



## Greenhouse Gas and Climate Change Impact Analysis



Sacramento Metropolitan Air Quality  
Management District Workshop  
April 20, 2009  
9 AM- 4 PM



## Unit 4 Project GHG Analysis

Shannon Hatcher  
ICF Jones & Stokes

Presented at the SMAQMD Climate Change Workshop  
April 20, 2009

## Project 1: Cosumnes River Interceptor Project

Construction project: replacement of an existing interceptor (sewer line) with a new interceptor in Folsom

- Project details:
  - Construction occurs 08/02/2010 through 09/03/2010
    - Site Grading 08/02/2010 through 09/03/2010
      - 1 grader: 150 hp @ 4 hours/day
    - Trenching 08/16/2010 through 08/27/2010
      - 1 backhoe: 100 hp @ 6 hours/day
    - Backfill 08/30/2010 through 09/03/2010
      - 1 backhoe: 100 hp @ 6 hours/day
      - 1 roller: 85 hp @ 4 hours/day
  - No net soil imported/exported

## Cosumnes River Interceptor Project: Emission sources

Cosumnes River Interceptor Project - replacement of an existing interceptor with a new interceptor

- What are the sources of emissions?
  - Direct emissions
    - Construction equipment
    - Employee commute
    - Vender/delivery trips
  - Indirect emissions
    - Usually none

## Cosumnes River Interceptor Project: Tools to Calculate Emissions

- What tools would be used to calculate emissions?
  - URBEMIS2007
    - Direct emissions
      - Construction equipment
      - Employee commute
      - Vendor/delivery trips
  - The Climate Registry General Reporting Protocol
    - CH4 and N2O emissions calculations from diesel fuel consumption

## Cosumnes River Interceptor Project: Construction URBEMIS Inputs

Input project-specific data

This screenshot shows the 'Equipment Type' selection screen in URBEMIS. It includes a dropdown menu for 'Equipment Type' and a table for 'Emissions' with columns for 'Emission Type', 'Emission Factor', and 'Emission Rate'.

This screenshot displays a table of equipment types and their associated emissions. The table has columns for 'Equipment Type', 'Emission', and 'Emission Rate'.

Equipment Type	Emission	Emission Rate
1.0	1.0	1.0
2.0	2.0	2.0
3.0	3.0	3.0
4.0	4.0	4.0
5.0	5.0	5.0
6.0	6.0	6.0
7.0	7.0	7.0
8.0	8.0	8.0
9.0	9.0	9.0
10.0	10.0	10.0
11.0	11.0	11.0
12.0	12.0	12.0
13.0	13.0	13.0
14.0	14.0	14.0
15.0	15.0	15.0
16.0	16.0	16.0
17.0	17.0	17.0
18.0	18.0	18.0
19.0	19.0	19.0
20.0	20.0	20.0
21.0	21.0	21.0
22.0	22.0	22.0
23.0	23.0	23.0
24.0	24.0	24.0
25.0	25.0	25.0
26.0	26.0	26.0
27.0	27.0	27.0
28.0	28.0	28.0
29.0	29.0	29.0
30.0	30.0	30.0
31.0	31.0	31.0
32.0	32.0	32.0
33.0	33.0	33.0
34.0	34.0	34.0
35.0	35.0	35.0
36.0	36.0	36.0
37.0	37.0	37.0
38.0	38.0	38.0
39.0	39.0	39.0
40.0	40.0	40.0
41.0	41.0	41.0
42.0	42.0	42.0
43.0	43.0	43.0
44.0	44.0	44.0
45.0	45.0	45.0
46.0	46.0	46.0
47.0	47.0	47.0
48.0	48.0	48.0
49.0	49.0	49.0
50.0	50.0	50.0

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8.0	8.0	8.0
9.0	9.0	9.0
10.0	10.0	10.0
11.0	11.0	11.0
12.0	12.0	12.0
13.0	13.0	13.0
14.0	14.0	14.0
15.0	15.0	15.0
16.0	16.0	16.0
17.0	17.0	17.0
18.0	18.0	18.0
19.0	19.0	19.0
20.0	20.0	20.0
21.0	21.0	21.0
22.0	22.0	22.0
23.0	23.0	23.0
24.0	24.0	24.0
25.0	25.0	25.0
26.0	26.0	26.0
27.0	27.0	27.0
28.0	28.0	28.0
29.0	29.0	29.0
30.0	30.0	30.0
31.0	31.0	31.0
32.0	32.0	32.0
33.0	33.0	33.0
34.0	34.0	34.0
35.0	35.0	35.0
36.0	36.0	36.0
37.0	37.0	37.0
38.0	38.0	38.0
39.0	39.0	39.0
40.0	40.0	40.0
41.0	41.0	41.0
42.0	42.0	42.0
43.0	43.0	43.0
44.0	44.0	44.0
45.0	45.0	45.0
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7.0	7.0	7.0
8.0	8.0	8.0
9.0	9.0	9.0
10.0	10.0	10.0
11.0	11.0	11.0
12.0	12.0	12.0
13.0	13.0	13.0
14.0	14.0	14.0
15.0	15.0	15.0
16.0	16.0	16.0
17.0	17.0	17.0
18.0	18.0	18.0
19.0	19.0	19.0
20.0	20.0	20.0
21.0	21.0	21.0
22.0	22.0	22.0
23.0	23.0	23.0
24.0	24.0	24.0
25.0	25.0	25.0
26.0	26.0	26.0
27.0	27.0	27.0
28.0	28.0	28.0
29.0	29.0	29.0
30.0	30.0	30.0
31.0	31.0	31.0
32.0	32.0	32.0
33.0	33.0	33.0
34.0	34.0	34.0
35.0	35.0	35.0
36.0	36.0	36.0
37.0	37.0	37.0
38.0	38.0	38.0
39.0	39.0	39.0
40.0	40.0	40.0
41.0	41.0	41.0
42.0	42.0	42.0
43.0	43.0	43.0
44.0	44.0	44.0
45.0	45.0	45.0
46.0	46.0	46.0
47.0	47.0	47.0
48.0	48.0	48.0
49.0	49.0	49.0
50.0	50.0	50.0



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## Cosumnes River Interceptor Project: Construction CH<sub>4</sub>, N<sub>2</sub>O, and CO<sub>2</sub>e Emissions

Climate Registry data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for construction emissions

Phase	Days of construction	Construction Emissions					
		CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
Site grading	10	307.63	13.75	0.02	0.01	310.44	1.4
Trenching	10	255.31	11.41	0.01	0.01	257.64	1.2
Backfilling	5	416.81	18.63	0.02	0.01	420.62	1.0
<b>Total</b>		<b>979.75</b>	<b>43.78</b>	<b>0.06</b>	<b>0.03</b>	<b>988.71</b>	<b>3.5</b>

Units	Conversion factor	Source
kg CO <sub>2</sub> /gallon fuel	10.15	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.1
g CH <sub>4</sub> /gallon fuel	0.58	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
g N <sub>2</sub> O/gallon fuel	0.26	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
kilograms per pound	0.4535924	
grams per pound	453.5924	
pounds per metric tonnes	2204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from URBEMIS

Calculated from Climate Registry General Reporting Protocol data

Total construction CO<sub>2</sub>e emissions

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## Project 2: Happy Acres

Happy Acres – large mixed use development in Sacramento County

- Project details

Land use	Units	Number of units	Trip generation rate (number trips/unit)	Acres	Electricity use (kWh/unit/yr)	Natural gas use (Cubic feet/unit/yr)
Single family residential	Residence	1,500	9.08	400	10,000	50,000
High rise apartments	Residence	1,500	6.04	20	8,500	40,000
Elementary school	Student	600	1.29	1.96	2,500	98
Department store	Square feet	50,000	54.15	2.75	750	100
Strip mall	Square feet	100,000	42.94	4.59	11,000	90
Office park	Square feet	15,000	11.00	0.55	11,000	85

- 1,500 total acre-feet water/year
- Construction phased equally over 5 years: Start 2010, end 2014. Fully operational 2015

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## Happy Acres: Project Details

- Project details:
  - Construction occurs 01/01/2010 through 12/31/2014
    - Equal number of units built each year
    - [Each subsequent year has previously built land uses operational](#)

Land use	2010		2011		2012		2013		2014		2015	
	Units built	Units operate	Units built	Units operate	Units built	Units operate	Units built	Units operate	Units built	Units operate	Units built	Units operate
High rise apartments	300	0	300	300	300	600	300	900	300	1,200	0	1,500
Elementary school	0	0	0	0	0	0	0	0	0	0	0	0
Department store	10,000	0	10,000	10,000	10,000	20,000	10,000	30,000	10,000	40,000	0	50,000
Strip mall	20,000	0	20,000	20,000	20,000	40,000	20,000	60,000	20,000	80,000	0	100,000
Office park	3,000	0	3,000	3,000	3,000	6,000	3,000	9,000	3,000	12,000	0	15,000

## Happy Acres: Project Details

- Project details:
  - Construction phasing occurs each year (2010 to 2014):
    - Mass grading:
      - 01/04/201X through 02/12/201X
    - Asphalt paving
      - 02/15/201X through 02/26/201X
    - Building construction
      - 03/01/201X through 10/29/201X
    - Architectural coating
      - 11/01/201X through 12/31/201X

## Happy Acres: Emission Sources

- What are the sources of emissions?
  - Direct emissions
    - Construction
      - Construction equipment
      - Employee commute
      - Vender/delivery trips
    - Operations
      - On-road mobile source
      - Area source
  - Indirect emissions
    - Electricity
    - Natural gas
    - Water usage

## Happy Acres: Calculation Tools

- What tools would be used to calculate emissions?
  - URBEMIS2007
    - Direct emissions
      - Construction equipment
      - Employee commute
      - Vender/delivery trips
      - On-road mobile source
      - Area source
  - The Climate Registry General Reporting Protocol
    - CH<sub>4</sub> and N<sub>2</sub>O emissions calculations from fuel consumption
  - California Climate Action Registry Reporting Online Tool
    - CO<sub>2</sub> emissions calculations from electricity consumption
  - California Climate Action Registry General Reporting Protocol
    - CH<sub>4</sub>, and N<sub>2</sub>O emission factors from electricity consumption

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## Happy Acres: URBEMIS Construction Inputs

Based on user-defined construction phasing and scheduling...

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## Happy Acres: URBEMIS Construction Inputs

...URBEMIS will calculate default construction information that should be updated, if available

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## Happy Acres: URBEMIS Detailed Construction Output Files (2011)

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Utahris 2007 Version 9.2.4  
Default Report for Summer Construction Unmitigated Emissions (Pounds/Day)

File Name: C:\urbemis 2007 9.2.4 Files\ SQAQMD Example 2 - Mixed Use 2011 ur5024  
Project Name: SQAQMD Example 2 - Mixed Use 2011  
Project Location: California State-wide  
On Road Vehicle Emissions Based on: Version: Emissions V2.3 Nov 1 2006  
Off Road Vehicle Emissions Based on: OFFROAD2007

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CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Unmitigated)

Task	CO <sub>2</sub> emissions
Time Slice 14/2/2011-2/11/2011	8,834.75
Active Date: 2/11/2011	8,834.75
Mass Grading 01/04/2011-02/01/2011	0.00
Mass Grading Over	0.00
Mass Grading Off Road Diesel	2,734.34
Mass Grading On Road Diesel	3,898.26
Mass Grading Tractor Type	226.93
Time Slice 2/16/2011-10/26/2011	4,238.05
Active Date: 10/26/2011	4,238.05
Plowing Off-Gas	0.00
Plowing Off Road Diesel	1,272.41
Plowing On Road Diesel	2,897.90
Plowing Tractor Type	127.74
Time Slice 3/1/2011-10/26/2011	13,022.66
Active Date: 1/1/2011	13,022.66
Building 03/01/2011-10/26/2011	11,372.62
Building Off Road Diesel	2,258.28
Building Tractor Type	2,275.45
Building Tractor Type	6,837.88
Time Slice 11/1/2011-12/31/2011	642.33
Active Date: 11/1/2011	642.33
Architectural Coating	0.00
Coating Tractor Type	642.33

Phase Assumptions  
Phase: Mass Grading 14/2/2011 - 2/11/2011 - Mass Site Grading Emissions  
Total Area Disturbed: 65.58

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Maximum Daily Average Disturbed: 21.4  
Fugitive Dust Level of Detail: Default  
20 lbs per acre/day  
On Road Truck Travel (VMT): 344.83  
Off-Road Equipment:  
1 Excavators (140 hp) operating at a 0.57 load factor for 8 hours per day  
1 Graders (174 hp) operating at a 0.61 load factor for 8 hours per day  
1 Rubber Tired Dozers (57 hp) operating at a 0.59 load factor for 8 hours per day  
2 Scrapers (173 hp) operating at a 0.72 load factor for 8 hours per day  
3 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day  
1 Water Trucks (189 hp) operating at a 0.5 load factor for 8 hours per day  
Phase: Plowing 2/16/2011 - 10/26/2011 - Default Plowing Description  
Area to be Plowed: 21.4  
Off-Road Equipment:  
1 Pavers (100 hp) operating at a 0.62 load factor for 8 hours per day  
2 Paving Equipment (104 hp) operating at a 0.53 load factor for 6 hours per day  
2 Rollers (95 hp) operating at a 0.54 load factor for 6 hours per day  
Phase: Building Construction 3/1/2011 - 10/26/2011 - Default Building Construction Description  
Off-Road Equipment:  
1 Crows (399 hp) operating at a 0.43 load factor for 7 hours per day  
3 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day  
1 Generator Sets (49 hp) operating at a 0.74 load factor for 8 hours per day  
3 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day  
1 Walkers (45 hp) operating at a 0.45 load factor for 8 hours per day  
Phase: Architectural Coating 11/1/2011 - 12/31/2011 - Default Architectural Coating Description  
Rule: Residential Interior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Residential Exterior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Nonresidential Interior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Nonresidential Exterior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250

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## Happy Acres: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Construction Emissions

Climate Registry data used to calculate CH<sub>4</sub> and N<sub>2</sub>O

Phase	Days of construction	Construction Emissions					
		CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
Site grading	30	8,834.75	394.82	0.50	0.23	8,915.51	121.3
Asphalt	10	4,238.05	189.39	0.24	0.11	4,276.79	19.4
Building construction	175	11,372.62	508.23	0.65	0.29	11,476.58	911.0
Architectural coating	45	642.33	28.71				
<b>Total</b>		<b>25,087.75</b>	<b>1,092.44</b>	<b>1.40</b>	<b>0.63</b>	<b>24,668.87</b>	<b>1,051.7</b>

Units	Conversion factor	Source
kg CO <sub>2</sub> /gallon fuel	10.15	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.1
g CH <sub>4</sub> /gallon fuel	0.58	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
g N <sub>2</sub> O/gallon fuel	0.26	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
kilograms per short ton	907.1847	
grams per pound	453.5924	
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

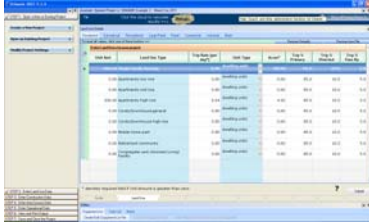
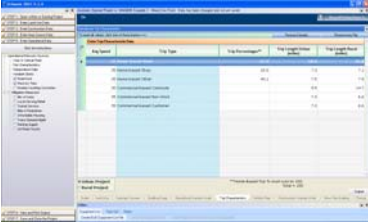
Calculated from URBEMIS

Calculated from CR General Reporting Protocol data

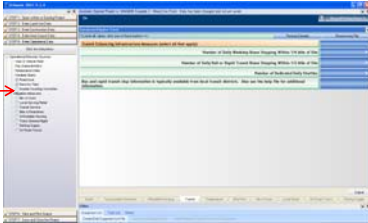
Total construction CO<sub>2</sub>e emissions

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**Happy Acres: URBEMIS Operational Inputs**

Operational mitigation measures. Do not use for projects in SMAQMD. Instead, use SMAQMD off-line mitigation measures for NO<sub>x</sub>.



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**Happy Acres: URBEMIS Detailed Operational Output Files**

Area source emissions

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Urbemis 2007 Version 9.2.4  
Combined Summer Emissions Reports (Pounds/Day)

File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2011.urb924  
Project Name: SMAQMD Example 2 - Mixed Use 2011  
Project Location: California State-wide  
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2008  
Off-Road Vehicle Emissions Based on: OFFROAD2007

Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated	
Source	CO <sub>2</sub>
Natural Gas	8,059.08
Hearth - No Summer Emissions	
Landscape	32.74
Consumer Products	
Architectural Coatings	
<b>TOTALS (6hr/day, unmitigated)</b>	<b>8,091.82</b>

Area Source Changes to Defaults

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## Happy Acres: URBEMIS Detailed Operational Output Files

Mobile source emissions

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Operational Unmitigated Detail Report:  
OPERATIONAL EMISSION ESTIMATES Summer Pounds Per Day, Unmitigated

Source	CO <sub>2</sub>
Single family housing	20,654.27
Apartments high rise	13,739.19
Free-standing discount superstore	2,626.98
Strip mall	3,550.42
Office park	226.82
<b>TOTALS (bistay, unmitigated)</b>	<b>40,797.66</b>

Operational Settings:  
Includes correction for passby trips  
Does not include double counting adjustment for internal trips  
Analysis Year: 2010 Temperature (°): 55 season: summer  
Emitac Version: Emitac2007 V2.3 Nov 1 2006

Summary of Land Uses

Land Use Type	Acreage	Trip Rate	Unit Type	No. Units	Total Trips	Total VMT
Single family housing	80.00	9.08	dwelling units	300.00	2,724.00	20,369.85
Apartments high rise	4.00	6.04	dwelling units	300.00	1,812.00	13,563.30
Free-standing discount superstore	54.15	1000 sq ft	10.00	541.50	2,604.15	
Strip mall	42.94	1000 sq ft	20.00	858.80	3,501.53	
Office park	11.00	1000 sq ft	3.00	33.00	224.66	
				5,969.30	40,283.49	

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## Happy Acres: URBEMIS Detailed Operational Output Files

Mobile source emissions

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Vehicle Fleet Mix

Vehicle Type	Percent	Type	Non-Catalyst	Catalyst	Diesel
Light Auto	48.9		1.2	98.4	0.4
Light Truck - 3750 lbs	10.9		2.8	91.7	5.5
Light Truck 3751-5750 lbs	21.7		0.9	98.6	0.5
Med Truck 5751-8500 lbs	9.5		1.1	98.9	0.0
Life-Heavy Truck 8501-10,000 lbs	1.7		0.0	76.5	23.5
Life-Heavy Truck 10,001-14,000 lbs	0.6		0.0	50.0	50.0
Med-Heavy Truck 14,001-33,000 lbs	1.0		0.0	20.0	80.0
Heavy-Heavy Truck 33,001-60,000 lbs	0.9		0.0	0.0	100.0
Other Bus	0.1		0.0	0.0	100.0
Urban Bus	0.1		0.0	0.0	100.0
Motorcycle	3.5		66.6	31.4	0.0
School Bus	0.1		0.0	0.0	100.0
Motor Home	1.0		0.0	90.0	10.0

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	10.8	7.3	7.5	9.5	7.4	7.4
Rural Trip Length (miles)	16.8	7.1	7.9	14.7	6.6	6.6
Trip speeds (mph)	35.0	35.0	35.0	35.0	35.0	35.0
% of Trips - Residential	32.9	19.0	49.1			

% of Trips - Commercial (by land use)

	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Free-standing discount superstore				2.0	1.0	97.0
Strip mall				2.0	1.0	97.0
Office park				36.0	18.0	46.0

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## Happy Acres: URBEMIS Summary Output Files (Total Emissions)

Summarizes both construction and operational (mobile and area source) emissions

Page: 1  
4/17/2009 4:44:56 PM

URBEMIS 2007 Version 9.2.4  
Summary Report for Summer Emissions (Pounds/Day)

File Name: C:\urbemis 2007 9.2.4 Files\\_SMAQMD Example 2 - Mixed Use 2011.urb924  
Project Name: SMAQMD Example 2 - Mixed Use 2011  
Project Location: California State-wide  
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006  
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES	
	CO2
2011 TOTALS (lbs/day unmitigated)	11,372.62

AREA SOURCE EMISSION ESTIMATES	
	CO2
TOTALS (lbs/day, unmitigated)	8,091.82

OPERATIONAL (VEHICLE) EMISSION ESTIMATES	
	CO2
TOTALS (lbs/day, unmitigated)	40,797.68

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES	
	CO2
TOTALS (lbs/day, unmitigated)	48,869.50

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## Happy Acres: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Mobile-Source Emissions

Climate Registry data used to calculate CH<sub>4</sub> and N<sub>2</sub>O from mobile sources

Land use	Number of units	Daily Trip generation rate	Acres	Mobile Source Emissions					
				URBEMIS Calculated VMT	CO <sub>2</sub> emissions (lbs./day)	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
SFR	1,500	9.08	400	20,389.85	20,854.27	6.09	2.27	21,484.51	3,557.0
high rise apartments	1,500	6.04	20	13,563.30	13,759.19	4.05	1.51	14,291.46	2,366.1
student elementary school	600								
		1.29	1.96	0.00	0.00	0.00	0.00	0.00	0.0
department store	50,000	54.15	2.75	2,604.15	2,626.98	0.78	0.29	2,733.02	452.5
strip mall	100,000	42.94	4.59	3,501.53	3,550.42	1.05	0.39	3,693.00	611.4
office park	15,000	11	0.55	224.66	226.82	0.07	0.02	235.97	39.1
		Total	429.85	40,283.49	40,797.68	12.03	4.48	42,437.95	7,026.1

Units	Conversion factor	Source
g CH <sub>4</sub> /mile traveled	0.1355	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.3
g N <sub>2</sub> O/mile traveled	0.0504	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.3
kilograms per pound	0.4535924	
grams per pound	453.5924	
pounds per metric tonnes	2204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from URBEMIS

Calculated from CR General Reporting Protocol data

Total mobile source CO<sub>2</sub>e emissions

Table 13.3 Default CH<sub>4</sub> and N<sub>2</sub>O Emission Factors for Highway Vehicles by Technology Type

Vehicle Type/Control Technology	N <sub>2</sub> O (g/mi)	CH <sub>4</sub> (g/mi)
<b>Gasoline Passenger Cars</b>		
EPA Tier 2	0.0036	0.0173
Low Emission Vehicles	0.0150	0.0105
EPA Tier 1	0.0429	0.0271
EPA Tier 0	0.0847	0.0704
Oxidation Catalyst	0.0504	0.1355
Non-Catalyst Control	0.0197	0.1698
Uncontrolled	0.0197	0.1790

This example assumes catalytic converters for passenger vehicles

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## Happy Acres: Electricity Emissions (CO<sub>2</sub>)

### CARROT Reporting tool for electricity generation

2007 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector

**Sacramento Municipal Utility District**  
6201 S St.  
Sacramento, CA, 95817  
website: www.smud.org

Reporting Year: 2007  
Direct Baseline Year:  
Indirect Baseline Year:  
Reporting Scope: CA and US  
Reporting Boundaries:  
Reporting Protocols: General Reporting Protocol Version 3.0 (April 2008)  
Power/Utility Reporting Protocol Version 1.0 (April 2005)

Legend:  
Blue = required  
Green = optional

Contact: Oksana Bartholomy  
Title: Project Manager  
Telephone: 916.222.4839  
Email: obarth@smud.org  
Industry Type: Power Generation  
Entity Name: 2211 Electric Power Generation, Transmission and Distribution  
Entity NAICS Code: 2211 Electric Power Generation, Transmission and Distribution  
Entity Description: The Sacramento Municipal Utility District is the nation's sixth largest publicly owned and operated electric utility in terms of customer served. SMUD generates, transmits, and distributes electric power within a 100 square mile service area in and around the City of Sacramento, California. SMUD owns and operates 1371 MW of electrical generation resources located in the California Counties of Sacramento, El Dorado and Sutter. SMUD's electrical generation is comprised of 998 MW of natural gas-fired fossil generation, cogeneration, and peaking resources, 488 MW of hydroelectric, 100 MW of wind, and 6.8 MW of solar photovoltaic generation. SMUD owns and operates a 76-mile natural gas transmission pipeline serving the cogeneration and fossil generation facilities. SMUD has equity shares in the Rose Natural Gas Production Field in New Mexico and in a Northern California transmission line known as the California Oregon Transmission Project, or the Transmission Association of Northern California.

Do you deliver power to an end-user/retail customer? (Enter yes or no) **yes**

EMISSIONS EFFICIENCY METRICS

Electricity Delivered:	724.22 lbs CO <sub>2</sub> /MWh delivered (includes CO <sub>2</sub> from owned and purchased generation)
Net Generation:	718.58 lbs CO <sub>2</sub> /MWh net owned generation (does not include hydroelectric, nuclear, solar, etc.)
Net Fossil Generation:	859.23 lbs CO <sub>2</sub> /MWh net owned fossil generation only

Note: Efficiency metrics are calculated using CO<sub>2</sub> emissions from stationary combustion for purposes of electricity generation. CO<sub>2</sub> emissions from biogenic sources are not included in the Electricity Delivered metric; however MWh from biogenic and all other generation sources are included. Geothermal generation CO<sub>2</sub> emissions and MWh are included in Net Generation metric but not Net Fossil Generation metric. Combustion sources related to any non-electricity generating natural gas operations are not included.

Comments:

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SMUD CO<sub>2</sub> emission rate

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## Happy Acres: Electricity Emissions (CH<sub>4</sub> and N<sub>2</sub>O)

### California Climate Action Registry General Reporting Protocol CH<sub>4</sub> and N<sub>2</sub>O emission rates

Emission Factors for Electricity Use

**Table C.2 Carbon Dioxide, Methane and Nitrous Oxide Electricity Emission Factors by eGRID Subregion**

eGRID Subregion Acronym	eGRID Subregion Name	CO <sub>2</sub> (lbs/MWh)	CH <sub>4</sub> (lbs/MWh)	N <sub>2</sub> O (lbs/MWh)
AKGD	ASCC Alaska Grid	1,232.36	0.0256	0.0065
AKMS	ASCC Miscellaneous	496.86	0.0208	0.0041
AZNM	WECC Southwest	1,311.05	0.0175	0.0179
CAMX	WECC California	724.12	0.0302	0.0081

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**Happy Acres: Electricity Emissions CH<sub>4</sub> & N<sub>2</sub>O**

CARROT data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for electricity emissions

Land use	Number of units	Acres	kWh/unit	Electricity Emissions			
				CO <sub>2</sub> emissions (tons/year)	CH <sub>4</sub> emissions (tons/year)	N <sub>2</sub> O emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
SFR	1,500	400	10,000	4,860.08	0.21	0.06	4,881.5
high rise apartments	1,500	20	8,500	4,131.07	0.17	0.05	4,149.3
student elementary school	600						
		1.96	2,500	486.01	0.02	0.01	488.1
department store	50,000	2.75	750	12,150.21	0.51	0.14	12,203.7
strip mall	100,000	4.59	11,000	356,406.06	15.07	4.04	357,975.4
office park	15,000	0.55	11,000	53,460.91	2.26	0.61	53,696.3
		429.85		431,494.34	18.24	4.89	433,394.3

Units	Conversion factor	Source
SMUD lbs. CO <sub>2</sub> /MWh	714.31	CARROT Reporting Tool
lbs. N <sub>2</sub> O/MWh	0.0081	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2
lbs. CH <sub>4</sub> /MWh	0.0302	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from CARROT data

Calculated from CCAR General Reporting Protocol data

Total electricity CO<sub>2</sub>e emissions

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**Happy Acres: Natural Gas Emissions (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O)**

The Climate Registry General Reporting Protocol CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emission rates

Table 12.1 U.S. Default Factors for Calculating CO<sub>2</sub> Emissions from Fossil Fuel Combustion

Fuel Type	Tier B Method			Tier C Method	
	Heat Content (MMBtu / Short ton)	Carbon Content (lbs. / Short ton)	Fraction Oxidized	CO <sub>2</sub> Emission Factor (lbs. CO <sub>2</sub> / MMBtu)	CO <sub>2</sub> Emission Factor (lbs. CO <sub>2</sub> / Short ton)
Coal and Coke					
Anthracite coal	25.00	25.25	1.00	103.82	2,596.83
Bituminous coal	24.55	25.48	1.00	93.85	2,320.84
Sub-bituminous coal	17.25	26.48	1.00	87.90	1,674.88
Lignite	14.41	26.32	1.00	85.41	1,322.32
Unsegregated (Residential/Commercial)	22.85	26.00	1.00	95.31	2,162.29
Unsegregated (Industrial/Utility)	25.27	25.56	1.00	93.72	2,452.12
Unsegregated (Other Industrial)	22.85	25.63	1.00	93.98	2,072.19
Unsegregated (Electric, MWs)	19.95	25.75	1.00	84.45	1,894.53
Coke	24.30	31.00	1.00	111.67	2,133.65
Natural Gas (by Heat Content)	Btu / Standard cubic foot	kg C / MMBtu		kg CO <sub>2</sub> / MMBtu	kg CO <sub>2</sub> / Standard cub. ft.
870 to 1,000 Btu / Std cubic foot	870 - 1,000	14.73	1.00	54.01	Varies
1,000 to 1,025 Btu / Std cubic foot	1,000 - 1,025	14.82	1.00	53.91	Varies
1,025 to 1,050 Btu / Std cubic foot	1,025 - 1,050	14.87	1.00	53.06	Varies
1,050 to 1,075 Btu / Std cubic foot	1,050 - 1,075	14.58	1.00	53.48	Varies
1,075 to 1,100 Btu / Std cubic foot	1,075 - 1,100	14.65	1.00	53.72	Varies
Greater than 1,100 Btu / Std cubic foot	> 1,110	14.92	1.00	54.71	Varies
Unsegregated (Weighted U.S. Average)	1,029	14.47	1.00	53.06	0.0546

Fuel Type / End-Use Sector	CH <sub>4</sub> (g/MMBtu)	N <sub>2</sub> O (g/MMBtu)
<b>Coal</b>		
Residential	316	1.6
Commercial	11	1.6
Industrial	11	1.6
<b>Electric Power</b>	1	1.6
<b>Petroleum Products</b>		
Residential	11	0.6
Commercial	11	0.6
Industrial	3	0.6
<b>Electric Power</b>	3	0.6
<b>Natural Gas</b>		
Residential	5	0.1
Commercial	1	0.1
Industrial	1	0.1
<b>Electric Power</b>	1	0.1

CR General Reporting Protocol CO<sub>2</sub> emission factor

CR General Reporting Protocol CH<sub>4</sub> and N<sub>2</sub>O emission factors

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## Happy Acres: Natural Gas CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e emissions

Climate Registry data used to calculate CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from natural gas

Land use	Number of units	Natural Gas Emissions					
		Natural gas use (Cubic feet/unit/yr)	Natural gas use (Cubic feet/yr)	CO <sub>2</sub> emissions (tons/year)	CH <sub>4</sub> emissions (tons/year)	N <sub>2</sub> O emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
SFR	1,500	50,000	75,000,000	4,095.0	0.39	0.01	4,105.5
high rise apartments	1,500	40,000	60,000,000	3,276.0	0.31	0.01	3,284.4
student elementary school	600	98	58,800	3.2	0.00	0.00	3.2
department store	50,000	100	5,000,000	273.0	0.03	0.00	273.7
strip mall	100,000	90	9,000,000	491.4	0.05	0.00	492.7
office park	15,000	85	1,275,000	69.6	0.01	0.00	69.8
<b>Total</b>			<b>150,333,800</b>	<b>8,208.2</b>	<b>0.77</b>	<b>0.02</b>	<b>8,229.3</b>

kg CO <sub>2</sub> /cubic foot	0.0546	The Climate Registry General Reporting Protocol, Version 1.1, Table 12.1
g CH <sub>4</sub> /MMBTU	5	The Climate Registry General Reporting Protocol, Version 1.1, Table 12.9
g N <sub>2</sub> O/MMBTU	0.1	The Climate Registry General Reporting Protocol, Version 1.1, Table 12.9
kilograms per pound	0.4535924	
grams per pound	453.5924	
BTU Nat gas/CF	1,029	The Climate Registry General Reporting Protocol, Version 1.1, Table 12.1
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from CR General Reporting Protocol data → Total natural gas CO<sub>2</sub>e emissions

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## Happy Acres: Water Supply Emissions (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O)

Index No.	Author	Study Title	Date	Water-Related Energy Use Data Item	Comments
9	Worff (PIER)	"Quantifying the Potential..."	July 2006	1,000 kWh/acre-ft (3,070 kWh/MG) for urban Water Supply: Surface/Import	Fig. 28: "generic import"

CEC generic energy usage data for water supply

REFINING ESTIMATES OF WATER-RELATED ENERGY USE IN CALIFORNIA

PIER FINAL PROJECT REPORT

Prepared For:  
California Energy Commission  
Public Interest Energy Research Program

Prepared By:  
Navigant Consulting, Inc.

NAVIGANT CONSULTING

December 2006  
CEC-600-2006-116

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## Happy Acres: Water Supply Emissions (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O)

**2007 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector**  
**Sacramento Municipal Utility District**  
 Reporting Year: 2007  
 Reporting Period: CA 2007 DR  
 Reporting Protocol: General Reporting Protocol Version 3.0 (April 2008)

SMUD electricity CO<sub>2</sub> emission rate

**Emission Factors for Electricity Use**

**Table C.2 Carbon Dioxide, Methane and Nitrous Oxide Electricity Emission Factors by eGRID Subregion**

eGRID Subregion Region	eGRID Subregion Name	CO <sub>2</sub> (lbs./MWh)	CH <sub>4</sub> (lbs./MWh)	N <sub>2</sub> O (lbs./MWh)
AKGD	ASCC Alaska Grid	1,232.36	0.0256	0.0065
AKMS	ASCC Miscellaneous	498.86	0.0208	0.0041
AZNM	WECC Southwest	1,311.05	0.0175	0.0179
CAMX	WECC California	724.12	0.0302	0.0081

CCAR General Protocol CH<sub>4</sub> and N<sub>2</sub>O electricity emission rates

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## Happy Acres: Water Supply Emissions

CARROT data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for electricity emissions

		Water Supply Emissions				
Water supply	per year	kWh per year	CO <sub>2</sub> emissions (tons/year)	CH <sub>4</sub> emissions (tons/year)	NO <sub>2</sub> emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
Acre-foot water	1,500	1,500,000	486.0	0.02	0.0	488.1
kWh/acre-foot water	1,000	CEC Refining Estimates of Waterrelated Energy Use in California, 2006, Appendix B, Index 9				
SMUD lbs. CO <sub>2</sub> /MWh	714.31	CARROT Reporting Tool				
lbs. N <sub>2</sub> O/MWh	0.0081	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2				
lbs. CH <sub>4</sub> /MWh	0.0302	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2				
pounds per metric tonnes	2,204.623					
CH <sub>4</sub> GWP	21					
N <sub>2</sub> O GWP	310					

Total water supply CO<sub>2</sub>e emissions

Calculated from CCAR General Reporting Protocol data

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## Happy Acres: Multiple Years

Previous examples for 2011, need to do for all years!

<p style="text-align: center;"><b>2010</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2010 urb504 Project Name: SMAQMD Example 2 - Mixed Use 2010 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2010 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">48,161.74</td> </tr> </table>	2010 TOTALS (lbs/day, unmitigated)	CO2	48,161.74	<p style="text-align: center;"><b>2013</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2013 urb524 Project Name: SMAQMD Example 2 - Mixed Use 2013 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2013 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">28,911.37</td> </tr> </table>	2013 TOTALS (lbs/day, unmitigated)	CO2	28,911.37																		
2010 TOTALS (lbs/day, unmitigated)	CO2	48,161.74																							
2013 TOTALS (lbs/day, unmitigated)	CO2	28,911.37																							
<p style="text-align: center;"><b>2012</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2012 urb504 Project Name: SMAQMD Example 2 - Mixed Use 2012 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2012 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">26,466.47</td> </tr> </table> <p style="text-align: center;">AREA SOURCE EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">16,172.40</td> </tr> </table> <p style="text-align: center;">OPERATIONAL (VEHICLE) EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">81,091.98</td> </tr> </table> <p style="text-align: center;">SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">97,663.39</td> </tr> </table>	2012 TOTALS (lbs/day, unmitigated)	CO2	26,466.47	TOTALS (lbs/day, unmitigated)	CO2	16,172.40	TOTALS (lbs/day, unmitigated)	CO2	81,091.98	TOTALS (lbs/day, unmitigated)	CO2	97,663.39	<p style="text-align: center;"><b>2013</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2013 urb524 Project Name: SMAQMD Example 2 - Mixed Use 2013 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2013 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">28,911.37</td> </tr> </table> <p style="text-align: center;">AREA SOURCE EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">24,749.96</td> </tr> </table> <p style="text-align: center;">OPERATIONAL (VEHICLE) EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">126,402.26</td> </tr> </table> <p style="text-align: center;">SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">151,362.21</td> </tr> </table>	2013 TOTALS (lbs/day, unmitigated)	CO2	28,911.37	TOTALS (lbs/day, unmitigated)	CO2	24,749.96	TOTALS (lbs/day, unmitigated)	CO2	126,402.26	TOTALS (lbs/day, unmitigated)	CO2	151,362.21
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TOTALS (lbs/day, unmitigated)	CO2	151,362.21																							

## Happy Acres: Multiple Years

Previous examples for 2011, need to do for all years!

<p style="text-align: center;"><b>2014</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2014 urb524 Project Name: SMAQMD Example 2 - Mixed Use 2014 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2014 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">39,899.25</td> </tr> </table> <p style="text-align: center;">AREA SOURCE EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">32,830.54</td> </tr> </table> <p style="text-align: center;">OPERATIONAL (VEHICLE) EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">167,574.30</td> </tr> </table> <p style="text-align: center;">SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">200,404.84</td> </tr> </table>	2014 TOTALS (lbs/day, unmitigated)	CO2	39,899.25	TOTALS (lbs/day, unmitigated)	CO2	32,830.54	TOTALS (lbs/day, unmitigated)	CO2	167,574.30	TOTALS (lbs/day, unmitigated)	CO2	200,404.84	<p style="text-align: center;"><b>2015</b></p> <p style="text-align: center;">Urbemis 2007 Version 9.2.4 Summary Report for Summer Emissions (Pounds/Day)</p> <p>File Name: C:\Urbemis 2007 9.2.4 Files\SMAQMD Example 2 - Mixed Use 2015 urb524 Project Name: SMAQMD Example 2 - Mixed Use 2015 Project Location: California State-wide On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006 Off-Road Vehicle Emissions Based on: OFFROAD2007</p> <p style="text-align: center;">CONSTRUCTION EMISSION ESTIMATES</p> <table border="0"> <tr> <td>2015 TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">40,911.12</td> </tr> </table> <p style="text-align: center;">AREA SOURCE EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">40,911.12</td> </tr> </table> <p style="text-align: center;">OPERATIONAL (VEHICLE) EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">208,362.39</td> </tr> </table> <p style="text-align: center;">SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES</p> <table border="0"> <tr> <td>TOTALS (lbs/day, unmitigated)</td> <td style="text-align: right;">CO2</td> <td style="text-align: right;">249,293.51</td> </tr> </table>	2015 TOTALS (lbs/day, unmitigated)	CO2	40,911.12	TOTALS (lbs/day, unmitigated)	CO2	40,911.12	TOTALS (lbs/day, unmitigated)	CO2	208,362.39	TOTALS (lbs/day, unmitigated)	CO2	249,293.51
2014 TOTALS (lbs/day, unmitigated)	CO2	39,899.25																							
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TOTALS (lbs/day, unmitigated)	CO2	249,293.51																							

## Happy Acres: Summary of Emissions

Metric tonnes CO<sub>2</sub>e for year 2011

Construction	
Phase	CO <sub>2</sub> e emissions (tons/year)
Site grading	121.3
Asphalt	19.4
Building construction	911.0
Architectural coating	NA
<b>Total</b>	<b>1,051.7</b>

Total construction CO<sub>2</sub>e emissions

Land use	Operations			
	Mobile CO <sub>2</sub> e emissions (tons/year)	Electricity CO <sub>2</sub> e emissions (tons/year)	Natural Gas CO <sub>2</sub> e emissions (tons/year)	Water Supply CO <sub>2</sub> e emissions (tons/year)
SFR	3,557.0	4,881.5	4,105.5	488.1
high rise apartments	2,366.1	4,149.3	3,284.4	
student elementary school	0.0	488.1	3.2	
department store	452.5	12,203.7	273.7	
strip mall	611.4	357,975.4	492.7	
office park	39.1	53,696.3	69.8	
<b>Total</b>	<b>7,026.1</b>	<b>433,394.3</b>	<b>8,229.3</b>	

Total operational CO<sub>2</sub>e emissions

449,137.8

## Project 3: Acme Industries

Acme Industries – aggregate mining project in Sacramento County

- Project details

- New aggregate mining project with a 75 year lifespan (2015 start)
- 15 haul truck trips/day, 30 miles round trip, average of 35 mph/trip
- Mining excavation rate of 250,000 cubic yards annually
- Aggregate plant capacity: 500 tons per hour
- Asphalt batch mix (natural gas) capacity: 300 tons per hour (125,000 tons per year)
- Concrete batch plant: 100 tons per hour
- Facility uses 100,000 kWh electricity/year

## Acme Industries: Project Details

- Project details (continued)

- Mining activities equipment includes :

Equipment	Horsepower	Hours/day
Bulldozer	410	4
Excavator	760	8
Front-end loader	500	8
Front-end loader	500	8
Haul truck (off-highway)	525	8
Motorgrader	185	2
Service Truck	NA	1
Water truck	NA	2

## Acme Industries: Emission sources

- What are the sources of emissions?

- Direct emissions

- Construction from initial infrastructure development
  - Construction equipment
  - Employee commute
  - Vender/delivery trips
- Operations
  - On-road mobile source from haul trucks/employees
  - Process emissions

- Indirect emissions


- Electricity
  - Natural gas
  - Water usage
- } not evaluated in this example


## Acme Industries: Calculation Tools

- What tools would be used to calculate emissions?
  - URBEMIS2007
    - Direct emissions
      - Construction activities
      - Employee commute
      - Vender/delivery trips
      - Mining activities
      - Area source
  - EMFAC2007
    - Direct emissions on-road mobile source emissions

## Acme Industries: Calculation Tools

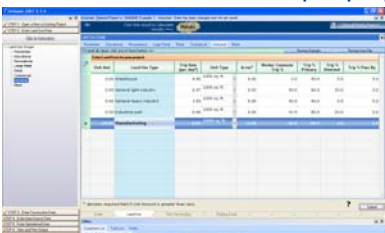
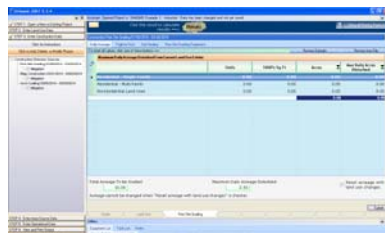
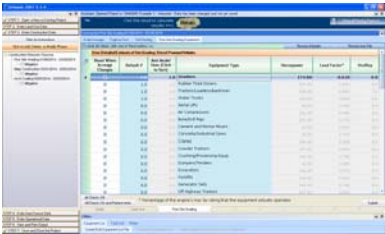
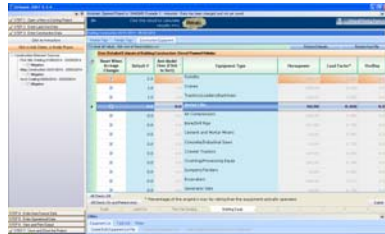
- What tools would be used to calculate emissions (continued)?
  - The Climate Registry General Reporting Protocol
    - CH<sub>4</sub> and N<sub>2</sub>O emissions calculations from fuel consumption
  - California Climate Action Registry Reporting Online Tool
    - CO<sub>2</sub> emissions calculations from electricity consumption
  - California Climate Action Registry General Reporting Protocol
    - CH<sub>4</sub>, and N<sub>2</sub>O emission factors from electricity consumption
  - U.S. EPA AP-42
    - Calculate emissions from asphalt batch plants







## Acme Industries: URBEMIS Construction Inputs

Input project-specific data

SMAQMD [www.airquality.org](http://www.airquality.org)
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[jonesandstokes.com](http://jonesandstokes.com) & [icfi.com](http://icfi.com)





## Acme Industries: URBEMIS Construction Output File

### URBEMIS2007 output file

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URBEMIS 2007 Version 6.2.4  
Detail Report for Summer Construction Unmitigated Emissions (Pounds/Day)

File Name:  
Project Name: SMAQMD Example 3 - Industrial  
Project Location: Sacramento County AQMD  
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006  
Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Unmitigated)	
Time Slice 1/6/2014-3/30/2014	2,339.28
Active Days: 92	
File Grading 01/06/2014-03/29/2014	2,339.20
File Grading Dust	0.00
File Grading Off Road Diesel	2,347.32
File Grading On Road Diesel	0.00
File Grading Worker Trips	111.80
Time Slice 3/31/2014-6/30/2014	1,126.47
Active Days: 35	
Building Off Road Diesel	1,126.47
Building Off Road Diesel	893.30
Building Worker Trips	192.89
Building Worker Trips	91.64
Time Slice 6/30/2014-8/30/2014	13.60
Active Days: 30	
Coating 06/03/2014-08/30/2014	13.60
Architectural Coating	0.00
Coating Worker Trips	13.60

Phase Assumptions

Phase: File Grading 1/6/2014 - 3/29/2014 - Default File Grading Description

SMAQMD [www.airquality.org](http://www.airquality.org)
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[jonesandstokes.com](http://jonesandstokes.com) & [icfi.com](http://icfi.com)

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Total Acres Disturbed: 10  
Maximum Daily Acreage Disturbed: 2.5  
Fugitive Dust Level of Detail: Default  
20 lbs per acre-day  
On Road Truck Travel (VMT): 0  
Off-Road Equipment:  
1 Graders (174 hp) operating at a 0.61 load factor for 6 hours per day  
1 Rubber Tired Dozers (357 hp) operating at a 0.69 load factor for 6 hours per day  
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day  
1 Water Trucks (169 hp) operating at a 0.5 load factor for 6 hours per day

Phase: Building Construction 3/31/2014 - 6/30/2014 - Default Building Construction Description  
Off-Road Equipment:  
1 Cranes (300 hp) operating at a 0.43 load factor for 4 hours per day  
2 Forklifts (145 hp) operating at a 0.3 load factor for 6 hours per day  
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 8 hours per day

Phase: Architectural Coating 6/5/2014 - 8/30/2014 - Default Architectural Coating Description  
Off-Road Equipment:  
Rule: Residential Interior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Residential Exterior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Nonresidential Interior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250  
Rule: Nonresidential Exterior Coatings begins 1/1/2005 ends 12/31/2040 specifies a VOC of 250

CO<sub>2</sub> emissions  
(pounds per day)

**SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT** | **ICF Jones & Stokes**

## Acme Industries: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Construction Emissions

Information from URMEMIS used to calculate fuel consumption and associated CH<sub>4</sub> and N<sub>2</sub>O emissions

Construction Emissions							
Phase	Days of construction	CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
Site grading	60	2,359.20	105.43	0.13	0.06	2,380.77	64.8
Building construction	25	1,126.47	50.34	0.06	0.03	1,136.77	12.9
Architectural coating	20	13.99	0.63	0.00	0.00	14.12	0.1
<b>Total</b>		<b>3,499.66</b>	<b>156.40</b>	<b>0.20</b>	<b>0.09</b>	<b>3,531.65</b>	<b>77.8</b>

Units	Conversion factor	Source
kg CO <sub>2</sub> /gallon fuel	10.15	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.1
g CH <sub>4</sub> /gallon fuel	0.58	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
g N <sub>2</sub> O/gallon fuel	0.26	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
kilograms per pound	0.4535924	
grams per pound	453.5924	
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from URBEMIS

Calculated from Climate Registry General Reporting Protocol data

Total construction CO<sub>2</sub>e emissions

SMAQMD [www.airquality.org](http://www.airquality.org) | 43 | [jonesandstokes.com](http://jonesandstokes.com) & [icfi.com](http://icfi.com)

**SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT** | **ICF Jones & Stokes**

## Acme Industries: Process Emissions

- Process sources include are predominantly associated with operation of the asphalt batch plant
- Emission factor sources

Table 11.1-6. EMISSION FACTORS FOR TOC, METHANE, AND VOC FROM BATCH MIX HOT MIX ASPHALT PLANTS<sup>a</sup>

Process	TOC <sup>b</sup>	EMISSION FACTOR RATING	CH <sub>4</sub> <sup>c</sup>	EMISSION FACTOR RATING	VOC <sup>d</sup>	EMISSION FACTOR RATING
Natural gas-fired dryer, hot screens, and mixer (SCC 3-05-002-45)	0.015 <sup>e</sup>	D	0.0074	D	0.0082	D
No. 2 fuel oil-fired dryer, hot screens, and mixer (SCC 3-05-002-46)	0.015 <sup>e</sup>	D	0.0074	D	0.0082	D
No. 6 fuel oil-fired dryer, hot screens, and mixer (SCC 3-05-002-47)	0.043 <sup>f</sup>	E	0.0074	D	0.036	E

SMAQMD [www.airquality.org](http://www.airquality.org) | 44 | [jonesandstokes.com](http://jonesandstokes.com) & [icfi.com](http://icfi.com)

## Acme Industries: Process Emissions

- Emission factor sources
  - U.S. EPA AP-42

Table 11.1-5. EMISSION FACTORS FOR CO, CO<sub>2</sub>, NO<sub>x</sub>, AND SO<sub>2</sub> FROM BATCH MIX HOT MIX ASPHALT PLANTS<sup>1</sup>

Process	CO <sup>1</sup>	EMISSION FACTOR RATING	CO <sub>2</sub> <sup>1</sup>	EMISSION FACTOR RATING	NO <sub>x</sub> <sup>1</sup>	EMISSION FACTOR RATING	SO <sub>2</sub> <sup>1</sup>	EMISSION FACTOR RATING
Natural gas-fired dryer, hot screens, and mixer (SCC 3-05-002-45)	0.40	C	37 <sup>2</sup>	A	0.025 <sup>3</sup>	D	0.0048 <sup>4</sup>	E
No. 2 fuel oil-fired dryer, hot screens, and mixer (SCC 3-05-002-46)	0.40	C	37 <sup>2</sup>	A	0.12 <sup>2</sup>	E	0.088 <sup>3</sup>	E
Waste oil-fired dryer, hot screens, and mixer (SCC 3-05-002-47)	0.40	C	37 <sup>2</sup>	A	0.12 <sup>2</sup>	E	0.088 <sup>3</sup>	E
Coal-fired dryer, hot screens, and mixer (SCC 3-05-002-98)	ND	NA	37 <sup>2</sup>	A	ND	NA	0.043 <sup>4</sup>	E

Table 11.1-8. EMISSION FACTORS FOR TOC, METHANE, VOC, AND HCl FROM DRUM MIX HOT MIX ASPHALT PLANTS<sup>1</sup>

Process	TOC <sup>1</sup>	EMISSION FACTOR RATING	CH <sub>4</sub> <sup>1</sup>	EMISSION FACTOR RATING	VOC <sup>1</sup>	EMISSION FACTOR RATING	HCl <sup>1</sup>	EMISSION FACTOR RATING
Natural gas-fired dryer (SCC 3-05-002-55, -56, -57)	0.044 <sup>2</sup>	B	0.012	C	0.032	C	ND	NA
No. 2 fuel oil-fired dryer (SCC 3-05-002-58, -59, -60)	0.044 <sup>2</sup>	B	0.012	C	0.032	C	ND	NA
Waste oil-fired dryer (SCC 3-05-002-61, -62, -63)	0.044 <sup>2</sup>	E	0.012	C	0.032	E	0.00021	D

Table 11.1-7. EMISSION FACTORS FOR CO, CO<sub>2</sub>, NO<sub>x</sub>, AND SO<sub>2</sub> FROM DRUM MIX HOT MIX ASPHALT PLANTS<sup>1</sup>

Process	CO <sup>1</sup>	EMISSION FACTOR RATING	CO <sub>2</sub> <sup>1</sup>	EMISSION FACTOR RATING	NO <sub>x</sub> <sup>1</sup>	EMISSION FACTOR RATING	SO <sub>2</sub> <sup>1</sup>	EMISSION FACTOR RATING
Natural gas-fired dryer (SCC 3-05-002-55, -56, -57)	0.13	B	33 <sup>2</sup>	A	0.020 <sup>3</sup>	D	0.0034 <sup>4</sup>	D
No. 2 fuel oil-fired dryer (SCC 3-05-002-58, -59, -60)	0.13	B	33 <sup>2</sup>	A	0.055 <sup>3</sup>	C	0.011 <sup>3</sup>	E
Waste oil-fired dryer (SCC 3-05-002-61, -62, -63)	0.13	B	33 <sup>2</sup>	A	0.055 <sup>3</sup>	C	0.058 <sup>3</sup>	B
Coal-fired dryer <sup>3</sup> (SCC 3-05-002-98)	ND	NA	33 <sup>2</sup>	A	ND	NA	0.19 <sup>3</sup>	E

## Acme Industries: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Process Emissions

Asphalt Batch Plant Activities  
EPA AP-42 data used to emissions

Asphalt Batch Plant Emissions

Asphalt production	Tons per year	CH <sub>4</sub> emissions (tons/year)	CO <sub>2</sub> emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
Tons asphalt produced	125,000	0.4	2,097.9	2,106.7

Units	Factor	Source
lbs CH <sub>4</sub> /ton asphalt	0.0074	EPA AP-42, Table 11.1-6
lbs CO <sub>2</sub> /ton asphalt	37	EPA AP-42, Table 11.1-5
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	

Total mobile source  
CO<sub>2</sub>e emissions

AP-42 Emission Factors

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

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## Acme Industries: Process Mining Activities

Input equipment data

URBEMIS output file

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Urbenis 2007 Version 9.2.4  
Detail Report for Summer Construction Unmitigated Emissions (Pounds/Day)

File Name: C:\Urbenis 2007 9.2.4 Files\SMAQMD Example 3 - Industrial Operations\urb504

Project Name: SMAQMD Example 3 - Industrial Operational

Project Location: Sacramento County AGMD

On-Road Vehicle Emissions Based on: Version: Emfacs2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Unmitigated)

Time Slice	CO <sub>2</sub>
11/20/15-12/31/15	8,637.14
Active Days: 261	8,637.14
Mass Grading 01/01/15-12/31/15	0.00
Mass Grading Off-Road Diesel	6,441.28
Mass Grading On-Road Diesel	0.00
Mass Grading Worker Tips	192.82

Phase Assumptions

Phase: Mass Grading 11/20/15 - 12/31/15 - Mining Activities

Total Area Disturbed: 10

Maximum Daily Average Disturbed: 0.1

Fugitive Dust Level of Detail: Default

20 lbs per acre-day

On-Road Truck Travel (VMT): 0

Off-Road Equipment

- 1 Excavators (100 hp) operating at a 0.07 load factor for 8 hours per day
- 1 Graders (150 hp) operating at a 0.81 load factor for 2 hours per day
- 1 Off-Highway Trucks (205 hp) operating at a 0.57 load factor for 8 hours per day
- 2 Rubber Tired Loaders (500 hp) operating at a 0.54 load factor for 8 hours per day
- 1 Tractors/Loaders/Backhoes (410 hp) operating at a 0.55 load factor for 4 hours per day

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## Acme Industries: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Process Emissions

### Mining activities

### Information from URBEMIS used to calculate fuel consumption

Phase	Days of construction	Mining Activity Emissions				
		CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)
Mining activities	365	8,637.14	385.98	0.49	0.22	8,716.09

Units	Conversion factor	Source
kg CO <sub>2</sub> /gallon fuel	10.15	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.1
g CH <sub>4</sub> /gallon fuel	0.58	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
g N <sub>2</sub> O/gallon fuel	0.26	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
kilograms per pound	0.4535924	
grams per pound	453.5924	
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from URBEMIS

Calculated from Climate Registry General Reporting Protocol data

Total mining activity CO<sub>2</sub>e emissions (1,443.0)

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## Acme Industries: On-Road Mobile Source Emissions

Can use URBEMIS or EMFAC2007 to estimate emissions

Year analyzed

Average truck speed

CH<sub>4</sub> emission factor (grams/mile)

CO<sub>2</sub> emission factor (grams/mile)

County	Average	Substance	County	Average
Table: E207 Running Exhaust Emissions (grams/mile)				
Pollutant Name:	Methane	Temperature:	50F	Relative Humidity:
Speed	MPH	LOA	LOF	MOF
YS	0.013	0.008	0.005	0.002
Pollutant Name: Carbon Dioxide temperature: 50F Relative Humidity: 50%				
Speed	MPH	LOA	LOF	MOF
YS	306.056	395.486	522.087	585.402

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## Acme Industries: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Process Emissions

### Haul truck activities

- EMFAC2007 emission factors and VMT data used to calculate emissions
  - URBEMIS2007 may also be used

Haul Truck Activity	miles traveled per year	Haul Truck Emissions		
		CH <sub>4</sub> emissions (tons/year)	CO <sub>2</sub> emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
Total miles	112,500	0.002	167.1	167.2
trips/day	15	Source		
Days/year	250			
Miles/round trip	30	EMFAC2007		
grams per metric ton	1,000,000.0			
g CO <sub>2</sub> /mile	1,485.401	EMFAC2007		
g CH <sub>4</sub> /mile	0.022			
CH <sub>4</sub> GWP	21	Total haul truck CO <sub>2</sub> e emissions		

EMFAC2007 emission factors

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## Acme Industries: Electricity Emissions (CO<sub>2</sub>)

### CARROT Reporting tool for electricity generation

2007 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector

**Sacramento Municipal Utility District**  
6201 S St.  
Sacramento, CA, 95817  
website: www.smud.org

Reporting Year: 2007  
Direct Baseline Year:  
Indirect Baseline Year:  
Reporting Scope: CA and US  
Reporting Boundaries:  
Reporting Protocols: General Reporting Protocol Version 3.0 (April 2008)  
Power/Utility Reporting Protocol Version 1.0 (April 2005)

Legend:  
Blue = required  
Green = optional

Contact:  
Title: Oksana Bartholomy  
Project Manager  
Telephone: 916.372.4839  
Email: obarth@smud.org  
Industry Type: Power Generation  
Entity Name: 2211 Electric Power Generation, Transmission and Distribution  
Entity NAICS Code: 2211 Electric Power Generation, Transmission and Distribution  
Entity Description: The Sacramento Municipal Utility District is the nation's sixth largest publicly owned and operated electric utility in terms of customers served. SMUD generates, transmits, and distributes electric power within a 100 square mile service area in and around the Sacramento-Sutter area, California. SMUD owns and operates 1371 MW of electrical generation resources located in the California Counties of Sacramento, El Dorado and Sutter. SMUD's electrical generation is comprised of 998 MW of natural gas-fired fossil generation, cogeneration, and peaking resources, 448 MW of hydroelectric, 100 MW of wind, and 6.8 MW of solar photovoltaic generation. SMUD owns and operates a 76-mile natural gas transmission pipeline serving the cogeneration and fossil generation facilities. SMUD has equity shares in the Rose Natural Gas Production Field in New Mexico and in a Northern California transmission line known as the California Oregon Transmission Project or the Transmission Association of Northern California.

Do you deliver power to an end-user/retail customer? (Enter yes or no) **yes**

**EMISSIONS EFFICIENCY METRICS**

Electricity Deliveries: **74,311,000 lbs CO<sub>2</sub>/MWh deliveries (includes CO<sub>2</sub> from owned and purchased generation)**

Net Generation: 718.58 lbs CO<sub>2</sub>/MWh net owned generation (does not include hydroelectric, nuclear, solar, etc.)

Net Fossil Generation: 859.23 lbs CO<sub>2</sub>/MWh net owned fossil generation only

Note: Efficiency metrics are calculated using CO<sub>2</sub> emissions from stationary combustion for purposes of electricity generation. CO<sub>2</sub> emissions from biogenic sources are not included in the Electricity Deliveries metric; however MWh from biogenic and all other generation sources are included. Geothermal generation CO<sub>2</sub> emissions and MWh are included in Net Generation metric but not Net Fossil Generation metric. Combustion sources related to any non-electricity generating natural gas operations are not included.

Comments:

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SMUD CO<sub>2</sub> emission rate

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## Acme Industries: Electricity Emissions (CH<sub>4</sub> and N<sub>2</sub>O)

### California Climate Action Registry General Reporting Protocol CH<sub>4</sub> and N<sub>2</sub>O emission rates

Emission Factors for Electricity Use

**Table C.2 Carbon Dioxide, Methane and Nitrous Oxide Electricity Emission Factors by eGRID Subregion**

eGRID Subregion Acronym	eGRID Subregion Name	CO <sub>2</sub> (lbs/MWh)	CH <sub>4</sub> (lbs/MWh)	N <sub>2</sub> O (lbs/MWh)
AKGD	ASCC Alaska Grid	1,232.36	0.0256	0.0065
AKMS	ASCC Miscellaneous	496.86	0.0208	0.0041
AZNM	WECC Southwest	1,311.05	0.0175	0.0179
CAMX	WECC California	724.12	0.0302	0.0081

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## Acme Industries: Electricity Emissions (CH<sub>4</sub> and N<sub>2</sub>O)

CARROT data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for electricity emissions

Electricity Emissions					
Total	kWh/year	CO <sub>2</sub> emissions (tons/year)	CH <sub>4</sub> emissions (tons/year)	N <sub>2</sub> O emissions (tons/year)	CO <sub>2</sub> e emissions (tons/year)
Electricity usage	100,000	32.40	0.0014	0.0004	32.5

Units	Conversion factor	Source
SMUD lbs. CO <sub>2</sub> /MWh	714.31	CARROT Reporting Tool
lbs. N <sub>2</sub> O/MWh	0.0081	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2
lbs. CH <sub>4</sub> /MWh	0.0302	California Climate Action Registry General Reporting Protocol, Version 3.1, Table C.2
pounds per metric tonnes	2,204.623	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from CARROT data

Calculated from CCAR General Reporting Protocol data

Total electricity CO<sub>2</sub>e emissions

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## Acme Industries: Summary of Emissions

Metric tonnes CO<sub>2</sub>e/year

Construction	
Phase	CO <sub>2</sub> e emissions (tons/year)
Site grading	64.8
Building construction	12.9
Architectural coating	0.1
<b>Total</b>	<b>77.8</b>

Total construction CO<sub>2</sub>e emissions

Operations	
Phase	CO <sub>2</sub> e emissions (tons/year)
Mining activities	1,443.0
Asphalt production	2,106.7
Haul Truck Activity	167.2
Electricity usage	32.5
<b>Total</b>	<b>3,749.4</b>

Total operational CO<sub>2</sub>e emissions

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## Project 4: Baker Street

### Baker Street – Road widening project in Sacramento

- Project details
  - Seven-mile stretch of roadway widened from 4- to 6- lanes
  - Construction to start in Spring 2012 and last 18 months
  - Project area is 61 acres and 1,000 CY soil exported/day
  - Open-to-traffic year is 2015 and design year is 2035
  - Assume Sacramento default traffic mix

## Baker Street: Project Details

### Traffic data: daily VMT by peak and non-peak hour periods

VMT by Speed Bin - Combined Peak Hour		2009		2015 No Project		2015 With Project		2035 No Project		2035 With Project	
CT-EMFAC Speed Bin Name	VMT Speed Bins Actual	VMT	%	VMT	%	VMT	%	VMT	%	VMT	%
5	0.0 - 4.99	138	0.6%	56	0.2%	319	1.1%	90	0.2%	77	0.2%
10	5.0 - 9.99	654	2.6%	98	0.4%	405	1.4%	249	0.7%	352	0.9%
15	10.0 - 14.99	454	1.8%	95	0.3%	390	1.4%	249	0.7%	472	1.3%
20	15.0 - 19.99	304	1.2%	254	0.9%	303	1.1%	330	0.9%	769	2.1%
25	20.0 - 24.99	900	3.7%	409	1.5%	475	1.7%	818	2.4%	1,006	2.7%
30	25.0 - 29.99	1,278	5.1%	284	1.1%	679	2.4%	696	2.0%	794	2.1%
35	30.0 - 34.99	1,931	7.7%	794	2.9%	1,647	5.7%	1,054	3.1%	1,243	3.3%
40	35.0 - 39.99	1,565	5.5%	801	3.0%	1,430	5.0%	748	2.2%	1,004	2.7%
45	40.0 - 44.99	1,085	4.3%	1,146	4.3%	1,150	4.0%	785	2.3%	1,703	4.5%
50	45.0 - 49.99	540	2.2%	1,616	6.0%	2,422	8.4%	414	1.2%	1,271	3.4%
55	50.0 - 54.99	1,366	5.3%	2,715	10.1%	2,234	7.8%	5,889	17.1%	7,268	19.4%
60	55.0 - 59.99	1,178	4.7%	2,495	9.3%	4,772	16.6%	5,404	15.6%	6,869	18.3%
65	60.0 - 64.99	3,961	15.8%	5,327	19.8%	4,327	15.1%	5,272	15.3%	4,631	12.4%
70	65.0 - 69.99	9,832	39.3%	10,796	40.1%	8,148	28.3%	12,440	36.0%	9,719	26.0%
75	70.0 - 74.99	0	0.0%	52	0.2%	43	0.2%	101	0.3%	55	0.1%
Total		25,000	100.0%	26,935	100.0%	28,745	100.0%	34,531	100.0%	37,453	100.0%

VMT by Speed Bin - Non Peak		2009		2015 No Project		2015 With Project		2035 No Project		2035 With Project	
CT-EMFAC Speed Bin Name	VMT Speed Bins Actual	VMT	%	VMT	%	VMT	%	VMT	%	VMT	%
5	0.0 - 4.99	414	0.6%	168	0.2%	927	1.1%	270	0.3%	320	0.2%
10	5.0 - 9.99	1,968	2.8%	283	0.4%	1,178	1.4%	747	0.7%	1,000	0.9%
15	10.0 - 14.99	1,361	1.8%	280	0.3%	1,135	1.4%	747	0.7%	1,041	1.0%
20	15.0 - 19.99	911	1.2%	761	0.9%	882	1.1%	961	0.9%	2,242	2.1%
25	20.0 - 24.99	2,760	3.7%	1,226	1.5%	1,382	1.7%	2,454	2.4%	3,426	3.2%
30	25.0 - 29.99	3,814	5.1%	882	1.1%	1,979	2.4%	2,088	2.0%	2,256	2.1%
35	30.0 - 34.99	5,792	7.7%	2,382	2.9%	4,788	5.7%	3,163	3.1%	3,532	3.3%
40	35.0 - 39.99	4,089	5.3%	2,404	3.0%	4,159	5.0%	2,245	2.2%	2,851	2.7%
45	40.0 - 44.99	3,255	4.3%	3,438	4.3%	3,343	4.0%	2,356	2.3%	4,839	4.5%
50	45.0 - 49.99	1,620	2.2%	4,847	6.0%	7,043	8.4%	1,243	1.2%	3,611	3.4%
55	50.0 - 54.99	4,097	5.3%	8,146	10.1%	6,498	7.8%	17,668	17.1%	20,658	19.4%
60	55.0 - 59.99	3,527	4.7%	7,484	9.3%	18,876	18.6%	16,212	15.6%	19,513	18.3%
65	60.0 - 64.99	11,883	15.8%	15,981	19.8%	12,583	15.1%	15,817	15.3%	11,154	12.4%
70	65.0 - 69.99	29,495	39.3%	32,387	40.1%	23,694	28.3%	37,330	36.0%	27,609	26.0%
75	70.0 - 74.99	0	0.0%	155	0.2%	126	0.2%	304	0.3%	156	0.1%
Total		75,000	100.0%	80,804	100.0%	85,587	100.0%	103,583	100.0%	108,387	100.0%

## Baker Street: Emission sources

- What are the sources of emissions?
  - Direct emissions
    - Construction emissions
      - Construction equipment
      - Employee commute
      - Vender/delivery trips
    - Operations
      - On-road mobile source from haul trucks/employees
  - Indirect emissions
    - No major sources

## Baker Street: Calculation Tools

- What tools would be used to calculate emissions?
  - SMAQMD Road Construction Emissions Model
    - Construction emissions
  - CT-EMFAC or EMFAC2007
    - Direct emissions on-road mobile source emissions
  - The Climate Registry General Reporting Protocol
    - CH<sub>4</sub> and N<sub>2</sub>O emissions calculations from fuel consumption

**Baker Street: Construction Emissions**

Use the SMAQMD's Road Construction Emissions Model

- Will calculate default values for construction equipment and schedule if project-specific data is unavailable

**Road Construction Emissions Model** Version 6.3.1

**Data Entry Worksheet**

Note: Required data input sections have a yellow background.  
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.  
The user is required to enter information in cells C10 through C25.

Input Type	Baker Street Road Widening	
Project Name	Baker Street Road Widening	
Construction Start Year	2012	Enter a Year between 2005 and 2025 (inclusive)
Project Type	2	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	18.0	months
Predominant Soil/Site Type: Enter 1, 2, or 3	1	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	7	miles
Total Project Area	61.0	acres
Maximum Area Disturbed/Day	15.3	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported	1000.0	yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)

To begin a new project, click this button to clear data previously entered. The button will only work if you opted not to disable macros when loading this spreadsheet.

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

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**Baker Street: Construction Emissions**

Road Construction Emissions Model output screen

Road Construction Emissions Model, Version 6.3.1

Emission Estimates for -> Baker Street Road Widening										
Project Phases (English Units)	ROG (lb/day)	CO (lb/day)	NOx (lb/day)	Total PM10 (lb/day)	Exhaust PM10 (lb/day)	Fugitive Dust PM10 (lb/day)	Total PM2.5 (lb/day)	Exhaust PM2.5 (lb/day)	Fugitive Dust PM2.5 (lb/day)	CO2 (lb/day)
Grubbing/Land Clearing	21.3	84.3	193.3	162.7	7.2	155.5	38.3	3.6	31.7	18,526.2
Grading/Excavation	24.9	143.8	150.3	101.3	8.8	152.5	39.0	7.9	31.7	21,073.0
Drainage/Utilities/Sub-Grade	14.0	51.1	85.1	157.5	5.0	152.5	30.3	4.8	31.7	8,584.7
Paving	14.7	52.0	71.4	8.2	8.2	-	5.7	5.7	-	7,248.8
Maximum (lb/day)	24.9	143.8	150.3	161.3	8.8	152.5	39.0	7.9	31.7	21,073.0
Total (lb/day) (construction project)	3.9	18.7	25.2	27.1	1.4	25.7	6.9	1.3	6.9	2,454.4
Notes: Project Start Year -> 2012 Project Length (months) -> 18 Total Project Area (acres) -> 61 Maximum Area Disturbed/Day (acres) -> 16 Total Soil Imported/Exported (yd <sup>3</sup> /day) -> 1000										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										
Emission Estimates for -> Baker Street Road Widening										
Project Phases (Metric Units)	ROG (kg/day)	CO (kg/day)	NOx (kg/day)	Total PM10 (kg/day)	Exhaust PM10 (kg/day)	Fugitive Dust PM10 (kg/day)	Total PM2.5 (kg/day)	Exhaust PM2.5 (kg/day)	Fugitive Dust PM2.5 (kg/day)	CO2 (kg/day)
Grubbing/Land Clearing	9.7	38.3	75.0	72.0	3.3	68.7	17.4	3.0	14.4	7,586.0
Grading/Excavation	11.3	65.4	78.9	73.3	4.0	69.3	18.0	3.6	14.4	9,879.0
Drainage/Utilities/Sub-Grade	6.3	22.2	35.4	71.0	2.3	69.3	15.5	2.1	14.4	3,606.7
Paving	6.7	23.8	32.4	2.8	2.8	-	2.6	2.6	-	3,259.8
Maximum (kg/day)	11.3	65.4	78.9	73.3	4.0	69.3	18.0	3.6	14.4	9,879.0
Total (avg) (kg/day) (construction project)	3.5	15.9	22.5	24.0	1.3	23.3	6.0	1.2	4.8	2,678.0
Notes: Project Start Year -> 2012 Project Length (months) -> 18 Total Project Area (hectares) -> 25 Maximum Area Disturbed/Day (hectares) -> 6 Total Soil Imported/Exported (meter <sup>3</sup> /day) -> 795										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										

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## Baker Street: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e Construction Emissions

Information from RCEM used to calculate fuel consumption and associated emissions

Phase	Construction (months)	Construction (days)	Construction Emissions					
			CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
Grubbing/Land Clearing	1.8	36	16,026.20	716.19	0.92	0.41	16,172.70	13.2
Grading/Excavation	7.2	144	21,073.88	941.77	1.20	0.54	21,266.52	69.5
Drainage/Utilities/Sub-Grade	6.3	126	8,394.73	384.09	0.49	0.22	8,673.29	24.8
Paving	2.7	54	7245.632543	323.80	0.41	0.19	7,311.86	6.6
<b>Total</b>			<b>52,840.45</b>	<b>2,365.85</b>	<b>3.03</b>	<b>1.36</b>	<b>53,424.37</b>	<b>116.4</b>

Units	Conversion factor	Source
kg CO <sub>2</sub> /gallon fuel	10.15	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.1
g CH <sub>4</sub> /gallon fuel	0.58	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
g N <sub>2</sub> O/gallon fuel	0.26	The Climate Registry General Reporting Protocol, Version 1.1, Table 13.6
kilograms per pound	0.4535924	
grams per pound	453.5924	
pounds per metric tonnes	2,204.623	
Days construction/month	20	
CH <sub>4</sub> GWP	21	
N <sub>2</sub> O GWP	310	

Calculated from Road Construction Emissions Model

Calculated from Climate Registry General Reporting Protocol data

Total construction activity CO<sub>2</sub>e emissions

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## Baker Street: Operational Emissions

Input project-specific data into CT-EMFAC

The screenshot shows the CT-EMFAC software interface. The left window displays input parameters for Scenario Title (SMAQMD Example 4 - 2008), Geographic Area (Sacramento), Analysis Year (2008), Season (Summer), Vehicle Mix (User Default), and Pollutants (TSP, CO, NOx, SOx, O3, PM10, PM2.5, Diesel PM, Benzene, Acetone, Acetaldehyde, Formaldehyde, 1,3-Butadiene). The right window displays output results for Total VMT, Volume (Inch), Road Length (Inch), and Number of Hours for both Diesel and All Diesel categories, along with pollutant emissions.

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**Baker Street: Operational Emissions**  
**CT-EMFAC output file**

Vehicle activity and speed bin data summary

EMFAC2007 emission factor data from CT-EMFAC database

CT-EMFAC will also calculate overall CO<sub>2</sub> emissions in grams, kilograms, and U.S. tons

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**Baker Street: Calculation of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>e mobile-source emissions**  
 Climate Register data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for mobile sources

Calculated from CR General Reporting Protocol data

Total construction activity CO<sub>2</sub>e emissions

Calculated from CT-EMFAC

Default CH<sub>4</sub> and N<sub>2</sub>O Emission Highway Vehicles by Technology

This example assumes catalytic converters for passenger vehicles

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**Baker Street: Summary of Emissions**

Climate Register data used to calculate CH<sub>4</sub> and N<sub>2</sub>O for mobile sources

Construction Emissions								
Phase	Construction (months)	Construction (days)	CO <sub>2</sub> emissions (lbs./day)	Gallons diesel	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
Grubbing/Land Clearing	1.8	36	16,026.20	7,269.36	9.30	4.17	17,513.11	14.3
Grading/Excavation	7.2	144	21,073.86	9,538.95	12.22	5.46	23,029.12	75.2
Drainage/Utilities/Sub-Grade	6.3	126	8,594.73	3,898.50	4.96	2.23	9,392.15	26.8
Paving	2.7	54	7245.632543	3,286.56	4.20	1.86	7,917.88	9.7
<b>Total</b>			<b>52,940.45</b>	<b>24,013.38</b>	<b>30.71</b>	<b>13.76</b>	<b>57,852.26</b>	<b>126.0</b>

Total construction CO<sub>2</sub>e emissions →

Total operational CO<sub>2</sub>e emissions →

Mobile Source Emissions						
Comparison of alternatives to 2009	VMT	CO <sub>2</sub> emissions (lbs./day)	CH <sub>4</sub> emissions (lbs./day)	N <sub>2</sub> O emissions (lbs./day)	CO <sub>2</sub> e emissions (lbs./day)	CO <sub>2</sub> e emissions (tons/year)
2015 No Project - 2009	7,738.0	3,804.6	2.3	0.9	4,119.7	882.1
2015 with Project - 2009	12,332.0	9,456.5	3.7	1.4	9,958.7	1,648.8
2035 No Project - 2009	38,125.0	35,034.3	11.4	4.2	36,586.7	6,057.3
2035 with Project - 2009	43,840.0	34,551.4	13.1	4.9	36,336.5	6,015.9
<b>Comparison of alternatives to No Project</b>						
2015 with Project - 2015 No Project	4,594.0	5,651.9	1.4	0.5	5,838.9	966.7
2035 with Project - 2035 No Project	5,715.0	-482.9	1.7	0.6	-250.2	-41.4

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**Project 5: General Plan**

- What are the sources of emissions?
  - Construction activities
  - Direct emissions
    - On-road mobile source
    - Area source
    - Processes emissions
  - Indirect emissions
    - Electricity
    - Natural gas
    - Water usage
    - Waste emissions

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## General Plan: Items to Consider

- When evaluating General Plans, you need to evaluate:
  - Effects of General Plan to
    - Population growth
    - Employment growth
    - Changes in and land use patterns and effects to traffic/air quality
    - Transportation
  - Adaption to climate change, as well as contribution to climate change
  - Quantify existing/baseline emissions
  - Compare projected emissions associated with buildout of the proposed general plan to both existing conditions and business as usual (typically old general plan)
  - Will the General Plan impede implementation of AB-32?
  - Incorporate and identify GP policies that would reduce GHG emissions

## General Plan: Calculation Tools

- What tools would be used to calculate emissions?
  - URBEMIS2007
    - Construction emissions
    - Operational emissions
      - Be careful of using default values on large, complex land use projects!
  - SMAQMD Road Construction Emissions Model
    - Construction emissions
  - EMFAC2007
    - Direct emissions on-road mobile source emissions
      - More appropriate for larger projects
  - The Climate Registry General Reporting Protocol
    - CH<sub>4</sub> and N<sub>2</sub>O emissions calculations from fuel consumption

## General Plan: Calculation Tools

- What tools would be used to calculate emissions?
  - California Climate Action Registry General Reporting Protocol, Version 3.1
    - Local government inventory protocol for California The Climate Registry
  - The Climate Registry General Reporting Protocol, Version 1.1
    - Local government inventory protocol
  - ARB/ICLEI/CCAR/Climate Registry Local Government Operations Protocol
    - Local government inventory protocol for government operations
  - U.S. EPA Methodology from Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007
    - Methodology for U.S. GHG inventory

## General Plan: Components of GP Elements

### Land Use Element

- Foster land use intensity near and connectivity to retail and employment centers and services to reduce vehicle miles travelled
- Increase efficiency of delivery of services through adoption and implementation of smart growth principles and policies
- Improving the local jobs/housing balance to reduce vehicle miles travelled
- Linking residential and commercial development to transit facilities
- Promoting recycling to reduce waste and energy consumption

## General Plan: Components of GP Elements

### Conservation Element

- Conservation of natural lands for carbon sequestration
- Water conservation to promote energy efficiency
- Promote recycling and waste recovery
- Promote urban forestry and reforestation

## General Plan: Components of GP Elements

### Circulation Element

- Identify and prioritize infrastructure improvements needed to support increased use of alternatives to private vehicle travel, including transit, bicycle, and pedestrian modes
- Incorporate of "Complete Streets" policies that foster equal access by all users, including pedestrians and bicyclists
- Promote linkages between development locations and transportation facilities
- Identify opportunities, in cooperation with transit providers, to provide financing for transit operations and maintenance

## General Plan: Components of GP Elements

### Open Space Element

- Identify existing and potential future urban growth boundaries to limit sprawling development patterns and foster a more compact urban form
- Promote trail systems to facilitate bicycle and pedestrian trips as alternatives to vehicle travel

## General Plan: Components of GP Elements

### Housing Element

- Identify sites for higher density housing closer to employment centers, retail and services, and transit facilities
- Identify sites for affordable housing for workers close to employment centers
- Establish/ support programs to assist in the energy efficient retrofitting of older affordable housing units