CITY OF SHASTA LAKE

GREENHOUSE GAS REDUCTION MEASURE QUANTIFICATION METHODOLOGY

This appendix summarizes the methodology for quantifying greenhouse gas (GHG) reductions resulting from implementing the Climate Action Plan (CAP) measures. Calculations and/or background information are only shown for horizon year 2020. Energy emissions factors based on an RPS-compliant energy source mix were used to quantify emissions reductions for all measures resulting in electricity savings to avoid double counting.

Measure BE-1: Energy Efficiency Retrofits

This measure estimates the reduction in energy-related emissions (i.e., electricity and natural gas) resulting from retrofitting existing residential units and commercial properties. The measure includes retrofitting both single- and multi-family units based on a pre-defined package of energy efficiency retrofits that include installation of programmable thermostats, gas water heater upgrades, installation of high-efficiency light bulbs, gas furnace upgrades, duct sealing, foundation insulation, and building envelope sealing/weatherization.

Baseline electricity and natural gas consumption levels per unit type were identified using CEC's Residential Appliance Saturation Survey data for Forecast Climate Zone 3, which covers 85 to 95 percent of Shasta County. Mitigated energy savings estimates were based on outputs from Lawrence Berkeley Laboratory's Home Energy Saver ™ building energy modeling software. The model-derived energy savings estimates were downscaled in order to be conservative in emissions reduction calculations. Total energy savings were calculated by subtracting the mitigated electricity and natural gas consumption levels from baseline levels. See Table B-1 for data used to calculate emissions reductions.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	2% of existing single family residential units perform cost-effective energy efficiency package improvements (e.g., insulation, duct sealing, AC refrigerant recharge)	25 MT CO_2e/yr	*Building Data: Shasta County Assessor's Office parcel data* *Baseline Energy Consumption: Commercial End Use Survey, CEC, 2006* *Energy Savings from Retrofit Packages: AECOM SSIMe™ Building Energy Analysis* *Baseline Energy Consumption: Residential Appliance Saturation Survey, CEC, 2010* *Energy Savings from Retrofit Packages: SSIMe Building Energy Model, AECOM 2011* *Participation Rates: City of Shasta Lake, 2012*
	2% of multi-family residential units perform cost-effective energy efficiency package improvements (e.g., insulation, duct sealing, AC refrigerant recharge)		

Measure BE-2: New Construction

Reductions associated with this measure are described in Statewide Measures Reductions on page B-76.

Table B-1 Residential Retrofits						
Baseline Energy Consumption						
	Total Units	**Participation Rate**	**kWh/unit/year**	**therms/unit/year**	**Total kWhr/year**	**Total therms/year**
Single Family	3,093	2%	8,836	562	546,595	34,743
Townhome	25	2%	5,762	327	2,881	163
2-4 unit apartment	225	2%	4,595	305	20,678	1,375
5+ unit apartment	104	2%	5,248	199	10,916	413
Mobile Home	441	0%	na	na	na	na
Total	**3,888**				**581,069**	**36,695**
Mitigated Energy Consumption						
	Total Units	**Participation Rate**	**kWh/unit/year**	**therms/unit/year**	**Total kWhr/year**	**Total therms/year**
Single Family	3,093	2%	8,836	489	546,595	30,275
Townhome	25	2%	5,722	305	2,861	153
2-4 unit apartment	225	2%	4,566	272	20,548	1,225
5+ unit apartment	104	2%	5,217	189	10,851	393
Mobile Home	441	0%	na	na	na	na
Total	**3,888**				**580,855**	**32,045**
Energy Savings					**215**	**4,649**

Measure BE-3: Commercial Lighting

This measure estimates the reduction in electricity-related emissions resulting from indoor and outdoor light retrofits within commercial land uses. Baseline lighting electricity loads per square foot per non-residential use type were identified using CEC's Commercial End Use Survey data for Forecast Climate Zone 3 (see Table B-2).

The measure assumes that indoor lighting retrofits would occur at a performance level identified within the State's *Database for Energy Efficient Resources*. For 2020, the City assumes that 90% of total community-wide nonresidential square footage would implement a 40% indoor lighting load reduction. It was also assumed that 20% of total community-wide nonresidential square footage would implement a 20% exterior lighting load reduction. All non-residential uses (office, retail, and warehouse) are included in these calculations. Participation rates also reflect the assumption that State and federal light bulb efficiency standards (i.e. Energy Independence and Security Act of 2007) will assist in the implementation of this measure.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	90% of businesses improve interior lighting efficiency by 40% 20% of businesses improve exterior lighting efficiency by 20%.	137 MT CO_2e/yr	*Baseline Energy Consumption: Commercial End Use Survey, CEC, 2006* *Energy Savings from Retrofit Packages: CEC/CPCU Database for Energy Efficient Resources, 2005* *Participation Rates: City of Shasta Lake, 2011*

Table B-2
Indoor and Exterior Lighting Energy

Commercial Use Type	Baseline (kWh/SF/Year)	Mitigated (kWh/SF/Year)
Grocery	36.27	33.31
Health	15.04	13.54
Lodging	10.07	9.44
Large Office	14.20	12.62
Restaurant	33.25	30.81
Retail	10.06	8.43
School	8.82	7.63
Small Office	9.40	8.26
Warehouse (All)	22.67	21.55

Source: CEC 2006

Measure BE-4: Efficient Appliances

This measure estimates the reduction in electricity-related emissions resulting from installing energy-efficient appliances in new and existing residential units. This measure focuses on installation of energy-efficient refrigerators, clothes washers, and dishwashers. The CAPCOA report "*Quantifying Greenhouse Gas Mitigation Measures*" provides a methodology for calculating the electricity reductions associated with the installation of energy-efficient refrigerators, clothes washers, and dishwashers. The City selected participation rates on the assumption that State and utility outreach programs will increase the market share of ENERGY STAR appliances above current levels. Baseline market share values from a *Northwestern Energy Alliance* study indicate that approximately 33% of consumers purchase ENERGY STAR refrigerators, 83% purchase ENERGY STAR dishwashers, and 36% purchase ENERGY STAR clothes washers. The study shows a strong trend of increasing ENERGY STAR appliance market share over the past decade. For 2020, the City assumes that additional outreach and rebates will further increase the ENERGY STAR appliance market share in Shasta Lake. For new residential units, the measure assumes use of energy-efficient refrigerators will increase to a market share of 80%, use of energy-efficient clothes washers will increase to a market share of 90%, and use of energy-efficient dishwashers will increase to a market share of 90%. The City assumes that 20% of existing residential units will install energy-efficient refrigerators, clothes washers, and dishwashers.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	20% of existing homes will replace old model refrigerators, dishwashers, and clothes washers with new Energy Star models	173 MT CO_2e/yr	*Quantification Methodology: Energy Efficient Appliance Reduction: CAPCOA. 2010 (August). Quantifying Greenhouse Gas Mitigation Measures. Available: <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>.* *Participation Rates: ENERGY STAR Consumer Products Program: Market Progress Evaluation Report. Prepared by KEMA, Inc. July 24, 2007. Prepared for Northwestern Energy Efficiency Alliance.*
	80% of new homes will install Energy Star refrigerators		
	90% of new homes will install Energy Star dishwashers and clothes washers		

Measure BE-5: Solar Water Heaters

This measure quantifies natural gas and electricity-related emissions reductions resulting from the installation of solar hot water heaters in residential units and commercial buildings. Baseline water heating-related natural gas consumption levels per residential unit type were identified using CEC's Residential Appliance Saturation Survey data for Forecast Climate Zone 3. In addition, CEC data identifies the energy savings potential of solar hot water heaters for specific climates in California. The measure assumes that 40-67% of water-heating natural gas can be reduced through the use of solar hot water heaters. The measure assumes that 10% of all residential units (i.e., single family and multi-family) and 10% of all commercial buildings will install solar hot water heaters to meet their hot water demands. Care should be taken to avoid double-counting between a solar hot water heater installed to help new residential units achieve the building code-mandated energy efficiency performance and solar hot water heaters installed in excess of that requirement. Table B-3 provides the assumptions used to quantify reductions from solar water heaters.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	10% of residences and commercial buildings install a solar hot water system	254 MT CO_2e/yr	*Baseline Hot Water Natural Gas Consumption: Residential Appliance Saturation Survey, CEC, 2010* *Solar Fraction: Solar Water Heating CEC 2013 Title 24 Pre-rulemaking Workshop, California Energy Commission, June 9, 2011* *Solar Insolation: National Renewable Energy Laboratory Renewable Resource Data Center, 2011* *PV Participation Rates: City of Shasta Lake, 2012*

Table B-3 Solar Water Heaters – 2020						
Residential Units						
	Units (2020)	Hot Water Heater Energy per Unit (therms/year)	Solar Water Heater Effectiveness	Energy Savings per Unit (therms/year)	Participation Rate (% of units)	Total Savings (therms/year)
Single Family	3,281	196	67%	131.54	10%	43,152
Townhouse	27	170	67%	114.15	10%	303
2-4 unit apartment	239	135	59%	79.65	10%	1,901
5+ unit apartment	110	84	59%	49.30	10%	544
Total	**3,656**	-	-	-	-	**45,899**
Commercial Buildings						
	SQFT (2020)	Hot Water Heater Energy per SQFT (kBTU/year)	Solar Water Heater Effectiveness	Energy Savings per SQFT (kBTU/year)	Participation Rate (% of SQFT)	Total Savings (kBTU/year)
All Warehouse	171,073	0.00	40%	0.00	10%	0
Grocery	23,731	0.00	40%	0.00	10%	0
Health	23,276	17.34	40%	6.93	10%	16,141
Lodging	10,869	14.27	40%	5.71	10%	6,204
Restaurant	22,535	29.95	40%	11.98	10%	26,992
Retail	77,704	1.91	40%	0.77	10%	5,951
School	7,966	9.55	40%	3.82	10%	3,042
Small Office	6,834	1.23	40%	0.49	10%	337
Total	**346,008**	-	-	-	-	**58,668**

Measure BE-6: Solar Photovoltaic Systems

This measure estimates the reduction in electricity-related emissions resulting from installation of grid connected photovoltaic (PV) systems in residential and commercial uses. The measure uses National Renewable Energy Laboratory solar insolation data specific to Shasta Lake's geographic location and climate. For 2020, it was assumed that approximately 3% of single-family and town-home units would install 3-kilowatt grid-connected PV systems. It was also assumed that 1.5 MW of non-residential PV systems would be installed. See Table B-4 for calculations and assumptions associated with this measure.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	3% of single-family homes install 3.0 kW solar PV systems 100,000 SF of non-residential PV systems installed in the community	867 MT CO_2e/yr	*Solar Insolation: National Renewable Energy Laboratory Renewable Resource Data Center, 2011* *Participation rates: City of Shasta Lake, 2012.* *Building Data: Shasta County Assessor's Office parcel data*

Table B-4
Solar PV Systems – 2020

Single-Family Residential			
Photovoltaic System Size per Unit (kW)	Number of SFR Units	Generation Potential (kWh/sqft/year)	Electricity Generated (kWh/year)
3.0	99	166	493,547
Multi-Family Residential and Commercial			
Total Photovoltaic System Capacity Installed (MW)	Area (sqft)	Generation Potential (kWh/sqft/Year)	Electricity Generated (kWh/Year)
1.5	100,000	166	2,487,270
Total Electricity Generated (kWh/Year)			**2,980,817**

Measure W-1: Water Conservation

To estimate GHG reductions associated with implementation of the City's proposed water conservation strategies, water demand data for 2008 from the City and population and employment growth projections from the SRTA traffic model were used to establish base-case and future year estimates under business-as-usual-and mitigated scenarios. Annual water savings were calculated by subtracting the mitigated scenario demand from the base-case scenario demand in both 2020 and 2035. The annual water savings were translated into GHG reductions by applying water-energy intensity factors (kWh/million gallons/year) and California-wide electricity-generation emissions factors (MT CO_2e/kWh/year). Separate water-energy intensity factors were applied to indoor and outdoor portions of water savings. The ratio of indoor water to outdoor water was based on estimates typical of northern central valley water use. See Table B-5 for assumptions and calculations used to quantify reductions from this measure.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	20% reduction in per capita water demand	314 MT CO_2e/yr	Navigant Consulting, Inc. 2006. Refining Estimates of Water-Related Energy Use in California. California Energy Commission

Table B-5
Senate Bill 7X: Per Capita Water Reduction

2008 Water Consumption

Total Demand (AF/yr)	Percent Urban Water Use (%)	Total Urban Water (AF)	Baseline Population	Per Capita Water Consumption (AF/capita/yr)	
2,853	100%	2,853	10,069	0.283	

2020 Water Consumption

Total Demand (AF/yr)	Percent Urban Water Use (%)	Total Urban Water (AF)	Horizon Year 1 Population	BAU Per Capita Water Consumption (AF/capita/yr)	SB 7 Per Capita Water Consumption (AF/capita/yr)
3,210	100%	3,210	11,210	0.286	0.227

2020 Water Savings

Total AF/yr (without SB 7X)	3,210
Total AF/yr (with SB 7X)	2,541
Water Savings (AF/yr)	669

Indoor/Outdoor Water Use Assumption

Indoor % of total	45%
Outdoor % of total	55%

GHG Emission Reductions (indoor water)

Water Energy Intensity (KWh/acre feet /year)	acre-ft/year	Total KWh	MWh	Emission Factor (lb CO2/MWh)	Emission Factor (lb CH4/MWh)	Emission Factor (lb N2O/MWh)	Total CO_2e Reduced (MT/year)
1763	301	530,916	531	724.12	0.0302	0.0081	**175**

GHG Emission Reductions (outdoor water)

Water Energy Intensity (KWh/acre feet /year)	acre-ft/year	Total KWh	MWh	Emission Factor (lb CO2/MWh)	Emission Factor (lb CH4/MWh)	Emission Factor (lb N2O/MWh)	Total CO_2e Reduced (MT/year)
1140	368	419,727	420	724.12	0.0302	0.0081	**138**
TOTAL	**669**	**950,643**	**951**				**314**

Measure SW-1: Enhanced Organic Waste Diversion

An inventory of the community's organic waste was created using Cal Recycle waste volume and characterization data. Using the first-order decay methodology from the 2006 IPCC guidelines, fugitive methane emissions from the organic landfill waste were calculated for base-case and mitigated scenarios. This measure assumes that residential and commercial uses will divert 50% of yard waste (highlighted in green in Tables B-7 and B-8) and construction/demolition waste (highlighted in blue in Tables B-6 and B-7) from landfills by 2020. This measure would apply to GHG emissions associated with new waste generated and would not apply to waste in place disposed prior to CAP implementation.

Calculations for this measure factored in the advanced methane recovery rate described in Measure SW-2 to avoid double counting emissions reductions.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	Community increases diversion of yard waste by 50%	118 MT CO_2e/yr	*CalRecycle Waste Characterization Data, 2011* *IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5 Chapter 3.*
	Community increases diversion of construction and demolition waste by 50%		

Table B-6
Baseline Degradable Organic Carbon Disposed

Commercial Waste – Baseline Mass of Degradable Organic Carbon Disposed (DDOC mdt)

Year	Newspaper	Office Paper	Corrugated Boxes	Coated Paper	Food	Grass	Leaves	Branches	Lumber	Textiles	Diapers	Construction/ Demolition	Sludge/ Manure	Total
2008	2.2	16.8	31.4	17.2	40.3	1.7	6.6	6.4	47.4	15.9	8.4	3.5	0.0	197.8
2009	2.2	17.0	31.7	17.4	40.7	1.7	6.7	6.4	47.9	16.1	8.5	3.6	0.0	199.7
2010	2.2	17.2	32.0	17.6	41.1	1.7	6.8	6.5	48.3	16.2	8.5	3.6	0.0	201.7
2011	2.2	17.3	32.3	17.7	41.5	1.7	6.8	6.6	48.8	16.4	8.6	3.6	0.0	203.7
2012	2.2	17.5	32.6	17.9	41.9	1.8	6.9	6.6	49.3	16.5	8.7	3.7	0.0	205.7
2013	2.3	17.7	32.9	18.1	42.3	1.8	7.0	6.7	49.8	16.7	8.8	3.7	0.0	207.7
2014	2.3	17.9	33.3	18.3	42.8	1.8	7.0	6.8	50.3	16.9	8.9	3.7	0.0	209.8
2015	2.3	18.0	33.6	18.4	43.2	1.8	7.1	6.8	50.8	17.0	9.0	3.8	0.0	211.9
2016	2.3	18.2	33.9	18.6	43.6	1.8	7.2	6.9	51.3	17.2	9.1	3.8	0.0	213.9
2017	2.4	18.4	34.3	18.8	44.0	1.9	7.2	7.0	51.8	17.4	9.1	3.8	0.0	216.1
2018	2.4	18.6	34.6	19.0	44.5	1.9	7.3	7.0	52.3	17.5	9.2	3.9	0.0	218.2
2019	2.4	18.8	34.9	19.2	44.9	1.9	7.4	7.1	52.8	17.7	9.3	3.9	0.0	220.4
2020	2.4	19.0	35.3	19.4	45.4	1.9	7.5	7.2	53.3	17.9	9.4	4.0	0.0	222.5

Residential Waste – Baseline Mass of Degradable Organic Carbon Disposed (DDOC mdt)

Year	Newspaper	Office Paper	Corrugated Boxes	Coated Paper	Food	Grass	Leaves	Branches	Lumber	Textiles	Diapers	Construction/ Demolition	Sludge/ Manure	Total
2008	8.8	31.4	25.3	40.0	135.1	5.2	12.6	5.3	39.1	36.9	43.2	3.2	0.1	386.3
2009	8.9	31.7	25.5	40.4	136.4	5.3	12.7	5.4	39.4	37.3	43.6	3.2	0.1	390.1
2010	8.9	32.0	25.8	40.8	137.8	5.3	12.9	5.4	39.8	37.7	44.1	3.2	0.1	393.9
2011	9.0	32.4	26.1	41.2	139.2	5.4	13.0	5.5	40.2	38.0	44.5	3.3	0.1	397.8
2012	9.1	32.7	26.3	41.6	140.5	5.4	13.1	5.5	40.6	38.4	44.9	3.3	0.1	401.7
2013	9.2	33.0	26.6	42.0	141.9	5.5	13.3	5.6	41.0	38.8	45.4	3.3	0.1	405.7
2014	9.3	33.3	26.8	42.5	143.3	5.5	13.4	5.6	41.4	39.2	45.8	3.4	0.1	409.7
2015	9.4	33.7	27.1	42.9	144.7	5.6	13.5	5.7	41.8	39.6	46.3	3.4	0.1	413.8
2016	9.5	34.0	27.4	43.3	146.2	5.6	13.7	5.7	42.3	40.0	46.7	3.4	0.1	417.9
2017	9.6	34.3	27.6	43.7	147.6	5.7	13.8	5.8	42.7	40.4	47.2	3.5	0.2	422.0
2018	9.7	34.7	27.9	44.2	149.1	5.7	13.9	5.8	43.1	40.8	47.7	3.5	0.2	426.2
2019	9.8	35.0	28.2	44.6	150.5	5.8	14.1	5.9	43.5	41.2	48.1	3.5	0.2	430.4
2020	9.9	35.3	28.5	45.0	152.0	5.9	14.2	6.0	44.0	41.6	48.6	3.6	0.2	434.6

Table B-7
Mitigated Degradable Organic Carbon Disposed

Commercial Waste – Mitigated Mass of Degradable Organic Carbon Disposed (DDOC mdt)

Year	Newspaper	Office Paper	Corrugated Boxes	Coated Paper	Food	Grass	Leaves	Branches	Lumber	Textiles	Diapers	Construction/ Demolition	Sludge/ Manure	Total
2008	**2.2**	**16.8**	**31.4**	**17.2**	**40.3**	**0.8**	**6.6**	**6.4**	**23.7**	**15.9**	**8.4**	**3.5**	**0.0**	**173.2**
2009	**2.2**	**17.0**	**31.7**	**17.4**	**40.7**	**0.9**	**6.7**	**6.4**	**23.9**	**16.1**	**8.5**	**3.6**	**0.0**	**174.9**
2010	2.2	17.2	32.0	17.6	41.1	0.9	6.8	6.5	24.2	16.2	8.5	3.6	0.0	**176.7**
2011	2.2	17.3	32.3	17.7	41.5	0.9	6.8	6.6	24.4	16.4	8.6	3.6	0.0	**178.4**
2012	2.2	17.5	32.6	17.9	41.9	0.9	6.9	6.6	24.6	16.5	8.7	3.7	0.0	**180.2**
2013	2.3	17.7	32.9	18.1	42.3	0.9	7.0	6.7	24.9	16.7	8.8	3.7	0.0	**182.0**
2014	2.3	17.9	33.3	18.3	42.8	0.9	7.0	6.8	25.1	16.9	8.9	3.7	0.0	**183.8**
2015	2.3	18.0	33.6	18.4	43.2	0.9	7.1	6.8	25.4	17.0	9.0	3.8	0.0	**185.6**
2016	2.3	18.2	33.9	18.6	43.6	0.9	7.2	6.9	25.6	17.2	9.1	3.8	0.0	**187.4**
2017	2.4	18.4	34.3	18.8	44.0	0.9	7.2	7.0	25.9	17.4	9.1	3.8	0.0	**189.3**
2018	2.4	18.6	34.6	19.0	44.5	0.9	7.3	7.0	26.1	17.5	9.2	3.9	0.0	**191.1**
2019	2.4	18.8	34.9	19.2	44.9	0.9	7.4	7.1	26.4	17.7	9.3	3.9	0.0	**193.0**
2020	2.4	19.0	35.3	19.4	45.4	1.0	7.5	7.2	26.7	17.9	9.4	4.0	0.0	**194.9**

Residential Waste – Mitigated Mass of Degradable Organic Carbon Disposed (DDOC mdt)

Year	Newspaper	Office Paper	Corrugated Boxes	Coated Paper	Food	Grass	Leaves	Branches	Lumber	Textiles	Diapers	Construction/ Demolition	Sludge/ Manure	Total
2008	**8.8**	**31.4**	**25.3**	**40.0**	**135.1**	**3.0**	**12.6**	**5.3**	**19.5**	**36.9**	**43.2**	**3.2**	**0.1**	**364.5**
2009	**8.9**	**31.7**	**25.5**	**40.4**	**136.4**	**3.0**	**12.7**	**5.4**	**19.7**	**37.3**	**43.6**	**3.2**	**0.1**	**368.1**
2010	**8.9**	**32.0**	**25.8**	**40.8**	**137.8**	**3.0**	**12.9**	**5.4**	**19.9**	**37.7**	**44.1**	**3.2**	**0.1**	**371.7**
2011	**9.0**	**32.4**	**26.1**	**41.2**	**139.2**	**3.1**	**13.0**	**5.5**	**20.1**	**38.0**	**44.5**	**3.3**	**0.1**	**375.4**
2012	**9.1**	**32.7**	**26.3**	**41.6**	**140.5**	**3.1**	**13.1**	**5.5**	**20.3**	**38.4**	**44.9**	**3.3**	**0.1**	**379.1**
2013	**9.2**	**33.0**	**26.6**	**42.0**	**141.9**	**3.1**	**13.3**	**5.6**	**20.5**	**38.8**	**45.4**	**3.3**	**0.1**	**382.8**
2014	**9.3**	**33.3**	**26.8**	**42.5**	**143.3**	**3.2**	**13.4**	**5.6**	**20.7**	**39.2**	**45.8**	**3.4**	**0.1**	**386.6**
2015	**9.4**	**33.7**	**27.1**	**42.9**	**144.7**	**3.2**	**13.5**	**5.7**	**20.9**	**39.6**	**46.3**	**3.4**	**0.1**	**390.5**
2016	**9.5**	**34.0**	**27.4**	**43.3**	**146.2**	**3.2**	**13.7**	**5.7**	**21.1**	**40.0**	**46.7**	**3.4**	**0.1**	**394.3**
2017	**9.6**	**34.3**	**27.6**	**43.7**	**147.6**	**3.2**	**13.8**	**5.8**	**21.3**	**40.4**	**47.2**	**3.5**	**0.2**	**398.2**
2018	**9.7**	**34.7**	**27.9**	**44.2**	**149.1**	**3.3**	**13.9**	**5.8**	**21.5**	**40.8**	**47.7**	**3.5**	**0.2**	**402.1**
2019	**9.8**	**35.0**	**28.2**	**44.6**	**150.5**	**3.3**	**14.1**	**5.9**	**21.8**	**41.2**	**48.1**	**3.5**	**0.2**	**406.1**
2020	**9.9**	**35.3**	**28.5**	**45.0**	**152.0**	**3.3**	**14.2**	**6.0**	**22.0**	**41.6**	**48.6**	**3.6**	**0.2**	**410.1**

Measure SW-2: Methane Recovery

This measure estimates the reductions resulting from installation of a landfill gas recovery system at the West Central Landfill in order to comply with an adopted ARB regulation described as a discrete early action GHG emissions reduction measure in the AB 32 *Climate Change Scoping Plan.* Two landfills currently accept municipal solid waste (MSW) in Shasta County. The Anderson Landfill already has a landfill gas recovery system in place, and no efficiency upgrades are anticipated at this time. Table B-8 shows the percentage of total waste sent to each landfill that is attributed to Shasta Lake. It also shows the baseline and mitigated methane capture rate scenarios upon which emissions reductions were calculated.

This measure would apply to GHG emissions associated with new waste generated and waste-in-place disposed prior to GGRP implementation.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	West Central Landfill achieves a methane control efficiency of 75%	2,551 MT CO_2e/yr	*CalRecycle Waste Characterization Data, 2011* *IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5 Chapter 3.*

Table B-8
Waste Contributions per Landfill and Methane Capture Rates

Landfill	Proportion of Total Refuse Received at Landfill from Shasta Lake	BAU Scenario – Methane Capture Rates	Mitigated Scenario – Methane Capture Rates
West Central Landfill	4.00%	0%	75%
Anderson Landfill	1.00%	80%	80%
Benton Landfill	0.00%	90%	90%

Source: Ascent Environmental, 2012

Measure T-1: Mixed Use Development

Research demonstrates that households located in areas of mixed use development including commercial retail, employment, and schools generate lower amounts of vehicle miles traveled than households located in single use residential areas. The City of Shasta Lake estimates that 70% of all new residential units will be developed in mixed-use development areas within the City. It is estimated that the households located in these mixed use development areas will generate 6% less VMT than business as usual development in the City. See Table B-9 for calculations and assumptions used to quantify VMT reductions.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	70% of all new residential units constructed in mixed-use development	290 MT CO_2e/yr	*Housing Unit Assumptions: Shasta County Forecast Assumptions, Dowling Associates, 2011* *Percent Mixed Use: City of Shasta Lake, 2011* *VMT Reduction Estimate:* Travel and the Built Environment, *Ewing and Cervero, 2001*

Table B-9
Mixed Use Development VMT Reductions

	Community Vehicle Miles Traveled (miles)	Fuel Consumption (gallons)
Total New Development BAU VMT - 2020		
Gasoline	10,812,662	566,108
Diesel	1,135,031	177,349
Total	**11,947,692**	**743,456**
New Mixed Use Development VMT - 2020		
Gasoline	7,114,731	372,499
Diesel	746,850	116,695
Total	**7,861,582**	**489,194**
VMT Reductions from Mixed Use Development		
Gasoline	454,132	23,777
Diesel	47,671	7,449
Total	**501,803**	**31,225**
Building Inventory and Reduction Assumptions		**2020**
Total New Units		236
New Mixed Used Units (70% of total)		165
VMT Reduction Potential from Mixed Use Development		6%

Note: Assumes average fuel efficiency of 19.1 miles/gallon for gasoline vehicles and 6.4 miles/gallon for diesel vehicles

Measure T-2: Bicycle Lane Expansion

This measure quantifies reductions resulting from increasing Shasta Lake's bicycle mode share through expansion of its bicycle infrastructure, primarily Class I and II bicycle facilities. This measure assumes the construction of 10 miles of new Class I and II facilities by 2020. Emissions reductions come from VMT differences between a BAU scenario and a mitigated scenario (see Table B-10). The CAPCOA methodology was used to help quantify VMT reductions based on the proposed bicycle infrastructure improvements. A mode share study conducted by Dill and Carr was used to help define assumptions regarding how additional bicycle lanes translate into increased bicycle mode share (see Table B-11). The methodology assumes that the ratio of additional bicycle lane mileage per community area correlates to increased bicycle mode share, above levels reported in the 2010 US Census.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	10 new miles of Class I and II bicycles lanes constructed	14 MT CO_2e/yr	*CAPCOA. Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emissions Reductions from Greenhouse Gas Mitigation Measures. August, 2010.* *Dill, J and Carr, T. Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them. 2003.*

Table B-10 Communitywide VMT Reductions – Bicycle Infrastructure Improvements		
BAU Scenario – Vehicles Miles Traveled		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	85,673,144	4,485,505
Diesel	8,993,314	1,405,205
Total	94,666,458	5,890,710
Mitigated Scenario – Vehicles Miles Traveled		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	85,651,808	4,484,388
Diesel	8,991,074	1,404,855
Total	94,642,881	5,889,243
BAU minus Mitigated Scenario		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	21,337	1,117
Diesel	2,240	350
Total	**23,577**	**1,467**

Table B-11 Bicycle Infrastructure Assumptions	
Land Area of Community (sq miles)	10.5
Existing Scenario	
Bike Lanes (Class I and II)	10
Bike Lanes/sq mile	0.95
Mitigated Scenario	
Bike Lanes (Class I and II)	20
Bike Lanes/sq mile	1.90
% Increase in Bicycle Commute Mode Share for each Additional Mile of Bike Lane/sq mile	1.0%
Mitigated Bicycle Commute Mode Share	1.0%

Measure T-3: Pedestrian Environment Enhancements

This measure quantifies reductions resulting from pedestrian enhancements based on the EPA's Smart Growth INDEX (SGI) model, and uses a variety of indicators to measure changes in the pedestrian environment, including: sidewalk availability, ease of street crossing, connectivity of street/sidewalk system, terrain, and the pedestrian environment factor. This measure assumes that 3% of intersections within the city are improved to facilitate greater pedestrian crossing and that additional sidewalks are added to improve pedestrian circulation options. Emissions reductions come from VMT differences between a BAU scenario and a mitigated scenario. The SGI model was used to help develop VMT reduction assumptions based on the proposed changes in the measure. Table B-12 shows the VMT reduction assumptions, and Table B-13 shows the VMT reduction calculations for this measure.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	Improve pedestrian infrastructure and conditions in 3% of streets in the community	31 MT CO_2e/yr	*EPA Pedestrian Smart Growth INDEX model*

Table B-12
Application of Pedestrian Environment Factor Elasticities to VMT

Pedestrian Environment Factors (PEF)	Baseline	Mitigated
Sidewalk Availability	1.0	2.0
Ease of Street Crossing	1.0	2.5
Connectivity of Street/Sidewalk System	1.0	1.0
Terrain	1.0	1.0
PEF Score	**4.0**	**6.5**
Percent Change in PEF	-	0.625
Smart Growth INDEX PEF Elasticity	-	-0.03
Percent Change in VMT	-	-0.01875
Percent of Community Retrofitted		3%

Source: EPA Pedestrian Smart Growth INDEX model, adapted by AECOM, 2012

Table B-13 Communitywide VMT Reductions – Pedestrian Environment Improvements		
BAU Vehicles Miles Traveled Scenario		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	85,673,144	4,485,505
Diesel	8,993,314	1,405,205
Total	94,666,458	5,890,710
Mitigated Vehicles Miles Traveled Scenario		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	84,066,773	4,401,402
Diesel	8,824,689	1,378,858
Total	92,891,462	5,780,259
VMT and Fuel Reduction from Measure		
	Community Travel (miles)	Fuel Consumption (gallons)
Gasoline	48,191	2,523
Diesel	5,059	790
Total	**53,250**	**3,314**

Measure GI-1: Urban Forest

This measure is based on extrapolating the carbon potential of a typical tree planting palette. The City's goal is that 3,000 new trees will be planted by public and private development by 2020. Carbon sequestration rates specific to the species and age of the planted trees were collected from the Center for Urban Forest Research (CUFR) Tree Carbon Calculator and used to calculate the annual sequestration potential of the trees from 2008 – 2020. For purposes of the calculation it was assumed that an equal number of trees will be planted each year between 2008 and 2020 though the exact number of trees planted per year may vary. See Tables B-14 and B-15 for carbon sequestration assumptions used in this measure.

Year	Progress Indicators	GHG Reduction (MT CO_2e/yr)	Sources
2020	Plant 3,000 new trees	190 MT CO_2e/yr	The Center for Urban Forest Research (CUFR) Tree Carbon Calculator, Central Valley Climate Zone.

Table B-14
Carbon Sequestration of Trees Planted 2012-2020 in 2020

Year	Trees Planted per Year	Years of Growth	GHG Emissions Reductions (lbs CO_2e in 2020)	Carbon Sequestration (MT CO_2e in 2020)
2012	380	0	116,516	52.9
2013	380	1	95,014	43.1
2014	380	2	74,910	34.0
2015	380	3	56,085	25.4
2016	380	4	40,567	18.4
2017	380	5	27,675	12.6
2018	380	6	16,877	7.7
2019	380	7	0	0.0
Cumulative Total in 2020	**3,040**	NA	**427,644**	**194.0**

Note: Assumes age of tree at planting = 4 years

Table B-15
Carbon Sequestration per Species per Year of growth

Species	Camphor Tree *Cinnamomum camphora*		*Modesto Ash* *Fraxinus vlutina*		Sweetgum *Liquidambar styraciflua*		Roble Negro *Quercus ilex*		Turkish Pine *Pinus brutia*		*AVERAGE*	
Age	per year	Total	per year	Total	per year	Total	per year	Total	per year	Total	per year	Total
	20%		20%		20%		20%		20%			
1	**0.6**	0.6	**1.5**	1.5	**0.2**	0.2	**0.0**	0.0	**0.6**	0.6	0.3	0.6
2	**0.6**	1.2	**13.7**	15.2	**0.2**	0.4	**0.5**	0.5	**0.6**	1.2	1.4	3.7
3	**2.6**	3.8	**30.0**	45.2	**0.2**	0.6	**3.1**	3.6	**4.9**	6.1	3.7	11.9
4	**6.0**	9.8	**43.7**	88.9	**0.7**	1.3	**8.0**	11.6	**12.3**	18.4	6.4	26.0
5	**10.3**	20.1	**54.3**	143.2	**1.7**	3.0	**14.3**	25.9	**21.5**	39.9	9.3	46.4
6	**13.1**	33.2	**58.6**	201.8	**2.5**	5.5	**18.3**	44.2	**27.5**	67.4	10.9	70.4
7	**16.6**	49.8	**63.2**	265.0	**3.7**	9.2	**23.5**	67.7	**35.1**	102.4	12.9	98.8
8	**21.2**	71.0	**68.2**	333.2	**5.4**	14.5	**30.1**	97.9	**44.8**	147.2	15.4	132.8
9	**26.9**	97.9	**73.6**	406.8	**7.9**	22.4	**38.6**	136.5	**57.2**	204.3	18.6	173.6
10	**34.2**	132.1	**79.4**	486.2	**11.6**	34.0	**49.5**	186.0	**73.0**	277.3	22.5	223.1
11	**37.6**	169.7	**80.7**	566.9	**13.7**	47.7	**54.2**	240.2	**78.4**	355.7	24.0	276.0
12	**41.3**	211.0	**81.9**	648.8	**16.1**	63.8	**59.4**	299.6	**84.1**	439.9	25.7	332.6

Source: Center for Urban Forest Research, CUFR Model, USDA, 2008

Statewide Measures Reductions

For climate action planning purposes, baseline GHG emissions are projected under a business-as-usual scenario to a future year, assuming that conditions and consumption rates occurring in the baseline year would continue. However, even without local climate action planning, statewide measures and regulations would affect future business-as-usual GHG emissions.

Estimates of the local effect of statewide reduction measures should be conservative to avoid overestimating GHG reductions. In many cases, the regulation may not have the same effectiveness at a particular local level as it does on a statewide level. Furthermore, some regulations that affect certain industries or practices may occur more frequently in one jurisdiction than another and therefore various levels of statewide reductions would be anticipated in each jurisdiction. Therefore, AECOM has selected the following statewide reduction measures that would create reasonably foreseeable emissions reductions attributable to Shasta Lake at a local level.

Renewable Portfolio Standard

Executive Order S-21-09 established a statewide renewable energy portfolio target of 33% by year 2020. Therefore, California utilities, including PG&E, will increase their renewable portfolio standard (RPS) to at least 33% by year 2020. The GHG reductions associated with the RPS were estimated by evaluating PG&E's RPS increase from baseline year 2008 to year 2020 and 2035. PG&E's year 2008 baseline RPS-eligible electricity sources were determined to be approximately 12%. However, PG&E also maintains other renewable electricity sources that don't qualify for RPS (e.g., large hydroelectric sources); however, would also not generate GHG emissions. These non-RPS eligible sources account for approximately 20% of PG&E's year 2008 baseline electricity portfolio. Therefore, the anticipated change from baseline year 2008 to year 2020 is a 21% increase in RPS sources (i.e., 33% - 12% = 21%). Assuming that PG&E will only focus on RPS-eligible sources, year 2020 renewable portfolio would be approximately 53% (i.e., 33% RPS + 20% non-RPS = 53%). Although it is likely that PG&E would add additional RPS and non-RPS sources between 2020 and 2035, or that new regulations would require an increase in RPS sources, for a conservative analysis, the projections assume the 33% RPS and 20% non-RPS eligible renewable sources remained constant between 2020 and 2035. Table B-16 presents calculations used to estimate GHG emission reductions associated with the RPS.

Table B-16 Communitywide Renewable Portfolio Standard Calculations		
Parameter	**2020**	**2035**
Total Business-As-Usual Electricity Emissions (MT CO_2e/yr)	53,629	59,371
Business-As-Usual RPS [1]	12%	12%
Target RPS	33%	33%
Additional RPS Percent Increase	21%	21%
Total Renewable, Non-Carbon Electricity Sources	53%	53%
Total Electricity Emissions with RPS Target (MT CO_2e/yr) (Electricity BAU × (1-Additional RPS))	37,067	41,036
Emission Reduction (MT CO_2e/yr)	16,562	18,335

Notes: MT CO_2e/yr = metric tons of carbon dioxide equivalent per year; BAU = business as usual; RPS = renewable portfolio standard

[1] Business-as-usual renewable portfolio standard (RPS) (year 2008) and non-RPS eligible resources were obtained from Pacific Gas and Electric.

Source: AECOM 2012

Scoping Plan Transportation Measures

The AB 32 Climate Change Scoping Plan (Scoping Plan) has established several statewide measures that will contribute to California achieving its GHG reduction goal. Several statewide measures would affect the transportation-related business-as-usual emissions. In order to account for GHG reductions associated with Pavley I and the Low Carbon Fuel Standard (LCFS), the ARB-approved Pavley I and Low Carbon Fuel Standard Postprocessor Version 1.0 was used to estimate reductions from EMFAC2007 outputs (ARB 2010b). Table B-17 presents GHG emission reductions associated with Pavley I and the LCFS transportation measures.

The AB 32 Scoping Plan includes other transportation measures that would reduce motor vehicle emissions on a statewide level, which are not estimated in any ARB-approved models. AECOM has selected Medium- and Heavy-Duty Vehicle Efficiency and Pavley II as measures that can be reasonably assumed to be implemented and affect transportation emissions within Shasta Lake. To estimate the local effect of these reductions, AECOM divided the anticipated transportation emission reductions associated with the Scoping Plan transportation measures by the ARB-projected 2020 transportation emissions to estimate the percent reduction in transportation emissions attributed to implementation of the Scoping Plan. The percent reduction achieved by these measures from the state's total transportation sector was applied to the City's business-as-usual transportation emissions. This method assumes that the City will achieve the same relative level of transportation emission reductions associated with transportation measures as the Scoping Plan assumes at the statewide level. Table B-18 presents calculations used to estimate GHG emission reductions associated with the Medium- and Heavy-Duty Vehicle Efficiency and Pavley II transportation measures.

Table B-17
Pavley I and Low Carbon Fuel Standard Emission Reductions

Transportation Measure	Preferred Project (MT CO_2e/yr) 2020	Preferred Project (MT CO_2e/yr) 2035
Pavley I	11,931	25,083
Low Carbon Fuel Standard	5,462	6,173
Total	**17,393**	**31,256**

Notes: MT CO_2e/yr = metric tons of carbon dioxide equivalents per year.
Source: AECOM 2012, ARB 2010b

Table B-18
Communitywide Scoping Plan Measures Calculations

Energy Source and Year	Statewide Total Emissions (MMT CO_2e/yr) [1]	AB 32 Scoping Plan Reductions (MMT CO_2e/yr) [2]	Percent Reduction	Shasta Lake Total Emissions (MT CO_2e/yr)	Shasta Lake Total Emissions with Reduction Measure (MT CO_2e/yr)	Emission Reductions (MT CO_2e/yr)
Med- and Heavy-Duty Vehicle Efficiency[3]						
2020	168.10	1.4	0.03%	56,608	56,269	339
2035 [4]	168.10	1.4	0.03%	78,196	77,707	489
Pavley II						
2020	168.10	4.0	2.4%	56,608	55,000	1,608
2035 [4]	168.10	4.0	2.4%	78,196	76,242	1,954
Total Reductions						
2020	-	-	-	-	-	19,340 [5]
2035 [4]	-	-	-	-	-	33,699 [5]

Notes: MMT CO_2e/yr = million metric tons of carbon dioxide equivalent per year; MT CO_2e/yr = metric tons of carbon dioxide equivalent per year.

[1] Obtained from the ARB's 2020 projected inventory.

[2] Obtained from ARB's updated AB 32 Scoping Plan implementation schedule.

[3] Combines two AB 32 Scoping Plan action items: Heavy-Duty Vehicle Aerodynamic Efficiency Program and Medium- and Heavy-Duty Vehicle Hybridization Program

[4] ARB has not projected California statewide emissions or emission reductions associated with the AB 32 Scoping Plan out to year 2035. It is anticipated that additional efficiency could increase the measures reductions; however, the same level of reductions was assumed for both 2020 and 2035.

[5] Total reductions equal the sum of emissions reductions from Pavley I and Low Carbon Fuel Standard (see Table B-18) and the transportation measures described and presented above.

Source: AECOM 2012, ARB 2010c, ARB 2011.

2008 and 2013 California Title-24 Standards

Impact of 2008 Title-24

The first step of this analysis estimates the reduction in energy-related emissions (i.e., electricity and natural gas) associated with new buildings constructed from January 2010 through December 2013. This construction is subject to the current (2008) Title 24 energy code and therefore more efficient than buildings constructed under the 2005 Title 24 energy code requirements. Business-as-usual electricity and natural gas consumption levels for residential and non-residential construction were established using the CEC's Residential Appliance Saturation Survey data and the Commercial End Use Survey data for Forecast Climate Zone 3. The California Energy Commission's (CEC) report entitled *Impact Analysis - 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings* provides data on the energy savings potential of construction subject to 2008 requirements compared to construction subject to the 2005 baseline requirements. This savings potential was applied to projected levels of residential and non-residential construction for the jurisdiction (see Table B-19).

Table B-19
Impact of 2008 T-24 on Building Energy Use

Residential - Local Climate Zone		
Title-24 Period	**kWH/unit/year**	**therms/unit/year**
T-24 2005 Residential (SFR) Energy Use	7,514	364
T-24 2008 Residential (SFR) Energy Use	7,410	316
% difference	-1.4%	-13.1%

Non-Residential - Local Climate Zone		
Title-24 Period	**kWH/unit/year**	**kBTU/unit/year**
T-24 2005 Residential (SFR) Energy Use	13.64	29.49
T-24 2008 Residential (SFR) Energy Use	13.04	25.45
% difference	-4.4%	-13.7%

Note:
-Used RASS 'SFR' category for residential.
-Used CEUS 'All Commercial' category for non-residential.

Impact of 2013 Title-24

The second step of this analysis estimates the reduction in energy-related emissions (i.e., electricity and natural gas) associated with new buildings constructed from January 2014 forward. The CAPCOA report "*Quantifying Greenhouse Gas Mitigation Measures*" provides a methodology for calculating the reduction in energy-related emissions (i.e., electricity and natural gas) resulting from new construction built to energy efficiency standards above the current (2008) Title 24 energy code. The methodology calculates the reduction in electricity and natural gas consumption for each percent increase over current Title 24 standards per residential and non-residential building type and climate zone.

Baseline electricity and natural gas consumption levels per residential unit type were identified using CEC's Residential Appliance Saturation Survey data for Forecast Climate Zone 3. Mitigated levels of electricity and natural gas consumption levels per building type were calculated using the CAPCOA methodology. The measure assumes that all new buildings constructed after January 2014 will exceed 2008 Title 24 energy standards by 25%. This assumption was based on the following CEC press release. http://www.energy.ca.gov/title24/2013standards/rulemaking/documents/2013_Building_Energy_Efficiency_Standards_FAQ.pdf

Building Construction Projections

Projections of new residential development were developed from SCTPA traffic model inputs. Projections for new non-residential development were developed by using existing non-residential building area data from the County Assessors database and assuming the SCTPA traffic model employment growth rate to estimate growth in non-residential building stock.