
APPENDIX E

**GREENHOUSE GAS & AIR QUALITY
EMISSIONS CALCULATIONS**

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MEMORANDUM

To: Stephanie Strelow

From: Don Ballanti

Date: April 6, 2011

Subject: Santa Cruz GP GHG Emissions

I applied the URBEMIS program and the Bay Greenhouse Model (BGM) to the incremental growth expected by 2030. The trip rates used were adjusted trip rates accounting for interactivity between land uses and smart growth factors (enhanced mixed uses, local serving retail, transit/bike/pedestrian accessibility).¹

Greenhouse gas emissions were estimated using the BGM Model developed by the Bay Area Air Quality Management District.² The Bay Area Air Quality Management District's (BAAQMD's) Greenhouse Gas Model (BGM) is an Excel spreadsheet program that allows users to estimate operational greenhouse gas (GHG) emissions from land development projects. BGM reads URBEMIS-2007 project files to generate a portion of a project's GHG emission estimates.

URBEMIS-2007 is a land-use based program. Inputs are land use type, amount of each land use, a trip generation rate. The general plan growth increments by land use were input along with adjusted daily trip rates. URBEMIS-2007 has no Single Room Occupancy land use category, so the land use "low rise apartment" was substituted.

Air Pollution Meteorology • Dispersion Modeling • Climatological Analysis

¹ Memorandum to Chris Schneiter from Ron Marquez, General Plan Traffic Analysis Methodology, March 30, 2010.

² Bay Area Air Quality Management District, *Draft Bay Area Air Quality Management District Greenhouse Gas Model User's Manual*, April 29, 2010.

Stephanie Strelow

April 6, 2011

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My emissions estimates for General Plan Growth should be directly comparable to the inventory of GHG for the City of Santa Cruz CAP. Because the inventory only includes vehicle emissions within the Santa Cruz city limits, a 2.2 mile average trip length for all trip types was used. This average trip distance was based on studies of peak hour VMT and trip generation prepared in 2003.

The project build-out year is 2030. URBEMIS-2007 and BGM were run for this year. A second URBEMIS-2007 and BGM run was made for the same land use/trip inputs but for the year 2008. Comparison of the two sets of results revealed the BGM includes the effects of vehicle fleet changes and California fuel rules, as transportation emissions from the same land use inputs drop 30% between 2008 and 2030. It also revealed that BGM makes no adjustments for future energy efficiency as area sources, electricity use and natural gas emissions were identical for the 2008 and 2030 model runs. BGM assumes that homes and businesses in 2030 would be no more energy efficient in 2030 than homes and businesses in 2008. Therefore, the URBEMIS-2007/BGM results needed adjustment to reflect the State regulations and AB 32 programs, as described below.

Future buildings will be more energy efficient than existing buildings, so the BGM results had to be modified to reflect that fact. The Bay Area Air Quality Management District recently performed an analysis of GHG emission reductions that are anticipated to occur from implementation of the State regulations and AB 32 programs. Measures such as the Renewable Portfolio Standard, improvements in energy efficiency through periodic updates to Title 24, Solar Roofs program and other measures were determined to account for an estimated 9.5% reduction in natural gas GHG emissions and a 38.2% percent reduction in GHG emissions from electricity by 2020.³ These reductions were been applied to the BGM emission calculations.

The results are shown in Table 1. It is possible that refinements to the analysis could be made in water/wastewater and solid waste as the BGM assumptions for these emissions categories may not be accurate for Santa Cruz. The wastewater treatment plant uses biogas to generate electricity, and this fact is not accounted for by BGM. Also, future improvements in Increased water efficiency and solid waste generation reductions would also reduce water/wastewater and solid waste emissions, but BGM cannot take this into account. Therefore, the emissions projections shown in Table 1 should be considered as conservative estimates.

³ Bay Area Air Quality Management District, [BAAQMD CEQA Guidelines](#), Appendix D, June 2010.

Stephanie Strelow

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Table 1: General Plan Growth GHG Emissions, in CO₂ Equivalent Metric Tons/Year

Source	2008	2030
Transportation	39,805.84	28,208.41
Area Sources	2,918.54	2,918.54
Electricity	14,861.48	9,184.39
Natural Gas	6,809.85	6,162.91
Water and Wastewater Treatment	679.88	636.05
Solid Waste	6,045.40	6,061.82
Total	71,120.98	53,172.12

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MEMORANDUM

To: Stephanie Strelow

From: Don Ballanti

Date: August 29, 2011

Subject: Santa Cruz GP Criteria Pollutant Emissions

The California Air Resources Board provides estimates of emission inventories for past and future years on a county, air basin and state basis. There are currently no complete emission inventories for criteria pollutants available for specific cities.

Therefore, I have calculated vehicular emissions (the largest single source in the inventory) within city limits. The methodology involved developing estimates of Vehicle Miles Travelled (VMT) within city limits and multiplying by an annual average emission factor derived from the EMFAC-2007 program.

Vehicle travel on local roads within city limits were provided by Caltrans' Highway Performance Modeling System (HPMS) Data Library¹, which showed that total daily VMT within the Santa Cruz City limits was 566,070 in 2008. The URBEMIS-2007 analysis of projected growth through 2030 estimated that anticipate growth would increase daily VMT within city limits by 231,828 to a total of 797,898.

The EMFAC 2007 program was used to generate emissions factors for the Santa Cruz County vehicle fleet in the years 2008 and 2030 under the following assumptions:

Average Vehicle Speed: 30 mph
Temperature: 60 degrees F
Relative Humidity: 50%

Air Pollution Meteorology • Dispersion Modeling • Climatological Analysis

¹ <http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php>

Stephanie Strelow
 August 29, 2011
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The 2008 EMFAC 2007 emission factors were multiplied by the 2008 VMT estimate to generate a baseline estimate of vehicular emissions within city limits. Year 2030 EMFAC 2007 emission factors were multiplied by the year 2030 VMT to generate forecasted 2030 emission estimates.

The results are shown in Table 1. Ozone precursors (ROG and NO_x) and CO show substantial reductions by 2030 despite anticipated increases in VMT due to reductions in per-mile emission rates for the 2030 vehicle fleet.

PM₁₀ are expected to increase slightly by 2030. Vehicular emissions for this pollutant are not expected to decrease in the future as fast other criteria pollutants. This is because it has two components: exhaust and tire wear. While exhaust emissions will decrease over time, tire wear does not. Even so, the anticipated increase is less than 6 pounds per day, and would represent a significant air quality impact.

Table 1: City-Wide Existing and Future Criteria Pollutant Emissions, in Pounds Per Day

Year	Daily Average Emissions in Pounds/Day			
	ROG	CO	NO _x	PM ₁₀
2008	328.6	6,854.1	1,194.6	40.0
2030	82.8	1,997.6	332.93	45.8
Change	-245.8	-4,856.5	-861.7	+5.8

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Urbemis 2007 Version 9.2.4

Combined Annual Emissions Reports (Tons/Year)

File Name: C:\Users\Weatherman\My Documents\Business\Project Files\Santa Cruz GP\Santa Cruz GP 2030.urb924

Project Name: Santa Cruz General Plan Growth 2008

Project Location: Santa Cruz County

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	65.51	11.04	122.75	0.35	18.36	17.67	14,062.36

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	125.41	117.81	1,146.43	0.40	73.45	14.53	41,672.73

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	190.92	128.85	1,269.18	0.75	91.81	32.20	55,735.09

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

<u>Source</u>	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
Natural Gas	0.67	8.90	5.22	0.00	0.02	0.02	11,090.21
Hearth	25.28	2.11	114.90	0.35	18.33	17.64	2,967.76
Landscape	0.39	0.03	2.63	0.00	0.01	0.01	4.39
Consumer Products	32.56						
Architectural Coatings	6.61						
TOTALS (tons/year, unmitigated)	65.51	11.04	122.75	0.35	18.36	17.67	14,062.36

Area Source Changes to Defaults

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

<u>Source</u>	<u>ROG</u>	<u>NOX</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM25</u>	<u>CO2</u>
Single family housing	5.55	4.88	50.70	0.02	2.98	0.59	1,744.07
Apartments low rise	8.31	6.86	71.32	0.02	4.19	0.83	2,453.71
Apartments mid rise	11.08	9.15	95.06	0.03	5.59	1.11	3,270.17
Condo/townhouse general	5.97	5.17	53.75	0.02	3.16	0.63	1,849.15
General office building	17.90	16.37	162.51	0.06	10.13	2.01	5,808.42
General light industry	7.16	6.21	63.12	0.02	3.81	0.76	2,212.30
Commercial	69.44	69.17	649.97	0.23	43.59	8.60	24,334.91
TOTALS (tons/year, unmitigated)	125.41	117.81	1,146.43	0.40	73.45	14.53	41,672.73

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2008 Season: Annual

Emfac: Version : Emfac2007 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	148.67	9.57	dwelling units	446.00	4,268.22	9,390.08
Apartments low rise	70.81	5.30	dwelling units	1,133.00	6,004.90	13,210.78
Apartments mid rise	39.74	5.30	dwelling units	1,510.00	8,003.00	17,606.60
Condo/townhouse general	34.88	8.11	dwelling units	558.00	4,525.38	9,955.84
General office building		11.01	1000 sq ft	1,318.92	14,521.31	31,946.88
General light industry		6.97	1000 sq ft	783.54	5,461.27	12,014.80
Commercial		44.32	1000 sq ft	1,412.29	62,592.69	137,703.93
					105,376.77	231,828.91

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	44.8	2.9	96.2	0.9
Light Truck < 3750 lbs	18.7	3.7	91.5	4.8
Light Truck 3751-5750 lbs	19.8	1.5	98.0	0.5
Med Truck 5751-8500 lbs	6.9	1.4	98.6	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.2	0.0	66.7	33.3
Lite-Heavy Truck 10,001-14,000 lbs	0.8	0.0	50.0	50.0

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Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Med-Heavy Truck 14,001-33,000 lbs	1.1	9.1	18.2	72.7
Heavy-Heavy Truck 33,001-60,000 lbs	0.1	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	5.0	78.0	22.0	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	1.3	7.7	84.6	7.7

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	2.2	2.2	2.2	2.2	2.2	2.2
Rural Trip Length (miles)	2.2	2.2	2.2	2.2	2.2	2.2
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
General office building				35.0	17.5	47.5
General light industry				50.0	25.0	25.0
Commercial				2.0	1.0	97.0

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Urbemis 2007 Version 9.2.4

Combined Annual Emissions Reports (Tons/Year)

File Name:

Project Name: Santa Cruz General Plan Growth 2030

Project Location: Santa Cruz County

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

Summary Report:

AREA SOURCE EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	65.51	11.04	122.75	0.35	18.36	17.67	14,062.36

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	36.44	25.89	264.99	0.38	73.08	14.24	41,127.05

SUM OF AREA SOURCE AND OPERATIONAL EMISSION ESTIMATES

	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
TOTALS (tons/year, unmitigated)	101.95	36.93	387.74	0.73	91.44	31.91	55,189.41

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Area Source Unmitigated Detail Report:

AREA SOURCE EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

<u>Source</u>	<u>ROG</u>	<u>NOx</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM2.5</u>	<u>CO2</u>
Natural Gas	0.67	8.90	5.22	0.00	0.02	0.02	11,090.21
Hearth	25.28	2.11	114.90	0.35	18.33	17.64	2,967.76
Landscape	0.39	0.03	2.63	0.00	0.01	0.01	4.39
Consumer Products	32.56						
Architectural Coatings	6.61						
TOTALS (tons/year, unmitigated)	65.51	11.04	122.75	0.35	18.36	17.67	14,062.36

Area Source Changes to Defaults

Operational Unmitigated Detail Report:

OPERATIONAL EMISSION ESTIMATES Annual Tons Per Year, Unmitigated

<u>Source</u>	<u>ROG</u>	<u>NOX</u>	<u>CO</u>	<u>SO2</u>	<u>PM10</u>	<u>PM25</u>	<u>CO2</u>
Single family housing	1.61	1.07	11.78	0.02	2.97	0.58	1,721.37
Apartments low rise	2.50	1.50	16.58	0.02	4.17	0.82	2,421.77
Apartments mid rise	3.33	2.00	22.09	0.03	5.56	1.09	3,227.61
Condo/townhouse general	1.75	1.13	12.49	0.02	3.14	0.62	1,825.08
General office building	5.23	3.59	37.65	0.05	10.08	1.97	5,732.76
General light industry	2.13	1.36	14.66	0.02	3.79	0.74	2,183.61
Commercial	19.89	15.24	149.74	0.22	43.37	8.42	24,014.85
TOTALS (tons/year, unmitigated)	36.44	25.89	264.99	0.38	73.08	14.24	41,127.05

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Operational Settings:

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2030 Season: Annual

Emfac: Version : Emfac2007 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	148.67	9.57	dwelling units	446.00	4,268.22	9,390.08
Apartments low rise	70.81	5.30	dwelling units	1,133.00	6,004.90	13,210.78
Apartments mid rise	39.74	5.30	dwelling units	1,510.00	8,003.00	17,606.60
Condo/townhouse general	34.88	8.11	dwelling units	558.00	4,525.38	9,955.84
General office building		11.01	1000 sq ft	1,318.92	14,521.31	31,946.88
General light industry		6.97	1000 sq ft	783.54	5,461.27	12,014.80
Commercial		44.32	1000 sq ft	1,412.29	62,592.69	137,703.93
					105,376.77	231,828.91

Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	45.1	0.0	100.0	0.0
Light Truck < 3750 lbs	17.6	0.0	99.4	0.6
Light Truck 3751-5750 lbs	20.3	0.0	100.0	0.0
Med Truck 5751-8500 lbs	7.1	0.0	100.0	0.0
Lite-Heavy Truck 8501-10,000 lbs	1.2	0.0	75.0	25.0
Lite-Heavy Truck 10,001-14,000 lbs	0.9	0.0	55.6	44.4

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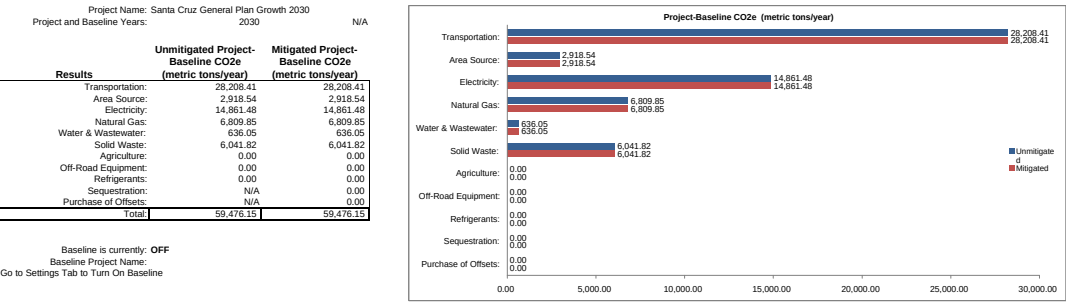
Vehicle Fleet Mix

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Med-Heavy Truck 14,001-33,000 lbs	1.1	0.0	18.2	81.8
Heavy-Heavy Truck 33,001-60,000 lbs	0.1	0.0	0.0	100.0
Other Bus	0.0	0.0	0.0	0.0
Urban Bus	0.1	0.0	0.0	100.0
Motorcycle	5.1	33.3	66.7	0.0
School Bus	0.1	0.0	0.0	100.0
Motor Home	1.3	0.0	92.3	7.7

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	2.2	2.2	2.2	2.2	2.2	2.2
Rural Trip Length (miles)	2.2	2.2	2.2	2.2	2.2	2.2
Trip speeds (mph)	30.0	30.0	30.0	30.0	30.0	30.0
% of Trips - Residential	32.9	18.0	49.1			
% of Trips - Commercial (by land use)						
General office building				35.0	17.5	47.5
General light industry				50.0	25.0	25.0
Commercial				2.0	1.0	97.0

Summary Results



Detailed Results

Unmitigated	CO2 (metric tpy)	CH4 (metric tpy)	N2O (metric tpy)	CO2e (metric tpy)	% of Total
Transportation*:				28,208.41	47.43%
Area Source:	2,697.05	10.13	0.03	2,918.54	4.91%
Electricity:	14,837.74	0.12	0.07	14,861.48	24.99%
Natural Gas:	6,792.44	0.64	0.01	6,809.85	11.45%
Water & Wastewater:	635.04	0.01	0.00	636.05	1.07%
Solid Waste:	88.93	283.47	N/A	6,041.82	10.16%
Agriculture:	0.00	0.00	0.00	0.00	0.00%
Off-Road Equipment:	0.00	0.00	0.00	0.00	0.00%
Refrigerants:	N/A	N/A	N/A	0.00	0.00%
Sequestration:	N/A	N/A	N/A	N/A	N/A
Purchase of Offsets:	N/A	N/A	N/A	N/A	N/A
Total:				59,476.15	100.00%

Baseline	CO2 (metric tpy)	CH4 (metric tpy)	N2O (metric tpy)	CO2e (metric tpy)	% of Total
Transportation*:				0.00	N/A
Area Source:	0.00	0.00	0.00	0.00	N/A
Electricity:	0.00	0.00	0.00	0.00	N/A
Natural Gas:	0.00	0.00	0.00	0.00	N/A
Water & Wastewater:	0.00	0.00	0.00	0.00	N/A
Solid Waste:	0.00	0.00	N/A	0.00	N/A
Agriculture:	0.00	0.00	0.00	0.00	N/A
Off-Road Equipment:	0.00	0.00	0.00	0.00	N/A
Refrigerants:	N/A	N/A	N/A	0.00	N/A
Sequestration:	N/A	N/A	N/A	N/A	N/A
Purchase of Offsets:	N/A	N/A	N/A	N/A	N/A
Total:				0.00	0.00%

* Several adjustments were made to transportation emissions after they have been imported from URBEMIS. After importing from URBEMIS, CO2 emissions are converted to metric tons and then adjusted to account for the "Pavley" regulation. Then, CO2 is converted to CO2e by multiplying by 100/95 to account for the contribution of other GHGs (CH4, N2O, and HFCs [from leaking air conditioners]). Finally, CO2e is adjusted to account for its low carbon fuels rule.

Mitigated	CO2 (metric tpy)	CH4 (metric tpy)	N2O (metric tpy)	CO2e (metric tpy)	% of Total
Transportation*:				28,208.41	47.43%
Area Source:	2,697.05	10.13	0.00	2,918.54	4.91%
Electricity:	14,837.74	0.12	0.07	14,861.48	24.99%
Natural Gas:	6,792.44	0.64	0.01	6,809.85	11.45%
Water & Wastewater:	635.04	0.01	0.00	636.05	1.07%
Solid Waste:	88.93	283.47	N/A	6,041.82	10.16%
Agriculture:	0.00	0.00	0.00	0.00	0.00%
Off-Road Equipment:	0.00	0.00	0.00	0.00	0.00%
Refrigerants:	N/A	N/A	N/A	0.00	0.00%
Sequestration:	N/A	N/A	N/A	0.00	0.00%
Purchase of Offsets:	N/A	N/A	N/A	0.00	0.00%
Total:				59,476.15	100.00%

Mitigation Measures Selected:

- Transportation:** Go to the following tab: [Transp. Detail Mit](#) for a list of the transportation mitigation measures selected (in URBEMIS)
- Electricity:** The following mitigation measure(s) have been selected to reduce electricity emissions.
- Natural Gas:** The following mitigation measure(s) have been selected to reduce natural gas emissions.
- Water and Wastewater:** The following mitigation measure(s) have been selected to reduce water and wastewater emissions.
- Solid Waste:** The following mitigation measure has been selected to reduce solid waste related GHG emissions.
- Ag:** No existing mitigation measures available.
- Off-Road Equipment:** No existing mitigation measures available.
- Refrigerants:** The following mitigation measure has been selected to reduce refrigerant emissions:
- Carbon Sequestration:** Project does not include carbon sequestration through tree planting.
- Emission Offsets/Credits:** Project does not include purchase of emission offsets/credits.