabulate summary tables of allocated costs and costs to allocate. The HCASModule calls these methods to give data to the model before calling the **getAllocatedCostsByWorkType()** and **getCostsToAllocate()** methods.

- **setSummaryTypesClasses()**

  Captures definitions of summary work types and puts them into self.summaryWorkTypes. The key is the work type and the value is the summary work type.

  Captures definitions of summary weight classes and puts them into self.summaryWeightClasses. The key is the weight class and the value is the summary weight class.

VMT ANALYSIS METHODS

The **makeVMTMaster()** method returns VMT by functional class, ownership, weight class, and number of axles for the model year. It uses VMT by weight class and number of axles (VCTotals, obtained from self.baseVMT), VMT by functional class and ownership (FCTotals, obtained from self.VMTbyFC), and the seed data from self.seedData to create a VMT Master table.

Using iterative proportional fitting, the program repeatedly scales the seed data until each row sums to its corresponding VC total and each column sums to its corresponding FC total. The program stops fitting data once the sum of squared errors for the fitted values falls below a specified threshold.

METHODS WITHIN MAKEVMTMASTER()

The following methods are defined and used within the **makeVMTMaster()** class method:

- **findFCSums()** sums VMTData by functional class and ownership across weight classes and numbers of axles.
- **findVCSums()** sums VMTData by weight class and number of axles across functional class and ownership.
- **scaleToFC()** multiplies each value in VMTData by the ratio of its FCTotal control total to its current FCSum.
- **scaleToVC()** multiplies each value in the VMTData by the ratio of its VCTotal control total to its current VCSum.
- **findSSE()** calculates the sum of squared errors for the FCSums. (The SSE for VCSums will equal zero because the scaling process for VCSums runs after scaling for FCSums.) The "errors" are differences between the sums of VMT by individual facility class and the control total for that facility class. They are squared (multiplied by themselves) before adding up over facility classes for two reasons: positive and negative differences can't cancel each other out and a large difference in an individual facility class will be given greater weight than several small differences that add up to the large difference. It is important that none be off by a lot, but it is acceptable for many to be off by a tiny amount each.

HOW MAKEVMTMASTER() WORKS

VMTMaster is a matrix of vehicle-miles traveled (VMT) by vehicle classes and by road classes. Vehicle classes are combinations of 2,000-pound weight increments and numbers of axles. Road classes are combinations of functional classes (defined by the Federal Highway Administration) and ownership.

We start with base-year VMT by declared weight class by tax class to develop the row totals. Vehicles weighing 80,000 pounds and under are not classified by axles (axles=0). Base-year VMT by weight-mile-tax vehicles between 80,000 and 105,500 pounds are available by numbers of axles because the tax rate varies with the number of axles. Other vehicles in this range (e.g., farm, publicly-owned, or road-use assessment fee) are assumed to have the same distribution of miles by number of axles within each weight class as weight-mile tax vehicles.

Base-year VMT by road-use-assessment-fee vehicles weighing more than 105,500 pounds are distributed among numbers of axles according to the proportions specified in self.axleShares. A dictionary named VCTotals, keyed by weight class and number of axles, is built to contain the row totals for the VMT Master matrix.

The column totals are copied from self.VMTbyFC and scaled to add up to exactly the same total as the row totals. The individual cells of the VMT Master matrix are initialized with the proportions from self.seedData. The columns initially sum to one.

The iterative proportional fitting follows the following steps:

1. Scale each column so that it adds up to its column control total (scaleToFC())
2. Sum each row (findVCSums())
3. Scale each row so that it adds up to its row control total (scaleToVC())
4. Sum each column (findFCSums())
5. Find the sum of squared differences between column totals and column control totals and compare to the threshold value (findSSE()). The threshold value is arbitrarily set to 48, meaning that if each of the 48 facility classes was off by less than one vehicle mile traveled (out of a total of more than 30 billion), it would be satisfied.
6. If the sum of squared errors is less than the threshold, stop. Otherwise, return to Step 1.

Once iterative proportional fitting is complete, the growth rates for each weight class from self.growthRates are applied to the fitted base-year VMT data to bring it to the model year (the middle 12 months of the study biennium).

Three additional, summary facility classes are then added to the matrix. FC 0 is all state-owned roads, FC -1 is all roads, and FC -2 is all locally owned roads.

VMTMaster is copied to self.VMTMaster for use by other methods, is written to disk, and selected portions (FC -2 to FC 0, and all combinations of state ownership and functional class) are returned to the *Model VMT* tab in the outputs workbook.

The key in self.VMTMaster is a tuple consisting of facility class, declared weight class, and declared number of axles. Values are model-year VMT.

Once VMTMaster is built, it is used to convert self.paveFactors, which are by operating weight, actual number of axles, and functional class, into factors by declared weight class, declared number of axles (zero if declared weight under 80,000 pounds and nine if nine or more), and facility class (combinations of functional class and ownership, including the aggregate facility classes for all roads, all state-owned roads, and all locally owned roads), which are stored in self.pavement and used in allocateCosts() to allocate pavement costs to declared weight classes. The factors in self.pavement are VMT-weighted averages of the factors in self.paveFactors. Factors are constructed for both flexible and rigid pavements.

The structure of self.pavement is a nested dictionary. The outer key is the pavement type (Flex or Rigid) and the inner key is a tuple consisting of facility class, declared weight class, and declared number of axles. The code for preparing the pavement factors is intermingled with the code for building VMTMaster to save repeated looping over the same data structures.

The makeVMTByVehicles() method multiplies VMT values in self.baseVMT by the appropriate compounded growth rates to produce self.vmtByVehicles, which contains model-year VMT by weight class and tax class. These are returned to the HCAS Outputs workbook. self.vmtByVehicles is a nested dictionary. The outer key is the tax class and the inner key is the weight class.

COST ALLOCATION METHODS

The **allocateCosts()** method performs the following processes:

- Combine local costs data from self.localCosts with project costs data from self.projectCosts into self.projectCosts.
- Do bridge splits on project costs. For projects in work types 13, 14, 15, 19, 67, 68, 113, 114, 115, 119, 167, and 168 (bridge and interchange projects), the bridge type for each project is identified and the project's cost is split into multiple work types (60-65) using the bridge factors appropriate to the bridge type. Costs in the original work types are removed from self.projectCosts and the aggregated, split costs in work types 60-65 are inserted into self.projectCosts. Bridge projects that add capacity (work types 67, 68, 167, and 168) get their base increment allocated according to the allocator(s) specified in work type 65, so the portion of their costs that would go to work type 60 according to the bridge factors defined in the Bridge Splits tab of the workbook is instead assigned to work type 65.
- Separate bond projects and apply the bond factor. Projects where the funding source is "bond" are identified, their costs are multiplied by the bond factor, and they are removed from self.projectCosts and inserted into bondsToAllocate.
- Do studded tire adjustment. For each work type and corresponding dollar amount in self.studdedTire, the dollar amount is divided proportionally among all projects in that work type in self.projectCosts and moved out of those projects and into work type 39 or 139 (if the original work type was over 100, indicating work on locally owned roads).
- Set up allocation vector data structure (allocators) and build allocation vectors. There are allocation vectors for each combination of allocator, functional class, and ownership. Within each allocation vector, there is an element for each combination of weight class and number of axles.
- Build allocation vectors with the vector of allocation factors appropriate to the allocator. The allocation factors are proportional to costs imposed per VMT and come from self.simpleFactors, self.pavement, and self.pceFactors. Each allocation factor is then multiplied by the VMT in that

combination of weight class and number of axles for the combination of functional class and ownership for which the allocation vector is being prepared, which come from self.VMTMaster. The VMT multiplied by the allocation factors for Congested PCE are adjusted using the shares from self.peakShares so that they represent VMT during the peak hour for that functional class.

- Scale allocation vectors so that the elements of each vector sum to one. The resulting allocation vectors may then be multiplied by a project cost and the result will be a vector of allocated costs with each element containing the dollar amount for that combination of weight class and number of axles. All the elements in the allocated costs vector sum to the original amount to be allocated. For this to work, it is necessary that there be non-zero VMT in the combination of functional class and ownership associated with the project. Incorrectly recorded functional classes (e.g., locally owned interstates) can cause costs to disappear during allocation.
- Apply allocation vectors to project costs to allocate (except for "other construction" and "other bridge" costs) as described above to generate allocated project costs.
- Make Other Bridge and Other Construction allocators. Once bridge project costs other than "other bridge" have been allocated, a special allocation vector is built to allocate these costs in proportion to all previously allocated bridge project costs. The same is done to create a special allocation vector to allocate "other construction" costs in proportion to all previously allocated construction project costs.
- Apply Other Bridge and Other Construction allocators to "other bridge" and "other construction" costs.
- Apply allocators to non-project costs. Any bond-funded projects found in self.nonProjectCosts are removed, multiplied by self.bondFactor, and added to bondsToAllocate. Remaining non-project costs have the appropriate allocation factors applied to them and are added to allocatedCosts.
- Apply allocation vectors to bonded costs to allocate. Applies the allocators to bondstoAllocate and stores the result in allocatedBonds.
- Store allocated bonded costs. Creates a text file of allocated bond costs (allocatedBonds) for use in future studies. (Future model runs will use this file to obtain prior allocated bond costs.)
- Get prior allocated bonds from files. Captures allocated, current payments due on bonds issued for projects in previous biennia (priorBonds).
- Add current and prior allocated bonded costs to allocatedCosts.
- Write out detailed allocation results to tab-delimited text files, one for each funding source. These are named AllocatedCosts_federal.txt, AllocatedCosts_state.txt, etc.
- Copy allocators to self.allocators and allocatedCosts to self.fullAllocatedCosts.
- Prepare a summary table of allocated costs and that is returned to the HCAS Outputs workbook. Columns are funding sources and rows are combinations of declared weight class and declared number of axles. Cells contain allocated biennial dollars.

The **getAllocationVectors()** method gets the allocation vectors from self.allocators. Columns are allocators and rows are combinations of facility class, declared weight class, and declared number of axles.

The **getAllocatedCostsByWorkType()** method gets allocated costs from self.fullAllocatedCosts and aggregates them by summary work type from self.summaryWorkTypes and by summary weight class from self.summaryWeightClasses and returns the aggregated allocated costs to the *Allocated Costs by SWT* tab in the outputs workbook. Columns are summary weight classes and rows are combinations of funding source and summary work type. Cells contain allocated biennial dollars.

The **getCostsToAllocate()** method gets costs to allocate from self.projectCosts (which now includes local costs and excludes bonded costs), self.nonProjectCosts (which now excludes bonded costs), self.bondCosts, and self.priorBondAmount and aggregates them by summary work type from self.summaryWorkTypes. It returns the aggregated costs to allocate to *Costs to Allocate* tab in the outputs workbook. Note that prior bond amounts do not contain information about their original work type and are put into their own summary work type (21). Columns are funding sources and rows are summary work types. Cells contain biennial dollars.

REVENUE ATTRIBUTION METHODS

The **attributeRevenue()** method performs the following processes:

- Attribute road-use assessment fee (RUAF) revenue. RUAF revenues are attributed to weight classes by multiplying their model-year VMT in each combination of weight class and number of axles by the appropriate RUAF rate from self.RUAFRates. RUAF VMT are the total VMT in that combination of weight class and number of axles from self.VMTMaster times the ratio of RUAF VMT in that weight class to all VMT in that weight class from self.vmtByVehicles. This assumes that axle shares for RUAF vehicles under 105,500 pounds will be the same as for weight-mile tax vehicles in the same weight class, which has been determined to be a reasonable assumption. The resulting revenues are doubled to make them biennial. It is assumed that there is no evasion of road-use assessment fees. Attributed RUAF revenues are put into ruafRevenue, where the key is a tuple consisting of weight class and number of axles and the value is biennial dollars.
- Attribute weight-mile tax (WMT) revenue and as-if WMT revenue. WMT revenues are attributed to weight classes by multiplying their model-year VMT in each combination of weight class and number of axles form self.vmtByVehicles by the appropriate WMT rate from self.rates. The base-year VMT from which the model-year VMT were derived were adjusted upward from base-year WMT reports to account for assumed evasion, so the reverse adjustment must be applied to estimate WMT revenue. This is accomplished by multiplying revenues by (1.0 - self.wmtEvasion). The resulting revenues are doubled to make them biennial and stored in wmtRevenue. For all VMT by vehicles in weight classes to which WMT rates apply, but do not pay the WMT, flat fee, or RUAF, the weight-mile taxes they would pay if they did pay the WMT are calculated and stored in asifWmtRevenue. As-if WMT revenues for those paying flat fees are calculated later, along with flat-fee revenues. The key in both wmtRevenue and asifWmtRevenue is a tuple consisting of declared weight class and declared axles.
- Attribute flat-fee revenue. For each flat-fee commodity (log, dump, and chip), for each combination of weight class and number of axles, divide the model-year VMT by the average VMT per month for that commodity and weight, and multiply the resulting number of vehicle-months by the appropriate monthly flat-fee rate. As-if weight-mile taxes for flat-fee-paying vehicles are calculated at the same time. For flat-fee log trucks, the model VMT must be adjusted prior to estimating as-if WMT revenues. When paying the WMT, log trucks can declare a lower weight when empty and traveling with their trailer decked. When estimating as-if WMT revenues for flat-fee log trucks, VMT in each weight class are multiplied by (1.0 - self.emptyLogPercent) and then by the WMT rate appropriate to that weight class. The VMT then are multiplied by self.emptyLogPercent and the WMT rate appropriate to self.emptyLogWeight. The flat-fee and as-if WMT revenues are doubled to make them biennial and stored in ffRevenue and asifWmtRevenue, respectively. A tab-delimited text file, FlatFeeReport.txt, containing flat-fee VMT, revenues, and as-if WMT revenues by commodity and weight class is written out to disk as a text file.
- Attribute registration and title revenues. Budgeted total DMV registration, Motor Carrier Apportioned, Motor Carrier Non-Apportioned, and title fee revenues are attributed to vehicle classes using fee-weighted VMT. VMT for vehicles over 26,000 pounds are adjusted using the declared-to-registered factors. VMT by tax class and weight class are multiplied by the registration fee that applies to that combination and the resulting amounts are scaled so that they add up to the total expected registration fee revenue. For vehicles over 26,000 pounds, registration fee revenues by registered weight are converted back to revenues by declared weight class using the same declared-to-registered factors. A further adjustment is made to give RUAF vehicles credit for the registration fees they pay.
- This method eliminates the need for forecasting vehicle counts and automatically accounts for the substantial registration revenues that are produced by fees other than the regular registration fee (e.g., temporary registrations, duplicates, etc.). It also eliminates the need for directly forecasting the number of titles that will be issued. There is an implicit assumption that vehicles in the different weight classes of heavy vehicles all travel the same number of miles per title issuance. “As-if” registration fees are estimated for alternative-fee-paying vehicles. As of the 2011 Study, Flat Fee vehicles are no longer treated as alternative fee-paying vehicles.

- The method loops over the rows (combinations of declared weight class and declared number of axles) in self.rates, which are the current-law rates entered in the General tab of the HCAS Inputs workbook. It multiplies the fee per year by the VMT per year by the vehicles subject to that fee (as if the rate were per VMT). It then adds up those (large) numbers for each instrument and divides the biennial revenue control total for that instrument by the sum of annual miles times annual fee for that instrument. It applies that ratio to the annual miles times annual fee for each combination of declared weight class and declared number of axles to get biennial revenues for that combination and instrument.
- For vehicles over 26,000 pounds, an individual vehicle will have one registered weight, but may have multiple declared weights, depending on configuration. When getting the annual VMT to multiply by each rate, self.declaredRegistered, which contains the proportion of VMT for each declared weight class that is in each registered weight class, is used.
- For vehicles over 80,000 pounds, the revenues are attributed to vehicles classes defined by both declared weight and number of axles, so axle shares for each weight class are calculated and used to spread the registration revenues (which vary only with weight) among the numbers of axles for each weight class.
- At the same time that registration revenues are attributed for "alternative" registration fees (e.g., farm, charitable/non-profit, publicly owned, etc.), "as-if" registration fees are calculated as if they paid the "normal" registration rate for their weight. Those are used later to calculate the "subsidy" amount.
- Make an adjustment to registration revenues to give RUAF vehicles some credit. When a vehicle pays the road-use assessment fee, it is often operating at a weight above the maximum allowed declared or registered weight of 105,500 pounds. These vehicles do pay registration fees, but at a weight that does not correspond to the weight recorded in the RUAF data. Assumptions are specified in the Revenues tab of the workbook that allow RUAF vehicles to be credited with registration fees by transferring attributed fees from lower weight classes.
- Attribute fuel tax and VMT tax revenues. Gasoline and diesel fuel tax revenues are attributed separately because the model allows for different tax rates and different evasion/avoidance assumptions. VMT by fuel type and weight class for fuel-tax paying vehicles are assembled and adjusted for evasion/avoidance. A preliminary attribution is made by dividing the adjusted VMT in each combination of weight class and fuel type by the assumed miles per gallon for that weight class from the MPG data set and multiplying the resulting number of gallons by the per-gallon rate for that fuel type. The attribution to vehicles between 10,001 and 26,000 pounds is then adjusted to bring those weight classes, as a group, to equity (before considering subsidies). The attribution to basic vehicles (those 10,000 pounds and under) is adjusted to make the total revenues attributed add up to the forecast revenues from the budget. The implied miles per gallon after adjustment for each weight class is calculated and returned to the *MPG* tab in the outputs workbook where it may be examined for reasonableness. The reasons for using this approach are detailed in Issue Paper 6 from the 2005 study.
- The first step in attributing fuel tax revenues is finding the taxed VMT by weight class for the gas tax and for the use-fuel (diesel, etc.) tax, taking into account avoidance, evasion, the portion of basic vehicles that do not burn gasoline, and the fact that publicly owned vehicles such as transit and school buses do not have to pay the use-fuel tax.
- The taxed VMT for each weight class is divided by the assumed miles per gallon from self.MPG and multiplied by the tax rate per gallon to get revenues by weight class. The assumed miles per gallon for vehicles between 10,001 and 26,000 pounds are then adjusted to force those weight classes into perfect equity (before the subsidy adjustment) and their attributed fuel-tax revenues are recalculated. The sum of attributed non-basic (over 10,001 pounds) fuel taxes are subtracted from their revenue control totals, leaving the amount from basic vehicles. The assumed average basic-vehicle is then recalculated so that basic vehicles will produce this amount of revenue and that amount is attributed to basic vehicles. The calibrated miles-per-gallon assumptions are stored in self.adjustedMPG.
- Attribute other motor carrier revenue. Budgeted other motor carrier revenue is attributed to heavy vehicle weight classes on the basis of all RUAF and WMT VMT.

- Determine subsidy amount for each weight class. These are calculated for each tax class by subtracting what they do pay in each revenue category from what they would pay if they paid the "regular" tax or fee. Subsidy amounts may be negative.
- Prepare a table of attributed revenues and subsidy amounts to save to a tab in the outputs workbook.

Attributed revenues are saved in the *Attributed Revenues* tab of the outputs workbook. **getAdjustedMPG()** returns the calibrated miles-per-gallon assumptions from self.adjustedMPG to the *MPG* tab in the outputs workbook.

ALTERNATIVE REVENUE ATTRIBUTION METHODS

The **attributeAltRevenues()** method repeats the revenue attribution process using alternative rates specified by the analyst in the *Alt. Rates* tab of the inputs workbook.

The process for alternative revenue attribution is essentially the same as for the primary revenue attribution, but there are important differences:

- When attributing registration and title fee revenues, assume that the revenues per VMT for each combination of instrument and weight class will change by the ratio of alternative rate to original rate. This allows estimating revenues from alternative registration and title fees without specifying the total revenue they will produce in advance.
- When attributing fuel-tax revenues, use the calibrated miles per gallon from the original revenue attribution. This allows estimating revenues from alternative fuel-tax rates without specifying the total revenue they will produce in advance.

Alternate attributed revenues are saved in the *Alt. Attributed Revenues* tab of the outputs workbook.

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Appendix F: Model Input Tables

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F3 Model Assumptions and Data Sources

F7 Processing of Original Data

MODEL ASSUMPTIONS AND DATA SOURCES

This appendix documents the assumptions and data used in the final run of the HCAS model for the 2017 Highway Cost Allocation Study. Data used in the final model run were collected between roughly June 2015 and January 2017. The final model run was completed and verified in March 2017.

Table 1 through Table 6 list assumptions in the HCAS Inputs Excel workbook that are used in the final run of the model. Table 1 and Table 2 have the HCAS Inputs workbook tab listed in the first column followed by the assumption name or brief description.

Like prior HCAS inputs workbooks, this workbook includes a *Base VMT* tab. Table 1 lists the assumptions used to develop the Base VMT tab in the inputs workbook. These assumptions are yellow-shaded cells in their respective workbook tabs. The key tabs that are linked to and build up the Base VMT tab are the VMT Growth, DMV VMT, MCTD VMT, Federal VMT, and Bus VMT tabs.

Table 2 lists the assumptions in the HCAS inputs workbook. Most of the assumptions listed in Table 2 correspond to yellow-shaded cells in their respective workbook tab.

Table 3 through Table 6 display the assumptions for studded tires, motor home weight classes, bridge splits, and initial mpg because these assumptions are tables or ranges, not single values.

Table 3 displays expenditures related to studded tires. It shows biennium expenditures by funding source, work type and facility class.

Table 4 displays the assumed weight classes by motor home length used to assign motor home VMT to weight classes in the *DMV VMT* tab in the HCAS Inputs workbook.

Table 5 displays the assumed bridge splits used to split bridge project expenditures among the bridge reclassification work types. These assumed values are from the 2002 OBEC Bridge Allocation Report.

Table 6 contains the assumed initial MPG, created from regression of the 2002 Vehicle Inventory and User Survey published by the U.S. Census Bureau. The Vehicle Inventory and Use Survey was discontinued after 2002.

Table 7 lists the files and sources of the data used in the 2017 Final HCAS model run.

Table 1. Base VMT Worksheet Assumptions

Tab	Assumption	Value
DMV VMT	Commercial Trucks & Buses Annual VMT per vehicle (10,001 to 26,000 weight class)	19,000
DMV VMT	Tow Truck Annual VMT per vehicle	15,000
DMV VMT	Farm Vehicle Annual VMT per vehicle (by weight class)	
	less than 20,001 lbs	3,000
	20,001 to 40,000 lbs	3,500
	40,001 to 50,000 lbs	4,000
	50,001 to 70,000 lbs	4,500
	70,001 to 80,000 lbs	5,000
	80,001 to 90,000 lbs	6,000
	90,001 to 100,000 lbs	7,000
	100,001 to 104,000 lbs	7,500
	104,001 lbs and up	8,000
DMV VMT	State & Local Annual VMT per vehicle (by weight class)	
	less than 20,001 lbs	13,000
	10,001 to 26,000 lbs	12,000
	26,001 lbs and up	11,000
DMV VMT	Charitable & Non-Profit Annual VMT per vehicle	10,000
DMV VMT	Motorhome Annual VMT per vehicle	3,988
DMV VMT	Motorhome length/weight class assumptions (from Winnebago vehicle spec. information)	See Table 4

See: *DMV VMT* tab, HCAS Inputs.xlsx

Table 2. HCAS Model User-Specified Assumptions

Tab	Assumption	Value	Justification/Source
General	Split of bridge expenditures across bridge reclassification work types	See Table 5	2002 OBEC Bridge Allocation Study
General	Base Year	2013	Ch. 2, pg. 9
General	Biennium	2015	Ch. 2, pg. 9
General	BondFactor	0.1605	Ch. 3, pgs. 21-22
General	Forecast Year (also, Model Year)	2016	Ch. 2, pg. 9
General	Percent of basic gallons that are diesel	5%	NA
General	Percent of RV gallons that are diesel	40%	NA
General	Percent of taxed gallons that are basic	94%	NA
MPG	MPG (initial) by weight class	See Table 6	Regression on 2002 VIUS data
Policy	Preliminary and Construction Engineering (and etc.) Share 1	55.95%	Ch. 3, pg. 17
Policy	Right of Way (and Utilities) Share 1	73.75%	Ch. 3, pg. 17
Policy	New Pavements-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 17
Policy	New Pavements-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 17
Policy	Pavement and Shoulder Reconstruction-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 17
Policy	Pavement and Shoulder Reconstruction-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 17
Policy	Pavement and Shoulder Rehab-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 17
Policy	Pavement and Shoulder Rehab-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 17
Policy	Surface and Shoulder Maintenance-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 17
Policy	Surface and Shoulder Maintenance-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 17
Policy	Local Gov: Preliminary and Construction Engineering (and etc.) Share 1	55.92%	Ch. 3, pg. 19
Policy	Local Gov: Right of Way (and Utilities) Share 1	55.92%	Ch. 3, pg. 19
Policy	Local Gov: New Pavements-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 19
Policy	Local Gov: New Pavements-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 19
Policy	Local Gov: Pavement and Shoulder Reconstruction-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 19
Policy	Local Gov: Pavement and Shoulder Reconstruction-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 19
Policy	Local Gov: Pavement and Shoulder Rehab-Flexible Allocator/Share 1	3.99%	Ch. 3, pg. 19
Policy	Local Gov: Pavement and Shoulder Rehab-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 19
Policy	Local Gov: Surface and Shoulder-Rigid Allocator/Share 1	3.99%	Ch. 3, pg. 19
Policy	Local Gov: Surface and Shoulder-Flexible Allocator/Share 1	5.43%	Ch. 3, pg. 19
Policy	All other Allocators Shares for work types not Prelim. Engineering, ROW, or Pavement	100%	Ch. 3, pgs. 17-20

Table 2 (continued). HCAS Model User-Specified Assumptions

Tab	Assumption	Value	Justification/Source
General	Gas Tax Avoidance Rate	3.53%	Ch. 3, pg. 23
General	Diesel Tax Evasion & Avoidance Rate	4.53%	Ch. 3, pg. 23
General	WMT Evasion Rate	5%	Ch. 3, pg. 23
General	Basic Diesel (percent of basic VMT by diesel vehicles)	5%	
General	Taxed Diesel (percent of taxed gallons that are diesel)	9.47%	
General	RUAF Registration Adjustment	4.5%	NA
General	RUAF Reg. from 78001	14%	NA
General	RUAF Reg. from 96001	15%	NA
General	RUAF Reg. from 104001	71%	NA
General	Log truck miles empty	50%	Ch. 7, pg. 63
General	Empty log truck declared weight (lbs)	42,001	Ch. 7, pg. 63
General	E-Plate Registration, annualized	40%	One-time registration fee of $2 divided by 5 yrs.
General	Split of studded tire expenditures across funding sources and work types	See Table 3	NA
General	State/Local-State split (speed adjustment factor)	11%	NA
General	Preservation costs inflation rate	3%	NA

See: HCAS Report; *General*, *Policy* and *MPG* tabs, HCAS Inputs.xlsx

Table 3. Studded Tire Assumptions

Funding	Work Type	Facility Class	Biennium Expenditures ($)	Distribution by Work Type
state	-	0	8,570,779[1]	100%
state	1	0	407,453	5%
state	11	0	6,790,885	79%
state	26	0	1,372,441	16%
local-state	-	-2	942,786[2]	100%
local-state	101	-2	44,820	5%
local-state	111	-2	746,997	79%
local-state	126	-2	150,968	16%

See: *General* tab, HCAS Inputs.xlsx

[1]Figure 5.5, Review of Studded Tires in Oregon, Final Report, SPR 304-671, December 20, 2014, ODOT Research Section
[2]Equal to 11% of state expenditures (using state / local-state split, speed adjustment factor).

Table 4. Motorhome Vehicle Length to Weight Class Assumptions

Min. Length (feet)	Max. Length (feet)	Weight Class
0	22	1
23	24	10,001
25	26	12,001
27	30	14,001
31	32	16,001
33	34	18,001
35	35	22,001
36	36	24,001
37	37	26,001
38	38	28,001
39	50	30,001

See: *DMV VMT* tab (Motorhomes Table), HCAS Inputs.xlsx

Table 5. Bridge Split Assumptions

Bridge Type	Work Type	Share
0	60	0.6849
0	61	0.2520
0	62	0.0000
0	63	0.0000
0	64	0.0631
1	60	0.6666
1	61	0.2999
1	62	0.0000
1	63	0.0000
1	64	0.0335
2	60	0.6849
2	61	0.2520
2	62	0.0000
2	63	0.0000
2	64	0.0631
3	60	0.7221
3	61	0.1697
3	62	0.0000
3	63	0.0514
3	64	0.0568
4	60	0.8713
4	61	0.1029
4	62	0.0000
4	63	0.0000
4	64	0.0258

See: *General* tab (Bridge Splits Table), HCAS Inputs.xlsx

Table 6. MPG Assumptions (Initial MPG)

Declared	MPG	Declared (cont.)	MPG (cont.)
1	20.00	110,001	5.07
10,001	10.85	112,001	5.04
12,001	10.27	114,001	5.01
14,001	9.77	116,001	4.99
16,001	9.33	118,001	4.96
18,001	8.94	120,001	4.93
20,001	8.59	122,001	4.91
22,001	8.27	124,001	4.88
24,001	7.98	126,001	4.86
26,001	7.15	128,001	4.83
28,001	7.04	130,001	4.81
30,001	6.94	132,001	4.79
32,001	6.85	134,001	4.76
34,001	6.76	106,001	4.74
36,001	6.67	108,001	4.72
38,001	6.59	136,001	4.70
40,001	6.52	138,001	4.67
42,001	6.45	140,001	4.65
44,001	6.38	142,001	4.63
46,001	6.31	144,001	4.61
48,001	6.25	146,001	4.59
50,001	6.19	148,001	4.57
52,001	6.13	150,001	4.55
54,001	6.07	152,001	4.53
56,001	6.02	154,001	4.51
58,001	5.97	156,001	4.49
60,001	5.92	158,001	4.47
62,001	5.87	160,001	4.45
64,001	5.82	162,001	4.43

Table 6 (continued): MPG Assumptions (Initial MPG)

Declared	MPG	Declared (cont.)	MPG (cont.)
66,001	5.78	164,001	4.42
68,001	5.73	166,001	4.40
70,001	5.69	168,001	4.38
72,001	5.65	170,001	4.36
74,001	5.61	172,001	4.34
76,001	5.57	174,001	4.33
78,001	5.53	176,001	4.31
80,001	5.49	178,001	4.29
82,001	5.45	180,001	4.28
84,001	5.42	182,001	4.26
86,001	5.38	184,001	4.24
88,001	5.35	186,001	4.23
90,001	5.31	188,001	4.21
92,001	5.28	190,001	4.19
94,001	5.25	192,001	4.18
96,001	5.22	194,001	4.16
98,001	5.19	196,001	4.15
100,001	5.16	198,001	4.13
102,001	5.13	200,001	4.12

See: *MPG* tab, HCAS Inputs.xlsx

PROCESSING OF ORIGINAL DATA

The following section discusses data sets that require pre-processing outside of the HCAS model. Due to the complexity of the data tabulations and calculations or the sheer size of the data sets, these data transformation/summary tables were created in a database program which the output summary tables from these transformations pasted into the appropriate workbook tabs or text files.

DMV REGISTRATION DATA

DMV registrations by weight class and tax class are used to estimate the base year VMT in the *DMV VMT* tab in the HCAS Inputs workbook. SQL code was used to process the raw DMV Registration data. The plate numbers were used to determine the tax class and the veh_weight variable was used to assign the weight class. With the exception of exempt (E), buses (B), and school buses (SC) whose registrations do not necessarily expire, the data were filtered using the expiration date. The "Fuel" column may also be labeled "Power."

DMV MOTORHOME REGISTRATIONS

Motorhome VMT were estimated using motorhome vehicle counts from the DMV data with an assumed annual VMT. Weights are not included for motorhomes in the DMV data so the vehicle length (in feet) is used with motorhome manufacturer's data on vehicle lengths and weights to assign the motorhome vehicle counts to weight classes. The DMV data were used to create a table of motorhome registration counts by vehicle length. This table is available in the *DMV VMT* tab in the HCAS inputs workbook.

WMT COLLECTIONS

The SQL code for the WMT Collection reports data first create the weight class and axle count variables and then creates the WMT summary table, which is pasted into the *MCTD VMT* tab in the HCAS inputs workbook.

FLAT FEE COLLECTION REPORTS

In previous studies, the cleaned Flat Fee Reports were obtained in a raw, database format. Since the 2015 Study, Flat Fee Reports were provided in a series of tabs/tables in an Excel workbook. Given that the Flat Fee data were already in Excel, there was no need to read the Flat Fee Reports into a database and run SQL queries.

Table 7. 2015 HCAS Data Files and Sources

Data	Source	File Name
Bridge Project Information	ODOT	Project Costs - Final Rpt Sep 2014 (b)with br numbers.xlsx, 2015_HCAS_BR_Length.xlsx
DMV Registration Data	ODOT	DMV_2013_12.csv (also see HCAS_DMV_2013_12.csv, 2011-2013 VMT by type.xlsx)
Federal Fleet Report	http://www.gsa.gov/portal/category/102859	2013 Federal Fleet Report. US General Services Administration (GSA).
FHWA Highway Statistics-Table MV7	http://www.fhwa.dot.gov/policyinformation/statistics/2012/mv7.cfm	FHWA Highway Statistics-Table MV7 (2012): mv7.xls
FHWA Highway Statistics-Table VM2	http://www.fhwa.dot.gov/policyinformation/statistics/2012/vm2.cfm	FHWA Highway Statistics-Table VM2 (2012): vm2.xls
Flat Fee Collections Reports	ODOT	LOGS_100pc_95pc_90pc_85pc_80pc_2013.xlsx, SAND&GRAVEL_2013.xlsx, FINAL_2013_FLAT_FEE_STUDY.docx
OR HPMS Submittal Data	ODOT	Submit_2013_41_Metadata.csv, Submit_2013_41_NAAQS_Summaries.csv, Submit_2013_41_Sample_Sections_Details.csv, Submit_2013_41_Sample_Sections.csv, Submit_2013_41_Summaries.csv, Submit_2013_41_Urban_Summary.csv, Submit_2013_41_Vehicle_Summaries.csv
Local Costs: Local Roads and Streets Survey	Jon Oshel, AOC	2013 Survey Form Combined City County_summary.xls
Motor Carrier Registrations	ODOT	
Non-Project Costs	ODOT	Costs to Allocate Report_2014_Final.xlsx
Pavement Factors	Roger Mingo, Mingo and Assoc.	Calc Pave Shrs 2014 v3f.xlsm, gwdist.xlsx, relative_shares.xlsx
Project Costs	ODOT	Project Costs - Final Rpt Sep 2014 (b).xlsx, Project Costs - Final Rpt Sep 2014 (c).xlsx, Project worktypes.xlsx
Studded Tire Expenditures	ODOT	Figure 5.5, Review of Studded Tires in Oregon, Final Report, SPR 304-671, December 20, 2014, ODOT Research Section
VMT Forecast	ODOT	VMT Forecast for HCAS_2015.xls
Revenue Forecast	ODOT	Transactions & Revenues 2013-15.xls, Transactions Revenues 2015-17 v2.xlsx
RUAF Collection reports	ODOT	RUAFRPT.TXT
Transit VMT: Lane Transit District	George Trauger, LTD	
Transit VMT: Tri-Met	Kurtis McCoy, TriMet	
Weigh-In-Motion Data	Chris Monsere, Portland State University	wimdata_2013.csv, wim_tags.csv, transponders.csv
WMT Collection Reports	ODOT	WM_HUS_2013.csv