Truckee Tahoe Air Show and Family Festival

Greenhouse Gas Emissions Analysis

September 2021

Prepared for: Truckee Tahoe Airport District
10356 Truckee Airport Road
Truckee, California 96161

Prepared by: First Environment, Inc.
770 L Street, Suite 950
Sacramento, California 95814

TABLE OF CONTENTS

TABLES

FIGURES

List of Acronyms

ACI - Airports Council International

ACERT - Airport Carbon and Emissions Reporting Tool

AEDT - Federal Aviation Administration Aviation Environmental Design Tool

AR4 - Intergovernmental Panel on Climate Change's Fourth Assessment Report

CH_4 - methane

CO_2 – carbon dioxide

CO_2e - Carbon Dioxide Equivalents

eGRID – US EPA Emissions & Generation Resource Integrated Database

EPA – Environmental Protection Agency

FAA – Federal Aviation Administration

GHG – greenhouse gas

GWP – global warming potential

IPCC - Intergovernmental Panel on Climate Change

LTO – landing and take-off

MT – metric tonnes

MSW – municipal solid waste

N_2O – nitrous oxide

SAR - Intergovernmental Panel on Climate Change's Second Assessment Report

TCR – The Climate Registry

TD PUD – Truckee Donner Public Utility District

TTAD – Truckee Tahoe Airport District

UNFCCC – United Nations Framework Convention on Climate Change

Executive Summary

First Environment, Inc. (First Environment) was retained by Truckee Tahoe Airport District (TTAD) to perform an analysis of greenhouse gas (GHG) emissions associated with the Air Show and Family Festival.

The analysis estimated GHG emissions associated with the following Airshow activities:

- aerial performances and aircraft exhibits;
- vehicle travel to the event by volunteers and attendees;
- deliveries of event supplies to the airport;
- operation of portable generators by exhibitors and food trucks;
- disposal of waste generated during the event;
- hotel stay energy consumption by attendees.

In addition, the analysis also estimated "avoided" emissions from aircraft landing and take-off operations that would not occur at the Airport during Air Show activity.

The analysis estimated emissions from the above activities for the three primary greenhouse gases (GHGs):

- carbon dioxide (CO_2),
- methane (CH_4), and
- nitrous oxide (N_2O).

Emissions in the GHG Inventory are reported in Carbon Dioxide Equivalents (CO_2e). CO_2e is used to quantify total emissions because each GHG has a different Global Warming Potential (GWP). Using CO_2e equalizes all GHGs to one standard reference of metric tons of carbon dioxide equivalent. Unless otherwise noted in this report, GHG emissions were converted to CO_2e using Global Warming Potentials (GWPs), a standard conversion factor, from the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (SAR), in order to facilitate comparison with emission quantities report in Truckee Tahoe Airport's 2015 GHG Inventory.

The analysis estimated that Airshow activities would generate 160.76 MTCO2e and avoid LTO emissions of 10.64 MTCO2e, resulting in net emissions of 150.12 MTCO2e associated with the Airshow event.

For comparison, the Airport's 2015 GHG Inventory estimated daily GHG emissions from stationary and mobile combustion to be 0.41 MTCO2e and daily GHG emissions from airport electricity use to be 0.38 MTCO2e. Average daily emissions associated with aircraft LTO operations were 5.13 MTCO2e.

As an additional point of reference, 150.12 MT CO_2e is approximately equivalent to the GHG emissions produced by 32.6 passenger vehicles driven for a year according to the US EPA's Greenhouse Gas Equivalencies Calculator.

Identification of GHG emissions associated with an event, such as the Truckee Tahoe Airshow, provides a better understanding of its climate impacts and facilitates informed action. The emission estimates provided by this analysis can assist airport management with future event planning. Consideration of these aspects demonstrates the District's recognition of its relationship to both the local and global environment.

Introduction

First Environment, Inc. (First Environment) was retained by Truckee Tahoe Airport District (TTAD) to perform an analysis of greenhouse gas (GHG) emissions associated with the Air Show and Family Festival.

Truckee Tahoe Airport Air Show

Truckee Tahoe Airport District is a regional general aviation airport serving the Town of Truckee, communities along the northern side of Lake Tahoe, and other nearby areas in the central Sierra Nevada mountain range of California.

The District presents the Truckee Tahoe Air Show & Family Festival, typically during the summer. The Air Show includes a variety of aviation attractions including aerial performances, airplane rides, aircraft displays, and speakers. The Festival includes family entertainment, a STEM expo, exhibitors, and food. The event is attended by over 15,000 visitors and supported by over 200 volunteers.

Airshow Emission Sources and Estimates

GHG emission sources associated with Air Show activity included:

- aerial performances and aircraft exhibits;
- vehicle travel to the event by volunteers and attendees;
- deliveries of event supplies to the airport;
- operation of portable generators by exhibitors and food trucks;
- disposal of waste generated during the event;
- hotel stay energy consumption by attendees.

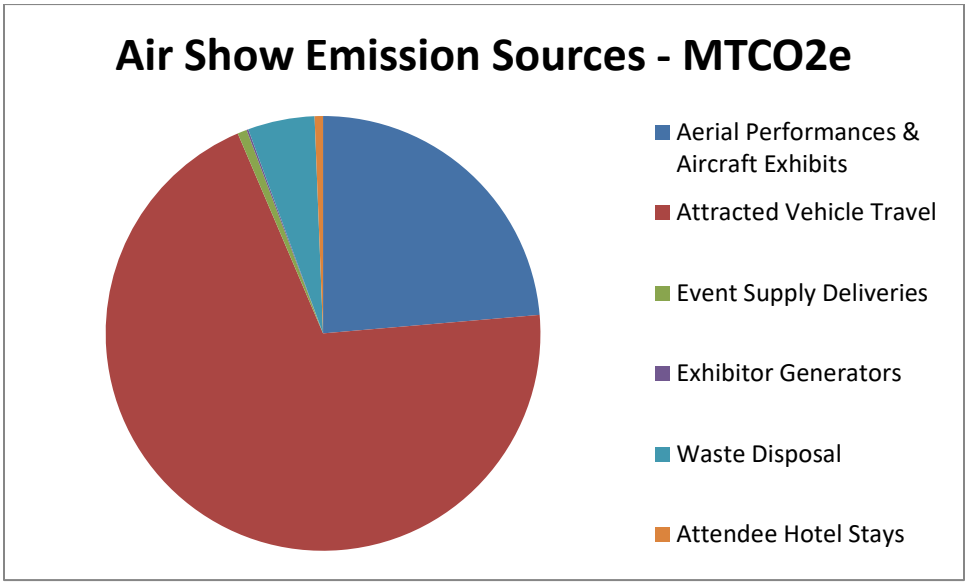
Avoided emissions from aircraft landing and take-off operations that would not occur at the Airport during Air Show activity were also considered.

Total emissions from the Air Show sources were calculated as 160.76 MTCO2e.

TABLE 1: Air Show Sources & Emission Estimates

Air Show Emission Source	MTCO2e
Aerial Performances & Aircraft Exhibits	38.01
Attracted Vehicle Travel	112.43
Event Supply Deliveries	1.12
Exhibitor Generators	0.21
Waste Disposal	7.99
Attendee Hotel Stays	1.00
Total	**160.76**

FIGURE 1: Air Show Source Emissions



Avoided emissions from LTO operations during the Air Show activity were estimated as -10.64 MTCO2e.

TABLE 2: Avoided Aircraft Operation Emissions

Avoided Aircraft Operations	MTCO2e
LTO - Pistons	-2.62
LTO – Turboprops	-2.40
LTO – Jets	-5.35
LTO - Helicopters	-0.16
Engine Startup	-0.11
Total	**-10.64**

As a result, net emissions of 150.12 MTCO2 were associated with the Airshow event.

TABLE 3: Air Show Net Emissions

Net Air Show Emissions	MTCO2e
Air Show Emissions	160.76
Avoided Operations Emissions	-10.64
Net Emissions	150.12

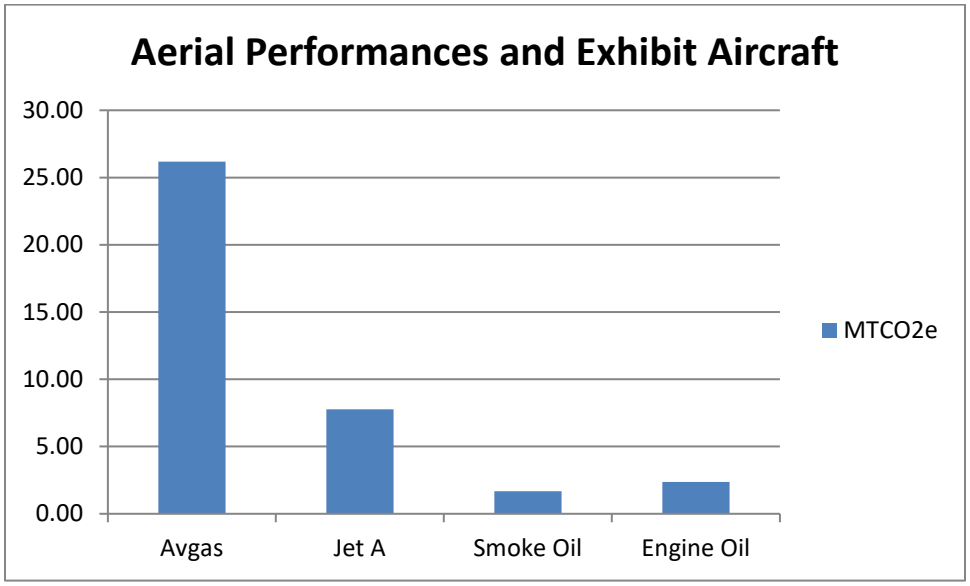
The following sections provide a description of the individual Air Show emissions sources and emission estimates.

Aerial Performances and Aircraft Exhibits

Airshow performances include military jets, aerobatic aircraft and sky-diving teams. The operation of the performance aircraft produces GHG emissions through the combustion of aviation gasoline, jet fuel, smoke oil, and engine oil.

Air Show Emissions from aerial performances and exhibits were estimated to be 38.01 MTCO2e.

FIGURE 2: Aerial Performances and Exhibit Aircraft Emissions

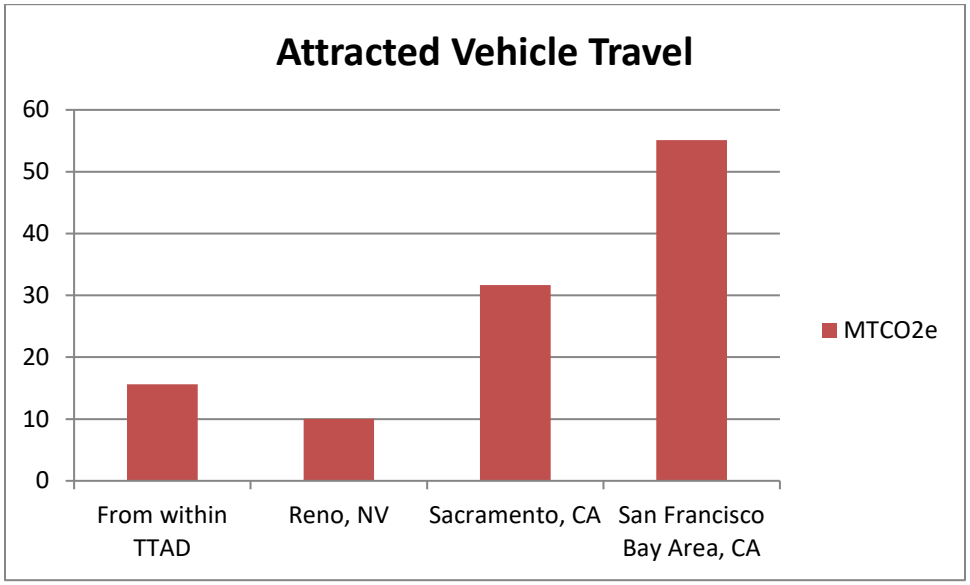


Attracted Vehicle Travel

Air Show volunteers and attendees arrive at the event in over 4,000 vehicles from origins including the Lake Tahoe region, Reno, Sacramento, and the San Francisco Bay Area. These vehicles produce GHG emissions through the combustion of gasoline and diesel fuels.

Air Show Emissions from attracted vehicle travel were estimated to be 112.43 MTCO2e.

FIGURE 3: Attracted Vehicle Travel Emissions



Event Supply Deliveries

Preparations for the Air Show include the delivery of event supplies to the airport including tents, fencing, golf carts, and porta-potties. These delivery trucks produce GHG emissions through the combustion of gasoline and diesel fuels.

Air Show Emissions from event supply deliveries were estimated to be 1.12 MTCO2e.

Portable Generator Operation

Some Air Show exhibitors and food suppliers power their operations during the event using portable generators. The generators produce GHG emissions through the combustion of the gasoline.

Air Show Emissions from portable generator operation were estimated to be 0.21 MTCO2e.

Waste Disposal

The Air Show generates municipal solid waste such as food and beverage containers, banners, and other promotional materials which require disposal after the event. This disposal produces GHG emissions as these waste materials break down in a landfill and methane is released.

Air Show Emissions from waste disposal were estimated to be 7.99 MTCO2e.

Attendee Hotel Stays

Some Air Show attendee visits include stays at local hotels either before or after the event. The hotel stays generate GHG emissions through natural gas combustion associated with water heating and food preparation, and electricity consumption associated with lighting and other facility equipment operation.

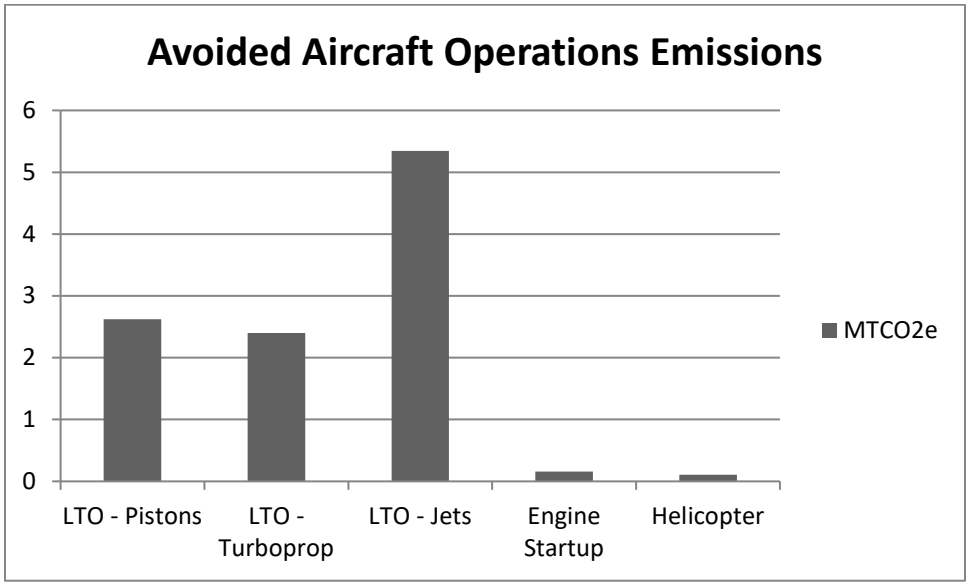
Air Show Emissions from attendee hotel stays were estimated to be 1.0 MTCO2e.

Avoided Aircraft Operations Emissions

During the Air Show the Airport is closed to landing and take-off operations by aircraft. Since these operations do not occur, emissions generated by the combustion of aviation gasoline and jet fuel during start-up, take-off, and landing are decreased.

Avoided aircraft operation emissions due to Air Show activity were estimated to be 10.64 MTCO2e.

FIGURE 4: Avoided Aircraft Operations Emissions



Emissions Estimates Points of Reference

To understand the analysis results and apply this information in decision-making, it is useful to have a context for the identified GHG estimates. The following are two points for reference to facilitate consideration of the Air Show emissions.

Airport GHG Inventory Emissions Comparison

As a first benchmark for the Air Show emissions presented in this report, the following were annual GHG totals from the 2015 Truckee Tahoe Airport Report as well as daily averages for comparison.

TABLE 4: TTAD GHG Inventory Comparison Values

TRK GHG Inventory Source	EY2015 MTCO2e	Daily Average MTCO2e
Scope 1 Stationary & Mobile Combustion	147.82	0.41
Scope 2 Purchased Electricity	138.07	0.38
Scope 3 Aircraft LTO Operations	1873.25	5.13

EPA Reference Equivalents

To provide an additional measure for the Airshow emissions identified in this report, the following emission equivalencies were calculated using US EPA's Greenhouse Gas Equivalencies Calculator.

TABLE 5: Air Show Emission Equivalencies

Emissions Category	$MTCO_2e$	These emissions are equivalent to the following:		
		Emissions from number of passenger vehicles driven for one year	Emissions from number of homes' electricity use for one year	Carbon sequestered by number of acres of forest in one year
Air Show Emission Sources	160.76	35	29.2	197
Avoided Operations Emissions	-10.64	2.3	1.9	13
Net Emissions	150.12	32.6	27.3	184

Conclusion

GHG emissions information from this analysis will allow Airport management to better understand climate impacts and take informed action, especially relative to events which it hosts, sponsors, or supports.

In addition, these emission estimates may be useful in:

- educating and engaging with event participants, and other District stakeholders,
- identifying opportunities to reduce impacts when planning future events, and
- facilitating efforts to mitigate impacts from the Air Show, or similar events.

Consideration of these aspects of the Air Show demonstrates the District's recognition of its relationship to both the local and global environment.

Appendix A - Emissions Estimation Approaches

GHG emissions in this Air Show analysis are calculated using methodologies from:

- United States Environmental Protection Agency Center for Corporate Climate Leadership Greenhouse Gas Inventory Guidance for:
    - Direct Emissions from Stationary Combustion Sources;
    - Direct Emissions from Mobile Combustion Sources;
    - Indirect Emissions from Purchased Electricity;
    - Indirect Emissions from Events and Conferences.
- Federal Aviation Administration Office of Environment and Energy Aviation Emissions and Air Quality Handbook.
- Airports Council International - Airport Carbon and Emission Reporting Tool.

In addition, GHG emissions are calculated using emission factors sourced from:

- United States Environmental Protection Agency Center for Corporate Climate Leadership Emission Factors for Greenhouse Gas Inventories.
- Truckee Donner Public Utility District 2020 Power Content Label.
- United States Environmental Protection Agency Emissions & Generation Resource Integrated Database (eGRID).
- Federal Aviation Administration Aviation Environmental Design Tool (AEDT).
- The 2020 EPA Automotive Trends Report.

The quantification methodology for each source is summarized in the following paragraphs.

Aerial Performances and Aircraft Exhibits

Analysis fuel estimates were based on 2019 Air Show usage totals of:

- fuel (100LL and Jet A), and
- oil (smoke oil and engine oil).

These quantities include usage by the performance and exhibit aircraft during the event, including rehearsals, as well as for transit to and from the Airport.

The 100LL and Jet A fuel usage totals in gallons were multiplied by aviation gasoline and kerosene-type jet fuel emission factors for CO_2, CH_4, and N_2O sourced from the US EPA emission factors for GHG inventories.

The smoke oil and engine oil totals in gallons were multiplied by kerosene and lubricant emission factors for CO_2, CH_4, and N_2O sourced from the US EPA emission factors for GHG inventories.

The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions that were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Attracted Vehicle Travel

The quantity of vehicles traveling to the Air Show was estimated as130 vehicles for volunteers and 4,000 vehicles for attendees. All volunteer travel originated within the District. Attendee travel origin was assumed as 70% local (i.e. within the District), 10% from Reno, 10% from Sacramento, and 10% from the San Francisco Bay Area. GIS-analysis identified an average one-way travel distance to the Airport from within the District as seven miles. One-way travel distances for Reno, Sacramento, and the Bay Area were identified using Google Maps. All one-way travel distances were doubled to reflect round-trip travel to and from the event. Allocated vehicle counts for each origin were multiplied by round trip travel distances to estimate total vehicle-miles associated with each travel origin.

These vehicle mile totals by origin were then multiplied by a distance-based CO_2 emission factor derived from U.S. fleet data in the 2020 EPA Automotive Trends Report, and distance-based CH_4, and N_2O emission factors for passenger cars sourced from EPA's US EPA emission factors for GHG inventories.

The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions that were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Event Supply Deliveries

To estimate the vehicle-miles associated with Airshow supply deliveries from Reno, Nevada, a roundtrip distance of 66 miles was multiplied by 12 truck deliveries.

The resulting vehicle-mile total was multiplied by distance-based emission factors for CO_2, CH_4 and N_2O sourced from the US EPA emission factors for GHG inventories for medium- and heavy-duty truck vehicle types. The results of these calculations were pounds of CO_2, CH_4, and

N_2O emissions, which were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Portable Generator Operation

Fuel capacities were identified for a larger (Westinghouse WGen7500) and smaller (Westinghouse iGen 4500) portable generator types commonly used by food truck operators. Using these capacities as an estimate of fuel consumption during Airshow activities, the quantities were multiplied by two larger units and three smaller units to estimate total gasoline consumption by portable generators at the event.

Emissions were calculated by multiplying the total gallons of estimated gasoline usage by gasoline emission factors for CO_2, CH_4 and N_2O sourced from the US EPA emission factors for GHG inventories. The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions, which were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Waste Disposal

An estimate of the total mass of waste generated during the Air Show was calculated by multiplying a CalRecycle event attendee waste generation factor of 2.44 lbs by the Air Show's expected attendance of 15,000 visitors.

This quantity was multiplied by an EPA emission factor for landfill disposal of mixed solid waste to calculate an emissions output in units of metric tonnes CO_2e, though calculated using IPCC GWPs from the fourth assessment report (AR4). For consistency with other CH_4 emission sources reported in the inventory, the AR4 GWP for CH_4 was used to convert the output to metric tonnes of CH_4 emissions, which is the primary GHG released from landfills. This value was then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Attendee Hotel Stays

Natural gas and electricity usage from hotel stays were estimated by multiplying 140 stay nights by EPA energy consumption factors for mid-scale hotels, consistent with accommodations located nearby the Airport.

Natural gas emissions were calculated by multiplying the hotel stay mmBtu totals by natural gas emission factors for CO_2, CH_4, and N_2O sourced from the US EPA emission factors for GHG inventories. The results of these calculations were pounds of CO_2, CH_4 and N_2O emissions, which were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

"Market-based electricity emissions" were calculated by multiplying the hotel stay megawatt hour totals by an electricity emission factor for CO_2e sourced from the Truckee Donner PUD 2020 Power Content Label. The results of these calculations were pounds of CO_2e, emissions that were converted to metric tonnes CO_2e.

Avoided Aircraft Operation Emissions

An estimate of the aircraft operations that would be displaced during the Airshow was identified by averaging the historical operations of piston, turboprop, jet, and helicopter aircraft that occurred on Saturday June 29, 2019 and Saturday, July 20, 2019.

Aircraft LTO Cycle

Aircraft-type arrival and departure totals were multiplied by representative aircraft fuel burn quantities for landing and takeoff cycle modes (e.g., taxi-out, takeoff, climbout, etc.), which were modeled for Truckee Tahoe Airport conditions to an altitude of 3,000 feet using the FAA AEDT, to identify total aviation gasoline or jet fuel combusted for piston, turbo prop, and jet aircraft categories. The aircraft category fuel totals were multiplied by LTO-specific avgas and Jet A emission factors for CO_2, CH_4, and N_2O sourced from the FAA Aviation Emissions and Air Quality Handbook. The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions that were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Helicopter LTO Cycle

Helicopter LTOs were multiplied by a fuel usage per LTO value for the Eurocopter AS350, as the helicopter model most representative of airport helicopter operations available, sourced from the Airports Council International (ACI) Airport Carbon and Emissions Reporting Tool (ACERT) to identify total jet fuel combusted for helicopter LTO. The helicopter Jet A total was multiplied by LTO-specific Jet A emission factors for CO_2, CH_4, and N_2O sourced from the FAA Aviation

Emissions and Air Quality Handbook. The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions that were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Jet Engine Startup

Consistent with the jet engine startup fuel usage methodology from the FAA Aviation Emissions and Air Quality Handbook, single jet engine aircraft and twin engine aircraft departure totals were multiplied by an engine-specific "idle" fuel flow rate for the Pratt & Whitney JT15D-5, as an overall representative jet engine, sourced from FAA AEDT, adjusted to a 42-second startup period, to identify total jet fuel combusted for jet engine startups. The jet engine startup Jet A fuel total was multiplied by "startup mode"-specific Jet A emission factors for CO_2, CH_4, and N_2O sourced from the FAA Aviation Emissions and Air Quality Handbook. The results of these calculations were pounds of CO_2, CH_4, and N_2O emissions that were converted to metric tonnes of CO_2, CH_4, and N_2O emissions, and then multiplied by IPCC SAR GWPs to identify total emissions in units of metric tonnes CO_2e.

Global Warming Potentials

The Global Warming Potentials, identified in the Second Assessment Report of the Intergovernmental Panel on Climate Change, were used to convert the GHG emissions associated with Airport activities into carbon dioxide equivalents (CO_2e).

The Global Warming Potentials applied to all emission sources in the TTAD GHG inventory were the following:

Name	Chemical Formula	SAR GWP Value
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310

Appendix B – Technical References

Airports Council International
Airport Carbon and Emission Reporting Tool (ACERT), v3.2

Federal Aviation Administration
Office of Environment and Energy
Aviation Emissions and Air Quality Handbook
Version 3, Update 1
January 2015

Federal Aviation Administration
Aviation Environmental Design Tool (AEDT), Version 2c

Intergovernmental Panel on Climate Change
Climate Change 1995
Second Assessment Report
1996

United States Environmental Protection Agency
Center for Corporate Climate Leadership
Greenhouse Gas Inventory Guidance
Direct Emissions from Stationary Combustion Sources
January 2016

United States Environmental Protection Agency
Center for Corporate Climate Leadership
Greenhouse Gas Inventory Guidance
Direct Emissions from Mobile Combustion Sources
January 2016

United States Environmental Protection Agency
Center for Corporate Climate Leadership
Greenhouse Gas Inventory Guidance
Indirect Emissions from Purchased Electricity
January 2016

United States Environmental Protection Agency
Center for Corporate Climate Leadership
Greenhouse Gas Inventory Guidance
Indirect Emissions from Events and Conferences
December 2018

United States Environmental Protection Agency
Center for Corporate Climate Leadership
Emission Factors for Greenhouse Gas Inventories
1 April 2021

United States Environmental Protection Agency
Emissions & Generation Resource Integrated Database (eGRID)
eGRID2019
2/23/2021

Truckee Donner Public Utility District
2020 Power Content Label

United States Environmental Protection Agency
Office of Transportation and Air Quality

The 2020 EPA Automotive Trends Report

Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975

January 2021

CalRecycle

Targeted Statewide Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry Groups

6/1/2006