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Subject: Yolo County Regional Greenhouse Gas Emissions Inventory Update for the Cities of Davis, Winters and Woodland – Draft Technical Memorandum

INTRODUCTION

In July 2019, the Yolo County Board of Supervisors approved a contract for Ascent Environmental (Ascent) to prepare greenhouse gas (GHG) emissions inventories for the cities of Davis, Winters, and Woodland to promote consistency between jurisdictions and support a regional approach to climate action planning. The contract included development of a GHG inventory tool, used to produce the results described in this report that will allow the cities to update calculations in the future. Ascent updated the inventories for the cities to a 2016 baseline year using new data sources, emissions factors, and methodologies. This technical memorandum summarizes the inventories; provides informative graphics to illustrate the share of GHG emission for each city and by emissions sector; and includes a detailed description of the data, methods, and assumptions used to achieve these results.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- **Section 1, "Summary of Inventory Results,"** presents an overview of the GHG inventory results for each city, including tables and charts. It also compares annual regional GHG emissions by jurisdiction.
- **Section 2, "Data, Methods, and Assumptions,"** summarizes the data inputs, methodology, and assumptions used in the GHG inventories, by sector.

1 SUMMARY OF INVENTORY RESULTS

1.1 INVENTORY RESULTS

Results from the three communitywide GHG emissions inventories for the cities of Davis, Winters, and Woodland are shown in Table 1 and Figures 1–3. The largest proportion of GHG emissions for each jurisdiction in 2016 came from the On-Road Transportation sector, followed by the Building Energy sector, consistent with statewide trends.

Table 1 GHG Emissions by Sector for the Cities of Davis, Winters and Woodland in 2016

Sector	City of Davis		City of Winters		City of Woodland	
	GHG Emissions (MT CO_2e)	Percent of Annual Total	GHG Emissions (MT CO_2e)	Percent of Annual Total	GHG Emissions (MT CO_2e)	Percent of Annual Total
Building Energy	86,405	18	8,236	12	87,012	26
On-Road Transportation	321,955	69	54,550	81	193,849	59
Off-Road Transportation	24,825	5	2,451	4	20,426	6
Solid Waste	14,609	3	2,272	3	27,308	8
Water	19,804	4	239	<1	1,999	<1
Total	467,598	100	67,748	100	330,594	100

Notes: CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; MT= metric tons.

Columns may not add to totals because of rounding.

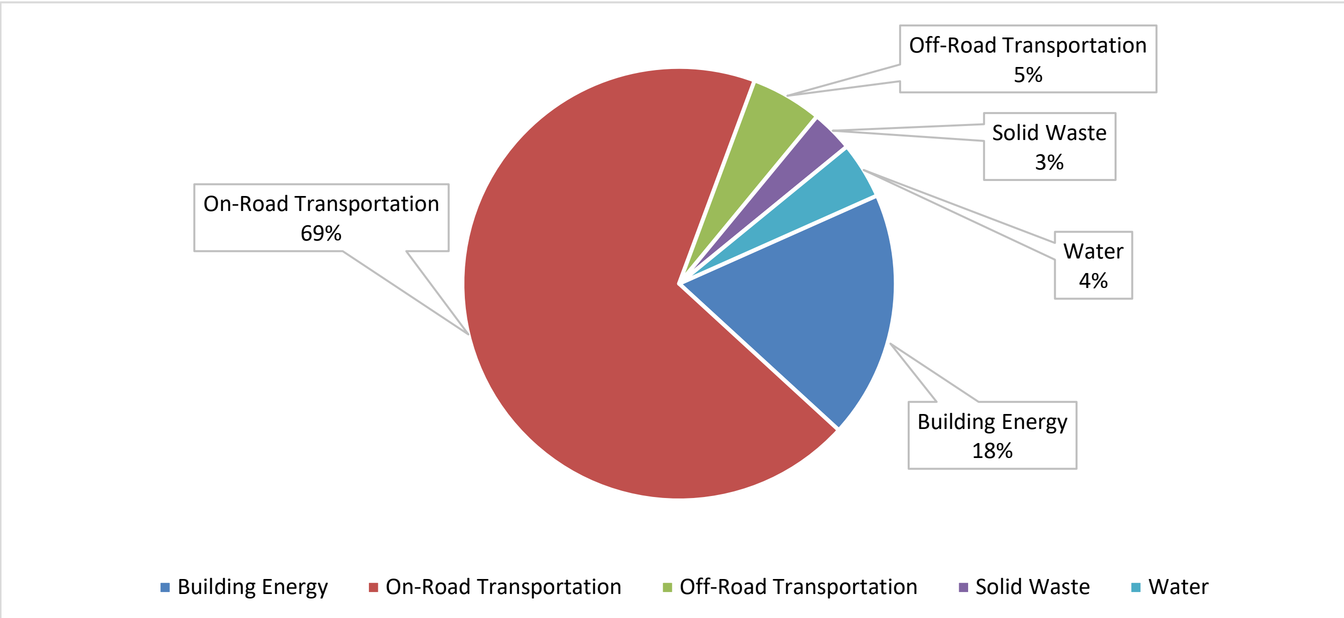
Source: Data compiled by Ascent Environmental in 2020

The Building Energy sector covers electricity and natural gas use from all nongovernmental commercial and residential buildings. Although the cities also contain industrial energy users, this type of energy consumption data is subject to the California Public Utilities Commission's (CPUC's) 15/15 Rule, which was adopted to protect customer confidentiality. The 15/15 Rule requires that any aggregated information provided by the utilities must be made up of information from at least 15 customers (100 for residential sectors) and that a single customer's load must be less than 15 percent of an assigned category.

The Solid Waste sector focuses on waste generation, which covers annual GHG emissions from all waste generated by a community, including community-generated waste disposed of within the community's boundaries or transferred to landfills outside the community. Gases are also released as waste in landfills decays over time; this is called waste-in-place. Waste-in-place emissions include the annual GHG emissions released from landfills located in a community. Emissions are calculated using historical information about the number of tons disposed of in the landfill since its opening; the composition of the waste; and the use of management practices, such as landfill gas management, that seek to mitigate the release of GHGs. Waste-in-place data were limited or unavailable for the cities of Davis, Winters, and Woodland; thus, this category of emissions was not included in the analysis. Landfills in these jurisdictions were closed decades ago, and no retroactive review of waste deposited historically has been conducted. Furthermore, the cities have limited control over landfill practices outside of their jurisdiction, and landfills, which are the major source of solid waste–related GHG emissions, are already addressed in Yolo County's climate action plan.

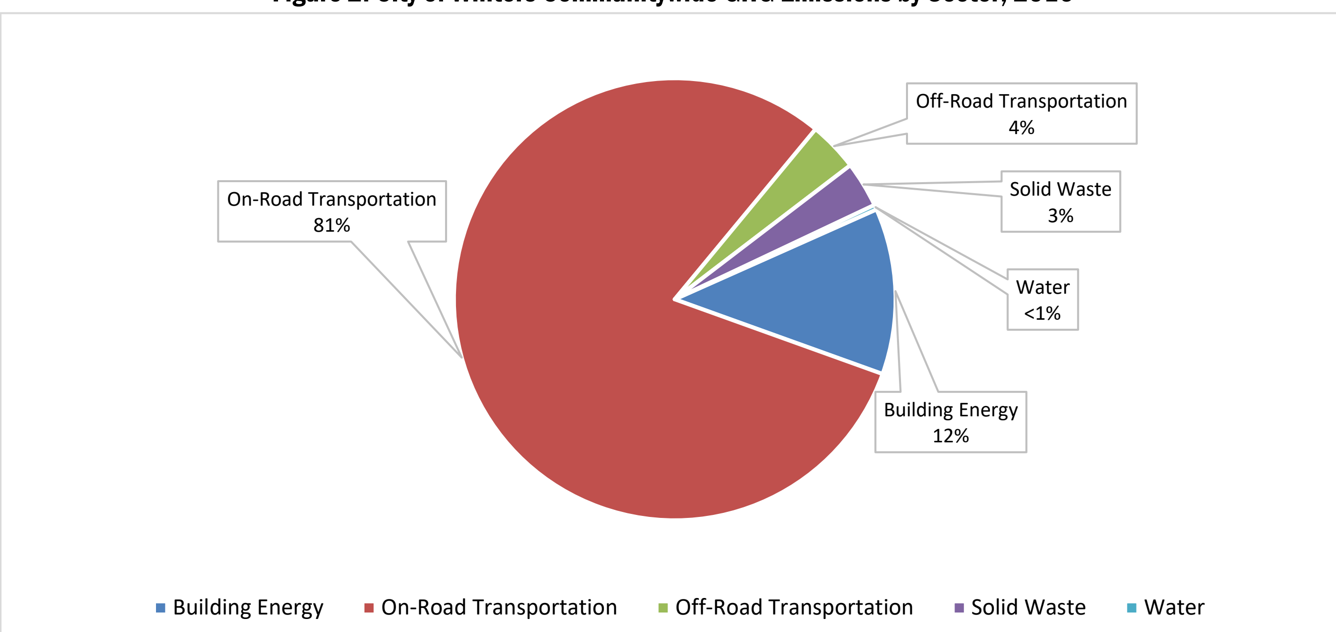
The Water sector includes electricity associated with water supplies, as well as process and fugitive emissions associated with wastewater treatment. Process emissions are associated with industrial processes and result from physical or chemical processing rather than from fuel combustion. Fugitive emissions are not physically controlled but result from the intentional or unintentional release of GHGs. Examples include methane (CH_4) from wastewater treatment lagoons or solid waste landfills.

Figure 1: City of Davis Communitywide GHG Emissions by Sector, 2016



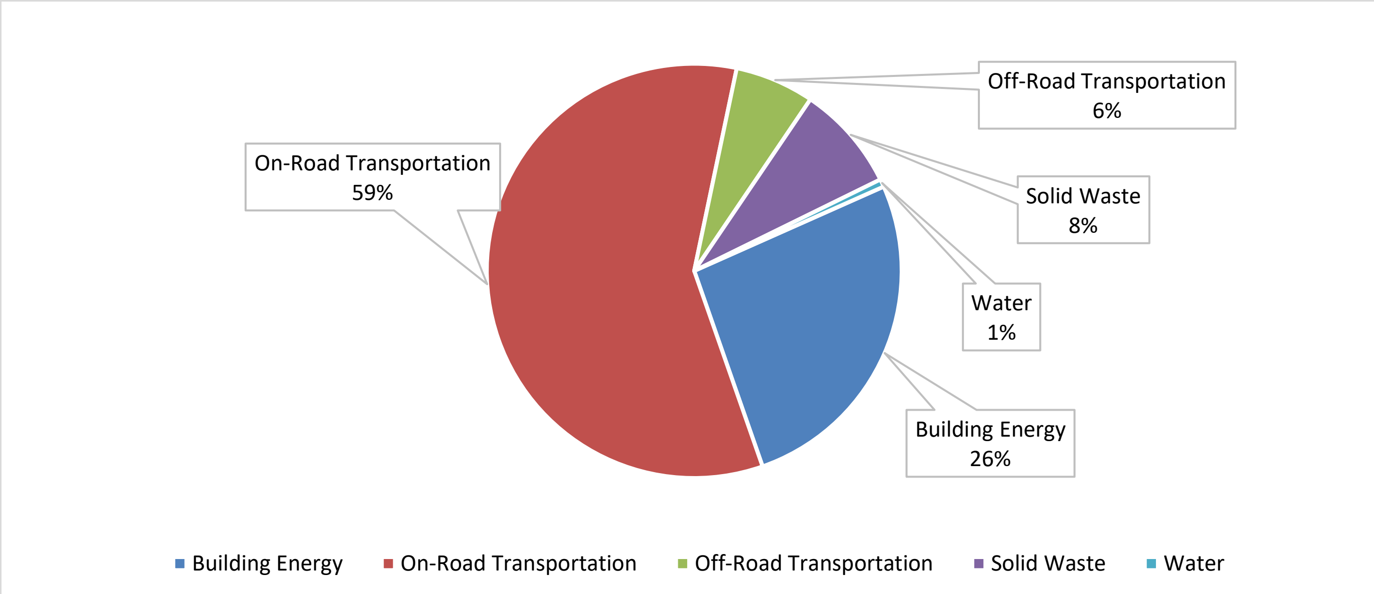
Source: Data compiled by Ascent Environmental in 2020

Figure 2: City of Winters Communitywide GHG Emissions by Sector, 2016



Source: Data compiled by Ascent Environmental in 2020

Figure 3: City of Woodland Communitywide GHG Emissions by Sector, 2016



Source: Data compiled by Ascent Environmental in 2020

Table 2 presents a comparison of annual regional GHG emissions by jurisdiction.

Table 2 Regional GHG Emissions Comparison

Community	GHG Emissions ($MT\ CO_2e$)	Percent of Estimated Regional Total
Davis	467,598	20
West Sacramento	365,140	16
Winters	67,748	3
Woodland	330,594	14
Yolo County - Unincorporated	1,082,801	47
Total – Regional	2,313,881	100

Notes: CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; MT= metric tons.

Yolo County - Unincorporated includes emissions from the Agricultural sector. The information presented for the city of West Sacramento is from a 2011 baseline.

Source: Data compiled by Ascent Environmental in 2020

2 DATA, METHODS, AND ASSUMPTIONS

GHG inventories were previously prepared for the cities with baseline years of 2012 for Davis, 2005 for Winters, and 2005 for Woodland. Since then, new protocols have been developed for calculating communitywide GHG emissions in various sectors. These changes reflect refinements in the planning process that have resulted from research in the field and shared knowledge from local governments engaged in climate action planning. The International Council for Local Environmental Initiatives (ICLEI) develops guidance for local-scale accounting of emissions that many local governments are now using to develop their GHG inventories. The most recent guidance for community-scale emissions inventories is ICLEI's July 2019 publication *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI 2019). The GHG inventories and the GHG inventory tool were developed in accordance with the methodologies presented in ICLEI's July 2019 protocol. The 2019 protocol is similar to the 2013 U.S. community protocol used by Ascent for Yolo County's GHG inventory, with the only substantial difference that the 2019 protocol includes a chapter for quantifying GHGs associated with forests, which is not applicable to the incorporated cities covered in this analysis.

The calculations relied on data provided by the cities of Davis, Winters, and Woodland; sector-specific sources of information; and The Climate Registry's default emission factors and global warming potential (GWP) figures from the Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report (AR5). In the past decade, there has been much research on the GWP values of various emissions. In 2014, the IPCC released AR5, which adjusted GWP values for CH_4 and nitrous oxide (N_2O), as well as other substances regulated by the Montreal Protocol (Myhre et al. 2013). In most equations associated with GHG accounting protocols, CH_4 and N_2O emissions are adjusted for GWP and combined with carbon dioxide (CO_2) to determine carbon dioxide equivalents (CO_2e), the common metric used to measure GHG emissions. Because GWP values are multipliers, small changes to these values can influence the resultant calculations. The GHG inventory tools for each city were developed so that the GWP values may be easily adjusted in the "Assumptions" tab to use GWP figures from prior IPCC reports. This feature can be useful for comparing communitywide GHG inventories to CARB's 2016 statewide GHG inventory, which was calculated using GWPs from the IPCC's Fourth Assessment Report. The GHG inventory tool can also incorporate updated values from future IPCC assessment reports.

2.1 BUILDING ENERGY

2.1.1 Residential Energy Consumption

GHG emissions in the residential energy subsector result from the consumption of natural gas and electricity in single-family, multifamily, and mixed-use buildings. These energy resources are used for lighting, air-conditioning, space and water heating, and the operation of appliances and electronics. Community energy use data for residential building types in the cities of Davis, Winters, and Woodland were provided by the Pacific Gas & Electric Company (PG&E) for 2009–2018 and included City, District, and Non-Government classification types. Non-Government figures from 2016 were used for this inventory update. Energy use metrics included natural gas, expressed as million metric British thermal units, and electricity, expressed as kilowatt hours (kWh). To calculate the CO_2e of residential energy consumption, fuel use was converted to CO_2, CH_4, and N_2O emissions using emissions factors for natural gas and electricity generation from PG&E, eGrid, and The Climate Registry. CH_4 and N_2O emissions were translated into CO_2e by multiplying those figures by AR5 GWPs and summed to show CO_2e for natural gas and electricity consumption in residential uses.

2.1.2 Commercial Energy Consumption

GHG emissions in the Commercial Energy subsector result from the consumption of natural gas and electricity in privately owned office buildings, shopping centers, and other nonresidential uses. Electricity covers all retail customers supplied power by PG&E. Commercial energy consumption data were provided by PG&E and included natural gas and electricity delivered to City, District, and Non-Government customers from 2009 to 2018. Non-Government figures from 2016 were used for Davis's and Woodland's GHG inventories. No data were provided in 2016 for nongovernmental customers in the city of Winters because of CPUC's 15/15 Rule, as discussed in Section 1.1, which prohibits the release of energy data if the sample size is not large enough to ensure anonymity. The ICLEI community protocol for GHGs provides guidance on estimating commercial fuel use in years for which consumption data are not available, but this guidance is limited to fuel oils, which are not commonly used in California. Thus, natural gas consumption data from 2011 and electricity consumption data from 2014 (the most recent years available) were used to complete Winters's inventory for the Commercial Energy subsector.

2.2 TRANSPORTATION

2.2.1 On-Road Transportation

GHG emissions in the On-Road Transportation sector result from fuel combustion in on-road vehicles, which include passenger vehicles (i.e., cars and light-duty trucks), medium- and heavy-duty trucks, motorcycles, and other types of vehicles permitted to operate "on-road." Ascent requested a customized vehicle miles traveled (VMT) data set from the region's metropolitan planning organization, the Sacramento Area Council of Governments (SACOG). SACOG publishes the region's Metropolitan Transportation Plan (MTP) and has developed a Senate Bill 375 Regional Targets Advisory Committee–compliant model called the Sacramento Activity-Based Travel Simulation (SACSIM) model to estimate VMT in the Sacramento region, including for cities in Yolo County. An update to the regional MTP in 2019 used 2016 as a baseline year for VMT, using a model similar to those used in previous plans. Ascent requested VMT data by speed bin from 2016 for the cities of Davis, Winters, and Woodland. Updated emission factors by speed bin were obtained from EMFAC 2017 and were used to calculate the CO_2e for 2016.

In March 2020, the U.S. Environmental Protection Agency (EPA) issued the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks. The final rule reduces the annual fuel economy improvement required for new passenger cars and light trucks from 5 percent to 1.5 percent and assumes no increase in electric vehicle sales share by 2026 beyond the current level of 2 percent. These adjustments could have an effect on the accuracy of projected on-road transportation emission factors for future years. The long-term GHG implications of the SAFE rule are still being determined. An adjustment factor for the SAFE rule's effect on EMFAC 2017 was released in late 2019; however, this approach covers criteria air pollutants only, not GHG emissions (CARB 2019).

2.2.2 Off-Road Transportation

GHG emissions in the Off-Road Transportation sector result from fuel combustion associated with vehicles, heavy equipment, and machinery operating off paved roads. GHG emissions for this sector were estimated using a CARB-approved modeling tool called OFFROAD 2007, which provides CO_2, CH_4, and N_2O emissions for several categories of off-road equipment for Yolo County. The following equipment categories were excluded from the analysis because they are not relevant for urban environments: Logging Equipment, Airport Ground Support, Military Tactical Support Equipment, Oil Drilling, and Dredging. Categories that were included in the GHG inventories were:

- Agricultural Equipment,
- Construction and Mining Equipment,
- Entertainment Equipment,
- Industrial Equipment,
- Lawn and Garden Equipment,
- Light Commercial Equipment,
- Pleasure Craft,
- Railyard Operations,
- Recreational Equipment, and
- Transport Refrigeration Units.

Because OFFROAD 2007 provides data at the county level, these emissions were scaled using demographic data, employment data, and land use acreages to estimate each city's proportion of the total county off-road emissions. These estimates were then multiplied by AR5 GWP values and summed to calculate annual CO_2e.

2.3 SOLID WASTE

GHG emissions in the Solid Waste sector result from fuels combusted in the equipment used to transport and process waste and from gases released as waste in landfills decays over time. These processes are categorized into two subsectors: waste generation and waste-in-place. As discussed in Section 1.1, waste-in-place was omitted from this analysis.

To estimate waste generation for the GHG inventories, Ascent used the U.S. Community Protocol's SW.4 method. This method calculates CO_2e from the annual waste generated by a community, including waste exported to landfills outside a community's boundaries. Data were obtained using the California Department of Resources Recycling and Recovery's Jurisdiction Disposal and Alternative Daily Cover Tons by Facility reporting tool. This tool shows the total amount disposed of by a jurisdiction at each disposal facility for a requested year. The tonnage of waste attributed to each city was converted to CH_4 using the EPA AP-42 conversion factor for tonnage to CH_4 which assumes the material is mixed solid waste composed of materials typically disposed at landfills nationwide. The CH_4 output was adjusted for facilities using landfill gas capture systems and then converted to CO_2e using GWP values from AR5.

2.4 WATER

2.4.1 Water Supply

GHG emissions from water consumption are associated with electricity used for water conveyance, treatment, and delivery. The cities of Davis and Woodland are supplied by the Woodland-Davis Clean Water Agency, and the city of Winters is supplied by the city's Public Works Department. The 2016 water consumption data were provided by the cities and converted into acre-feet of water per year. A 2015 report prepared for the CPUC analyzed the average energy intensity of water for several hydrologic regions and estimates the energy intensity of water supplied in the Sacramento River region to be 423 kWh per acre-foot. Total electricity use was calculated by multiplying water consumption by the energy intensity of water consumption. The CO_2e emissions of electricity used to supply water were then calculated using the same emission factors and methods as those used in the Building Energy subsector for electricity consumption.

2.4.2 Wastewater Treatment

Emissions associated with the treatment of sewage are highly dependent on the processes and components used by specific wastewater treatment plants (WWTPs), such as septic tanks, lagoons, centralized systems, and digester gas or combustion devices. To calculate emissions for this subsector, jurisdiction-specific data regarding the type of WWTP and population served are required. If the WWTP employs anaerobic or facultative lagoons to treat wastewater, the average biological oxygen demand (BOD) of the wastewater in kilograms per day is also required. BOD represents the amount of oxygen consumed by bacteria and other microorganisms while organic matter decomposes and is used as an index of the degree of organic pollution in water.

Process CH_4 emissions were calculated by inputting BOD data and relying on the 2019 ICLEI U.S. community protocol Equation WW.6 for anaerobic or facultative lagoons. Equation WW.6 contains factors for the maximum CH_4 production capacity of domestic wastewater and a CH_4 correction factor for anaerobic systems. Process N_2O emissions were calculated by inputting population data and relying on the 2019 ICLEI U.S. community protocol Equation WW.8 for centralized WWTPs without nitrification or denitrification. Equation WW.8 contains nitrogen loading factors and WWTP emission factors. Fugitive N_2O emissions were calculated by inputting population data and relying on the 2019 ICLEI U.S. community protocol Equation WW.12(alt) for effluent discharge to receiving aquatic environments. Equation WW.12(alt) contains factors for average total per capita nitrogen load per day, amount of per capita BOD per day, and emission factors for sewage discharge.

Wastewater process emissions from the city of Davis WWTP include process CH_4 emissions from facultative lagoons, process N_2O emissions from primary and secondary treatment, and fugitive N_2O emissions from effluent discharge. Population data were obtained from the California Department of Finance (CDF) (CDF 2019), and BOD data (a 5-year average from 2010 to 2015) were obtained from a technical memorandum prepared for the city regarding the impacts of the Innovation Center and Nishi property developments on WWTP capacity (West Yost Associates 2015).

The city of Winters operates a secondary aerobic WWTP without nitrification or denitrification and without the use of lagoons or septic tanks. An aerobic plant is one that depends on the use of bacteria to break down the organic matter in the water in the presence of oxygen. If sufficient oxygen is provided for the bacteria by aerating the basins during secondary treatment, the organic matter can break down without releasing significant quantities of CH_4. To provide enough oxygen, the Winters WWTP ponds are aerated and maintained at a specified depth. The depth is maintained by spraying treated water on the city field that surrounds the plant. Thus, wastewater process emissions from the city of Winters WWTP include process N_2O emissions from primary and secondary treatment and fugitive N_2O emissions from effluent discharge. Population data were obtained from the CDF (CDF 2019).

The city of Woodland operates a tertiary aerobic WWTP without nitrification or denitrification and without the use of lagoons or septic tanks. Effluent is discharged to the Tule Canal. Thus, wastewater process emissions from the city of Woodland WWTP include process N_2O emissions from primary and secondary treatment and fugitive N_2O emissions from effluent discharge. Population data were obtained from the CDF (CDF 2019).

REFERENCES

California Air Resources Board. 2019 (November 20). *EMFAC Off-Model Adjustment Factors to Account for the SAFE Vehicle Rule Part One.* Available: https://ww3.arb.ca.gov/msei/emfac_off_model_adjustment_factors_final_draft.pdf. Accessed April 29, 2020.

California Department of Finance. 2019. *Report E-5, Population and Housing Estimates for Cities, Counties, and the State, January 1, 2011-2019, with 2010 Benchmark.*

CARB. *See* California Air Resources Board.

CDF. *See* California Department of Finance.

ICLEI. *See* International Council for Local Environmental Initiatives.

International Council for Local Environmental Initiatives. 2019. *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2.*

Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura, and H. Zhang. 2013. *Anthropogenic and Natural Radiative Forcing*. *In* Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY.

West Yost Associates. 2015 (February 27). *Technical Memorandum: Impacts of Innovation Center/Nishi Property Development on Wastewater Treatment Plant Capacity*. Available: https://www.cityofdavis.org/home/showdocument?id=4697. Accessed April 29, 2020.