CalEEMod®

California Emissions Estimator Model®

Appendix E
Technical Source Documentation

Prepared for:
California Air Pollution Control Officers Association (CAPCOA)

Prepared by:

ENVIRON International Corporation and the California Air Districts

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Contents

1 Construction Survey by SCAQMD

South Coast Air Quality Management District performed some construction surveys in order to develop default equipment usage and construction phase lengths. The initial survey was for projects less than five acres in size and is described in the following reference: The Sample Construction Scenarios for Projects Less than Five Acres in Size (http://www.aqmd.gov/ceqa/handbook/LST/FinalReport.pdf)

An additional 16 sites between five and thirty acres were surveyed for mid-sized projects. The amount and types of equipment was developed by attempting to find trends in data (i.e., comparing projects within the same project size, length of construction phases, number of pieces of equipment with areas disturbed, etc.).

The results of these surveys are included in the following tables.

Demolition
One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	1
Concrete/Industrial Saws	1	8
Excavators		
Bore/Drill Rigs		
Tractors/Loaders/Backhoes	2	6
	4	

Demolition
Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw	1	8
Excavators		
Bore/Drill Rigs		
Tractors/Loaders/Backhoes	3	8
	5	

Demolition
Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Concrete Saw	1	8
Excavators		
Bore/Drill Rigs		
Tractors/Loaders/Backhoes	3	8
	5	

Demolition
Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Grading
One Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	6
Excavators		
Graders	1	6
Scrapers		
Tractors/Loaders/Backhoes	1	7
	3	

Grading
Two Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators		
Graders	1	8
Scrapers		
Tractors/Loaders/Backhoes	2	7
	4	

Grading
Three Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Graders	1	8
Scraper		
Tractors/Loaders/Backhoes	2	7
	4	

Grading
Five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers		
Tractors/Loaders/Backhoes	3	8
	6	

Construction
One Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	4
Welders		
Excavators		
Forklifts	2	6
Generator Sets		
Tractors/Loaders/Backhoes	2	8
	5	

Construction
Two Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	6
Welders	3	8
Excavators		
Forklifts	1	6
Generator Sets	1	8
Tractors/Loaders/Backhoes	1	6
	7	

Construction
Three Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	8
Welders	3	8
Excavators		
Forklifts	2	7
Generator Sets	1	8
Tractors/Loaders/Backhoes	1	6
	8	

Construction
Five Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Coating/Paving
One Acre

Equipment Type	No. of Equip	hr/day
Pavers	1	7
Paving Equipment		
Cement and Mortar Mixers	4	6
Plate Compactors		
Rollers	1	7
Tractors/Loaders/Backhoes	1	7
	7	

Coating/Paving
Two Acre

Equipment Type	No. of Equip	hr/day
Pavers	1	6
Paving Equipment	1	8
Cement and Mortar Mixers	1	6
Plate Compactors		
Rollers	1	7
Tractors/Loaders/Backhoes	1	8
	5	

Coating/Paving
Three Acre

Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	1	8
Cement and Mortar Mixers	1	8
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes	1	8
	6	

Coating/Paving
Five Acre

Equipment Type	No. of Equip	hr/day
Pavers	1	8
Paving Equipment	2	6
Cement and Mortar Mixers	2	6
Plate Compactors		
Rollers	2	6
Tractors/Loaders/Backhoes	1	8
	8	

Site Preparation
One Acre

Equipment Type	No. of Equip	hr/day
Grader	1	8
Bulldozer		
Excavator		
Scraper		
Tractor/Loader/Backhoe	1	8
	2	

Site Preparation
Two Acre

Equipment Type	No. of Equip	hr/day
Grader	1	8
Bulldozer	1	7
Excavator		
Scraper		
Tractor/Loader/Backhoe	1	8
	3	

Site Preparation
Three Acre

Equipment Type	No. of Equip	hr/day
Grader	1	8
Bulldozer		
Excavator		
Scraper	1	8
Tractor/Loader/Backhoe	1	7
	3	

Site Preparation
Five Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Equipment

Demolition
Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Demolition
Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Demolition
Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Demolition
Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Grading
Ten Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	1	8
Graders	1	8
Scrapers		
Tractors/Loaders/Backhoes	3	8
	6	

Grading
Fifteen Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	2	
Graders	1	8
Scrapers	2	8
Tractors/Loaders/Backhoes	2	8
	8	

Grading
Twenty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	2	8
Graders	1	8
Scrapers	2	8
Tractors/Loaders/Backhoes	2	8
	8	

Grading
Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	2	8
Graders	1	8
Scrapers	2	8
Tractors/Loaders/Backhoes	2	8
	8	

Construction
Ten Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Construction
Fifteen Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Construction
Twenty Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Construction
Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Coating/Paving
Ten Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Coating/Paving
Fifteen Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Coating/Paving
Twenty Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Coating/Paving
Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Site Preparation
Ten Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Site Preparation
Fifteen Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Site Preparation
Twenty Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Site Preparation
Twenty-five Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Demolition
Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Demolition
Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	2	8
Concrete Saw	1	8
Excavators	3	8
Bore/Drill Rigs		
Tractors/Loaders/Backhoes		
	6	

Grading
Thirty Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	2	8
Graders	1	8
Scrapers	2	8
Tractors/Loaders/Backhoes	2	8
	8	

Grading
Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Rubber Tired Dozers	1	8
Excavators	2	8
Graders	1	8
Scrapers	2	8
Tractors/Loaders/Backhoes	2	8
	8	

Construction
Thirty Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Construction
Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Cranes	1	7
Welders	1	8
Excavators		
Forklifts	3	8
Generator Sets	1	8
Tractors/Loaders/Backhoes	3	7
	9	

Coating/Paving
Thirty Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Coating/Paving
Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Pavers	2	8
Paving Equipment	2	8
Cement and Mortar Mixers		
Plate Compactors		
Rollers	2	8
Tractors/Loaders/Backhoes		
	6	

Site Preparation
Thirty Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

Site Preparation
Thirty-four Acre

Equipment Type	No. of Equip	hr/day
Grader		
Bulldozer	3	8
Excavator		
Scraper		
Tractor/Loader/Backhoe	4	8
	7	

2 Building Construction Worker and Vendor Trip Rates

Construction Vendor Trips - Defaults for CalEEMod

Based on 2008 SMAQMD Field Survey - SCAQMD 2010 Update

				Square Footage			*Raw Data Collection in Field*				
Site	**Location**	**Type**	**# Units**	**Residential Area, sq ft**	**Commerical Area, sq ft**	**Office Area, sq ft**	**Light Duty**	**Medium Duty**	**Heavy Duty**	**Observation Time (minutes)**	**Multiplier to Equate Mins to 8 hrs/day**
Heritage Park	Woodland	Single Family Residential	2,037				13	3	6	37	12.97
Heritage Park (2nd visit)	Woodland	Single Family Residential	2,037				13	3	2	30	16
Yolo Co. Emergency Service	Woodland	Commercial			43,560		2	2	0	30	16
Woodshire	Woodland	Single Family Residential	2,000				5	3	5	35	13.71
Woodshire (2nd visit)	Woodland	Single Family Residential	2,000				10	0	3	30	16
815 H St.	Davis	Multi-Family Residential	8				1	0	0	30	16
Eleanor Roosevelt Cr.	Davis	Multi-Family Residential	60				2	0	0	30	16
Parlin Ranch	West Sac	Single Family Residential	306				2	1	3	30	16
Bridgeway Lakes 2	West Sac	Single Family Residential	487				7	2	0	30	16
The Rivers	West Sac	Single Family Residential	1,139				7	2	0	30	16
The River's Side	West Sac	Single Fam/ Multi Fam/ Comm	29	43,560	3,850		2	2	0	30	16
Carriage Lane	Sacramento	Multi-Family Residential	156				0	2	1	30	16
Promenade	Sacramento	Office/ Comm & Retail			751,000	504,000	10	1	6	40	12
Serenade	Sacramento	Single Family Residential					5	7	2	30	16
1801 L St. Building	Sacramento	Multi-Fam Res/ Comm & Retail	176	48,226	9,600		2	0	0	30	16
800 J Lofts	Sacramento	Multi-Fam Res/ Retail		144,035	50,965		2	1	0	30	16
Marriott Hotel	Sacramento	Multi-Family Res/ Comm	30	80,143	187,000		1	0	1	30	16
Anatolia I	Rancho Cordova	Single Fam Res/ Comm	1,038	7,122,060	631,620		19	15	10	30	16
Pappas Gateway Ctr	Elk Grove	Comm/ Retail			11,200		1	0	2	30	16
Sheldon Place	Elk Grove	Single Family Residential	164				6	2	0	30	16
Laguna Ridge (east pt)	Elk Grove	SF Res/ MF Res/ Office/ Comm & Retail	7,826	1,132,560	2,853,180	307,969	4	5	51	30	16
Laguna Ridge (west pt)	Elk Grove	SF Res/ MF Res/ Office/ Comm & Retail	7,826	1,132,560	2,853,180	307,969	7	8	8	30	16
		Total Units/SqFt	27,319	9,703,144	7,395,155	1,119,938					

Construction Vendor Trips - Defaults for CalEEMod

Based on 2008 SMAQMD Field Survey - SCAQMD 2010 Update

	Daily Count			Residential			Commercial			Office			
Site	**Light Duty**	**Medium Duty**	**Heavy Duty**	**Light Duty**	**Medium Duty**	**Heavy Duty**	**Light Duty**	**Medium Duty**	**Heavy Duty**	**Light Duty**	**Medium Duty**	**Heavy Duty**	**References for the Residential SqFt**
Heritage Park	169	39	78	169	39	78	0	0	0	0	0	0	
Heritage Park (2nd visit)	208	48	32	208	48	32	0	0	0	0	0	0	
Yolo Co. Emergency Service	32	32	0	0	0	0	32	32	0	0	0	0	
Woodshire	69	41	69	69	41	69	0	0	0	0	0	0	
Woodshire (2nd visit)	160	0	48	160	0	48	0	0	0	0	0	0	
815 H St.	16	0	0	16	0	0	0	0	0	0	0	0	
Eleanor Roosevelt Cr.	32	0	0	32	0	0	0	0	0	0	0	0	
Parlin Ranch	32	16	48	32	16	48	0	0	0	0	0	0	
Bridgeway Lakes 2	112	32	0	112	32	0	0	0	0	0	0	0	
The Rivers	112	32	0	112	32	0	0	0	0	0	0	0	
The River's Side	32	32	0	29	29	0	3	3	0	0	0	0	http://www.mintierharnish.com/projects/westsac/pdf/2008-2013HousingElementUpdate.pdf
Carriage Lane	0	32	16	0	32	16	0	0	0	0	0	0	
Promenade	120	12	72	0	0	0	72	7	43	48	5	29	
Serenade	80	112	32	80	112	32	0	0	0	0	0	0	Serenade at Regency Park Homeowners Association (916) 925-9000
1801 L St. Building	32	0	0	27	0	0	5	0	0	0	0	0	http://www.kuchman.com/architecture-portfolio/urban/1801L.html
800 J Lofts	32	16	0	24	12	0	8	4	0	0	0	0	http://www.cityofsacramento.org/econdev/development-projects/documents/700-800_K_Street_Final_Proposal_web.pdf
Marriott Hotel	16	0	16	5	0	5	11	0	11	0	0	0	http://sacramento.bizjournals.com/sacramento/business_travel/guide/hotels.html
Anatolia I	304	240	160	279	220	147	25	20	13	0	0	0	http://www.cityofranchocordova.org/Modules/ShowDocument.aspx?documentid=758
Pappas Gateway Ctr	16	0	32	0	0	0	16	0	32	0	0	0	
Sheldon Place	96	32	0	96	32	0	0	0	0	0	0	0	
Laguna Ridge (east pt)	64	80	816	17	21	215	43	53	542	4	6	59	http://sacramento.bizjournals.com/sacramento/stories/2008/05/12/story7.html
Laguna Ridge (west pt)	112	128	128	30	34	34	74	85	85	8	9	9	http://sacramento.bizjournals.com/sacramento/stories/2008/05/12/story7.html
Total Daily Vehicle Trips	1,846	925	1,547										
Total Daily Vehicle Trips				1,496	701	724	289	204	727	60	20	97	
Vehicle Trips per Unit or 1k Sq Ft				0.0548	0.0256	0.0265	0.0391	0.0275	0.0983	0.0538	0.0176	0.0863	
TOTAL Vehicle Trips per Unit or 1k SqFt					**0.1069**			**0.1649**			**0.1577**		

Construction Vendor Trips - Defaults for CalEEMod

Based on 2008 SMAQMD Field Survey - SCAQMD 2010 Update

Site	Commerical and Office Area, sq ft	Commercial and Office Daily Count		
		Light Duty	Medium Duty	Heavy Duty
Heritage Park	0	0	0	0
Heritage Park (2nd visit)	0	0	0	0
Yolo Co. Emergency Service	43,560	32	32	0
Woodshire	0	0	0	0
Woodshire (2nd visit)	0	0	0	0
815 H St.	0	0	0	0
Eleanor Roosevelt Cr.	0	0	0	0
Parlin Ranch	0	0	0	0
Bridgeway Lakes 2	0	0	0	0
The Rivers	0	0	0	0
The River's Side	3,850	3	3	0
Carriage Lane	0	0	0	0
Promenade	1,255,000	120	12	72
Serenade	0	0	0	0
1801 L St. Building	9,600	5	0	0
800 J Lofts	50,965	8	4	0
Marriott Hotel	187,000	11	0	11
Anatolia I	631,620	25	20	13
Pappas Gateway Ctr	11,200	16	0	32
Sheldon Place	0	0	0	0
Laguna Ridge (east pt)	3,161,149	47	59	601
Laguna Ridge (west pt)	3,161,149	82	94	94
TOTALs	**8,515,093**	**349**	**223**	**823**
		0.0410	0.0262	0.0967
			0.1639	

3 Analysis of Warehouse Trip Generation Rates by SCAQMD

Note – This appendix is based on information available at the time the first version of CalEEMod was released. SCAQMD is currently overseeing a study on High Cube Warehouse truck trip rates. Once this study has been completed, the CalEEMod Focus Group within CAPCOA will consider revising this appendix and the default High Cube Warehouse trip rates within CalEEMod. Further information regarding this study is available on the web here: http://www.aqmd.gov/ceqa/Warehouse/Warehouse.html.

Large Warehouse and Distribution Center Trip Rates

Introduction

New large warehouse projects and distribution centers (>100,000 square feet) have become a more common project type in the past several years, especially in the western Riverside County and San Bernardino County area. As an example, at least 8 new EIRs for warehouse projects totaling 17.75 million square feet have been reviewed by SCAQMD staff since late 2008 just in the vicinity of the city of Perris in Riverside County. These warehouse projects are commonly associated with substantial diesel emissions due to the high volume of heavy duty trucks that serve them. Diesel Particulate Matter (DPM) from internal combustion engines has been classified as a carcinogen by the California Air Resources Board (CARB). This white paper has been prepared because the number of truck trips associated with warehousing projects is a key component in determining the potential impact of DPM emissions on surrounding communities. Due to concern about these emissions, the CARB in its *Air Quality and Land Use Handbook* recommended providing a 1,000 foot setback from any distribution center serving more than 100 trucks per day.

For CEQA purposes, the volume of truck traffic predicted to serve a new large warehouse project is typically derived using the Institute of Transportation Engineers Trip Generation manual. This is the same source of traffic data used in the URBEMIS air quality model. The trip rate value used in URBEMIS is 4.96 trips per 1,000 square feet (TSF) for warehouse projects (land use type 150). This value is from the 7th Edition of the Trip Generation manual, published in 2003. Several developers of high-cube warehouses in recent years have questioned the validity of this value for modern warehousing operations and have commissioned local studies to investigate these trip rates. As a result, in the most recent version of the Trip Generation manual (8th Edition, 2008), additional data has been included to provide a new high-cube warehouse (land use 152) trip rate of 1.44 trips/TSF.

SCAQMD staff and other interested parties have questioned lead agencies about this lower rate because of concern that industrial warehouse project analyses may be underestimating the number of trucks serving them. If this were true, air quality impacts may be underreported in the corresponding CEQA analyses. This memo and attached spreadsheet presents a meta-analysis of available traffic studies that have targeted high-cube warehouses.

Studies

The seven studies included in this meta-analysis are listed below. Studies marked with an (*) are included in the 8th Edition of the ITE Trip Generation manual.

1. **Westside Industrial Park, Warehouse Trip Generation Study – Twenty Five Buildings, Duval County Florida*, December 5, 2008. King Engineering Associates, Inc.
2. **Westside Industrial Park, Warehouse Trip Generation Study –Eight Buildings, Duval County Florida*, December 5, 2008. King Engineering Associates, Inc.
3. **Trip Generation Study. High-Cube Warehouse Buildings, Fresno California*, January 19, 2007. Peters Engineering Group
4. **Trip Generation Study. Existing High-Cube Warehouse Buildings, Visalia California*, October 1, 2008. Peters Engineering Group
5. **Western Riverside County Warehouse/Distribution Center Trip Generation Study*, May 2008. Crain and Associates
6. **San Bernardino/Riverside County Warehouse/Distribution Center Vehicle Trip Generation Study (Inland Empire Study)*, January 2005. Crain and Associates
7. *Truck Trip Generation Study, City of Fontana,* August 2003. Transportation Engineering and Planning, Inc.

Together these seven studies include traffic counts for 68 different warehouse buildings. 35 of those warehouses are in California, and 25 are in the South Coast Basin. As a comparison, a total of 35 individual buildings were included in the ITE Trip Generation 8th Edition.

Data Analysis

In the ITE 8th Edition manual the trip rates range from 0.20-2.88 trips/TSF with an average of 1.44 and a standard deviation of 1.39. In order to investigate the high standard deviation and range of rates, all 68 warehouses from the above mentioned studies were investigated using overhead and oblique aerial photography to determine site-specific characteristics. Table 1 and Chart 1 present a statistical summary of trip rates determined from all seven studies. Based on this aerial reconnaissance, two factors were identified that may lower the reported trip rate for individual warehouses including the presence of a rail line serving the facility, and the potential partial vacancy of a facility.

Statistical Measure	Rail Service?	Potential Vacancy?	Number of Buildings	Trips/TSF
Minimum trip rate	No	Yes	68	0.17
Maximum trip rate	No	No	68	5.25
Average of all trip rates	Some	Some	68	1.57
Standard Deviation of all trip rates	Some	Some	68	0.81
95th Percentile of all trip rates	Some	Some	68	2.57
Average for CA warehouses	Some	Some	35	1.44
Average for SCAB warehouses	Some	Some	25	1.57
Average for all warehouses	Yes	Yes	14	0.73
Average for all warehouses	Yes	No	8	0.81
Average for all warehouses	No	Some	58	1.79
Average for all warehouses	No	No	54	1.91
95th Percentile for SCAB warehouses	No	No	13	3.68
95th Percentile for all warehouses	**No**	**No**	**54**	**2.59**
95th Percentile for all warehouses	**Yes**	**No**	**8**	**1.63**
ITE High-Cube warehouses	**Some**	**Some**	**35**	**1.44**

Table 1 Statistical summary of trip rates *CA= California, SCAB=South Coast Air Basin*

Rail lines are expected to lower the truck trip rate by diverting the transportation of goods from trucks to trains that directly service the facility. Rail service must include spurs that are adjacent to loading docks at the facility (Figure 1). Vacancies or partial vacancies in the trip rate studies are difficult to verify, however analysis of aerial photographs provides circumstantial evidence that anomalously low trip rates are associated with facilities with virtually no trucks parked at the loading docks at the time that the photograph was taken (Figure 2). While this accounts for the majority of the anomalously low trip rates, the lack of adequate business histories or historical photographic coverage make this correlation difficult to validate. Trip rates were also investigated in comparison to building size; however no correlation was identified (Chart 2).

In order to avoid underestimating the number of trips associated with large warehouse / distribution center operations without rail service, AQMD staff recommends that lead agencies utilize a rate of 2.59 trips per TSF for large warehouse air quality analyses on a project specific basis. The value of 2.59 from the nationwide dataset is preferable instead of the SCAB rate of 3.68 due to the greater reliability of data based on the larger sample size. For warehouses with rail service, a rate of 1.63 trips per TSF may be used. These values provide reasonable worst case default rates for individual new warehouses in the absence of more project-specific data.

In the case that air quality is evaluated for multiple warehouses (>10), such as in an analysis for a general plan, the average rate of 1.44 trips per TSF from the ITE 8th Edition Trip Generation manual is acceptable. This lower value may be more appropriate as on average, a small portion of warehouses can be expected to operate at varying levels of service, including some warehouses experiencing temporary partial or complete vacancy.

Fleet Mix

The fleet mix used in the URBEMIS model is derived from the regional average distribution of trips obtained from the EMFAC model. While this fleet mix may be appropriate for the majority of land uses, it may not be appropriate for specialized uses such as warehouses. For example, as reported in the ITE 8th Edition Trip Generation manual, truck trips may account for 9 to 29 percent of total trips. Five of the seven studies analyzed here did not report specific truck traffic data, though some generally reported similar rates. The Inland Empire study (#6) found that trucks accounted for 28 to 65 percent of total trips for the ten warehouses in the study, with an average of 48%. The Fontana study (#7) found that trucks make up approximately 20% of total trips for the four warehouses evaluated. This study also broke down the trip distribution among 2, 3, and 4+ axle trucks (3.46%, 4.64%, 12.33%, respectively). In order to avoid underestimating the number of trucks visiting warehouse facilities, AQMD staff recommends that lead agencies conservatively assume that an average of 40% of total trips are truck trips [(0.48*10 + 0.2*4)/(10+4)=0.4)]. Without more project-specific data (such as detailed trip rates based on a known tenant schedule), this average rate of 40% provides a reasonably conservative value based on currently available data.

The fleet mix from the Fontana study as quoted above may be used to determine the distribution of truck type. In order to convert the axle based fleet mix to the vehicle classes utilized by EMFAC, one of two methods may be used.

1. 4+ axles=HHDT, 3 axles=MHDT, 2 axles=LHDT1, all others=LDA
2. Caltrans *Transportation Project-Level Carbon Monoxide Protocol* Appendix B (illustrated below).
   %HDGT = 0.50(%2-axle) + 0.25(%3-axle) + 0.10(%4 axle)
   %HDDT = 0.50(%2-axle) + 0.75(%3-axle) + 0.90(%4-axle) + 1.0(%5-axle)
   All others=LDA

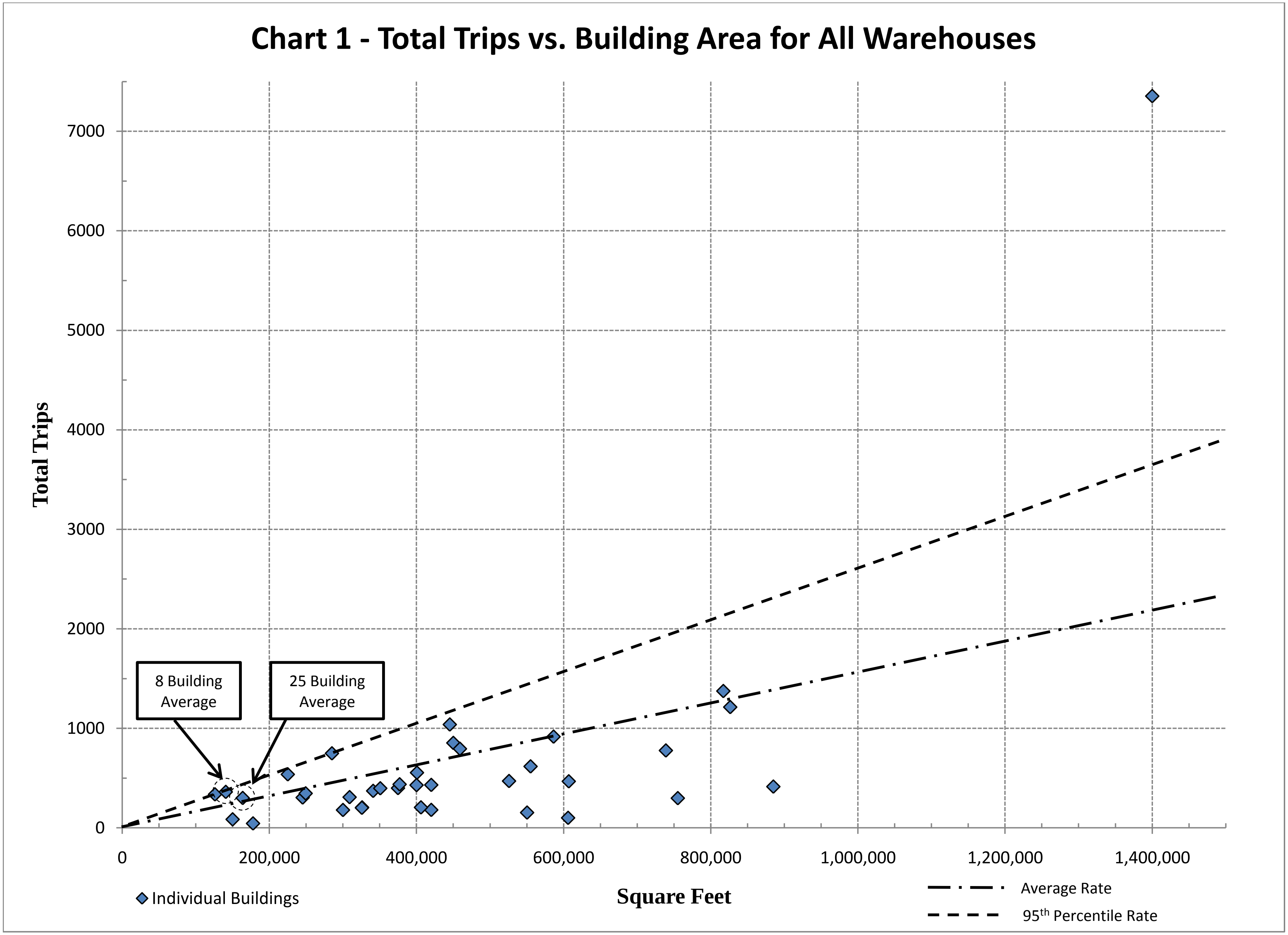

Chart 1 - Total Trips vs. Building Area for All Warehouses
Total Trips
7000
6000
5000
4000
3000
2000
1000
0
8 Building Average
25 Building Average
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
Square Feet
Individual Buildings
Average Rate
95th Percentile Rate

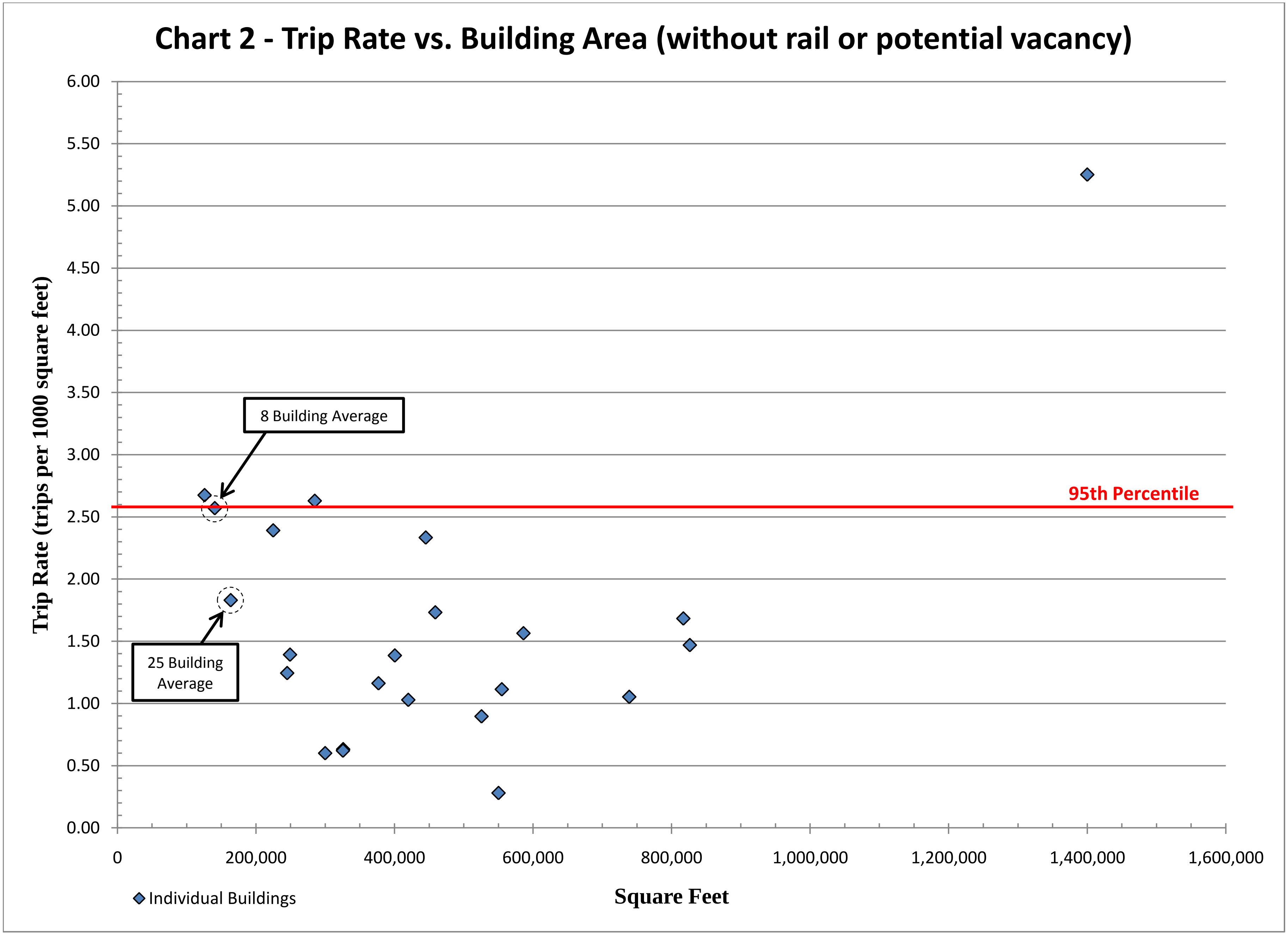

Chart 2 - Trip Rate vs. Building Area (without rail or potential vacancy)
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Trip Rate (trips per 1000 square feet)
8 Building Average
95th Percentile
25 Building Average
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
1,600,000
Square Feet
Individual Buildings

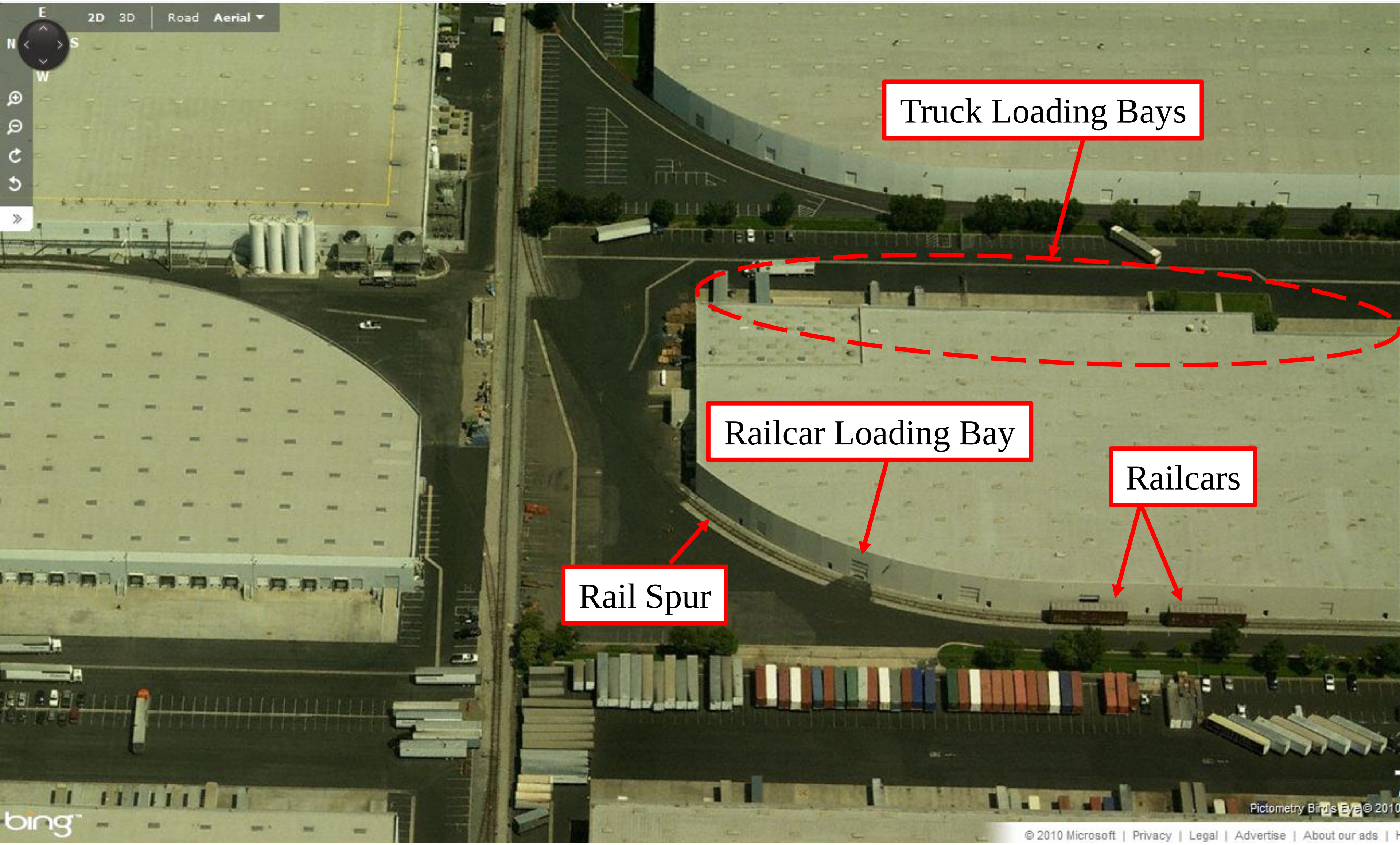

Figure 1 Oblique aerial photograph showing an example of a facility evaluated in the NAIOP San Bernardino County Truck Study. The truck trip rate for this facility was 1.13/TSF

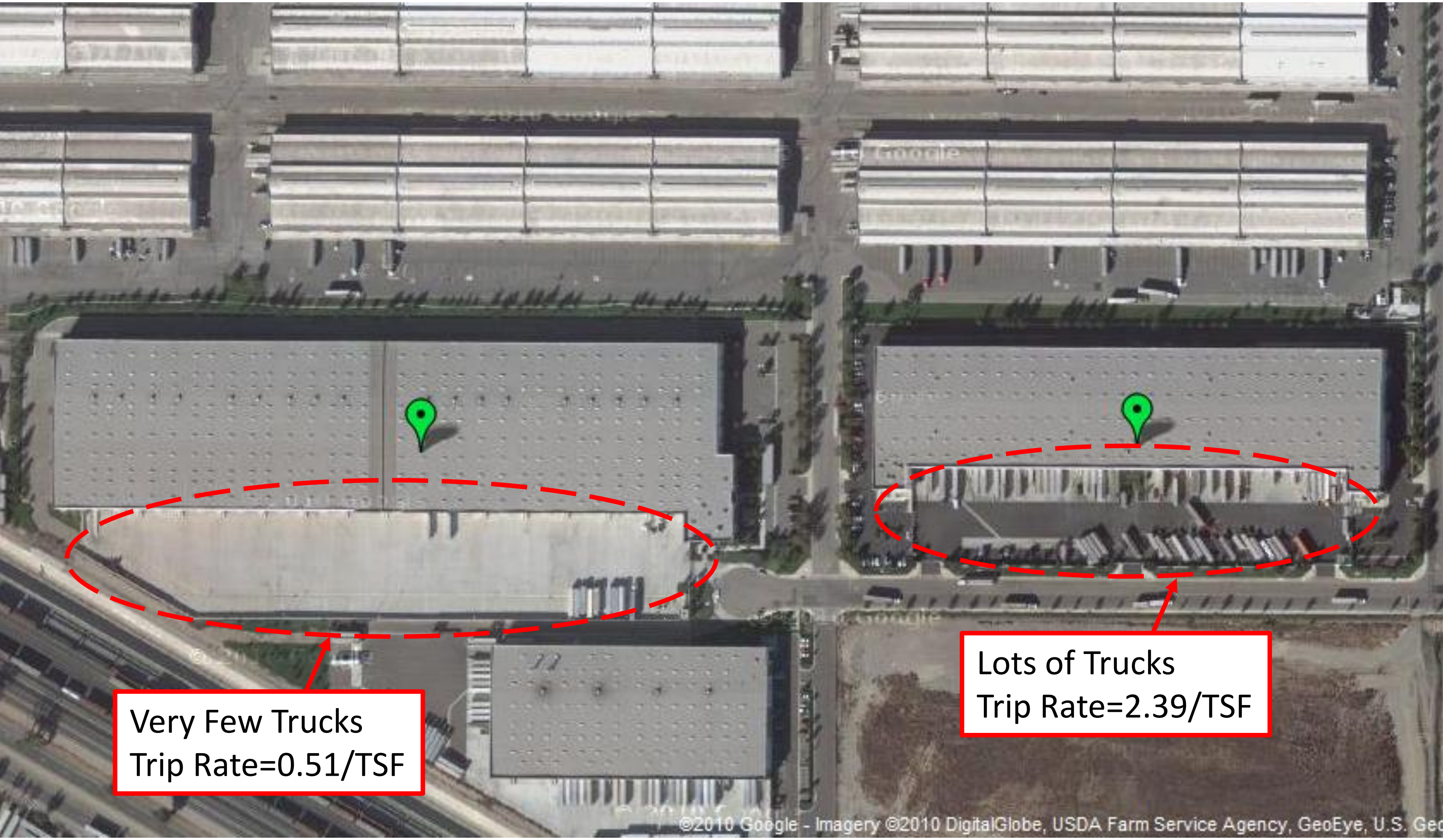

Figure 2 Aerial photograph showing an example of two facilities evaluated in the NAIOP Riverside County Truck Study. The facility on the left is suspected to be at least partially vacant.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

MEMORANDUM

Date: August 23, 2010

To: Jennifer Schulte, ENVIRON

From: David Robinson, Meghan Mitman, Fehr & Peers

Subject: Large Warehouse and Distribution Center Trip Rates

SF10-0495

Fehr & Peers completed its review of the Large Warehouse and Distribution Center Trip Rates white paper prepared by the Southern California Air Quality Management District (SCAQMD). The white paper presents the results of a meta-analysis of seven trip generation studies of warehouse and distribution centers located in California and Florida.

Our review of the white paper focused on the recommended trip generation rates presented in Table 1 (Statistical Summary of Trip Rates) and the statistical analysis provided in file SCAQMD Trip Rate Study_7-21-10.xlsx). We have the following observations based on our review:

- Use of 95 Percentile – The recommended trip generation rates are based on the 95 percentile of trip generation rate observations. The 95 percentile trip generation rate can be defined as the lowest trip generation rate that is greater than 95 percent of the observed trip generation rates. The use of the 95 percentile may be overly conservative. Another approach would be to base the recommended trip generation rate on the 95 percentile confidence interval, which would result in a trip generation rate between the average and 95 percentile rates for all warehouses.

- Observations – Both studies from Florida (i.e., reference 1 and 2 on Page 2) were treated as single observations to calculate the average trip generation rate for all warehouses, but were treated as multiple observations for the standard deviation calculation, which would affect the calculation of the confidence interval (discussed above). These studies and corresponding trip generation rates are based on the combined trip generation and building area of multiple buildings/uses in the same industrial park. One study included 31 buildings and the other included 9 buildings. The building size ranged from about 64,000 to about 440,000 square-feet.

- Outliers – One observation from the Fontana study (i.e., reference 7 on Page 2) is considerably higher than the other observations. Eliminating this observation results in a 20% decrease in the average trip generation rate for all warehouses.

Clarification Responses by SCAQMD regarding Fehr and Peers August 23, 2010 Memorandum
Large Warehouse and Distribution Center Trip Rates

Use of 95 Percentile

- AQMD STAFF RESPONSE – A CONFIDENCE INTERVAL APPROACH IS INAPPROPRIATE FOR A CEQA AIR QUALITY ANALYSIS AS THIS GIVES THE ODDS THAT A NEW POPULATION WILL RETURN AN AVERAGE WITHIN THE CONFIDENCE INTERVAL. IN THE CONTEXT OF CEQA, AIR QUALITY ANALYSES SHOULD EVALUATE A REASONABLE WORST CASE SCENARIO SO AS NOT TO UNDERESTIMATE IMPACTS. THIS CONERVATIVE APPROACH IS SUPPORTED BY CEQA CASE LAW AND IS CONSISTENT WITH AQMD GUIDANCE ON PREPARING AIR QUALITY ANALYSES. ALSO, IT IS WORTH NOTING THAT 11 OUT OF 54 BUILDINGS ARE ALREADY AT OR ABOVE THE 95^{TH} PERCENTILE.

Observations

- AQMD STAFF RESPONSE – THE STATISTACAL APPROACH DESCRIBED IN THIS COMMENT DOES NOT MAKE AFFECT THE TRIP RATE. SPLITTING OUT INDIVIDUAL BUILDINGS FOR THE AVERAGE DOESN'T ALTER THE TRIP RATE SINCE THE AVERAGE IS TRIPS/SQ. FT. HOWEVER, THE NUMBER OF INDIVIDUAL BUILDINGS ARE NEEDED FOR THE STANDARD DEVIATION, SO THE FLORIDA STUDIES WERE SPLIT UP TO OBTAIN A CORRECT 'N' (EVERY BUILDING WAS ASSIGNED THE SAME RATE).

Outliers

- AQMD STAFF RESPONSE - THIS IS EXACTLY THE POINT, IF WE KNOW THAT SOME BUILDINGS HAVE A RATE CONSIDERABLY HIGHER THAN OTHER BUILDINGS, THEN THE USE OF AVERAGES MAY CONSIDERABLY UNDERESTIMATE POTENTIAL AIR QUALITY IMPACTS. THIS IS ESPECIALLY IMPORTANT FOR ANY SENSITIVE RECEPTORS THAT MAY BE LOCATED IN CLOSE PROXIMITY TO EITHER THE FACILITIES OR THE TRUCK ROUTES SERVING THEM. UNLIKE SOME OTHER STATISTICAL STUDIES, THIS SINGULAR HIGH RATE (FROM A SMALL DATASET) IS NOT A MEASUREMENT ERROR, HENCE IT SHOULD NOT BE DISCARDED AS IT IS A REAL FACILITY WITH REAL IMPACTS IN THE COMMUNITY.

4 Consumer Product Use Analysis by SCAQMD

<u>Consumer Products Summary</u>

Statewide Volatile Organic Compound (VOC) emissions data was obtained from the 2008 California Air Resources Board (CARB) Consumer Product Emission Inventory.[1] Statewide total VOC emissions were 239.6 tons/day.

The statewide total building area is 22,435,267,518 square feet. The general building stock inventory was obtained from the HAZUS-MH software and backup databases prepared by the Federal Emergency Management Agency.[2] This inventory was found to be the most comprehensive statewide data available that included building area for all land use types. The inventory was developed from the following information:

- Census of Population and Housing, 2000: Summary Tape File 1B Extract on CDROM prepared by the Bureau of Census.
- Census of Population and Housing, 2000: Summary Tape File 3 on CD-ROM prepared by the Bureau of Census.
- Dun & Bradstreet, Business Population Report aggregated by Standard Industrial Classification (SIC) and Census Block, May 2002.
- Department of Energy, Housing Characteristics 1993. Office of Energy Markets and End Use, DOE/EIA-0314 (93), June 1995.
- Department of Energy, A Look at Residential Energy Consumption in 1997, DOE/EIA-0632(97), November 1999.
- Department of Energy, A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures, DOE/EIA-0625(95), October 1998.

Statewide VOC's per building square feet are therefore:
(239.6 tons/day x 2000 lbs/ton) / 22,435,267,518 sq. ft. = ***2.14e-5 lbs/(sq.ft.-day)***

[1] http://www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2008&F_DIV=-4&F_SEASON=A&SP=2009&F_AREA=CA#5

[2] Detailed information is contained in the HAZUS-MH Earthquake Technical Manual, Chapter 3.2.1.3 available here: http://www.fema.gov/plan/prevent/hazus/

Data Grouping	Total VOC (tons/day)	Population*	Total VOC (lbs/person-day)	Total Building Area (Square Feet)	
2003 Survey Commercial *(45.3% of 2003 Land Use Total)*	47.4				
2003 Survey Residential *(48.0% of 2003 Land Use Total)*	50.3				
2003 Survey Industrial *(6.7% of 2003 Land Use Total)*	7.0				
2003 Survey Land Use Total *(42.3% of Grand Total)*	*104.7*			8,600,000,000	from AQMD draft staff report for consumer products rule
2003 Survey ARB Data Total	186.3	34,650,690	1.08E-02		
2006 Survey ARB Data Total	61.1	36,457,549	3.35E-03		
Grand Total	***247.3***		***1.41E-02***	***22,435,267,518***	from HAZUS-MH, data from late 1990's - early 2000's

*Data from American Communities Survey from the US Census

		Total VOC (lbs/building sq. ft.)	
2008 ARB Emission Inventory (Consumer Products)	***239.6***	*2.14E-05*	Statewide Factor
SCAQMD R1143 reduction to 300 g/l (as of 1/1/11)	11.3	*2.04E-05*	
If 25 g/L gets upheld by the courts	17.5	1.98E-05	SCAQMD

5 Analysis of Building Energy Use Data by ENVIRON

Analysis of Building Energy Use Data by ENVIRON

This summarizes the steps and assumptions used in preparing building energy use estimates used in CalEEMod.

Background

GHGs are emitted as a result of activities in residential and commercial buildings when electricity and natural gas are used as energy sources. New California buildings must be designed to meet the building energy efficiency standards of Title 24, also known as the California Building Standards Code. Title 24 Part 6 regulates energy uses including space heating and cooling, hot water heating, ventilation, and hard-wired lighting. By committing to a percent improvement over Title 24, a development reduces its energy use and resulting GHG emissions.

The Title 24 standards have been updated twice (in 2005 and 2008)[1] since some of these data used to estimate energy use were compiled. California Energy Commission (CEC) has published reports estimating the percentage deductions in energy use resulting from these new standards. Based on CEC's discussion on average savings for Title 24 improvements, these CEC savings percentages by end use can be used to account for reductions in electricity and natural gas use due to the two most recent updates to Title 24. Since energy use for each different system type (ie, heating, cooling, water heating, and ventilation) as well as appliances is defined in this survey, the use of survey data with updates for Title 24 will easily allow for application of mitigation measures aimed at reducing the energy use of these devices in a prescriptive manner.

Another mitigation measure to reduce a building's energy consumption as well as the associated GHG emissions from natural gas combustion and electricity production is to use energy-efficient appliances. For residential dwellings, typical builder-supplied appliances include refrigerators and dishwashers. Clothes washers and ceiling fans would be applicable if the builder supplied them. For commercial land uses, only energy-efficient refrigerators have been evaluated for grocery stores.

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1 California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: http://www.energy.ca.gov/ceus/

Methodology

Datasets

The Residential Appliance Saturation Survey (RASS)[2] and California Commercial Energy Use Survey (CEUS)[3] datasets were used to estimate the energy intensities of residential and non-residential buildings, respectively, since the data are available for several land use categories in different climate zones in California. The RASS dataset further differentiates the energy use intensities between single-family, multi-family and townhome residences.

The Energy Star and Other Climate Protection Partnerships 2008 Annual Report[4] and subsequent Annual Reports were reviewed for typical reductions for energy-efficient appliances. ENERGY STAR residential refrigerators, clothes washers, dishwashers, and ceiling fans use 15%, 25%, 40%, and 50% less electricity than standard appliances, respectively. ENERGY STAR commercial refrigerators use 35% less electricity than standard appliances.

Calculations

RASS and CEUS datasets were used to obtain the energy intensities of different end use categories for different building types in different climate zones. Energy intensities from CEUS are given per square foot per year and used as presented. RASS presents Unit Energy Consumption (UEC) per dwelling unit per year and saturation values; the energy intensities used in this analysis are products of the UEC and saturation values.

Data for some climate zones are not presented in the CEUS and RASS studies. However, data from adjacent climate zones are assumed to be representative and substituted as follows:

For non-residential building types:
Climate Zone 11 used Climate Zone 9 data.
Climate Zone 12 used Climate Zone 9 data.
Climate Zone 14 used Climate Zone 1 data.
Climate Zone 15 used Climate Zone 10 data.

For residential building types:
Climate Zone 6 used Climate Zone 2 data.
Climate Zone 14 used Climate Zone 1 data.
Climate Zone 15 used Climate Zone 10 data.

RASS and CEUS data are based on 2002 consumption data. Because older buildings tend to be less energy efficient, and the majority of the buildings in the survey were likely constructed before 2001, the RASS and CEUS data likely overestimate energy use for a 2001 Title 24-compliant building.

2 California Statewide Residential Appliance Saturation Study Reporting Center. Available at: http://websafe.kemainc.com/RASSWEB/DesktopDefault.aspx

3 California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: http://www.energy.ca.gov/ceus/

4 United States Environmental Protection Agency 2009. ENERGY STAR and Other Climate Protection Partnerships: 2008 Annual Report. Available at: http://www.epa.gov/cpd/pdf/2008AnnualReportFinal.pdf

To account for updates since the 2001 Title 24 standards, percentage reductions for each end use category taken directly from the CEC's "Impact Analysis for 2005 Energy Efficiency Standards" and "Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings" reports were applied to the CEUS and RASS datasets for improvements from 2001 to 2005, and 2005 to 2008, respectively (see Table 1 and 2). For the CEUS data, exterior lighting was assumed to be covered by Title 24 lighting and therefore has the full percentage reductions taken. Interior lighting was assumed to be 50% Title 24 and 50% non-Title 24 uses. Therefore only half of the reduction for lighting was applied. The resulting 2008 numbers were then used as baseline energy intensities. In CalEEMod, if the user selects use historical (2005), the reductions only include up to the 2005 standards. The total baseline energy intensities are calculated as follows:

$$\text{Baseline} = \sum\left[\mathrm{T24}_{2001} \times \left(1 - \mathrm{R}_{2001\text{-}2005}\right) \times \left(1 - \mathrm{R}_{2005\text{-}2008}\right)\right] + \sum \mathrm{NT24}$$

Where:

Baseline	=	Total baseline energy intensities of building category
$\mathrm{T24}_{2001}$	=	Energy intensities of Title 24 regulated end use from RASS or CEUS
$\mathrm{R}_{2001\text{-}2005}$	=	Reduction from 2001 to 2005
$\mathrm{R}_{2005\text{-}2008}$	=	Reduction from 2005 to 2008
NT24	=	Non-Title 24 regulated end use energy intensities

Table 1
Reduction in Title 24 Regulated End Use for Non-Residential Buildings

Energy Source	End Use	Reduction from 2001 to 2005	Reduction from 2005 to 2008
Electricity	Heating	4.9%	37.2%
	Ventilation	5.0%	1.5%
	Refrigeration	0.0%	0.0%
	Process	0.0%	0.0%
	Office Equipment	0.0%	0.0%
	Motors	0.0%	0.0%
	Miscellaneous	0.0%	0.0%
	Interior Lighting	4.9%	5.9%
	Water Heating	0.0%	0.0%
	Cooking	0.0%	0.0%
	Air Compressors	0.0%	0.0%
	Cooling	6.7%	8.3%
	Exterior Lighting	9.8%	11.7%
Natural Gas	Cooking	0.0%	0.0%
	Cooling	10.4%	9.3%
	Heating	3.1%	15.9%
	Water Heating	0.0%	0.0%
	Process	0.0%	0.0%
	Miscellaneous	0.0%	0.0%

Table 2
Reduction in Title 24 Regulated End Use for Residential Buildings

Energy Source	End Use (As presented in RASS Dataset)	Reduction from 2001 to 2005			Reduction from 2005 to 2008		
		Multi-family	Single family	Town home	Multi-family	Single family	Town home
Electricity	Conv. Electric heat	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	HP Eheat	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Aux Eheat	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Furnace Fan	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Central A/C	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Room A/C	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Evap Cooling	24.3%	19.8%	24.3%	19.7%	22.7%	19.7%
	Water Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Solar Water Heater	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Dryer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Clothes Washer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Dish Washer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	First Refrigerator	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Second Refrigerator	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Freezer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pool Pump	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Spa	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Outdoor Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Range/Oven	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	TV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Spa Electric Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Microwave	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Home Office	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	PC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Water Bed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Well Pump	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Miscellaneous	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Natural Gas	Primary Heat	15.7%	6.7%	15.7%	7.0%	10.0%	7.0%
	Auxiliary Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Conv. Gas Water Heat	15.7%	6.7%	15.7%	7.0%	10.0%	7.0%
	Solar Water Heat w/Gas Backup	15.7%	6.7%	15.7%	7.0%	10.0%	7.0%
	Dryer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Range/Oven	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Pool Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Spa Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Miscellaneous	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

6 Assessment of Energy Emissions Associated with Parking Lots and Structures

Introduction

This paper recommends electricity energy use rates to calculate the energy consumption from the operation of car parking facilities in California. The energy uses considered include lighting, ventilation, and elevator use. Recommendations apply to open air parking lots, parking facilities with open walls and access to fresh air, and fully enclosed parking facilities, such as those that are underground, and require ventilation systems. These energy use rates allow the user to calculate lighting, ventilation and elevator use energy impacts separately.

Purpose

This effort was undertaken in conjunction with the CalEEMod Land Use Model ("CalEEMod") 2012 updates. Our intent is to determine if enough information is available to support the development of energy use rates for parking facilities in CalEEMod, and if so, what these recommended energy use rates should be.

Limitations

Energy use rates from water pumps, for fire safety systems or for storm water removal, were not considered because CalEEMod does not include emissions estimates from any stationary sources located at land use development projects. Our research has not identified energy use rates for operational systems, such as from systems designed to collect payments or secure the property, such as computer, ticketing, camera surveillance, or automated and human-activated gate systems. To our knowledge, research is not available to determine in which situations or size of facilities these systems would be utilized. Likewise, research is not available to determine in which situations parking facilities include energy use from natural gas, heating, cooling, and water delivery. Therefore, these energy use rates are not considered.

Proposed Energy Use Rates: Lighting and Ventilation

Energy Star is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy to promote energy efficient products and practices. As part of a larger project to evaluate the efficiency of buildings, Energy Star developed energy factors for parking facilities based on data from the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), and a review of existing building codes and local ordinances in the United States. **Table 1** below presents factors for energy use in parking facilities, based on the Energy Star "Performance Ratings Technical Methodology for Parking" technical paper.[i]

Table 1: Energy Use for Lighting and Ventilation by Parking Type			
		Hourly Watts or Horse Power Per Square Foot	**Assumed Hours of Operation**
Open Parking	Lighting	0.15 W/ft^2	16 hours/day
	Ventilation	none	
Unenclosed Parking (no walls)	Lighting	0.30 W/ft^2	24 hours/day
	Ventilation	none	
Fully Enclosed Parking (walls)	Lighting	0.30 W/ft^2	24 hours/day
	Ventilation[(1)(2)]	0.6 hp/1,000 ft^2	

Notes:

1. Ventilation is characterized in terms of flow rate (cubic feet per minute per square foot, cfm/ft^2 equals 0.6 horse power per 1,000ft^2).
2. One horse power(hp) is equal to 0.746 kiloWatts.

Table 2 shows the results of these factors in annual kWh per square foot of parking area.

Table 2: Energy Use for Lighting and Ventilation by Parking Type					
Type of Parking	**Use**	**Days/Year**	**Hours/Day**	**Annual kWh/SqFt**	**Total Annual kWh/SqFt**
Open Parking	Lighting	365	16	0.876	0.876
	(No) Ventilation				
Unenclosed Parking (no walls)	Lighting	365	24	2.63	2.63
	(No) Ventilation				
Fully Enclosed Parking (walls)	Lighting	365	24	2.63	6.55
	Ventilation			3.92	

The Energy Star energy rates are generally consistent with California Title 24 standards. The Title 24 year 2008 standard for indoor parking structure lighting is 0.30 Watts per foot squared; Title 24 year 2005 outdoor parking lighting standard is 0.15 Watts per foot squared; and the proposed Title 24 year 2013 standard for ventilation is 0.6 horse power per 1,000 feet squared[ii]. We have not identified any other sources to compare these factors to that are more appropriate. Note that the energy intensity of parking structures is one of the few land uses that the California Energy Commission (CEC) does not include in the California Commercial End-Use Survey (CEUS) analysis[iii].

None of the other land uses already accounted for in CalEEMod have energy use rates as low as the Energy Star rates for parking facilities, and this is to be expected. Based on the analysis above, parking facilities use between 0.05 and 0.40 kW per square foot per year, and this is much lower when compared to some of the land uses already represented in CalEEMod. The lower end of electric energy rates in CalEEMod includes manufacturing, unrefrigerated warehouses and racquet ball clubs. Depending upon the climate zone, CalEEMod estimates the kW per square foot in unrefrigerated warehouses to be between 3 and 10 kW, and for racquet clubs between 2 and 12 kW. While this doesn't confirm the appropriateness of the Energy Star energy use rates, it is reasonable that parking facilities would have lower energy use rates than other uses.

Proposed Energy Use Rates: Elevators

There are various elevator energy calculations available on the web[iv]. To our knowledge, none are independently verified by a public, private or government agency. This section presents three energy use rates for elevators. Energy use rates will depend on the manufacturer, the type and size of elevator, how many floors the elevator serves, the idle mode settings selected, how often the elevator is used and with how many people. For example, buildings with seven or fewer floors may use elevators powered by hydraulic motors, whereas buildings with eight or more floors will need more powerful and energy-intense "geared or gearless traction" elevators. These elevators are driven by direct current motor-generator sets (DC MG), silicon controlled rectified (SCR) DC motors, or variable voltage variable frequency (VVVF) drives coupled to alternate current (AC) motors. All of these configurations provide variable and high-speed operation and provide regeneration, but exhibit different operating efficiencies[v].

For our purposes, it is assumed that a parking structure elevator will serve ten or fewer floors. Elevators serving more than 10 floors are likely to be located in buildings with uses in addition to parking, and therefore CalEEMod will assume the energy use rates (including elevator use) associated with the other land uses in its calculations.

Table 3 presents the **first example**. Dover Elevators has calculated the average kWh required per day for a single elevator equipped with MG, SCR, and VVVF drives. Based on these daily estimates, Table 3 calculates the per hour and annual energy use for two to five floors and six to ten floors based on the type of elevator technology employed.

Table 3: Average Energy Consumption (kWh) for 2,500 Pound Capacity Elevators [(1)]						
Number of Floors	**kW Energy Use Based On How Electrical Current is Controlled (per hour)**					
	Variable Voltage Variable Frequency (VVVF)		Silicon Controlled Rectified *(SCR)*		DC MG Sets *(MG)*	
2 to 5	3.875		6.625		9	
6 to 10	4.875		6.75		9.5	
Number of Floors	**kW Energy Use Based On How Electrical Current is Controlled (per year)[(2)]**					
	16 hrs/day	24 hrs/day	16 hrs/day	24 hrs/day	16 hrs/day	24 hrs/day
2 to 5	22,630	33,945	38,690	58,035	52,560	78,840
6 to 10	28,470	42,705	39,420	59,130	55,480	83,220

Notes:
1. Based on calculations from Dover Elevators.
2. Combines calculations from Dover Elevators and Energy Star assumptions about hours of operations per day.

The **second example** is cited in the California Energy Commission (CEC) *2013 Nonresidential ACM Manual – Draft Version*, June 2011, (the "CEC Draft Manual")[vi]. These estimates are based on a TIAX report cited by the U.S. Energy Information Administration entitled, "Commercial and Residential Spector Miscellaneous Electricity Consumption: Y2005 and Projections to 2030" (the "TIAX Report") and includes buildings with at least 50 percent of space dedicated to non-residential uses, including agricultural, industrial, schools, and institutional uses[vii]. **Table 4** below presents unit energy consumption data from a sample of approximately 5,200 buildings for 2,500 pound capacity elevators, based on time spent in different elevator modes – active, ready, standby, and off:

Table 4: Average Energy Consumption (kWh) for 2500 Pound Capacity Elevators (1)				
Elevator Mode	**Percent of Time in Each Mode**	**Annual Hours in Each Mode**	**kWh Use in Each Mode**	**Annual kWh**
Active	3%	300	10	300
Ready	84%	7,365	0.5	3683
Standby	13%	1,095	0.25	274
Off	0%	0	0	0
Total	100%	8760 (2)	11	6,956 (3)

Notes:

1. TIAX LLC. *Commercial and Residential Spector Miscellaneous Electricity Consumption: Y2005 and Projections to 2030*. September 22, 2006.
2. Assumes operation 365 days per year for 24 hours per day.
3. This energy use represents rates from 2003 projected out to 2005. Year 2005 shows only a slight decrease from the year 2003 baseline.

The differences in energy use estimates in Table 3 and Table 4 is astonishing. The TIAX Report estimates the energy use from the average 2,500 pound capacity elevator to be approximately 20 percent of the kWhs needed for a 24-hour day of the least-energy intensive elevator in the Dover estimates.

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The **third example** is based on calculations provided by Kone Elevators documenting the energy savings between a hydraulic elevator and Kone's elevators with the most energy efficient features selected.[viii] These features include energy-saving LED lighting, standby modes for lights, signalization, ceiling fans, and destination control systems, a lightweight hoisting system, and energy regenerating technology. According to Kone, the bulk of energy use in hydraulic elevators comes from the hoisting system. **Table 5** below is based on the information presented by Kone on annual energy consumption from hydraulic elevators and its "EcoSpace" option.

Table 5: Kone Average Energy Consumption (kWh) for 3500 Pound Capacity Elevator (1)			
Energy Use	**Hydraulic Elevator (kWh/year)**	**Kone EcoSpace Elevator (kWh/year)**	**Percent Reduction**
Lighting	2,015	153	- 92%
Electrification	1,139	1,360	+19%
Hoisting	6,024	895	-85%
Total	9,178	2,408	-74%

Notes:

1. Based on information provided by Kone, Inc.

These estimates are based on a 3,500 pound capacity serving four floors with 200,000 starts per year, or 34 starts an hour, assuming 16 hours of operation per day.

Evaluation of Data

It is a challenge to compare the three available examples. The Dover (*first example*) data are detailed and offer specifics about energy use based on the types of elevator systems, but no information on the usage, such as hours per day of operation, speed, or starts per day. This source also presents energy consumption much higher than the other two sources. The Dover information was collected from a website maintained by Washington State University and the Western Area Power Administration and is not dated. It is not clear if these data are current. The Kone (*third example*) estimates are also based on very specific elevator specifications that will not necessarily transfer to our application, which requires a much more general approach. It is not anticipated that CalEEMod users will have detailed information about the size, capacity, usage rates, and type of elevators (hydraulic, geared or gearless traction, etc.) or other specifications, such as type of lighting or ceiling fans selected.

The CEC Draft Manual reports that that elevators are custom designed for each building and "little information is known on how to model elevators." Our research also resulted in few sources that were either specific to the manufacturer or very general.

TIAX (*second example*) is a reliable and reputable company who has conducted a robust study (5,200 buildings) of a variety of elevator types that would be more reflective of the real world and provides a simpler and direct method of determining energy use from an average-used elevator. The question still remains as to whether there is a standard in determining the number of elevators for a size of a parking lot. However, aside from the Americans with Disabilities Act requiring "one passenger elevator serving each level in all multi-story buildings," a building code does not seem to exist requiring how many per size or square footage. It should be noted that the Americans with Disabilities Act does allow parking structures that provide the correct number of accessible spaces on the ground floor to not install an elevator[ix]. As elevators would increase building costs and consume valuable square feet, it seems reasonable to conclude that parking structures are constructed with as few elevators as required by local building codes.

The TIAX Report does include energy use rate projections for a selected future year (2015, 2020, etc.) based on project build out year[x] but, at this time, such programming would be more complex and would require more information from the User. Thus, it is concluded for the default to use a fixed value in time.

Ultimately, decisions regarding the number of elevators is left to the developer who may choose based on a number of reasons. However, there are other sources, including this "rule of thumb" based on all modern American construction (not just commercial buildings):

Table 6: Estimates for Number of Elevators Needed [1]			
No. of Floors	**Building Meters Squared (gross)**	**Building Square Feet (gross)**	**Recommended No. of Elevators**
Up to 3	5,000	53,820	1
4 or more	6,000	64,583	2
4 of more	10,000	107,639	3

Notes:

1. Bhatia, A. *Building Elevator Systems*, CED Engineering.com. Course No: A06-001. Note that if elevators are distributed throughout the building, instead of at a centralized bank of elevators, to account for inefficiencies and imbalances in demand, increase the number of elevators by 60 percent.

Using TIAX study conclusion that one 2500 pound elevator consumes 7,000 kWh per year (**Table 4**) and the number of elevators for a particular sized parking lot (**Table 6**), data can be extrapolated to determine the energy factor to apply (**Table 7**).

Table 7: Annual kWh per Square Foot			
Gross Sq Ft	Elevators	Annual kWh	Annual kWh/square foot
54,000	1	7000	0.13
65,000	2	14000	0.22
108,000	3	21000	0.19
162,000	4	28000	0.17
216,000	5	35000	0.16
270,000	6	42000	0.16
324,000	7	49000	0.15
378,000	8	56000	0.15
432,000	9	63000	0.15
486,000	10	70000	0.14
540,000	11	77000	0.14
594,000	12	84000	0.14
648,000	13	91000	0.14
702,000	14	98000	0.14
756,000	15	105000	0.14
810,000	16	112000	0.14
864,000	17	119000	0.14
918,000	18	126000	0.14
972,000	19	133000	0.14
1,026,000	20	140000	0.14
1,080,000	21	147000	0.14
1,134,000	22	154000	0.14
1,188,000	23	161000	0.14

Conclusion

For the purposes of estimating energy use rates in parking lots and structures in California, CalEEMod should base energy use rate assumptions on the Energy Star estimates for lighting and ventilation. That would require CalEEMod to establish the following new sub-land uses (*with energy impact calculated*) under Parking:

1. Parking lot (*lighting energy use only*)
2. Unenclosed parking structure (*lighting energy use only*)
3. Enclosed parking structure (*lighting and ventilation energy use*)
4. Unenclosed parking structure with elevator (*lighting and elevator energy use*)
5. Enclosed parking structure with elevator (*lighting, ventilation, and elevator energy use*)

The default energy factor (annual kWh/square foot) recommended and used in CalEEMod is 0.19 annual kWh/sq ft which is based on the real data in Tables 4 and 6 and not the highest or lowest factor. CalEEMod will provide the ability for the User to override the default factor if the number of elevators is known (per total square feet) and is different than the default. For example, if a parking lot structure is known to be 200,000 sq ft with 6 elevators, then using the 7,000 annual kWh/elevator x 6 elevators is 42,000 annual kWh/200,000 sq ft equals a new factor of 0.21 annual kWh/sq ft that would be used to replace the CalEEMod default factor of 0.19 annual kWh/sq ft. In addition, if new data is known about kWh usage from a particular elevator (e.g., green elevator technology), the same methodology could be applied replacing the 7,000 annual kWh/elevator with a new known value.

Endnotes

[i] www.energystar.gov/ *Energy Star Performance Ratings Technical Methodology for Parking*. http://www.energystar.gov/ia/business/evaluate_performance/parking_tech_desc.pdf.

[ii] Parking and Title 24 standards: We have not adjusted the outdoor parking lighting factors in the Energy Star to meet 2008 or proposed 2013 Title 24 standards, which are lower than 2005 requirements, because additional lighting is often allowed in outdoor zones that are considered in need of additional safety lighting.

[iii] California Energy Commission. http://www.energy.ca.gov/ceus/

[iv] For example, see http://www.thyssenkruppelevator.com/energy%20calculator/energy.aspx and http://www.kone.com/media/en_US/green/index.html

[v] Washington State University and Western Area Power Administration. Energyexperts.org. http://energyexperts.org/EnergySolutionsDatabase/ResourceDetail.aspx?id=1709

[vi] CEC 2013 Nonresidential ACM Manual – Draft Version (CEC Alternative Calculation Method – June 2011). http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/2011-06-21_workshop/review/2013_NACM_Approval_Manual_Draft.pdf. The CEC website reports the final document will be released in January 2013.

[vii] TIAX LLC. *Commercial and Residential Spector Miscellaneous Electricity Consumption: Y2005 and Projections to 2030*. September 22, 2006. http://wpui.wisc.edu/news/EIA%20Posts/TIAX_EIA_MiscElecReport.pdf

[viii] Kone. *Kone Eco-efficient Solutions* (Brochure); *Elevator Energy Calculation Report*, 10/11/2011. Provided by Kone, Inc.

[ix] Email communication with the US Access Board (tel: 800-872-2253 email: ta@access-board.gov). The US Access Board referred us to local building codes to determine elevator requirements.

[x] Table 4 above presents the 2003 energy use average projected to 2005. The TIAX Report projects elevator energy use rates out in 5 year increments to 2030, however, the estimated decrease in energy use is slight between year 2005 and 2030 and unlikely to affect model results.

7 Studies on Amount of Parking Lot Area Painted

Three Studies were Conducted in 2012 on the Amount of Parking Lot Area Painted (for parking stalls, markings, etc)

Since the release of CalEEMod v2011.1.1, the percentage of space in parking lots that is painted has been questioned, so it was decided to re-evaluate the default currently used. A literature search was performed, but no studies were identified that provided information on the amount of coatings used for parking lots. As a result, contractors were contacted to assist in this research effort. It was determined that most contractors contacted use large volume containers of coatings and do not keep record of the specific amount used on individual parking lot jobs. Consequently, three of the California air district provided data on their own lots and the size of area painted to generate the following data. The compilation relies on the assumption that only one coat of paint was used to make the markings (e.g., stall lines, handicap symbols, no-parking curbs, traffic direction arrows, etc.). The results of the three studies showed a range in percentage of coatings applied. Because the sample size is so small, it was decided to set the default at the highest percentage of the 3 studies (6 percent of total square footage area). Using the highest percentage would also generate a more conservative impact evaluation of VOC emissions from coatings on parking lots. As additional information is obtained the default will be reevaluated and modified as necessary.

SMAQMD Parking Garage Painted Area Calculation (May 15, 2012)

19,000	Gross square footage of parking garage
1,000	Subtract office, storage cage, etc.
18,000	Net parking garage square footage
17	2 deep parking stalls
3456	square inches for a 2 deep parking stall paint
407.7	**square feet for 17 2 deep parking stalls paint**
12	3 deep parking stalls
5376	square inches for a 3 deep parking stall paint
447.7	**square feet for 12 3 deep parking stalls paint**
4	disabled parking stalls
2160	square inches for 1 handicapped parking stall paint
60.0	**square feet for 4 handicapped parking stalls paint**
36.0	**square feet of paint for handicapped square parking signs (4 of them)** (3 feet x 3 feet squares)
14.0	**square feet of no parking signs next to handicapped stalls (4 of them)** (3.5 feet x 1 feet rectangles)
77.0	**square feet of extra space/diagonals handicapped area next to and above parking stall** (5 8 feet diagonals, 4 11 feet diagonals, 5 6 feet diagonals, 13 9 feet diagonals)
1042.4	**square feet for paint in SMAQMD parking garage**
5.8%	**percent of total square footage of parking garage**

4	inches - width of stall painted line
192	inches - length of side stall line
96	inches - length of top stall line
4	inches - width of stall painted line
216	inches - length of side stall line handicapped
108	inches - length of top stall line handicapped

Actual Surface Area Painted & Emissions - SCAQMD Parking Lot (June 2012)

Line Type	Width (ft)	Length (ft)	Quantity	Total Painted Surface Area (sq ft)
Parking Stall Lines	0.33	18	224	1343.87
"Compact" Denotation	1.00	5	7	35.00
Arrows	4.00	3.5	6	84.00
"Slow 5 MPH" Denotation	5.00	6	2	60.00
Handicap Lines	0.33	18	8	48.00
Handicap Symbol	3.00	3	4	36.00
No Parking Red Curbs	0.50	32	4	64.00
No Parking Red Curbs	0.50	13	2	13.00
No Parking Red Curbs	1.00	20	1	20.00
No Parking Red Curbs	0.50	11	2	11.00
"Stop" Denotation	6.00	8	1	48.00

A_{actual} =	1763	Total Actual Painted Surface Area (sq ft)
	37,869	SCAQMD Repaved Parking Lot Area (sq ft)
	4.7%	**% Painted Using Single Coat**

NOTE: the SCAQMD parking stalls were separated by single lines (112), however, most commercial/recreational parking lots use double lines (224).

Actual Surface Area Painted & Emissions - SLO County APCD Parking Lot (June 2012)

Line Type	Width (ft)	Length (ft)	Quantity	Total Painted Surface Area (sq ft)	Width (inches)
Parking Place	0.33	18	29	174.00	4
Handicap Lines	0.33	9	5	15.00	4
Handicap Symbol	3.50	3.5	1	12.25	-
Bike Locker Protection	0.33	4	7	9.33	4
Red Curbs - Horizontal Paint	0.33	232	1	77.33	4
Red Curbs - Vertical Paint	0.50	232	1	116.00	6

A_{actual} =	404	Total Actual Painted Surface Area (sq ft)
	14,900	APCD Parking Lot Size (sq ft)
	2.7%	**% Painted Using Single Coat**

8 Default Water Use for Industrial Land Uses

Default Water Use Determination for Industrial Land Uses *(for version 2013.2)*

Since the release of CalEEMod v2011.1.1, the default water usage from industrial land uses has been questioned, so it was decided to re-evaluate the default currently used. The following are the assumptions used to determine the operation period of a typical industrial facility and the published water usage values (see web link). Specifically for industrial land use categories, the default water use rate is 925 gallons/workday/thousand square feet. This value was computed by dividing the annual water use in California industry (Table ES-6 in Gleick et al. 2002) by the industrial work area in California (Dun & Bradstreet, Business Population Report aggregated by Standard Industrial Classification (SIC) and Census Block, May 2002) where 225 was the annual number of workdays in a year.

365	days/year
7	days/week
52.14	weeks/year
5	Workdays/week
260.71	Potential Workdays/year
36	Average Holidays + Maintenance Shutdowns/year
225	Probable Days/year of Industrial Operations
AF	Acre-foot
SF	Square-foot

225	Industrial Work Days - *see CalEEMod User Manual Appendix A*
665	TAF; *Best Estimate of Water Use/year by California Industry - As identifed in Table ES-6 of Gleick et al. 2003* : www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
2,955.6	AF/Work Day ; *Best Estimate of Water Used by CA Industry/Industrial Work Day*
325,851.4	Gal/AF (*conversion)*
963,071,916	Gal Used by CA Industry/Industrial Work Day
1,041,386	TSF of Industrial Work Area in CA - *As identified by: Dun & Bradstreet, Business Population Report aggregated by Standard Industrial Classification (SIC) and Census Block, May 2002, the Industrial component reference identfied in the CalEEMod User Manual Appendix E on Consumer Products.*

925	**Gals/WorkDay/TSF**

9 Default Solid Waste Generation from Industrial Land Uses

Default Solid Waste Generation for Industrial Land Uses *(for version 2013.2)*

Since the release of CalEEMod v2011.1.1, the default solid waste generation from industrial land uses has been questioned, so it was decided to re-evaluate the default currently used. There is limited information available linking employment and solid waste generation for the various individual industrial land uses types as analyzed in CalEEMod. However, the Southern California Association of Governments (SCAG) that represents the six-county region of Los Angeles, Orange, Ventura, Riverside, San Bernardino and Imperial counties conducted a study in 2001 called the 'Employment Density Study' (http://www.scag.ca.gov/forecast/downloads/employ_den.pdf). Given the known challenge in locating statewide data and the fact that SCAG data represents close to half the state's population, the information is quasi-applicable to the state. In the study, SCAG identifies the following region-wide median employment densities for these specific industrial land use types:

Light manufacturing = 924 square foot (sq ft)/employee
Warehouse = 1,225 sq ft/employee

Using the 1999 CalRecycle Waste Characterization generation rate of 1.15 tons/employee/year, it has been determined to modify the current default of solid waste generation for industrial land use types using the following rates in CalEEMod:

Warehouses (all types) = 0.94 tons/1000 sq ft/year
All other industrial = 1.24 tons/1000 sq ft/year

Employee based rate for all industrial uses = 1.15 tons/employee/year

These rates seem more in line with other land use generation rates and also have the advantage of using employment densities that correspond more closely with trip generation rates.

10 Default N Load Factor for Wastewater Calculations

Default N Load Factor for Wastewater Calculations *(for version 2013.2)*

Since the release of CalEEMod v2011.1.1, the Sanitation Districts of Sacramento and Los Angeles have raised a concern that the default N load factor of 40mg/L from USEPA's database (2008) is too high. The N load is the mass of nitrogen dischared per volume of wastewater effluent. The factor is used in calculating nitrous oxide emissions produced when treated wastewater is discharged in aquatic environments such as rivers and estuaries. A high N load factor will overestimate the GHG emission throughout much of the State. US EPA has provided an online database (http://cfpub.epa.gov/dmr/ez_search.cfm) for plant-specific effluent results for various pollutants including nitrogen. Performing a query just for California, calculations show that the statewide average would be **26 mg/l** instead of 40 mg/l (current default). CalEEMod does not, at this time, allow the user to enter plant-specific numbers, so the default offers a more representative number for the state.

The following equation was used to determine statewide average:

$$Flow-weighted\ effluent\ Nitrogen\ in\ California\ (mg/L) = 203{,}953{,}373\ (N-lbs)/year * (2586502000\ Gals/day)^\wedge(-1) * (1 year/(365.25\ days)) * (453592.37 mg/1 lb) * (1 Gal/3.785 l) = \mathbf{25.87\ mg/l}$$

The following data was retrieved from the USEPA database (2013) for the equation:

Source: http://cfpub.epa.gov/dmr/ez_search.cfm

Statewide Sum:	203,953,373 lb/yr	2,586,502,000	gal/day	

Calif POTWs	Total Pounds (lbs/yr)	Average Flow (MGD)	
CA0107417*	1,020,535	17.4	*Corrected to reflect actual
CA0107611*	755,263	15.4	plant effluent as per discussion
CA0053813	47,848,683	273	with plant facility staff
CA0109991	46,073,447	267	
CA0107409	15,195,624	267	
CA0110604	12,660,447	152	
CA0077682	12,360,199	146	
CA0037664	9,556,191	148	
CA0037702	7,402,404	66.25	
CA0037869	5,197,299	61.4	
CA0038008	5,197,299	61.4	
CA0037613	4,822,150	57.3	
CA0037648	3,237,605	39.5	
CA0107395	2,620,463	24.6	
CA0054097	2,102,347	21.6	
CA0037681	1,886,655	32.4	
CA0053911	1,450,084	57.01	
CA0038318	1,284,429	1.18	
CA0107433	1,113,164	12.4	
CA0037737	962,571	6.88	
CA0048551	949,029	8.038	

CA0037541	913,876	12.2
CA0048194	904,330	8.46
CA0038130	860,572	9.29
CA0038547	778,946	8.77
CA0038628	762,472	9.31
CA0056227	727,201	27.7
CA8000304	709,805	34.8
CA0105350	683,282	29.4
CA8000409	608,790	26.7
CA0038024	562,781	4.606
CA0054011	553,291	19.6
CA0104523	525,445	3.69
CA0079189	504,795	8.46
CA0038539	484,861	8.94
CA0048216	479,712	5.09
CA0048160	456,062	4.054
CA0053856	417,294	13.09
CA0048143	367,016	15.2
CA0054119	362,093	12.2
CA0053953	352,926	14.2
CA0049224	349,790	3.89
CA0107981	349,112	10.3
CA0079103	344,510	10.6
CA0079260	333,956	3.069
CA0104973	316,751	4.015
CA0056294	285,797	9.77
CA7000009	283,784	2.73
CA0037788	262,829	3.41
CA0079219	261,626	8.013
CA0037796	255,924	3.082
CA0108031	254,610	1.21
CA0037842	244,169	100
CA0055221	241,546	8.83
CA0054216	202,111	14.5
CA0104426	196,783	3.54
CA0053651	194,981	5.63
CA0053716	190,189	8.047
CA0038091	182,140	2.52
CA0079138	168,719	26.6
CA0105295	165,877	5.89
CA8000188	162,763	6.23
CA0037532	160,569	1.53
CA0055531	154,954	6.71
CA0104400	145,679	1.24
CA0053619	142,296	4.83
CA0022764	115,563	4.27
CA0054313	110,962	4.97

CA0084573	100,294	6.54
CA0053597	97,150	3.18
CA0082589	94,621	3.37
CA0047996	92,294	0.71
CA8000316	86,643	5.74
CA0079235	84,324	2.97
CA0082660	80,744	3.23
CA0105015	76,603	0.72
CA8000027	74,164	8.066
CA0079651	73,795	1.15
CA0037575	71,906	8.35
CA0056014	67,209	3.36
CA0079154	63,785	9.06
CA8000383	59,920	2.81
CA0079731	59,579	7.42
CA0037621	58,350	11.05
CA0079197	57,484	3.92
CA0079049	52,185	4.65
CA8000326	47,842	3.42
CA0038067	40,548	1.54
CA0079111	36,353	49.2
CA0102695	35,497	0.96
CA0022888	35,088	1.93
CA0077704	34,804	1.22
CA0085235	34,282	1.96
CA0038598	30,598	1.68
CA0037753	30,300	0.63
CA0078671	29,039	1.601
CA0102822	28,556	8.65
CA0037826	27,040	0.74
CA0037711	26,202	2.76
CA0053961	25,767	1.99
CA0109045	24,679	3.54
CA0079022	23,671	0.89
CA0105619	19,761	3.77
CA0023345	19,753	0.91
CA0079511	18,563	0.97
CA0037834	18,079	20.1
CA0079243	16,843	3.025
CA0048127	15,525	2.83
CA0037810	13,909	4.104
CA0022756	13,284	1.67
CA0037851	12,955	2.25
CA0081434	12,534	1.209
CA0079316	12,134	2.201
CA0023060	12,025	0.74
CA0081558	11,221	5.702

CA0078981	10,228	0.54
CA0085260	9,257	0.34
CA0105376	8,569	2.82
CA0037800	7,266	2.18
CA8000395	6,652	0.58
CA0024449	6,336	9.048
CA0054372	6,277	0.38
CA8000100	5,890	0.81
CA0078891	4,768	1.48
CA0038776	4,591	3.017
CA0084727	4,292	0.107
CA0077712	4,075	1.56
CA0107492	3,943	0.84
CA0022730	3,912	0.42
CA0038768	2,485	3.019
CA0084239	2,480	0.063
CA0078948	2,146	9.86
CA0025135	1,521	1.12
CA0078662	1,493	4.71
CA0037770	1,309	1.72
CA0084271	1,252	0.54
CA0048151	1,059	1.074
CA0079898	787	2.25
CA0079081	749	6.54
CA0047364	743	1.33
CA0079502	706	9.209
CA0078956	613	0.74
CA0078590	481	1.65
CA0083771	480	0.19
CA0004995	418	0.71
CA0047899	248	0.95
CA0084476	216	2.15
CA0078034	194	0.73
CA0107999	191	1.77
CA0077828	184	0.38
CA0085201	117	0.095
CA0077836	115	1.57
CA0024490	0.033	4.40E-07
CA0005241	0	0
CA0022977	0	0
CA0023355	0	0
CA0048828	0	0.71
CA0049675	0	0
CA0059501	0	0
CA0064556	0	0
CA0077691	0	8.45
CA0077950	0	5.078

CA0081485	0	0
CA0108944	0	0
CA0110116	0	0.34
	203,953,373	**2586.50**

11 Additional References

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