CITY OF LA MESA

CLIMATE ACTION PLAN

APPENDIX A – Emissions Inventory and Forecast Methodology

PUBLIC REVIEW DRAFT
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This appendix describes the emissions sectors, data sources, and methodology used to prepare the CAP's 2010 baseline emissions inventory and the 2020 and 2035 emissions forecasts. In the future, inventory updates should follow the methodologies presented below to provide consistency between inventory versions and allow direct comparisons from one year to another. However, it is likely that inventory methodologies will continue to evolve, and the City may find it more beneficial to follow prevailing industry standards, even if those changes make direct comparisons to prior year inventories more difficult.

It should be noted that the 2010 baseline inventory and baseline methodology appendix were prepared by the University of San Diego's Energy Policy Initiatives Center (EPIC) as part of a separate project from the remainder of the CAP (i.e., emissions forecasts, CAP document). AECOM subsequently revised the transportation and solid waste inventory methodologies, and made corresponding revisions to the original baseline inventory methodology appendix. The 2010 inventory was then used as the baseline from which AECOM prepared the 2020 and 2035 emissions forecasts.

This appendix primarily represents EPIC's original baseline inventory methodology, with new descriptions of AECOM's revisions to the transportation and solid waste sector calculations, and a new section describing AECOM's emissions forecast methodology. EPIC's original methodology appendix included inventory data for three years (i.e., 2010-2012), which is still presented throughout this appendix. The CAP and baseline greenhouse gas (GHG) inventory were developed based on the 2010 data presented herein.

Baseline Emissions Inventory

Note: *Table A-1 presents global warming potential (GWP) values from the International Panel on Climate Change (IPCC) Fourth Assessment Report (4AR). The emissions forecasts prepared subsequent to this original baseline inventory incorporated the GWP values from the more recent Fifth Assessment Report (5AR), as presented in Appendix B – Reductions Methodology. Revisions to the baseline inventory transportation and solid waste sectors also incorporated the 5AR GWP values. Although a comprehensive update to the original baseline inventory was not completed as part of the CAP project, the changes from 4AR to 5AR would be minor.*

GHGs include the sum of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions and are known as CO_2 equivalents (CO_2e). Methane and nitrous oxide emissions are converted to carbon dioxide equivalents by multiplying by their Global Warming Potentials (GWP). In general, the GWPs used to estimate greenhouse gas emissions are consistent with 100-year GWPs reported by the Intergovernmental Panel on Climate Change (IPCC) in their Fourth Assessment Report (AR4) in 2007. The GWP values used are given in Table A-1.

Table A-1 Global Warming Potentials Used in La Mesa GHG Inventory	
Greenhouse Gas	**Global Warming Potential (GWP)**
Carbon Dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous Oxide (N_2O)	298

Community-scale emissions are calculated using standard methods as published by the ICLEI Community Protocol.[1] The ICLEI Community Protocol recommends including emissions from six sectors for a typical community-scale GHG inventory. These sectors are: electricity, natural gas, transportation, water, solid waste, and wastewater. For all the sectors, activity data was multiplied by a GHG emissions factor specific to each year and sector. Where region or city-specific data was available, the method deviated from the ICLEI methodology, which provides for default emissions factors by region. For example, wastewater emissions were estimated using proxy emissions factor data from the City of San Diego's Point Loma Wastewater Treatment Plant, in addition to wastewater generation estimates for La Mesa. More details on method, input data, and emissions factor information are provided in each section below.

ELECTRICITY

EPIC estimated emissions from electricity using the Built Environment (BE.2) method from the ICLEI Community Protocol. Annual electricity demand for La Mesa was provided by the utility and grossed up by 6.6%[3] to account for transmission and distribution losses. The resulting value was multiplied by the average annual electricity GHG emission factor for San Diego County, expressed in pounds of CO_2e per Megawatt-hour (lbs CO_2e/MWh).

EPIC developed emission factors associated with electricity consumption for 2010, 2011, and 2012 using FERC Form 1 data on purchased power and U.S. EPA Emissions and Generating Resource Integrated Database (eGRID) for electric plant emissions and allocation of cogeneration emissions between electric production and thermal energy. The emissions factors derived from these reports were validated by SDG&E personnel for accuracy. The combined ($CO_2 + CH_4 + N_2O$ in terms of CO_2e) emissions factors for each inventory year are expressed in pounds of CO_2e per megawatt-hour (lbs CO_2e/MWh). Total electricity consumption by La Mesa, the annual GHG emissions factors, and corresponding emissions are given in Table A-2.

[1] ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, 2013, at http://www.icleiusa.org/tools/ghg-protocol/community-protocol

[3] California Energy Demand 2015-2025 Revised Forecast, Volume 1: Statewide Electricity Demand, End-User Natural Gas Demand, and Energy Efficiency. California Energy Commission, Electricity Supply Analysis Division. Publication Number: CEC-200-2014-009-SF-REV

Table A-2 Electricity Consumption, Emissions Factors, and Corresponding GHG Emissions for La Mesa			
Year	**Electricity Consumption**	**Emissions Factor**	**GHG Emissions**
	(kWh)	(lbs CO_2e/MWh)	(MT CO_2e)
2010	296,069,929	680	96,604
2011	296,106,280	676	96,003
2012	304,250,152	778	113,711

The emissions factor is relatively high in 2012 due to the shutdown of electricity supply from the San Onofre Nuclear Generation Station (SONGS), a GHG emissions-free supply, and its replacement by electricity produced from two other plants based on natural gas.

Electricity emissions can be broken down further into residential and commercial/industrial categories, based on data provided by the utility. Figure A-1 below gives that breakdown.

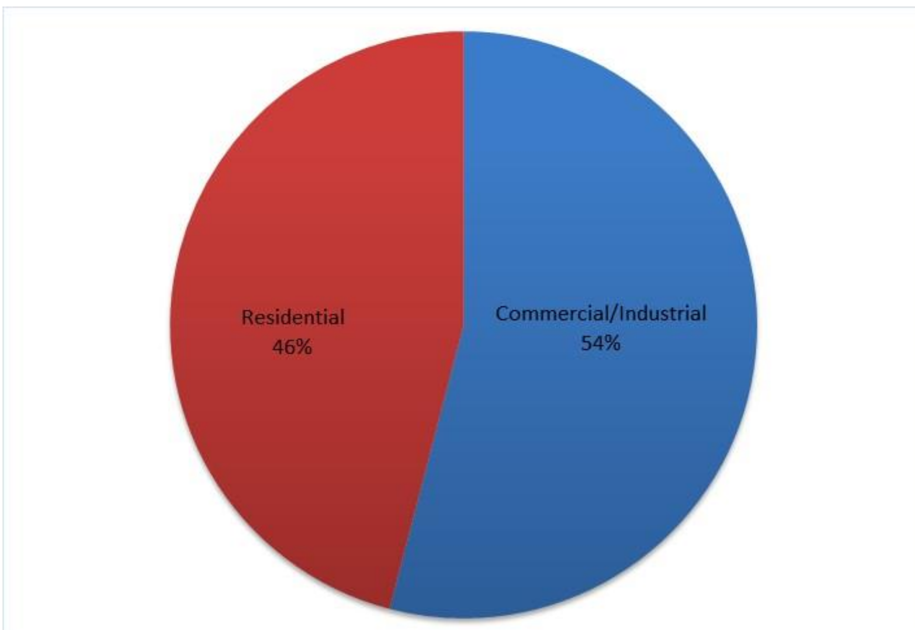

Figure A-1: GHG Breakdown of Electricity Sector

NATURAL GAS

Emissions from natural gas consumption by La Mesa were estimated using method Built Environment (BE.1) from the ICLEI U.S. Community Protocol. To estimate emissions from the combustion of natural gas, EPIC multiplied community fuel use by an emissions factor for natural gas[4], based on data from the California Air Resources Board. Table A-3 summarizes emissions from natural gas with the corresponding natural gas consumption.

Table A-3
Natural Gas Consumption and Corresponding GHG Emissions

Year	Natural Gas Consumption (Therms)	GHG Emissions ($MT\ CO_2e$)
2010	9,314,927	50,705
2011	9,506,014	51,745
2012	8,817,411	47,997

Emissions from the natural gas sector can be broken down further into residential and commercial/industrial categories, based on data provided by the utility. That breakdown is given in Figure A-2.

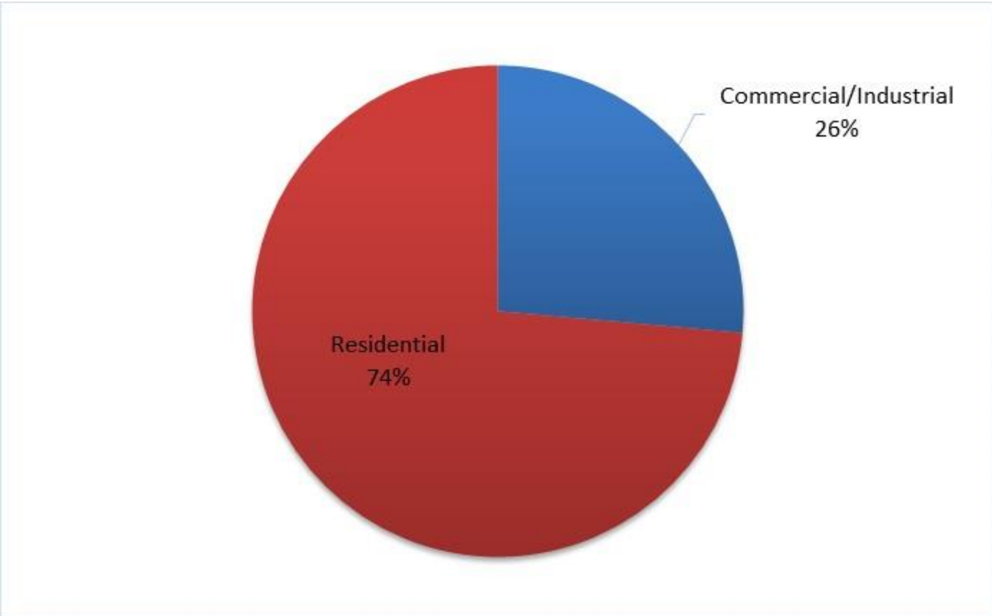

Figure A-2: GHG Breakdown of Natural Gas Sector

[4] Natural Gas emissions factor: 0.00544342248 MMT CO_2e/Million Therms

TRANSPORTATION

Note: *Two changes were made to the original transportation sector calculations during revisions to the 2010 baseline inventory. First, AECOM revised the IE/EI value used to calculate the baseline inventory following guidance from SANDAG. The original value used did not represent La Mesa's complete share of IE/EI trips, so the value was revised upward from 270,964 miles per day to 1,279,147 miles per day.*

Second, transportation sector emissions were quantified using the most current version of ARB's EMFAC model, EMFAC2014, as opposed to an older version (EMFAC2011) that was used to prepare the original GHG inventory. This change made the 2010 transportation sector emissions directly compatible with the 2020 and 2035 forecasts, which were also estimated using EMFAC2014 emissions factor outputs.

To estimate GHG emissions associated with on-road transportation, EPIC uses vehicle miles traveled (VMT) and the emission rates associated with the vehicle classes. SANDAG provided regional VMT data for La Mesa for all vehicle types based on the Origin-Destination (O-D) method for 2010 and 2020. EPIC interpolated for the years not provided. The O-D VMT method as proposed by the ICLEI Community Protocol estimates miles traveled based on where a trip originates and where it ends to more accurately allocate on-road emissions to cities and regions with policy jurisdiction over miles traveled as shown in Figure A-3. O-D VMT includes trips that originate and end within the designated boundary, in this case the La Mesa (Internal-Internal), and trips that either begin within the designated boundary and end outside of it (Internal-External), or vice versa (External-Internal). Internal-External and External-Internal miles are divided by 2 to evenly allocate the miles to the outside jurisdiction. Total VMT included is then multiplied by 0.96 to convert from average weekday VMT to average week VMT, including weekends. Finally, VMT from trips that begin and end outside the designated boundary (External-External) are excluded, and emissions from this category of VMT are not allocated to the jurisdiction. Table A-4 provides VMT data for 2010.[5]

[5] Table A-5 in the original inventory methodology prepared by EPIC incorrectly showed an Internal-External and External-Internal value of 541,927 DVMT for 2010, which was subsequently revised to 2,558,294 DVMT.

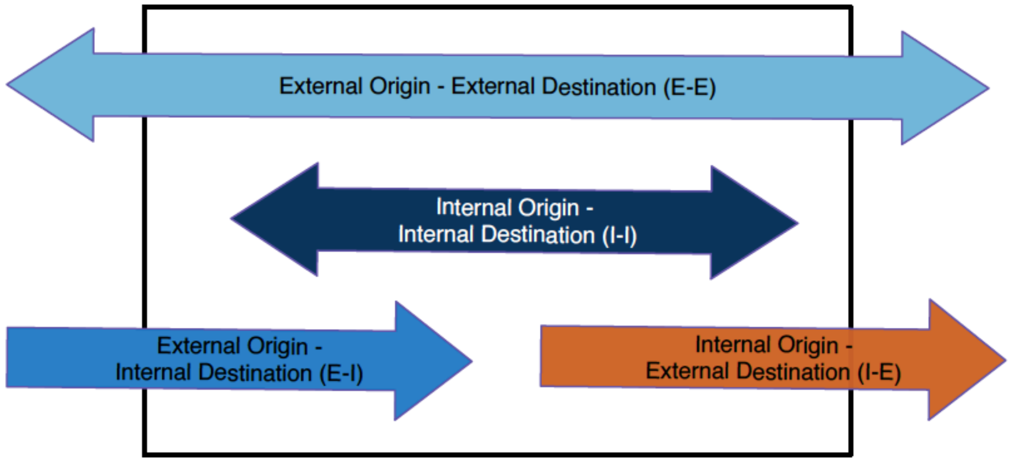

Figure A-3: Components of Origin Destination (O-D) method for calculation of Vehicle Miles Traveled (VMT) according to the ICLEI Community Protocol

Table A-4
Raw O-D VMT for La Mesa

Year	Internal-Internal	Internal-External and External-Internal [1]	External-External
	(miles/day)	(miles/day)	(miles/day)
2010	162,382	2,558,294	1,078,439

Note: The original baseline inventory methodology appendix from EPIC included data for years 2010, 2011, and 2012 in Table 4. When AECOM corrected the IE-EI DVMT value, revisions were only made to the 2010 data because it corresponds with the CAP 2010 baseline year. The original and incorrect 2011 and 2012 data have been deleted from this table to avoid confusion.

[1] The IE-EI value shown above represents the raw IE-EI value for La Mesa, which was multiplied by 0.5 per the O-D methodology described earlier in this section.

Emissions rates expressed in carbon-dioxide equivalent per mile driven (CO_2e/mi) were derived from the statewide EMFAC2014 model[6], which is the California Air Resources Board's (CARB) tool used to calculate air pollution emissions, including GHGs, on a metropolitan planning organization (MPO) basis. EMFAC2014 outputs were used to generate fleet-wide CO_2e/mi values for 2010. These emissions factors incorporate the effects of several statewide vehicle emissions reduction programs, including Pavley Regulations, the Advanced Clean Cars Program, Heavy-Duty GHG Phase 1, and Truck and Bus Regulations.[7] GHG emissions are calculated by multiplying VMT by the emissions factor.

[6] EMFAC is the Emissions Factor model developed and used by the State of California to estimate air pollutant and carbon dioxide gas emissions on a region-wide or Metropolitan Planning Organization (MPO) basis. SANDAG, the San Diego Regional Association of Governments, is the MPO for the San Diego region, which included 18 cities and 1 unincorporated county.

[7] Air Resources Board. *EMFAC2014 Volume III – Technical Documentation, v1.0.7*. May 12, 2015. Available: https://www.arb.ca.gov/msei/downloads/emfac2014/emfac2014-vol3-technical-documentation-052015.pdf

SOLID WASTE

Note: *This section describes the revised solid waste methodology and calculations prepared by AECOM, which replaced the original solid waste methodology prepared by EPIC.*

As part of the 2035 CAP revisions, AECOM recalculated solid waste emissions estimates for the 2010 base year, and the 2020 and 2035 forecast years using the methane commitment method outlined in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The equations and inputs associated with that method are presented below, followed by additional data items used to estimate La Mesa's solid waste emissions.

AECOM applied equations 8.1, 8.3, and 8.4 from the GPC (shown on the following pages). The calculations assumed a baseline methane capture factor of 75% at landfills receiving La Mesa's solid waste, which corresponds to the f_{rec} value in equation 8.3.

Equation 8.1: Degradable organic carbon (DOC)

DOC = (0.15 x A) + (0.2 x B) + (0.4 x C) + (0.43 x D) + (0.24 x E) + (0.15 x F) + (0.39 x G) + (0.0 x H) + (0.0 x I) + (0.0 x J) + (0.0 x K)	
A	= Fraction of solid waste that is food
B	= Fraction of solid waste that is garden waste and other plant debris
C	= Fraction of solid waste that is paper
D	= Fraction of solid waste that is wood
E	= Fraction of solid waste that is textiles
F	= Fraction of solid waste that is industrial waste
G	= Fraction of solid waste that is rubber and leather
H	= Fraction of solid waste that is plastics
I	= Fraction of solid waste that is metal
J	= Fraction of solid waste that is glass
K	= Fraction of solid waste that is other, inert waste

Source: Default carbon content values sourced from IPCC Waste Model spreadsheet, available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf
Note: GPC Equation 8.1 includes factors A-F; AECOM added factors G-K using the default DOC content in % of wet waste from the same IPCC Waste Model spreadsheet referenced in the source above

Equation 8.3: Methane commitment estimate for solid waste sent to landfill

CH_4 emissions = MSW_x x L_0 x (1-f_{rec}) x (1-OX)		
Description		**Value**
CH_4 emissions	= Total CH_4 emissions in metric tons	Computed
MSW_x	= Mass of solid waste sent to landfill in inventory year, measured in metric tons	User input
L_0	= Methane generation potential	Equation 8.4 Methane generation potential
f_{rec}	= Fraction of methane recovered at the landfill (flared or energy recovery)	User input
OX	= Oxidation factor	0.1 for well-managed landfills; 0 for unmanaged landfills

Source: Adapted from *Revised 1996 IPCC Guidelines for National Greenhous Gas Inventories*

AECOM used the following values in Equation 8.3 for La Mesa's calculations:

- MSWx = see Table A-6
- frec = 75%
- OX = 0.1

Equation 8.4: Methane generation potential, L_0

L_0 = MCF x DOC x DOC_F x F x 16/12		
Description		**Value**
L_0	= Methane generation potential	Computed
MCF	= Methane correction factor based on type of landfill site for the year of deposition (managed, unmanaged, etc., fraction)	Managed = 1.0 Unmanaged (≥ 5 m deep) = 0.8 Unmanaged (<5 m deep) = 0.4 Uncategorized = 0.6
DOC	= Degradable organic carbon in year of deposition, fraction (tons C/tons waste)	Equation 8.1
DOC_F	= Fraction of DOC that is ultimately degraded (reflects the fact that some organic carbon does not degrade)	Assumed equal to 0.6
F	= Fraction of methane in landfill gas	Default range 0.4-0.6 (usually taken to be 0.5)
16/12	= Stoichiometric ratio between methane and carbon	

Source: *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)*

AECOM used the following values in Equation 8.4 for La Mesa's calculations:

- MCF = 1.0

- DOCf = 0.6
- F = 0.5

Waste Disposal Data

EPIC obtained data on solid waste disposal in La Mesa from the California Department of Resources Recycling and Recovery (CalRecycle) Disposal Reporting System (DRS). Alternative Daily Cover (ADC) was not included in total tonnage. Waste disposal data are given in Table A-5.

Table A-5
Solid Waste Disposal and Corresponding GHG Emissions for La Mesa

Year	Solid Waste Disposed (Wet Short Tons)
2010	42,718
2011	35,709
2012	30,271

The solid waste disposal value from 2010 was used to estimate disposal amounts in 2020 and 2035 (see Table A-6). AECOM used the 2010 disposal value shown in Table A-5, and converted from short tons to metric tons for use in the preceding equations. The rate of disposal, expressed as metric tons per service population (MT/SP) was calculated based on 2010 values, and held constant to estimate future disposal values in the emissions forecasts.

Table A-6
Waste Disposal Forecasts

Year	Short Tons (ST)	Metric Tons (MT)	Service Population (SP) [3]	MT/SP [4]
2010	42,718 [1]	38,753 [2]	85,146	0.455
2020	-	41,394 [5]	90,949	0.455
2035	-	45,377 [5]	99,700	0.455

Source: AECOM 2016
Notes: Service population (SP) = population and jobs
[1] See Table A-5
[2] 1.0 short ton = 0.9072 metric tons
[3] See Table A-12 for demographic data sources
[4] Calculated for 2010 as MT/SP, and held constant for 2020 and 2035
[5] Calculated as SP * (MT/SP)

Waste Characterization

AECOM estimated landfill waste composition based on CalRecycle's statewide waste characterization studies. The 2010 baseline year inventory results are based on the *California 2008 Statewide Waste Characterization Study*. The 2020 and 2035 emissions forecasts were based on CalRecycle's *2014 Disposal-Facility-Based Characterization of Solid Waste in*

California report. Per the 2014 report, CalReycle's side-by-side analysis of the 2008 and 2014 study results identified an unexpected anomaly in the distribution of waste per sector (i.e., residential, commercial, and self-hauled). The report states that CalRecycle is currently obtaining additional data to verify the 2014 report results. In the interim, the 2014 report presents two sets of data: one reflecting the 2014 calculated sector percentages, and the other based on the 2008 report sector percentages. AECOM selected to use the set of data based on the 2008 report.

The CalRecycle studies estimate the percentage of different materials in California's waste stream. AECOM referred to *Table 7: Composition of California's Overall Disposed Waste Stream* in both studies to determine the distribution of waste by the material types included in Equation 8.1. Table A-7 shows the results of this data sorting.

Table A-7
Waste Characterization – Selected Material Categories

Material	Estimated % of Total Disposed Waste Stream		Material Categories/Sub-types from CalRecycle Reports [1, 2]
	2008	2014	
Paper	18.9%	18.1%	Paper category plus Gypsum Board sub-type from Inerts and Other category
Textiles	5.4%	5.6%	Textiles and Carpet sub-types from Other Organic category
Food	15.5%	16.5%	Food sub-type from Other Organic category
Garden and Park	10.9%	10.6%	Leaves and Grass, Prunings and Trimmings, Manures, and Remainder/Composite Organics sub-types from Other Organic category
Wood	15.1%	15.5%	Lumber sub-type from Inerts and Other category and Branches and Stumps sub-type from Other Organic category
Rubber and Leather	0.2%	0.1%	Tires sub-type from Special Waste category
Plastics	9.6%	10.4%	Plastic category
Metal	4.6%	3.1%	Metal category
Glass	1.4%	2.5%	Glass category
Other	18.4%	17.6%	Electronics category, Household Hazardous Waste (HHW) category, Mixed Residue category, Inerts and Other category (minus Lumber and Gypsum Board sub-types), and Special Waste category (minus Tires sub-type)
Total	100.0%	100.0%	

Source: AECOM 2016

[1] *California 2008 Statewide Waste Characterization Study,* California Integrated Waste Management Board 2009. Prepared by Cascadia Consulting Group. Available online at: <http://www.calrecycle.ca.gov/publications/Documents/General/2009023.pdf>

[2] *2014 Disposal-Facility-Based Characterization of Solid Waste in California,* CalRecycle 2015. Prepared by Cascadia Consulting Group. Available online at: <http://www.calrecycle.ca.gov/Publications/Documents/1546/20151546.pdf>

La Mesa Waste Disposal by Characterization Type

AECOM multiplied the solid waste disposal values (in metric tons) from Table A-6 by the waste characterization values presented in Table A-7 to estimate disposal values by waste type for the 2010, 2020, and 2035 inventory years. Table A-8 below presents the results, which were applied to Equations 8.1 and 8.3 to calculate La Mesa's solid waste emissions.

Table A-8
Waste Disposed by Waste Type

Waste Type	2010 (MT)	2020 (MT)	2035 (MT)
Paper	7,324	7,492	8,213
Textiles	2,093	2,318	2,541
Food	6,007	6,830	7,487
Garden and Park	4,224	4,388	4,810
Wood	5,852	6,416	7,033
Rubber and Leather	78	41	45
Plastics	3,720	4,305	4,719
Metal	1,783	1,283	1,407
Glass	543	1,035	1,134
Other	7,131	7,285	7,986
Total	**38,753**	**41,394**	**45,377**

Source: AECOM 2016
Notes: MT = metric tons

Table A-9 presents the emissions results by waste type and year.

Table A-9
Solid Waste Emissions by Waste Type

Waste Type	2010 (MT CO_2e)	2020 (MT CO_2e)	2035 (MT CO_2e)
Paper	7,383	7,552	8,279
Textiles	1,266	1,402	1,537
Food	2,271	2,582	2,830
Garden and Park	2,129	2,211	2,424
Wood	6,341	6,953	7,621
Rubber and Leather	76	41	45
Plastics	0	0	0
Metal	0	0	0
Glass	0	0	0
Other	0	0	0
Total	**19,465**	**20,741**	**22,736**

Source: AECOM 2016
Notes: MT CO_2e = metric tons of carbon dioxide equivalent

The results from Equation 8.3 were multiplied by a global warming potential (GWP) factor for CH_4 to convert to metric tons of carbon dioxide equivalent (MT CO_2e). The following GWP value was used from the UN IPCC 5th Assessment Report: CH_4 = 28.

WATER

To the extent possible, emissions from energy use associated with the conveyance and treatment of water consumed by the La Mesa Community were estimated using the WW.14 method from the ICLEI US Community Protocol. The method considers each element of the water cycle: (upstream [supply and conveyance], local conveyance/distribution, groundwater extraction, treatment, and distribution) separately, using a community-specific energy consumed per unit of water for each process of the water system given in Table A-10.

Table A-10
Commonly Used California Energy Commission (CEC) Estimates of Energy Intensity for Elements of Water Use Cycle, Southern California

Element of Water Use Cycle	Energy Intensity (kWh/Million Gallons)
Upstream[8]	9,727
Groundwater Extraction[9]	1,820
Distribution[10]	684
Local Conveyance/Distribution[11]	292
Treatment[12]	100

To estimate gallons of water consumed in La Mesa per year, an annual per capita consumption value[13] for the region for 2010 was multiplied by La Mesa's population.[14] The result was then split into groundwater and surface water using a breakdown for the Helix Water District from the 2010 San Diego County Water Authority Water Management Plan.[15] Total GHG emissions for La Mesa's water use were then estimated by taking a sum of the emissions from each process. About 90% of water sector emissions were a result of upstream energy use. The relative breakdown of emissions for the water sector is given in Figure A-4.

[8] California Energy Commission (CEC), Navigant Study, 2006

[9] Default ICLEI US Communities Protocol, assumed an extraction depth of 120 feet.

[10] California Energy Commission (CEC), 2006

[11] California Energy Commission (CEC), 2006

[12] Default estimate from ICLEI US Communities Protocol.

[13] Assumed per capita consumption was 150 gallons/person/day, equivalent to 2010 regional per capita water use as reported by San Diego County Water Authority, available at http://www.sdcwa.org/2010-urban-water-management-plan.

[14] Based on SANDAG Series 12 forecast.

[15] The split is based on the groundwater to surface water ratio for Helix Water District, which supplies water to La Mesa. 2010 Urban Water Management Plan of June 2011, Appendix F, Table F-2, available at http://www.sdcwa.org/2010-urban-water-management-plan.

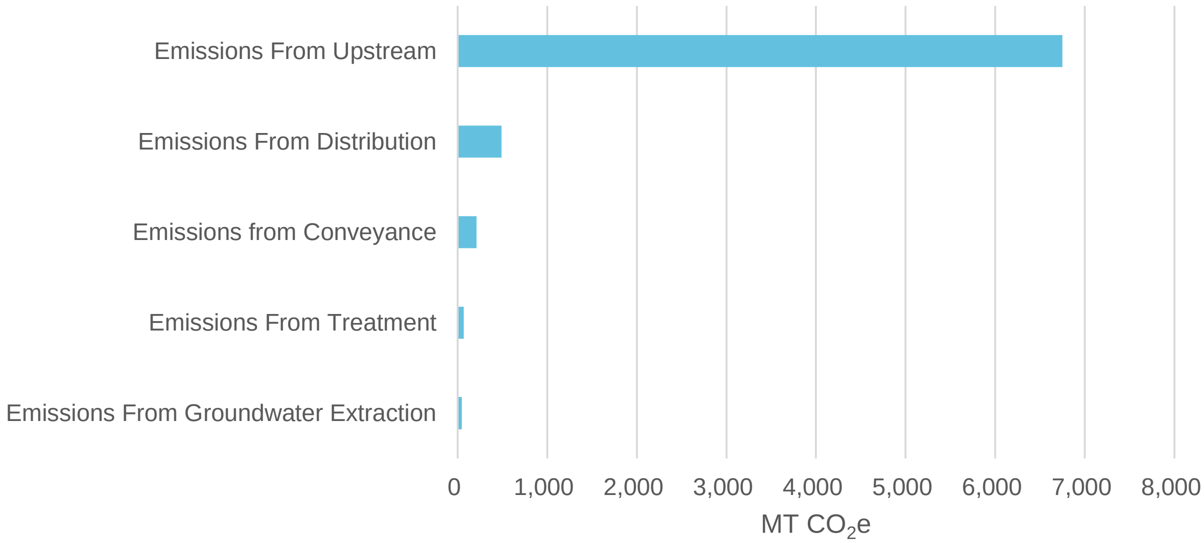

Figure A-4: Breakdown of Emissions from the Water Sector for La Mesa

WASTEWATER

Due to lack of data for wastewater treatment facilities used by the City of La Mesa, EPIC used energy intensity factors from the treatment of wastewater at the Point Loma Wastewater Treatment Plant in the City of San Diego as a proxy for other plants in the region. Note that if the City of La Mesa does not dispose its wastewater to the City of San Diego, these emissions estimates may underestimate La Mesa's wastewater treatment emissions. This is because the Point Loma facility is unique in that it is the only treatment plant in the state that has been given a waiver to treat to a lower standard than other newer treatment facilities in the state. Therefore, the energy use associated with Point Loma will generally be lower than that of other treatment facilities.

The City of La Mesa provided wastewater flow data. Table A-11 provides annual wastewater generated by La Mesa and corresponding GHG emissions.

Table A-11
Annual Wastewater Generated by La Mesa

Year	Wastewater Generated (Gallons/year)[16]	GHG Emissions ($MT CO_2e$/year)
2010	4,824,000	2,441
2011	4,978,000	2,519
2012	4,444,000	2,249

Community-wide Emissions Forecast Assumptions and Methodology

The baseline inventory presented above was used to project the future community-wide GHG emissions. La Mesa's GHG emissions were forecast for the years 2020 and 2035 assuming that historic trends describing energy and water consumption and solid waste generation will remain the same in the future, on a per service population (population plus employment) basis. Transportation growth estimates were provided separately by SANDAG from its Series 13 data. The emissions forecasts demonstrate what emissions levels are likely to be under a scenario in which no additional statewide or local actions are taken to curtail emissions growth (beyond the statewide transportation programs embedded within the EMFAC2014 model used to estimate transportation sector emissions).

Table A-12 presents the population and employment baseline and projection estimates used to develop the CAP's emissions forecasts. The 2020 and 2035 population and employment values come from SANDAG's Regional Transportation Plan/Sustainable Communities Strategy. The service population line represents the sum of the community's population and employment. The compound annual growth rate was calculated for the service population from 2010-2020 and 2010-2035, and was applied to all emissions sectors, except transportation and solid waste, to estimate future emissions levels, as described in the next section.

Solid waste emissions forecasts were based on service population growth and other factors, as described earlier in the Solid Waste baseline methodology section. Transportation emissions forecasts are described in the final section of this appendix.

Table A-12
Population and Employment Factors

	2010	2020	2035
Population	57,361	62,136	68,682
Employment	27,785	28,813	31,018
Service Population	85,146	90,949	99,700
Compound Annual Growth Rate from 2010	-	0.66%	0.63%

Source: AECOM 2016

Notes: MT CO_2e = metric tons of carbon dioxide equivalent

FORECAST METHODOLOGY

The projected population and employment growth described above was used to project the electricity, natural gas, water, and wastewater sector emissions.

The following formula describes how GHG emissions were projected using average annual growth rates:

$$\text{Emissions}_{PHY} = \text{Emissions}_{BASE} + (\text{Emissions}_{BASE} \times \text{AAGR} \times \text{Years})$$

Where:

$\textit{Emissions}_{PHY}$ = GHG emissions during the planning horizon year

$\textit{Emissions}_{BASE}$ = GHG emissions during the baseline year

AAGR = average annual growth rate (service population)

Years = years of growth between the baseline and planning horizon year

The planning horizon year 2020 and 2035 emissions were projected from the baseline year 2010, which involves 10 years of growth and 25 years of growth, respectively (i.e., *Years* factor above).

Transportation Forecast Methodology

The 2020 and 2035 transportation emissions forecasts were based on SANDAG's VMT estimates from the Series 13 model revenue-constrained scenario. Consistent with the 2010 baseline inventory, the 2020 and 2035 transportation sector emissions forecasts were estimated using outputs from EMFAC2014 and the same methodology as described in the Transportation baseline methodology section of this appendix. Table A-13 shows the daily vehicle miles traveled (DVMT) inputs from the SANDAG models that were used to estimate the 2020 and 2035 transportation emissions.

Table A-13
Daily Vehicle Miles Traveled (DVMT)

Year	Internal-Internal	Internal-External and External-Internal	External-External	Total DVMT[1]
2010	162,382	2,558,294	1,078,439	1,441,529
2020 Revenue Constrained	99,181	3,105,697	851,458	1,652,030
2035 Revenue Constrained	117,073	3,486,581	941,615	1,860,364

Source: AECOM 2017, data from SANDAG Series 13 Revenue-Constrained scenario

[1] Total value = (50% of total Internal-External and External-Internal trips) + (100% of Internal-Internal trips), per the origin-destination methodology