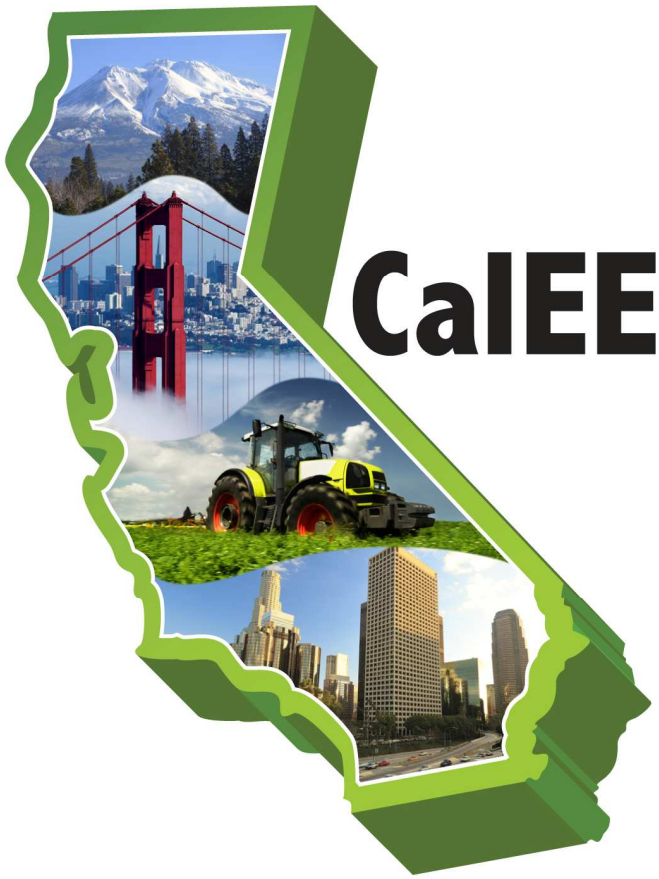

Technical Paper

Methodology Reasoning and Policy Development of the California Emission Estimator Model

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South Coast Air Quality Management District
Bay Area Air Quality Management District
Sacramento Metropolitan Air Quality Management District
San Joaquin Valley Air Pollution Control District
Santa Barbara County Air Pollution Control District
San Luis Obispo Air Pollution Control District

TABLE OF CONTENTS

Introduction 1

Features of CalEEMod.....2

Methodology Reasoning and Differences 3

Construction.....4

Area Sources 8

Operational 10

References.....14

TABLES:

Table 1 Updated/New Features in CalEEMod during Construction Phase 5

Table 2 Ranges of Off-Road Equipment Horsepower Not Included in CalEEMod.....7

Table 3 Updated/New Features in CalEEMod from Area Sources 9

Table 4 Updated/New Features in CalEEMod from Operational Phase.....10

Table 5 Trip Rates for Land Uses in CalEEMod.....11

Table 6 References to the Default Factors and Methodology Used in CalEEMod 15

Introduction

The California Emission Estimator Model (CalEEMod) is a statewide computer model developed in cooperation with air districts throughout the state, to quantify criteria pollutant and greenhouse gas (GHG) emissions associated with the construction and operational activities from a variety of land use projects, such as residential and commercial facilities. The model analyzes at the air district, county, air basin or statewide level. The development of the model is intended to fulfill the following tenets important to California air districts and those conducting air quality analyses:

- ✓ credible integrity of air quality analysis
- ✓ standardization of air quality analysis
- ✓ supported by substantial evidence
- ✓ ability to mitigate projects as feasibly possible
- ✓ compliance with requirements (e.g., CEQA, GHG, planning, etc.)
- ✓ ensure ongoing maintenance and upgrades

The model is available online and free of charge. The input screens are designed to function similar to current computer programs and to be intuitive to users. The software is specifically programmed with the following goals and policy parameters:

- ✓ use only approved emission factors, established methodology and the latest survey data
- ✓ evaluate land uses with Institute of Transportation Engineers (ITE) trip rates[1] but provide user defined land use categories
- ✓ provide defaults to allow the model to calculate emissions from projects with limited information
    - ensure the defaults are accurate and appropriate
    - provide the ability to modify most of the defaults[2]
    - allow the air districts to provide specific defaults reflecting their regional conditions, regulations, and policies
    - if defaults were not provided by the air districts, statewide defaults are applied
- ✓ can be used by persons with any level of air quality expertise
    - input minimal amount of information and rely on pre-programmed defaults
    - input project-specific information (e.g., trip rates from traffic study, etc.)

1 It should be noted that some of ITE's trip rates were derived from a limited data set. Users are encouraged to utilize traffic studies to provide more accurate input data and emission results.

[2] The only defaults that cannot be modified by the user are the OFFROAD emission factors generated by the California Air Resources Board (CARB) as better data is not available at this time. However, the construction equipment horsepower and load factor defaults listed in the model can be modified.

  - insert spreadsheets for all model screens for more complex projects
- ✓ can be used for a variety of applications:
  - single development projects
  - mixed use development projects
  - specific or master plans
  - emissions inventories
  - user defined land uses
- ✓ can not only be an air quality analysis tool, but can also be used as a planning tool and, thus, can be useful for a variety of operators:
  - environmental consultants/professional
  - public agency land use planners
  - air quality district staff
  - CEQA document reviewers
  - land use developers
  - decision-makers

Features of CalEEMod

The features and benefits of CalEEMod include the following:

- ✓ includes 63 subcategories of land uses, some new such as refrigerated warehouses, golf courses, swimming pools, parking lots and parking structures
- ✓ uses construction profile from the latest construction survey from South Coast Air Quality Management District[3]
- ✓ modifies methods for calculating fugitive dust from grading and site preparation
- ✓ allows user to select different vehicle classes for construction worker, vendor, and hauling trips
- ✓ updates methodology to calculate emissions from landscaping equipment at non-residential land uses
- ✓ uses the BURDEN mode in CARB's EMFAC model to provide more accurate regional characteristics (fleet mix, vehicle miles traveled, temperature, etc.)
- ✓ uses weighted average trip rates to reflect accurate vehicle activity from a specific land use type
- ✓ updates default warehouse trip rates
- ✓ includes the usage of consumer products at non-residential facilities

[3] If a project's specific construction equipment profile differs from the CalEEMod defaults, enter the equipment information and provide detailed documentation as to why the defaults were not used.

- ✓ includes the three combustion GHG pollutants: carbon dioxide, methane and nitrous oxide
- ✓ incorporates Pavley standards and Low Carbon Fuel standards into mobile source emission factors based on the future timelines for these standards
- ✓ calculates indirect GHG emissions from energy use, water/wastewater conveyance, wastewater treatment, solid waste disposal, and vegetation planting and/or removal
- ✓ calculates benefits from implementing mitigation measures, including GHG mitigation measures developed and approved by the California Air Pollution Control Officers Association (CAPCOA) that includes quantification of GHG reductions
- ✓ provides ability to import data from off-model spreadsheets for large projects (e.g., multiple land uses, on-road emission factors, construction equipment list, construction schedule, etc.)

Methodology Reasoning and Differences

In programming the CalEEMod software, critical decisions were made with regard to what emission sources were evaluated and how the emissions would be calculated. These decisions were driven by a number of factors including, but not limited to, the following:

1. Updated factors, methodologies, defaults and latest survey data
2. Methodology supported by substantial evidence (e.g., approved publications, peer-reviewed reports, etc.)
3. Interest in calculating indirect GHG impacts from energy use, water use, solid waste disposal and vegetation
4. Interest in accounting for criteria pollutant benefits from GHG traffic mitigation measures

In general, a primary goal in the development of CalEEMod was to provide a model that uses robustly documented methods, a limitation for other land use emission models.

From a design perspective, the ability to import csv (comma separated value) files or excel spreadsheet files of all the project data enhances usage flexibility and is advantageous particularly to those working on large projects with numerous land uses and complicated construction schedules. This functionality was not provided in other emission calculation models such as the Urban Emission (URBEMIS) model. CalEEMod also contains a separate energy module that increases flexibility in deriving GHG emissions as well as in mitigating the impacts from energy. The model has a separate mitigation module that consolidates all the mitigation measures into a single module, thus, allowing the user to keep better track of mitigation measures and enhances flexibility.

The following sections discuss the three primary emission source sectors (construction, area, and operational), the factors and methodology used in CalEEMod that were different from other models such as URBEMIS, and the justification if different from the URBEMIS model, which has been widely used it the past for calculating criteria pollutant emissions from land use development projects.

Construction

A construction schedule is critical in determining the appropriate CARB OFFROAD emission factors for construction equipment because the emission factors changes each year. In addition, the peak daily emissions will be different if the schedule between construction phases (e.g., site preparation, grading, building construction, etc.) overlaps. CalEEMod was developed using a construction survey to determine the construction profile (equipment type, number of equipment, hours of activity, etc.) for each construction phase. When changing the construction schedule, the model does not automatically change the default construction equipment type. The equipment type dictates construction phase activity, such as acres graded per day. Fugitive dust is generated when material (e.g., from demolition objects) and soil (e.g., from site preparation and grading) are transported to and from the site.

For non-residential land uses, the default lot acreage value corresponds to the building footprint. The lot acreage is used to calculate grading values. Therefore, any additional graded area must be entered separately as "other paved surfaces" or other land use to ensure an accurate grading calculation. For residential land uses, the default lot acreage value is greater than the default square footage value because the values are derived from different sources. The default lot acreage per residential dwelling unit is from the ITE Trip Generation and the square footage per dwelling unit is from the California Energy Commission's Residential Appliance Saturation Survey (RASS). Thus, the lot acreage includes building footprint, paved areas and undeveloped areas, so no additional grading area need to be entered separately.

Wind-blown fugitive dust is not calculated in CalEEMod because of the number of input parameters required such as soil type, moisture content, wind speed, etc. This limitation could result in underestimated fugitive dust emissions if high wind and loose soil are substantial characteristics for a given land use/construction scenario.

Construction activity also involves on-road mobile source emissions from vehicles driven to and from the construction site by workers, vendors (e.g., water trucks, product deliveries, etc.), and haulers. In addition, fugitive dust is generated by these vehicles.

Finally, volatile organic compound (VOC) emissions are generated when the interior and exterior surface walls of the structures are painted.

Differences in methodology between CalEEMod and URBEMIS for the construction emissions sector are summarized in the following table.

Table 1 – Updated/New Features in CalEEMod during Construction Phase

CalEEMod Updated/New Feature	Justification for Change in Methodology	General Trends in CalEEMod as compared to URBEMS
Uses a construction profile (equipment type, hours of activity) based on SCAQMD construction survey	Uses documented data (URBEMIS survey data is not well documented). During the development of its localized significance thresholds, SCAQMD staff worked with construction and building industries to conduct a construction site survey gathering accurate information to better estimate emissions from construction equipment based on their typical operations. The SCAQMD hired a consultant to conduct construction site surveys throughout the South Coast Air Basin. The consultant surveyed approximately 50 construction sites and compiled information on the various construction phases including demolition, site preparation, construction of structures, etc. The survey was limited to 35 acres or less. For those projects sized larger, the data was extrapolated by increasing the number of construction phase days but not increasing the number of construction equipment on a given day.	• Increase in construction ROG, NOx, CO and SO2 • Decrease in construction PM (see grading activity)
Revises amount of acres graded	Acreage graded based on construction equipment ability (i.e., maximum acres a piece of equipment can pass over land in an 8-hr day) from Walker's Building Estimator's Reference Book. Grading in URBEMIS is based on 25% of total project acreage in one day.	• Decrease in PM emissions from grading
Modifies calculation methodology from material hauling	Provides a more specific calculation based on actual construction equipment and amount of material hauled. Although the user inputs the amount of material hauled, the model calculates exhaust and fugitive dust emissions based on 16 cubic yards per truck (an industry average). The model credits "phased" trips (i.e., the truck enters and leaves with a load, thus reducing the total number of trips in half).	• PM emissions increase or decrease depending upon user input

Table 1 – Updated/New Features in CalEEMod during Construction Phase *(continued)*

CalEEMod Updated/New Feature	Justification for Change in Methodology	General Trends in CalEEMod as compared to URBEMS
Chooses most populated mode of horsepower (HP) for each construction equipment	A mathematical mode approach is used to choose a better representation of default HP, which is based on the average HP of the mode of the populations for the various engine HP tiers in CARB's OFFROAD model. If changing the default HP, the user needs to choose between the low and high range of off-road equipment HPs listed in Table 3.4 in Appendix D. HP ranges of OFFROAD equipment not programmed in CalEEMod are listed in Table 2 below. If the user enters a value outside of the ranges in this table, the emission estimate for that piece of equipment will be zero, thus underestimating the construction phase emissions.	• Tend to result in lower or equal HP (e.g., cranes - CalEEMod at 208 HP; URBEMIS at 399 HP; dozers - CalEEMod at 358 HP; URBEMIS at 357 HP) depending on type of equipment
Provides vehicle class options for on-road construction vehicles	Chooses a representative default vehicle category mix (e.g., LDA, LDT1, LDT2 for workers, HHD for hauling) but provides options of vehicle class grouping for user to choose (e.g., EMFAC fleet mix, MHD-HHD, etc.)	• Worker vehicle emissions tend to be lower • Vendor and hauling vehicle emissions tend to be higher
Updates default construction vendor trip rate	Uses the most updated construction vendor trip data (from the latest Sacramento Metropolitan AQMD survey) that includes vehicles such as water trucks. All vendor trips are listed under the Building Construction phase. However, if the user wants to specify additional vehicles (e.g., list out a water truck under grading, etc.), the user may manually enter any additional vehicles (on the Construction – Trips and VMT screen) under any construction phase to highlight the inclusion in the analysis.	• Tend to result in higher vendor trips and emissions

Table 1 – Updated/New Features in CalEEMod during Construction Phase *(concluded)*

CalEEMod Updated/New Feature	Justification for Change in Methodology	General Trends in CalEEMod as compared to URBEMS
Parking land use	For all project types except residential, parking is evaluated as a separate land use in CalEEMod to calculate more accurate construction phase emissions. CalEEMod defines the square footage of a land use simply based on the user entered size. In CalEEMod, the user should select either "parking lot" or "other asphalt surfaces" to account for off-road equipment, fugitive dust, and paving off-gassing emissions during construction. The URBEMIS model assumes a percentage of the project footprint was the parking area for a given land use.	• VOC and PM fugitive dust emissions increase or decrease depending upon user input

Table 2 - Ranges of Off-Road Equipment Horsepower Not Included in CalEEMod

Off- Road Equipment	Construction Year(s)	HP Range(s) Not Included
Aerial Lifts	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, 121-250 HP, >750 HP
Air Compressors	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >1000 HP
Bore/Drill Rigs	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >1000 HP
Cement/Mortar Mixers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >25 HP
Concrete/Industrial Saws	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >175 HP
Cranes	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, 751-1000 HP, >9999 HP
Crawler Tractors	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, >1000 HP
Crushing/Proc. Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, 751-1000 HP, >9999 HP
Dumpers/Tenders	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >25 HP
Excavators	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >750 HP
Forklifts	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, >500 HP
Generator Sets	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, 751-1000 HP, >9999 HP
Graders	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, >750 HP
Off-Highway Tractors	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 51 HP, 251-500 HP, >1000 HP
Off-Highway Trucks	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 121 HP, >1000 HP
Other Construction Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, 176-250 HP, >500 HP

Table 2 - Ranges of Off-Road Equipment Horsepower Not Included in CalEEMod *(concluded)*

Off- Road Equipment	Construction Year(s)	HP Range(s) Not Included
Other General Industrial Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >1000 HP
Other Material Handling Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, 501-1000 HP, >9999 HP
Pavers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >500 HP
Paving Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >250 HP
Plate Compactors	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >15 HP
Pressure Washers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >250 HP
Pumps	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, 751-1000 HP, >9999 HP
Rollers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >500 HP
Rough Terrain Forklifts	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, >500 HP
Rubber Tired Dozers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 121 HP, >1000 HP
Rubber Tired Loaders	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >1000 HP
Scrapers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 51 HP, >750 HP
Signal Boards	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, 16-25 HP, >250 HP
Skid Steer Loaders	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >120 HP
Surfacing Equipment	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 26 HP, >750 HP
Sweepers/Scrubbers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >250 HP
Tractors/Loaders/Backhoes	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 16 HP, >750 HP
Trenchers	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >750 HP
Welders	1990, 2000, 2005, 2010-2025, 2030, 2035, 2040	< 6 HP, >500 HP

Area Sources

Area sources are non-stationary, non-mobile emission sources found in a variety of land uses such as fireplaces, consumer products, landscaping equipment, and architectural coatings. These sources emit during the operational phase of the project. Differences in methodology between CalEEMod and URBEMIS for the area source emissions sector are summarized in the following table.

Table 3 – Updated/New Features in CalEEMod from Area Sources

CalEEMod Updated/New Feature	Justification for Change in Methodology	General Trends in CalEEMod as compared to URBEMS
Modifies consumer product calculation from " per person" to "per sq ft" (based on statewide consumer products/total building square footage)	Provides a more accurate calculation of VOC emissions from consumer products *and* allows for calculating VOC emissions from consumer products for non-residential land uses	• VOC emissions from consumer products for residential land uses tend to be lower • VOC emissions for non-residential land uses are higher
Modifies the non-residential landscaping calculation from being based on "# of business units" to based on statewide landscaping equipment operation (hours) per total non-residential square footage	Provides a more accurate calculation based on the size of the non-residential project (i.e., hours per sq ft per day). Residential factor is based on hours per dwelling unit per day. Activity hours of landscaping equipment from CARB's OFFROAD model and CARB's Technical Memo: Change in Population and Activity Factors for Lawn and Garden Equipment (6/13/2003).	• Emissions from landscaping equipment tend to be lower
Includes landscaping equipment (e.g., snowblowers) during winter season	Provides more accurate landscape emissions.	• Higher emissions from landscaping equipment during winter
Assumes certain percentage of homes without hearths	Provides more accurate hearth profile.	• Hearth emissions tend to be lower
Includes usage of hearths during summer	Provides more accurate hearth emissions.	• Higher hearth emissions from residential land uses during summer
Natural gas calculated under Energy Use (Operational)	Calculates natural gas impacts of both criteria pollutant and GHG emissions from both Title 24 and Non-Title 24 activities. Energy intensity default data provided by California Energy Commission.	• Criteria pollutant emissions increase or decrease depending upon land use; most trend with decrease in NOx and CO; slight increase in ROG and PM.

Operational

Emissions from the operation of land use projects are primarily from the mobile source emissions. Mobile source emission calculations are based on trip rates, trip lengths, percent trip type, and on-road emission factors generated by CARB. Differences in methodology between CalEEMod and URBEMIS for the operational emissions sector are summarized in the following table.

Table 4 – Updated/New Features in CalEEMod from Operational Phase

CalEEMod Updated/New Feature	Justification for Change in Methodology	General Trends in CalEEMod as compared to URBEMS
Chose different default land use ITE trip rates - maximum (for daily) and weighted average (for annual)	Uses more conservative daily and representative annual ITE trip rate compared to weekday trip rate (in URBEMIS).	• Exhaust emissions increase or decrease depending upon land use (e.g., maximum residential ITE trip rate higher than weekday resulting in higher residential exhaust emissions).
Used emission factors from BURDEN mode of CARB's On-Road EMFAC model	Took advantage of BURDEN's built-in regional VMT, fleet mix, temperatures, etc. so the user does not need to provide. In addition, the BURDEN mode is used to demonstrate State Implementation Plan (SIP) compliance. Further, use of BURDEN simplifies and reduces the size of the model. Finally, the model still allows the user to import EMFAC factors and run the program for results.	• VOC emissions tend to be lower
Included different % trips (home-work, home-shop, commercial- work, etc.)	Uses the latest defaults provided by air districts	• Exhaust emissions increase or decrease depending upon default changes and project location
Included diverted and pass-by trips	Provides more realistic on-road activity scenarios	• Exhaust emissions tend be lower

Due to limitations in availability of trip rates for some land uses, some known weekday rates needed to be used as Saturday and Sunday rates. In addition, in order to ensure proper reduction calculations from increased diversity mitigation in accordance to CAPCOA's GHG quantification guidance, default residential trip rates for condos and mid-and high-rise apartments are the same as low-rise apartments. Finally, to account for larger dataset and rail service at warehouse land uses, default trip rates for warehouses were modified based on the

SCAQMD's experience with these types of projects and review of surveys, traffic studies and environmental documents. The following color key and highlights have been provided below for quick reference to those additions/modifications to the trip rates used in CalEEMod.

Key:

This has been set to a non-ITE value deliberately based on CAPCOA method consistency
Assumed same trip rate as Weekday for Weekend
Used trip rate from an Alternative Land Use
Based on SCAQMD Review of Studies

Table 5 – Trip Rates for Land Uses in CalEEMod

Land Use Type	Land Use Sub Type	Size Metric	Trip Rate		
			Weekday	Saturday	Sunday
Residential	Single Family Housing	Dwelling Unit	9.57	10.08	8.77
Residential	Apartments Low Rise	Dwelling Unit	6.59	7.16	6.07
Residential	Apartments Mid Rise	Dwelling Unit	6.59	7.16	6.07
Residential	Apartments High Rise	Dwelling Unit	6.59	7.16	6.07
Residential	Condo/Townhouse	Dwelling Unit	6.59	7.16	6.07
Residential	Condo/Townhouse High Rise	Dwelling Unit	6.59	7.16	6.07
Residential	Mobile Home Park	Dwelling Unit	4.99	5	4.36
Residential	Retirement Community	Dwelling Unit	2.81	2.81	2.81
Residential	Congregate Care (Assisted Living)	Dwelling Unit	2.74	2.2	2.44
Residential	User Defined Residential	Dwelling Unit	0	0	0
Educational	Day-Care Center	Student	4.48	0.39	0.37
Educational	Day-Care Center	1000sqft	79.26	6.21	5.83
Educational	Day-Care Center	Employee	28.13	2.61	2.45
Educational	Elementary School	Student	1.29		
Educational	Elementary School	1000sqft	15.43		
Educational	Elementary School	Employee	15.71		
Educational	Junior High School	Student	1.62		
Educational	Junior High School	1000sqft	13.78		
Educational	Junior High School	Employee	16.39		
Educational	High School	Student	1.71	0.61	0.25
Educational	High School	1000sqft	12.89	4.37	1.79
Educational	High School	Employee	19.74	6.57	2.68
Educational	Junior College (2yr)	Student	1.2	0.42	0.04
Educational	Junior College (2yr)	1000sqft	27.49	11.23	1.21
Educational	Junior College (2yr)	Employee	15.55	6.16	0.66
Educational	University/College (4yr)	Student	2.38	1.3	
Educational	University/College (4yr)	Employee	9.13	3.12	
Educational	Library	Employee	52.52	47.68	23.54

Table 5 – Trip Rates for Land Uses in CalEEMod *(continued)*

Land Use Type	Land Use Sub Type	Size Metric	Trip Rate		
			Weekday	Saturday	Sunday
Educational	Library	1000sqft	56.24	46.55	25.49
Educational	Place of Worship	Seat	0.61	0.9	1.85
Educational	Place of Worship	1000sqft	9.11	10.37	36.63
Educational	User Defined Educational	User Defined Unit	0	0	0
Recreational	City Park	Acre	1.59	1.59	1.59
Recreational	Golf Course	Acre	5.04	5.82	5.88
Recreational	Golf Course	Hole	35.74	40.63	39.53
Recreational	Recreational Swimming Pool	1000sqft	32.93	20.87	26.73
Recreational	Racquet Club	1000sqft	32.93	20.87	26.73
Recreational	Health Club	1000sqft	32.93	20.87	26.73
Recreational	Movie Theater (No Matinee)	Screen	220	376	314
Recreational	Movie Theater (No Matinee)	Seat	1.8	1.8	1.8
Recreational	Movie Theater (No Matinee)	1000sqft	80	80	80
Recreational	Arena	Acre	33.33		
Recreational	Quality Restaurant	1000sqft	89.95	94.36	72.16
Recreational	High Turnover (Sit Down Restaurant)	1000sqft	127.15	158.37	131.84
Recreational	Fast Food Restaurant with Drive Thru	1000sqft	496.12	722.03	542.72
Recreational	Fast Food Restaurant w/o Drive Thru	1000sqft	716	696	500
Recreational	Hotel	Room	8.17	8.19	5.95
Recreational	Motel	Room	5.63	5.63	5.63
Recreational	User Defined Recreational	User Defined Unit	0	0	0
Parking	Parking Lot	Space	0	0	0
Parking	Parking Lot	Acre	0	0	0
Parking	Parking Lot	1000sqft	0	0	0
Parking	Parking Structure	Space	0	0	0
Parking	Parking Structure	Acre	0	0	0
Parking	Parking Structure	1000sqft	0	0	0
Parking	Other Asphalt Surfaces	Acre	0	0	0
Parking	Other Non-Asphalt Surfaces	Acre	0	0	0
Parking	Other Asphalt Surfaces	1000sqft	0	0	0
Parking	Other Non-Asphalt Surfaces	1000sqft	0	0	0
Parking	User Defined Parking	User Defined Unit	0	0	0
Retail	Free-Standing Discount store	1000sqft	57.24	71.07	56.36
Retail	Free-Standing Discount Superstore	1000sqft	53.13	64.07	56.12
Retail	Discount Club	1000sqft	41.8	53.75	33.67

Table 5 – Trip Rates for Land Uses in CalEEMod *(concluded)*

Land Use Type	Land Use Sub Type	Size Metric	Trip Rate		
			Weekday	Saturday	Sunday
Retail	Regional Shopping Center	1000sqft	42.94	49.97	25.24
Retail	Electronic Superstore	1000sqft	45.04	45.04	45.04
Retail	Home Improvement Superstore	1000sqft	29.8	56.72	55.8
Retail	Strip Mall	1000sqft	44.32	42.04	20.43
Retail	Hardware/Paint Store	1000sqft	51.29	82.52	68.65
Retail	Supermarket	1000sqft	102.24	177.59	166.44
Retail	Convenience Market (24 hour)	1000sqft	737.99	863.1	758.45
Retail	Convenience Market w/Gas Pumps	1000sqft	845.6	1448.33	1182.08
Retail	Convenience Market w/Gas Pumps	Pump	542.6	204.47	166.88
Retail	Automobile Care Center	1000sqft	62	62	62
Retail	Gasoline/Service Station	Pump	162.78	162.78	162.78
Retail	User Defined Retail	User Defined Unit	0	0	0
Commercial	Bank (with Drive-Through)	1000sqft	148.15	86.32	31.9
Commercial	General Office Building	1000sqft	11.01	2.37	0.98
Commercial	Office Park	1000sqft	11.42	1.64	0.76
Commercial	Research & Development	1000sqft	8.11	1.9	1.11
Commercial	Government Office Building	1000sqft	68.93	0	0
Commercial	Government (Civic Center)	1000sqft	27.92		
Commercial	Pharmacy/Drugstore with Drive Thru	1000sqft	88.16	88.16	88.16
Commercial	Pharmacy/Drugstore w/o Drive Thru	1000sqft	90.06	90.06	90.06
Commercial	Medical Office Building	1000sqft	36.13	8.96	1.55
Commercial	Hospital	1000sqft	16.5	10.18	8.91
Commercial	Hospital	Bed	11.81	8.14	7.19
Commercial	User Defined Commercial	User Defined Unit	0	0	0
Industrial	Unrefrigerated Warehouse-No Rail	1000sqft	2.59	2.59	2.59
Industrial	Unrefrigerated Warehouse-Rail	1000sqft	1.63	1.63	1.63
Industrial	Refrigerated Warehouse-No Rail	1000sqft	2.59	2.59	2.59
Industrial	Refrigerated Warehouse-Rail	1000sqft	1.63	1.63	1.63
Industrial	General Light Industry	1000sqft	6.97	1.32	0.68
Industrial	General Heavy Industry	1000sqft	1.5	1.5	1.5
Industrial	Industrial Park	1000sqft	6.96	2.49	0.73
Industrial	Manufacturing	1000sqft	3.82	1.49	0.62
Industrial	User Defined Industrial	User Defined Unit	0	0	0

References

References to the default factors and methodology used in CalEEMod are summarized in the following table. In addition, the date of the reference is listed. The CAPCOA Focus Group overseeing the maintenance and upgrades to the model will update when a later version is incorporated in the program. The Focus Group has also prepared a list of "User Tips" to assist the operators of CalEEMod including operational information, proper modification of the defaults, program limitations, program flexibilities, and design features to be modified. The User Tips can be found online at the CalEEMod website, www.caleemod.com.

Table 6 – References to the Default Factors and Methodology Used in CalEEMod

CalEEMod Factors/Methodology	Reference	Version Date
Climate zones	CEC's Climate Zone Forecast Map in Residential Appliance Saturation Survey (RASS)	2004
Wind speed	Western Regional Climate Center – California	2006
Precipitation frequency	Western Regional Climate Center – California	2007
Utility intensity factors	CARB's Local Government Operations Protocol (version 1.1)	2006
Utility intensity factors	Public Utility Protocols (PUP) Report Intensities – Modesto (2007), PG&E (2008) and Imperial (2008)	2007/2008
Global warming potential (GWP)	Intergovernmental Policy for Climate Change (IPCC)'s Second Assessment Report (SAR)	1995 (SAR)
Land use types	ITE Trip Generation Manual	8th edition
Housing density (DU/acre)	ITE Trip Generation Manual	8th edition
Population (people/DU)	US Census Bureau Statewide default (or supplied by air district)	2000
Construction equipment emission factors	CARB's OFFROAD Model	2007
Construction equipment phase	SCAQMD Construction Equipment Survey	2005
Construction equipment types	SCAQMD Construction Equipment Survey	2005
Construction equipment HP and load factors	CARB's OFFROAD Model	2007
Fugitive dust (PM) calculations	EPA's AP-42 (Section 11.9) method (Western Surface Coal Mining) and Section 13.2 (Introduction to Fugitive Dust Sources)	1998
Worker and vendor trips	Sacramento Metro AQMD 2008 construction survey	2010
On-road fugitive dust emissions on paved and unpaved roads	EPA's AP-42 (Section 13.2.1) Paved Road Emission Factors	2006
Trip rates	ITE Trip Generation Manual	8th edition
On-road vehicle operational emission factors	CARB's EMFAC model using the BURDEN mode or option	2007
Trip lengths	Statewide default (or supplied by air district)	2010
Hearth emissions	Criteria pollutant emission factors based on EPA's AP-42. GHG emission factors from California Climate Action Registry (CCAR)	2009

Table 6 – References to the Default Factors and Methodology Used in CalEEMod *(concluded)*

CalEEMod Factors/Methodology	Reference	Version Date
Consumer products	CARB's 2008 Consumer Product (VOC) Emission Inventory and 2000 Census (for California building square footage)	2008
Architectural coatings	Local/state VOC requirements from paints	Ongoing
Landscape equipment factors, activity	CARB's Technical Memo: Change in Population and Activity Factors for Lawn and Garden Equipment	2003
Electricity and natural gas as energy source	CCAR General Reporting Protocol, Version 3.1	2009
Energy usage from space heating/cooling, water heating, ventilation	California Code of Regulations, Title 24, Part 6 (California's Energy Efficiency Standards for Residential and Nonresidential Buildings)	2008
Energy use and intensity factors from residential appliances	CEC's Residential Appliance Saturation Survey (RASS)	2004
Energy use and intensity factors from non-residential sources	CEC's Commercial End-User Survey (CEUS)	2006
Indoor and Outdoor water use from land uses	Pacific Institute for Studies in Development and Environment "Waste Not, Want Not: Urban Water Conservation in California" and the American Water Works Association Research Foundation's "Commercial and Institutional End Uses of Water" report	2003/2000
Water-related energy use	Electricity intensity factors (KWh/million gallons) from CEC's "Refining Estimates of Water-Related Energy Use in California"	2006
Wastewater use	CARB's Local Government Operations Protocol: Chapter 10 – Wastewater Treatment Facilities and EPA's Inventory of US Greenhouse Gas Emissions and Sinks	2008
Solid waste GHG emission methodology	IPCC's Guidelines for National GHG Inventories	2006
Solid waste disposal rates	CalRecycle for annual disposal rates for individual land uses	2010
Vegetation GHG emission methodology	IPCC's Guidelines for National GHG Inventories	2006