

State of Colorado

TECHNICAL SUPPORT DOCUMENT FOR MOBILE AND AREA SOURCES EMISSIONS INVENTORY DEVELOPMENT

Supporting the

Denver Metro/North Front Range
Serious State Implementation Plan
for the 2008 8-Hour Ozone
National Ambient Air Quality Standard

Approved by:

Colorado Air Quality Control Commission

(Anticipated December xx, 2020)



COLORADO
Department of Public
Health & Environment



Mobile and Area Sources Emissions Inventory Development

Introduction

OVERVIEW

Per Clean Air Act (CAA), 42 U.S.C. §7511a(a)(1) (“§182(a)(1)”), on July 17, 2014, the Colorado Department of Public Health and Environment (CDPHE) submitted a 2011 Periodic Emissions Inventory for Ozone Precursors for the Denver Metro/North Front Range (DM/NFR) nonattainment area under the 2008 Ozone National Ambient Air Quality Standard (NAAQS). The 9–county nonattainment area consists of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, and portions of Larimer and Weld counties. The 2011 base year inventory was included as part of the Moderate Area State Implementation Plan (SIP) submittal and establishes the baseline from which Reasonable Further Progress (RFP) must be calculated for nonattainment areas classified as Moderate and higher (CAA §182(b)(1)(A)). Additionally, as part of the Moderate Area SIP, a projected 2017 attainment year emissions inventory was developed and submitted to U.S. Environmental Protection Agency (EPA) and was approved by EPA in 2018 (83 FR 31068). Due to EPA’s reclassification of the DM/NFR to Serious nonattainment for the 2008 NAAQS, effective January 2020, the CDPHE has prepared an updated 2017 emissions inventory (now referred to as a “milestone” year for purposes of RFP) based on currently available data, in accordance with EPA’s revised guidance on emissions inventory development, and is being resubmitted as part of this Serious Area SIP (CAA §182(c)(2)(B)).

2011 BASE YEAR EMISSIONS INVENTORY

An emissions inventory was developed for a typical July day for the year 2011 for the ozone precursors of oxides of nitrogen (NO_x) and volatile organic compounds (VOC) emitted in the DM/NFR area. An inventory of emissions was developed for all major source categories including oil and gas, point, area, non–road, and on–road sources (see Table 1). Residential fuel combustion is excluded because emissions from this category are negligible in the summer. Fire emissions and other “naturally occurring” emissions are not included in the anthropogenic portion of the inventory but are included as “biogenic” sources, which are held constant and are addressed in section 3.3.7 of the Serious Area SIP. The full discussion of the 2011 emissions inventory with detailed information on methodology is available in the Moderate Area SIP. This 2011 emissions inventory is the baseline year inventory for both RFP (Chapter 4) and the Contingency Measures Plan (Chapter 10) of this Serious Area SIP.

2017 MILESTONE YEAR EMISSIONS INVENTORY

The Regional Air Quality Council (RAQC), in conjunction with the Colorado Air Pollution Control Division (APCD or the Division hereafter), developed an updated 2017 “milestone year” emissions inventory for the DM/NFR Serious Nonattainment Area. When initially developed for the Moderate Area SIP, the 2017 inventory was calculated based on projected values. The 2017 inventory approved as part of the Moderate Area SIP has been updated for the purposes of the Serious Area SIP using actual data collected in 2017 and methodologies as presented in the

following sections. This inventory is also being used to meet requirements for the DM/NFR Marginal Nonattainment Area under the 2015 8-hour Ozone NAAQS. This inventory is in tons per summer day (tpd) and represents the most current available data for emissions estimates for an average episode day during the peak summer ozone season of June through September. This includes actual data for the oil and gas sector and stationary sources in addition to newer data from updated regional transportation demand models used by the two Metropolitan Planning Organizations in the DM/NFR.

The development of the 2017 *Milestone Year Emissions Inventory* for the 2015 8-hour Ozone NAAQS is described in the *Denver Metro Area/North Front Range Nonattainment Area 2017 Emission Inventory*, June 18, 2020, and the Technical Support Document for that inventory.

BASE AND FUTURE YEAR EMISSIONS PHOTOCHEMICAL MODELING INVENTORIES

The 2016 base year emissions data for the 36/12-km domains were initially based on the EPA/MJO 2016 Beta emissions (2016ff) and then updated to the 2016v1 emission estimates (2016fh). For the 4-km Colorado domain, the EPA 2016fh emissions with Division updates for Colorado oil and gas and on-road mobile sources were used. New emissions were generated for natural emission sources, including biogenic and lightning NO_x (LNO_x) for all three domains. The previous EPA 2016ff platform did not include LNO_x emissions and used the Biogenic Emission Inventory System (BEIS) biogenic emission model whose emissions were replaced by MEGAN biogenic emissions in all three domains for 2016fh. Future year emissions for 2020 were based on an interpolation between EPA's 2023 and 2016 emissions with some updates to Colorado provided by the Division.

Specifically, the Division supplied EPA hourly VMT data by county, vehicle type, and road type for both the 2016 and 2020 modeling years using methodology described below in the On-Road and Non-Road Mobile Sources section. The RAQC's contractor calculated highway emissions using the by county emission factors from the EPA modeling platform and the Division supplied VMT.

2020 ATTAINMENT YEAR EMISSIONS INVENTORY

The 2020 emissions inventory was developed for a typical high ozone day for the ozone precursors of NO_x and VOC emitted in the ozone nonattainment area. The 2020 inventory is a projection of the latest data available when the inventory was being developed in 2019.

This section presents the 2020 emissions inventory used in the modeling scenarios for the Serious Area SIP for the DM/NFR. This inventory is in tpd and represents emissions estimates for an average episode day during the peak summer ozone season (June through September). The 2020 inventory for VOC and NO_x accounts for emissions growth associated with projected changes in population, fuel use, and economic activity as well as emissions reductions associated with on-the-books controls. The EPA has provided guidance on developing emission projections to be used with models and other analyses for demonstrating attainment of air quality goals for

ozone. This guidance and other information¹ available from EPA was followed and used in developing the future year emission projections.

Highway emissions are estimated using the Environmental Protection Agency’s Motor Vehicle Emissions Simulator (MOVES) emissions model based on transportation information from the two metropolitan planning organizations (MPOs), the Denver Regional Council of Governments (DRCOG) and the North Front Range Metropolitan Planning Organization (NFRMPO), who are responsible for transportation planning in the DM/NFR nonattainment area. It is not possible to duplicate the process the contractor used for the modeling inventory for the SIP planning inventory because the MPO data are for annual average daily weekday VMT, and are link-based (links are highway segments) with speeds for each link that are from the MPO’s traffic demand models. The modeling platform speeds are different for each month and vehicle type and are a county wide distribution. The MPO speeds are an average over all vehicle types and are different for each link.

Non-highway sources were calculated using a combination of the latest version of EPA’s MOVES2014b emissions model, 2010 Census data updated to 2020, and area source data from the 2014 EPA National Emissions Inventory (NEI). Fire emissions are excluded from the anthropogenic emissions but were included in the ozone modeling on an episode dependent basis. Residential fuel combustion is excluded because emissions from this category are considered negligible in the summer. Table 1 includes an overall summary of anthropogenic daily ozone precursor emissions in the DM/NFR ozone nonattainment area.

Table 1 – 2020 Nonattainment Area Emissions Inventory (tpd)

Description	VOC	NO_x
Area	54.6	-
Architectural and Industrial Maintenance	25.1	-
Consumer Products	15.7	-
Other	13.9	-
Non-Road	44.3	39.1
Agriculture	0.2	1.8
Aviation	1.9	6.9
Commercial Equipment	6.5	14.1
Lawn and Garden	33.0	7.6
Railroad	0.4	8.2
Recreation	2.2	0.5
Oil and Gas	119.0	48.2
Area	54.5	34.4
Condensate/Oil Tanks	50.2	0.6
Point	14.3	13.1
On-Road	49.4	54.7
Light-Duty Vehicles	47.6	41.4
Medium/Heavy-Duty Vehicles	1.8	13.3
Point	25.0	21.7
Electric Generating Units (EGU)	0.4	4.6
Non-EGU	24.6	17.1

¹ U.S. Environmental Protection Agency’s (EPA) final 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements, 80 Fed. Reg. 12,264 (Mar. 6, 2015).

Grand Total	292.3	163.7
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On-Road and Non-Road Mobile Sources

The Motor Vehicle Emissions Simulator (MOVES2014b) is an emission factor model for predicting gram per mile emissions for ozone precursors VOC, CO, NO_x, and toxics from on-road cars, trucks, and motorcycles under various conditions. Non-road source emissions are from the Non-Road Model portion of the EPA MOVES2014b platform. This model also includes the impact of future controls on non-road engines, which is used in determining emissions from equipment such as lawn and garden equipment and construction equipment. Oil and gas sector equipment emissions from the Non Road Model have been excluded to avoid double counting with the Oil and Gas Point and Area inventories.

The NEI and Non-Road Model report emissions for the nine nonattainment counties as whole counties. For on-road mobile sources, emissions were apportioned to the partial nonattainment area within Larimer and Weld Counties using geographical information system (GIS) techniques involving population blocks, actual or projected vehicle miles traveled (VMT), and land area. Railroad emissions were apportioned to the nonattainment area by miles of track. The MOVES Model was run using data from DRCOG’s Travel Demand Model (TDM) and the NFRMPO’s TDM, with the outputs from these clipped to the nonattainment area using GIS. The default fuel formulation was used for 2017 and 2020.

ON-ROAD SOURCES

The MOVES model was run using DRCOG’s and the NFRMPO’s TDMs for 2020, and the outputs from these models were clipped using GIS techniques to the nonattainment area. The NO_x and VOC emission factors from MOVES were calculated on an hourly and integer-speed basis for 6 Highway Performance Monitoring System (HPMS) vehicle types and multiplied by the link (roadway) VMT from the TDMs. The vehicle types included are: 1) motorcycles; 2) passenger cars; 3) light trucks; 4) buses; 5) motor home, refuse, or single-unit short/long-haul trucks; and 6) combination-unit short/long-haul trucks. Hourly vehicle mix data for the six vehicle types was determined as a 5-year average from the most recently-available Colorado Department of Transportation (CDOT) long-term (permanent) and short-term (temporary) Automated Traffic Recorder (ATR) data from 2015 to 2019. The off-network emission factors from the MOVES model default to include stage 2 refueling of vehicles, thus postprocessing is done to exclude from the mobile source inventory. The off-network emission factors are used with vehicle populations calculated from 2017 registration data. Table 2 includes the on- and off-net daily emissions for light-duty and medium/heavy-duty vehicles in the DM/NFR nonattainment area.

Table 2 – 2020 On-Road Mobile Source Emission Inventory (tpd)

Description		VOC	NO_x
Class 10 – Motorcycles	On-Network	0.3	0.1
	Off-Network	1.8	0.007
Class 20 – Passenger Cars	On-Network	4.9	8.8
	Off-Network	14.9	6.0

Class 30 – Light Trucks	On-Network	5.8	14.2
	Off-Network	19.9	12.3
Class 40 – Buses	On-Network	0.1	0.7
	Off-Network	0.003	0.002
Class 50 – Motor Home / Refuse / Single-Unit Short/Long-Haul Trucks	On-Network	0.1	0.6
	Off-Network	0.3	0.2
Class 60 – Combination-Unit Short / Long-Haul Trucks	On-Network	0.3	5.8
	Off-Network	1.0	5.9
On-Road Mobile Sources Subtotal		49.4	54.7
Subtotals (All Classes)	On-Network	11.5	30.3
	Off-Network	37.9	24.4

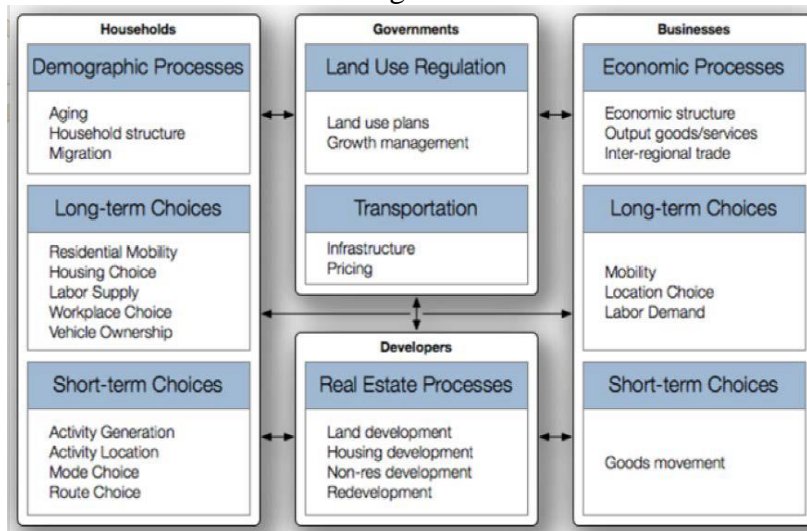
The Federal Highway Administration (FHWA) has 13 vehicle classes, and requires states to maintain a system of traffic counters (i.e., ATRs) to count vehicles by these 13 classes. CDOT has such a system of ATRs which they permanently maintain on selected principle arterials and freeways. They also supplement these permanent counters with temporary counters on lower level facilities/roadways. This is important because freeways and principal arterials have a higher percentage of heavy trucks than the lower level roads such as minor arterials, collectors, and local streets. The relationship or crosswalk² between the 13 FHWA vehicle classes and the 6 HPMS Mobile6 (precursor to MOVES) vehicle classes was modified to work with MOVES Source Types (vehicle classes). ENVIRON developed the original crosswalk for the Lake Michigan Air Directors Consortium (LADCO). The counters cannot differentiate all 14 of the MOVES Source Types, nor can they differentiate fuel type. The Online Transportation Information System (OTIS) builds on this crosswalk with the CDOT ATR count data in a table providing the fraction of VMT by HPMS vehicle class for each FHWA roadway type for each hour. There are two sets of VMT fractions by HPMS vehicle class used in the analysis because it was determined that Weld County has a substantially higher percentage of trucks than the rest of the nonattainment area. The VMT by vehicle type were then multiplied by the MOVES-generated emission factors to obtain the total emissions. Appendix 1 provides more information on the OTIS system.

Off-network emissions occur when the vehicle is not on a roadway and result from starting the vehicle, evaporation from the vehicle, and refueling of the vehicle. Long-haul combination heavy-duty trucks also have a unique emission type called “hotelling” which occur when the vehicle is parked and using electrical equipment and air conditioning. Off-network emission factors are calculated using MOVES and multiplied by the vehicle population to obtain the total emissions. The vehicle population data is compiled from Colorado registration and grown to 2020. Additional inputs include Inspection and Maintenance (I/M) data by fuel region.

VMT outputs are the product of sophisticated transportation and land use models used to predict the state of transportation in the future. For the northern subarea, the NFRMPO uses a four-step model process consisting of the following four models: Colorado Department of Local Affairs (DOLA) population and employment projections; Land Use Allocation Model; Travel Demand

² A reference table used to convert one type of data into another equivalent type.

Model; and Emissions Model. For the southern subarea, DRCOG uses UrbanSim to forecast socioeconomic changes and the Focus 30+ step activity-based travel model to synthesize individual regional household and population activity data to forecast travel throughout a typical weekday based on personal and travel-related characteristics. The proceeding figure depicts the DRCOG UrbanSim Socioeconomic Forecasting Process.



The outputs of these models include population, employment, and households in each transportation analysis zone (TAZ) as well as roadway use data (traffic volumes, speed and delay) and transit use data. Based on this data, forecasts can be made related to:

1. Generated trips land uses
2. Distributed trips on an identified transportation network
3. Distributed trips among mode choice (drive, carpool, transit, bike, walk)
4. Assigned traffic onto the identified transportation network
5. Impacts on the transportation network

Table 3 shows the change in VMT and vehicle population for 2020. Vehicle population and fleet age distribution are based on a 2017 data from a report by Eastern Research Group (ERG)³, with 2020 vehicle population being grown from 2017 by the ratio of the VMT increase from 2017 to 2020 for each subregion.

Both on-network and off-network data are processed by the APCD through MOVES2014b. The onroad model has multiple inputs including VMT, vehicle population, roadway activity data (speed and time of day), roadway classifications (urban, rural, restricted, unrestricted), fuel properties, I/M program, and temperature and humidity profiles. VMT is based on model output data from DRCOG and the NFRMPO. Appendix 2 shows the text of the MOVES run specification files (i.e., runspecs) for both the on-road and non-road models. The latest version and subsequent updates of the platform were used (MOVES2014b).

³ Eastern Research Group (ERG), Development of MOVES Registration Fraction and Population Files Using 2017 Colorado Registration Data, FINAL REPORT, Feb. 28, 2018.

Table 3 – 2020 VMT and Vehicle Population in Nonattainment Area

Vehicle Class by Subregion	2020 VMT (daily miles)	2020 Vehicle Population
DRCOG – Southern Subregion	84,812,961	3,421,628
Light-Duty Vehicles (Classes 10–30)	83,148,061	2,777,304
Medium and Heavy-Duty Vehicles (Classes 40–60)	1,664,900	644,324
NFRMPO – Northern Subregion	14,266,896	56,243
Light-Duty Vehicles (Classes 10–30)	13,961,805	40,220
Medium and Heavy-Duty Vehicles (Classes 40–60)	305,091	16,024
TOTAL	99,079,857	3,477,871

In addition to developing an inventory for modeling, the future year emissions inventory for on-road mobile sources is used for setting new motor vehicle emissions budgets (MVEBs) for Transportation Conformity, which is discussed in Chapter 11 of the SIP. The MVEBs for the Denver Metro/North Front Range Subareas are based on the on-road mobile source 2020 emissions inventory used in the Attainment Demonstration that includes the following control measures⁴: Federal On-Road and Non-Road Mobile Source Standards and Regulations; Vehicle Inspection and Maintenance (I/M) Program; 7.8 Reid Vapor Pressure with 1 PSI Ethanol Waiver (8.8 RVP), and Stage I Vapor Recovery. Table 4 includes MVEBs, in tons per day (tpd), for the ozone precursors VOC and NOx for both subareas as well as the whole nonattainment area budget.

Table 4 – 2020 Motor Vehicle Emissions Budget for VOC and NOx in Nonattainment Area

Motor Vehicle Emissions Budgets	2020	
	VOC (tpd)	NOx (tpd)
Northern Subarea Budget <i>(NFRMPO & UFR TPR Subarea)</i>	8.2	9.7
Southern Subarea Budget <i>(DRCOG & UFR TPR Subarea)</i>	41.2	45.0
Total Nonattainment Area Budget	49.4	54.7

Section 172(c)(9) of the CAA requires ozone nonattainment area SIPs to provide for the implementation of specific measures, termed contingency measures, if an area fails to timely attain the NAAQS or demonstrate RFP. For the DM/NFR Serious Nonattainment Area, the deadline to attain is July 20, 2021. Therefore, contingency measures must result in additional emissions reductions after the EPA’s finding of failure to attain or not meet RFP. Pursuant to EPA’s State Implementation Plan Requirements Rule⁵ for the 2008 NAAQS, contingency measures should represent one-year of progress, amounting to 3% of the baseline emissions inventory for the nonattainment area, which would be achieved while the state is revising its plan for the area. To demonstrate one-year of emissions reductions, or 3% of the baseline emissions inventory for DM/NFR, the total emissions reductions from these projects are compared to 2011 base year inventory for a nonattainment area (excluding biogenic sources) contained in Chapter 4

⁴ See Chapter 4 of the Serious Area SIP

⁵ EPA, 2008 Ozone NAAQS SIP Requirements Rule (80 FR 12264, March 6, 2015)

of the Serious Area SIP. Based on long-standing EPA policy, promulgated federal measures are allowed to be used as contingency measures as long as they provide emission reductions in the relevant years in excess of those needed for attainment or Reasonable Further Progress. To avoid early implementation of contingency measure emission reductions should the area fail to attain; EPA requires reductions to occur after the attainment date. Accordingly, 2022 on-road emission reductions through fleet turnover occurring after July 2021 attainment date were evaluated. If the on-road mobile source reductions exceed 3% of either the total NO_x or VOC baseline inventory, then the contingency measures provide the required emissions to cover the emission reduction target. Since a 2023 on-road mobile emissions inventory was developed for future ozone planning purposes, an estimate of VOC and NO_x emissions for 2022 was derived through linear interpolation between 2020 and 2023 on-road emissions. For this contingency plan, the target emissions reductions were 2% NO_x and 1% VOC from on-road mobile sources for a total of 3%. As demonstrated in Table 5, with the anticipated future year reductions, the region not only achieves a 3% reduction in criteria pollutants to satisfy the contingency measure requirement, but exceeds it by 1% for a total of a 4% reduction equating to 5.4 tpd of VOCs and 9.3 tpd of NO_x.

Table 5 – Contingency Measure 3% NO_x and VOC Emission Reduction from 2011 Base Case Nonattainment Area (NAA) Emission Inventory.

Line #	Description	VOC	NO _x
3% Contingency Requirement			
1	NAA 2011 base year emissions inventory	518.8	320.0
2	3% contingency reduction required (NO _x and/or VOC)	1.0%	2.0%
3	3% contingency reduction required (NO_x and/or VOC)^A	5.2	6.4
4	NAA 2020 on-road mobile emissions inventory	49.4	54.7
5	NAA 2022 on-road mobile emissions inventory	44.0	45.4
6	Total creditable mobile source reductions in 2022^B	5.4	9.3
7	% contingency reductions achieved ^C	1.0%	2.9%
8	Excess (+) / Shortfall (-) ^D	0.2	2.9
Is 3% Contingency Requirement Met?		Yes	Yes

- ^A Line 1 * Line 2
- ^B Line 4 – Line 5
- ^C Line 6/Line 1
- ^D Line 6 – Line 3

NON-ROAD SOURCES

Non-road mobile sources include large and small engines such as lawn and garden, commercial and industrial equipment, construction and mining, aircraft, and locomotives and are shown in Table 6. This inventory was developed using several methods with a majority of categories being based on the EPA's Non-Road Model within MOVES2014b, which accounts for federal regulations, including engine standards. Categories that are not based on the non-road model are aircraft and locomotives.

For aircraft, Denver International Airport (DIA) provided updated data on fleet composition and activity level to estimate emissions⁶ (see Appendix 3 to this TSD). Other aircraft is grown based on DIA 2014 Terminal data forecast to 2020 and aggregated for the nonattainment area. For railroad locomotives and switchers (i.e., rail yards), the activity levels from 2016 and growth projections for 2020 based on datasets from the Eastern Regional Technical Advisory Committee (ERTAC) Rail Group, Amtrak, and the Denver Terminal. Line-Haul locomotive (i.e., railroad equipment diesel) activity levels are apportioned based on fuel use per ton mile of freight in the nonattainment area. An emission factor is then applied based upon EPA’s guidance on Emission Factors for Locomotives to calculate emissions. Commercial lawn and garden is the largest source of VOC emissions in the non-road category, and is the fourth largest source of NO_x emissions, behind construction equipment, locomotives, and aircraft.

Table 6 – 2020 Non-Road Emissions Inventory (tpd)

Description	VOC	NO_x
Agriculture	0.2	1.8
Agricultural Equipment	0.2	1.8
Aviation	1.9	6.9
Aircraft	1.8	6.6
Airport Ground Support Equipment	0.1	0.3
Commercial	6.5	14.1
Commercial Equipment	4.4	3.2
Construction and Mining Equipment	1.7	8.2
Industrial Equipment	0.4	2.7
Logging Equipment	0.0	0.0
Lawn and Garden	33.0	7.6
Commercial	27.6	6.9
Residential	5.4	0.7
Railroad	0.4	8.2
Line Haul	0.2	5.3
Rail Yard - Switcher Locomotives	0.2	2.9
Railroad Support Equipment	0.0	0.0
Recreation	2.2	0.5
Pleasure Craft	1.0	0.4
Recreational Equipment	1.2	0.1
Non-Road Mobile Sources Subtotal	44.3	39.1

AREA SOURCES

Area sources (non-oil and gas) are primarily VOC sources and include a wide range of diverse categories such as coatings, household and personal care products, pesticides, automotive aftermarket products, and sealants. The 2020 emissions inventory is shown in Table 7 and was grown from EPA’s 2014 NEI based on county population projections from the State Demography Office.

⁶ Denver International Airport, State Implementation Plan (SIP) Air Quality Inventory, Nov. 2019.

Table This inventory also reflects reductions from implementation of Colorado Air Quality Control Commission (AQCC) Regulation Number 21⁷, which follows the same methodology as rules developed by the OTC⁸:

- 26.9% reduction for all household products and personal care products
- 30.0% reduction in industrial maintenance and other special purpose coatings
- 32.2% reduction in architectural coatings

Table 7 – 2020 Area Source Emissions Inventory (tpd)

Description	VOC
Agriculture	1.8
Agricultural Field Burning - whole field set on fire	0.0
Beef cattle production composite	0.7
Dairy cattle composite	0.2
Pesticide Application	0.7
Poultry production - broilers	0.0
Poultry production - layers with dry manure management systems	0.1
Swine production composite	0.1
Architectural and Industrial Maintenance	25.1
All Adhesives and Sealants	9.9
All Coatings and Related Products	5.2
Architectural Coatings	8.7
Industrial Maintenance Coatings	1.4
Consumer Products	15.7
All Household Products	7.9
All Personal Care Products	7.8
Cooking and Grilling	0.7
Commercial Cooking - Charbroiling	0.5
Commercial Cooking - Frying	0.1
Residential Grilling	0.1
Other	8.9
All Automotive Aftermarket Products	0.8
All FIFRA Related Products	7.1
Emulsified/Cutback Asphalt	0.2
Miscellaneous Products (Not Otherwise Covered)	0.8
Other Special Purpose Coatings	0.0
Tank Trucks in Transit	0.1
Traffic Markings	0.0
Portable Gas Cans	2.5
Commercial	1.1
Residential	1.3
Area Sources Subtotal	54.6

⁷ Control of Volatile Organic Compounds from Consumer Products and Architectural and Industrial Maintenance Coatings

⁸ Ozone Transport Commission (OTC) Technical Support Document (TSD), Consumer Products Amendments Phase 3 and 4, 06/28//2016, <https://otcair.org/upload/Documents/Reports/TSD%20Appendix%20A%20VOC%20Worksheets%20160824.xls>, accessed 3/16/20.

Table 8 presents the 2020 Denver International Airport (DIA) Inventory that represents a significant portion of the aviation VOC and NOx emissions in the nonattainment area which is summarized in the Serious Area SIP, Table 31 – 2020 Non-Road Emissions Inventory. The 2020 DIA aviation emission estimates used in the Serious SIP analysis did include DIA construction emissions, but they are accounted for under the “Commercial – Construction and Mining Equipment” category.

Table 8 – 2020 Denver International Airport Inventory (tpd)

Description	VOC	NOx
Aircraft	1.55	6.20
Auxiliary Power Units	0.02	0.27
Ground Support Equipment	0.09	0.28
Construction	0.29	0.56
DIA Sources Subtotal	1.95	7.31

More detail on the DIA emission inventory is included in the attached Appendix 3: State Implementation Plan (SIP) Air Quality Inventory for Denver International Airport, November 2019.

Appendix 1: Online Transportation Inventory System

MOVES Online Transportation Inventory System (OTIS)

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Environment.

Introduction

MOVES is the EPA emission factor model for calculation of vehicle emissions and emission factors.

MOVES stores input and output files in a database – MySQL.

This use of MySQL databases makes MOVES more flexible but it can be daunting to get data out of these databases.

Software Query Language (SQL) programming is often required to get the data in the needed format.

The System presented here is a method to utilize Microsoft Access with its Graphical User Interface (GUI).

The MySQL ODBC Driver is Installed With MOVES: (Slide from MOVES installation)



If the ODBC Connector is not installed, you will see the screen at left. Click Continue to proceed to the MySQL ODBC Connector installation. NOTE: If prompted, click Run on the "Open File– Security Warning." This will open the MySQL Connector/ODBC 5.1– Setup Wizard

We can use this driver to link to the MOVES output data tables in MySQL from Microsoft Access.

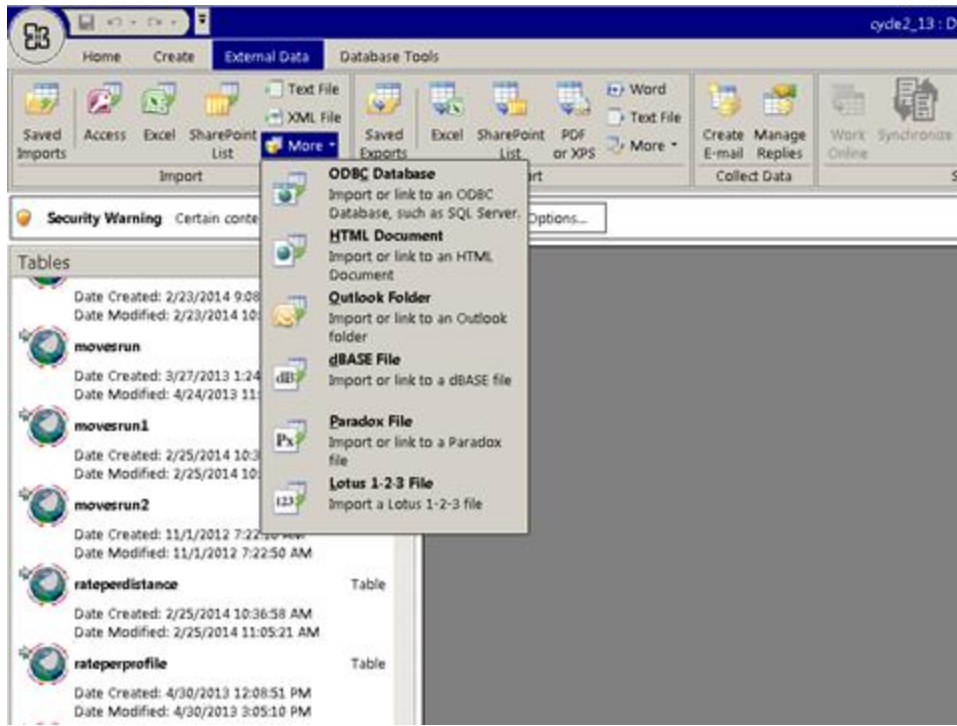
I use this process to calculate Highway Vehicle emissions for SIP Inventories, Conformity Budgets, Conformity Analyses, and Environmental Impact Analyses.

The process is fast and flexible to perform.

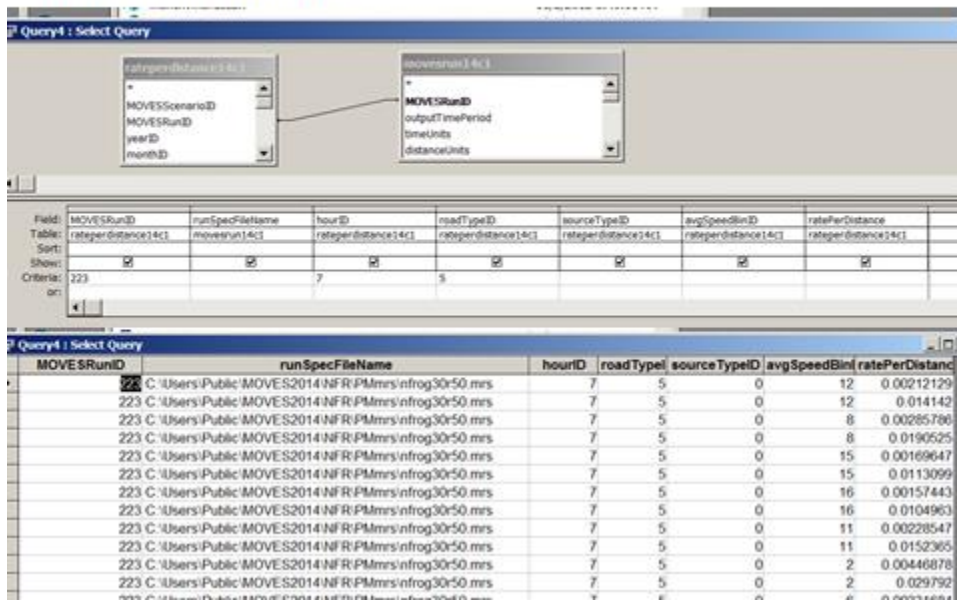
I use MOVES in the Emission Factor Mode to calculate emissions using link data From Metropolitan Transportation Planning Agencies (MPOs) such as the Denver Regional Council of Governments (DRCOG) .

Using MOVES in Emission Factor Mode separates the MOVES data from the Transportation Data and greatly improves transparency and accuracy. There is no pre-aggregation or averaging.

The linking process is shown on the next slide:



A simple query to examine the movesrun and rateperdistance tables. Note that emission factors are listed with each in a separate row by speed bin ID. The two tables are linked to each other by the MOVESrunID.



Having the each factor by speed bin on a separate row is not practical for calculating emissions for a particular link VMT and speed.

MOVES guidance says we are to linearly interpolate between speed bins by the speed.

We don't even know what speed each bin represents – we only have the ID.

Fortunately, Access has a query type called a crosstab query that allows us to put all the emission factors for all bins on a single row.

We can also link a new table into our query to decode the speed bin IDs into average speed.

wocNOx25RateQ : Crosstab Query

Field:	yearID	monthID	hourID	HPMSVtypeID: Val Of High	sourceTypeID	pollutantID	roadTypeID	avgBinSpeed	ratePerDistance
Table:	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance	ratePerDistance
Total:	Group By	Group By	Group By	Group By	Group By	Group By	Group By	Group By	Sum
Crosstab:	Row Heading	Row Heading	Row Heading	Row Heading	Row Heading	Row Heading	Row Heading	Column heading	Value
Sort:									
Criteria:									
or:									

wocNOxORRateQ : Crosstab Query

yearID	monthID	HPMSVtypeID	sourceType	pollut	roadType	hourID	2	5	10	15	20	25	30	35	40	45	50	5
2040	1	10	11	87	5	20	10.451	5.3886	2.8577	2.0140	1.591	1.3347	1.1651	1.0002	0.9851	0.9263	0.8784	0.8
2040	1	10	11	87	5	21	10.451	5.3886	2.8577	2.0140	1.591	1.3347	1.1651	1.0002	0.9851	0.9263	0.8784	0.8
2040	1	10	11	87	5	22	10.451	5.3886	2.8577	2.0140	1.591	1.3347	1.1651	1.0002	0.9851	0.9263	0.8784	0.8
2040	1	10	11	87	5	23	10.450	5.3886	2.8577	2.0140	1.591	1.3347	1.1651	1.0002	0.9851	0.9263	0.8784	0.8
2040	1	10	11	87	5	24	10.450	5.3886	2.8577	2.0140	1.591	1.3347	1.1651	1.0002	0.9851	0.9263	0.8784	0.8
2040	1	20	21	2	2	1	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	2	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	3	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	4	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	5	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	6	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0
2040	1	20	21	2	2	7	2.3105	1.3871	0.898	0.7351	0.6903	0.6613	0.7034	0.8817	1.0156	1.1043	1.1114	1.0

We now have our emission factors in a usable form, Now let's look at the Transportation Model output.

A typical sample of the link data from a transportation model is shown in the Next slide.

Transportation Model Output

ID	DIST	FT	AT	AM1_ABFLOW	AM1_BAFLOW	AM1_ABSPD	AM1_BASPD	AM2_ABFLOW	AM2_BAFLOW	AM2_ABSPD	AM2_BASPD
2701	0.5	8	5	11.47	4.24	28	28	31.02	11.46		
2929	0.52	8	4	93.09	30.07	20	20	251.83	81.34		
3088	0.64	4	5	264.93	375.31	42.92	31.32	747.49	899.24		
3991	0.21	3	3	1110.03	949.14	31.85	33.94	2859.61	2778.8		
8841	0.13	6	3	263.24	0	38.58	0	609.11	0		
8842	1.86	1	3	2915.51	0	39.7	0	6736.6	0		
8843	0.11	6	3	506.29	0	33.65	0	1134.9	0		
8844	0.29	3	3	907.56	1489.74	34.36	21.25	2201.25	3928.36		
8845	0.34	3	3	868.47	1433.83	34.7	23.13	1940.42	3674.73		
8846	0.53	4	3	504.53	183.16	25.92	30.97	1407.68	983.68		
8849	1.23	1	3	2031.51	0	61.5	0	4824.01	0		
8855	0.52	5	2	92.65	82.39	19.84	19.89	439.35	490.5		
8857	0.62	3	3	312.16	861.03	35.94	27.8	723.56	2326.12		

Again, this is not a good format for calculating emissions. We need each speed/VMT combination in a separate row.

We now have 20 speed/VMT combinations on each row (10 periods X 2 directions = 20).

I developed what I call a "reverse crosstab" to format this properly.

The following table has one row for each period and direction to facilitate this.

ExpandSpd Table

I70expSpd : Table					
	period	volume	COMvol	speed	field2
		AM1_ABFLOW	AM1_ABCOMF	AM1_AB	AM1_AB
1		AM1_BAFLOW	AM1_BACOMF	AM1_BA	AM1_BA
2		AM2_ABFLOW	AM2_ABCOMF	AM2_AB	AM2_AB
2		AM2_BAFLOW	AM2_BACOMF	AM2_BA	AM2_BA
3		AM3_ABFLOW	AM3_ABCOMF	AM3_AB	AM3_AB
3		AM3_BAFLOW	AM3_BACOMF	AM3_BA	AM3_BA
4		PM1_ABFLOW	PM1_ABCOMF	PM1_AB	PM1_AB
4		PM1_BAFLOW	PM1_BACOMF	PM1_BA	PM1_BA
5		PM2_ABFLOW	PM2_ABCOMF	PM2_AB	PM2_AB
5		PM2_BAFLOW	PM2_BACOMF	PM2_BA	PM2_BA
6		PM3_ABFLOW	PM3_ABCOMF	PM3_AB	PM3_AB
6		PM3_BAFLOW	PM3_BACOMF	PM3_BA	PM3_BA
7		OP1_ABFLOW	OP1_ABCOMF	OP1_AB	OP1_AB
7		OP1_BAFLOW	OP1_BACOMF	OP1_BA	OP1_BA
8		OP2_ABFLOW	OP2_ABCOMF	OP2_AB	OP2_AB
8		OP2_BAFLOW	OP2_BACOMF	OP2_BA	OP2_BA
9		OP3_ABFLOW	OP3_ABCOMF	OP3_AB	OP3_AB
9		OP3_BAFLOW	OP3_BACOMF	OP3_BA	OP3_BA
10		OP4_ABFLOW	OP4_ABCOMF	OP4_AB	OP4_AB
10		OP4_BAFLOW	OP4_BACOMF	OP4_BA	OP4_BA

Output of "reverse crosstab query:

vmtSpeedClassAreaOn_North_I25_2035_Prefered_Alternative : Select Query											
ID	Rural?	AT_	FT	RT	Cntymiles	periodDir	period	vol	spd	spdc	
16923	U	3	1	R	0.254630141	AM1_BA	1	0	0	2.5	
16923	U	3	1	R	0.254630141	AM1_AB	1	2350.55	57.09	57	
16923	U	3	1	R	0.254630141	AM2_AB	2	5373.62	46.78	47	
16923	U	3	1	R	0.254630141	AM2_BA	2	0	0	2.5	
16923	U	3	1	R	0.254630141	AM3_AB	3	4745.49	56.54	57	
16923	U	3	1	R	0.254630141	AM3_BA	3	0	0	2.5	
16923	U	3	1	R	0.254630141	PM1_AB	4	8618.44	58.36	58	
16923	U	3	1	R	0.254630141	PM1_BA	4	0	0	2.5	
16923	U	3	1	R	0.254630141	PM2_BA	5	0	0	2.5	
16923	U	3	1	R	0.254630141	PM2_AB	5	4552.78	55.11	55	
16923	U	3	1	R	0.254630141	PM3_BA	6	0	0	2.5	
16923	U	3	1	R	0.254630141	PM3_AB	6	4080.01	60.42	60	
16923	U	3	1	R	0.254630141	OP1_AB	7	6899.35	64	64	
16923	U	3	1	R	0.254630141	OP1_BA	7	0	0	2.5	
16923	U	3	1	R	0.254630141	OP2_AB	8	10546.32	60.71	61	
16923	U	3	1	R	0.254630141	OP2_BA	8	0	0	2.5	
16923	U	3	1	R	0.254630141	OP3_AB	9	15713.33	58.21	58	
16923	U	3	1	R	0.254630141	OP3_BA	9	0	0	2.5	
16923	U	3	1	R	0.254630141	OP4_BA	10	0	0	2.5	
16923	U	3	1	R	0.254630141	OP4_AB	10	11381.42	63.84	64	

Record: 1 of 20 (Filtered)

"AT_" is the areatype field– all area types except 5 are urban, and 5 is rural.
 "FT" is the facility type field– a facility type of 1 is a freeway thus the "RT"
 Field is equal to R for restricted. **Note that this link does not really exist in the "BA" direction.**

The previous table now is in the proper format to calculate emissions – one row for each speed, volume and distance (VMT equals volume times distance).

There is still one problem – we do not have the VMT by vehicle type.

MOVES has 14 vehicle types (Source Types), but has a super class of 6 HPMS classes. For example, HPMS Class 50 is broken down into 4 types as follows:

51 Refuse Truck Trucks primarily used to haul refuse to a central location.

52 Single Unit Short-haul Truck Single unit trucks with more than four tires with a range of operation of up to 200 miles

53 Single Unit Long-haul Truck Single unit trucks with more than four tires with a range of operation of over 200 miles

54 Motor Home Trucks whose primary functional design is to provide sleeping quarters.

Traffic Counts

The Federal Highway Administration (FHWA) has 13 vehicle classes, and requires states to maintain a system of traffic counters to count vehicles by these 13 classes.

The Colorado Department of Transportation (CDOT) has such a system which they permanently maintain on selected principle arterials and freeways. They also supplement these Permanent counters with temporary counters on lower level facilities.

This is important because freeways and principal arterials have a higher percentage of heavy trucks than the lower level roads such as minor arterials, collectors and local streets.

I have modified a crosswalk between the FHWA vehicle classes and the 6 HPMS Mobile6 vehicle classes for MOVES. ENVIRON developed the original crosswalk for The Lake Michigan Air Directors Consortium (LADCO). (The counters can not differentiate all 14 of the MOVES Source Types, nor can they differentiate fuel type).

I used this crosswalk with the CDOT traffic count data to develop the following table of the fraction of VMT by HPMS vehicle class

Vehicle Mix Fractions From CDOT Traffic Counters

Weld?	Rural?	FUNCCLA	RT	Hour	f10	f20	f30	f40	f50	f60
0	0.3	N		17	0.00240737	0.50090828	0.409348	0.00107214	0.0002044	0.01428
0	0.4	N		17	0.01762288	0.49921786	0.463876	0.00315087	0.0068742	0.0092585
0	0.5	N		17	0.02108039	0.49650913	0.462755	0.00403975	0.0076663	0.0079496
0	0.6	N		17	0.02108039	0.49650913	0.462755	0.00403975	0.0076663	0.0079496
0	0.7	N		17	0.02108039	0.49650913	0.462755	0.00403975	0.0076663	0.0079496
-1	-1.1	R		17	0.00366469	0.45711724	0.497437	0.00146128	0.0130645	0.0272553
-1	-1.2	R		17	0.00050244	0.48397010	0.499660	0.00017733	0.0062587	0.0094313
-1	0.1	R		17	0.00366469	0.45711724	0.497437	0.00146128	0.0130645	0.0272553
-1	0.2	R		17	0.00058261	0.47642730	0.499594	0.00023014	0.0080221	0.0151442
0	-1.1	R		17	0.00258812	0.48744728	0.498584	0.00024439	0.0027036	0.0084328
0	-1.2	R		17	0.00052117	0.49707371	0.499650	0.00017878	0.0014965	0.0010798
0	0.1	R		17	0.00104869	0.48612981	0.499348	0.00025568	0.0048788	0.0083392
0	0.2	R		17	0.00052117	0.49707371	0.499650	0.00017878	0.0014965	0.0010798

Weld County Colorado is broken out because of having a higher percentage of heavy trucks due to the intensive oil and gas development in that county.

Now we finally have all the information needed to calculate VMT by vehicle type.

The following query performs this calculation using the reverse crosstab query and the vehicle mix fraction table. The query also uses two additional tables to translate the DRCOG road types to the CDOT road types, and to translate the DRCOG periods to hours.

The design of this query is shown in the following slide:

Calculation of VMT by HPMS Vehicle Type

VMT by HPMS Vehicle Type

Area	hour	MOVESrt	spdc	10h	20h	30h	40h	50h	60h
	1	4	2.5	0	0	0	0	0	0
D	1	4	39	0.53540208	290.40552	319.4834	0.3148245	2.7426121	26.3352658
D	1	4	62	2.07408727	1124.9982	1237.6426	1.2195947	10.62457	102.019849
D	1	4	64	11.2267892	6089.4824	6699.2133	6.6015219	57.509541	552.221383
D	1	4	65	4.93970365	2679.3269	2947.604	2.9046205	25.303770	242.973297
D	1	5	13	4.96451516	132.66200	124.59648	1.3567360	3.3617913	8.65271517
D	1	5	16	12.9209285	345.27364	324.28187	3.531118	8.7495886	22.5200468
D	1	5	20	4.13223146	110.42168	103.70832	1.1292839	2.7981987	7.20211757
D	1	5	22	2.7604719	73.765456	69.280701	0.7544003	1.8692924	4.81126078
D	1	5	25	1.64842178	44.049202	41.371121	0.4504918	1.1162520	2.87305481
D	1	5	26	1.89382063	328.53469	304.10404	1.1848100	3.5722484	48.6954646
D	1	5	28	0.14610022	3.9040967	3.6667374	0.0399272	0.0989338	0.25463989
D	1	5	31	4.21807487	119.16323	110.23200	1.1994008	1.0701100	3.43561365
D	1	5	35	4.98559625	140.84619	130.28983	1.4176439	1.2648274	4.0607583
D	1	5	36	12.237682	2110.8764	1953.9363	7.627118	22.983971	312.691839
D	1	5	42	3.85979303	669.58607	619.79400	2.4147596	7.2805943	99.2461544
D	1	5	47	4.63521819	130.94779	121.13331	1.3180146	1.1759377	3.77537606
D	2	4	2.5	0	0	0	0	0	0
D	2	4	39	0.59941385	278.35831	319.29966	0.6182827	3.9045262	37.0368299
D	2	4	62	2.32206166	1078.3287	1236.9309	2.3951574	15.125694	143.476501

Emissions output in tons per day summed by vehicle type, month and pollutant code.
 VMT is also provided, and is an important QA check to see that the total is the same as we started with.

25N35_Preferrod_AlternativeEmissions2012Mx - Select Query									
pollutantID	yearID	monthID	HPMSVtypeID	VMT	t<=25	t<=50	t>=50	Total	
1	2040	1	10	11,217	0.0653600031	0.0503182378	0.0201100780	0.1357883189	
2	2040	1	20	1,702,463	0.2451799628	0.6735281052	0.8524761565	1.7711842245	
2	2040	1	30	1,708,842	0.2485145896	0.7454196447	1.0469107890	2.0408450223	
2	2040	1	40	4,189	0.0011237751	0.0012003479	0.0003231578	0.0026472808	
2	2040	1	50	24,025	0.0076562703	0.0159121639	0.0103934285	0.0339618627	
2	2040	1	60	62,731	0.0042089741	0.0116989127	0.0085003983	0.0244082851	
2	2040	7	10	11,217	0.0653600031	0.0503182378	0.0201100780	0.1357883189	
2	2040	7	20	1,702,463	0.3534672267	1.0364017075	1.1478772095	2.5377461437	
2	2040	7	30	1,708,842	0.3535443288	1.1369365745	1.3945811894	2.8850620927	
2	2040	7	40	4,189	0.0011237751	0.0012003479	0.0003231577	0.0026472807	
2	2040	7	50	24,025	0.0076562703	0.0159121666	0.0103934285	0.0339618654	
2	2040	7	60	62,731	0.0042089741	0.0116989126	0.0085003983	0.0244082850	
3	2040	1	10	11,217	0.0030911237	0.0033119186	0.0015032381	0.0079062805	
3	2040	1	20	1,702,463	0.0061448720	0.0258342365	0.0404417486	0.0724208571	
3	2040	1	30	1,708,842	0.0096567361	0.0391814933	0.0628879897	0.1117262192	
3	2040	1	40	4,189	0.0028562589	0.0026376242	0.000763087	0.0062569702	
3	2040	1	50	24,025	0.0050862187	0.0096305292	0.0069442963	0.0216610442	
3	2040	1	60	62,731	0.0167143177	0.0477100846	0.0396705254	0.1040949278	
3	2040	7	10	11,217	0.0026133118	0.0028015211	0.0012902821	0.0067051150	
3	2040	7	20	1,702,463	0.0060479017	0.0252236201	0.0385550578	0.0698265796	
3	2040	7	30	1,708,842	0.0097970656	0.0383476415	0.059940004	0.1080847110	
3	2040	7	40	4,189	0.0025724573	0.0023705976	0.0006961399	0.0056391949	
3	2040	7	50	24,025	0.0045605272	0.0084428492	0.0061851838	0.0191885602	
3	2040	7	60	62,731	0.0151133000	0.0427625305	0.0362459489	0.0941217794	
87	2040	1	10	11,217	0.0106398380	0.0052969063	0.0014153527	0.017352097	
87	2040	1	20	1,702,463	0.0124045389	0.0222268897	0.018420038	0.0530514666	

The example just presented is only for on-network emissions.
 The on-network emissions are roughly 75% of the CO and NOx emissions, but only about 25% of the VOC emissions.

To calculate the off-network emissions we link to the rates per vehicle and rates per profile Tables from the MOVES MySQL output database (using the MySQL ODBC driver).

Emissions from these tables are in grams per vehicle by hour, and we would calculate emissions by multiplying by the vehicle population for the appropriate vehicle class.

Questions?

Appendix 2: MOVES Input Files

The following sub-sections of Appendix 2 show the text of the MOVES run specification files (i.e., runspecs) for both the on-road and non-road models. The latest version and subsequent updates of the platform were used (MOVES2014b).

ON-ROAD MOVES RUNSPECS

The Division runs MOVES based on year, MPO, and HPMS vehicle type in order to help facilitate how APCD performs various analyses to determine accurate emissions. On-road run specifications are organized two different ways, depending on the MOVES source use type (i.e., HPMS vehicle type). The first runspec type is for HPMS vehicle types 10 and 20, and the second runspec type is for the remaining classes of 30, 40, 50, and 60. Types 10 and 20 are run as one file, while the remaining vehicle types are run individually. Besides vehicle designation, the major difference is in the *sourceusetype* designation (true for HPMS types 10/20, false for HPMS types 30 through 60).

DRCOG RunSpecs (for HPMS vehicle type 10 and 20; Motorcycles and Passenger Cars)

The following shows the runspec that was used to find emission factors related to the HPMS vehicle types 10 and 20 for the DRCOG MPO. The input database uses MOVES defaults except the vehicle populations, which are specific to the 7-county area associated with the DRCOG MPO. Meteorological data used for both DRCOG and the NFR MPOs was that of the last SIP (using July temperatures) and not from the MOVES default database.

```
<runspec version="MOVES2014b-20180726">
  <description><![CDATA[Conformity
  Moves Run 21-----HPMS type 10, 20
  03-04 Mar 2020
  Batch run
  Updated Age Distribution with 2017 numbers. The run specs are as follows:
  Scale: County
  Rates Run.
  Year: 2020
  Time: July, Weekdays, All hours
  Geographic Bounds: Adams (Denver Metro/non-Weld)
  Vehicles/Equipment: Motorcycles (Gas), Passenger Cars (Gas, Diesel, E85)
  Road Type: All (1-5)
  Pollutants and Processes: CO (2), NOx (3), VOC (87) and precursors (TGH - 1, NMHC - 79)
  Output: Units = grams, Joules, miles
  Emissions Detail: Source Use Type
  Input database: 19sipdrcog2020_14bin_ks
  Output database: conformity19sipout_ozone_ks]]></description>
  <models>
    <model value="ONROAD"/>
  </models>
  <modelscale value="Rates"/>
  <modeldomain value="SINGLE"/>
```


<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="91" processname="Auxiliary Power Exhaust"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="1" processname="Running Exhaust"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="11" processname="Evap Permeation"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="12" processname="Evap Fuel Vapor Venting"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="18" processname="Refueling Displacement Vapor Loss"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="19" processname="Refueling Spillage Loss"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
 <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="1" processname="Running Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="2" processname="Start Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="15" processname="Crankcase Running Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="16" processname="Crankcase Start Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90" processname="Extended Idle Exhaust"/>
 <pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="91" processname="Auxiliary Power Exhaust"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="12" processname="Evap Fuel Vapor Venting"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
 <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="18" processname="Refueling Displacement Vapor Loss"/>
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Compounds" processkey="11" processname="Evap Permeation"/>
        <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic
Compounds" processkey="12" processname="Evap Fuel Vapor Venting"/>
        <pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic
Compounds" processkey="13" processname="Evap Fuel Leaks"/>
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Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
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Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
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Compounds" processkey="18" processname="Refueling Displacement Vapor Loss"/>
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Compounds" processkey="19" processname="Refueling Spillage Loss"/>
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]]></internalcontrolstrategy>
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```

```

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```

DRCOG RunSpecs for HPMS vehicle types 30, 40, 50, and 60 (Light/Medium-Duty Trucks, Buses, Single-Unit Heavy Duty Trucks, Combination-Unit Heavy-Duty Trucks, respectively)

Unlike running MOVES to find the emission factors for motorcycles and passenger cars as described above, to find emission factors for the remaining HPMS vehicle types (30, 40, 50, and 60) the Division uses one runspec file for each type.

Each DRCOG runspec used for HPMS vehicle types 30 through 60 differs from the single runspec shown for motorcycles and passenger cars by two things: 1) each runspec designates the MOVES source types associated with each HPMS type, and 2) the designation for breaking down emissions by “source use type” is not selected (because each runspec serves as its own representation of each HPMS vehicle/source type). The same input database is used for all runspecs associated with 2020 and DRCOG.

Northern Front Range MPO Runspecs

The NFR uses the same file-format as DRCOG to determining on-road emissions from MOVES. The runspecs shown prior for DRCOG are nearly identical to those for the NFRMPO, except that the county used is Larimer rather than Adams. Additionally, runspecs for the NFR use a different input database specific to the NFR, which uses appropriate Larimer county inputs such as I/M coverage, fuel inputs, and other defaults (including vehicle populations for Larimer and Weld, combined). Meteorological data used for both DRCOG and the NFR MPOs was that of the last SIP (using July temperatures) and not from the MOVES default database. Additionally, a common vehicle age distribution was used for both DRCOG and NFR MPOs (this was determined from analysis by ERG along with the vehicle populations from county registrations).

NON-ROAD MOVES RUNSPEC

The Division runs MOVES for non-road sources in inventory mode for the 9-counties comprising the nonattainment area. The meteorology used is from the previous SIP for July. The oil and gas sector is excluded because Colorado provided a more detailed inventory (see the Point Source/Oil and Gas TSD for more information on the oil and gas inventory).

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    Boulder County"/>
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```

Appendix 3: Denver International Airport Inventory

STATE IMPLEMENTATION PLAN (SIP) AIR QUALITY INVENTORY

NOVEMBER 2019



DENVER
INTERNATIONAL
AIRPORT

Mead & Hunt
DENVER, COLORADO

Synergy Consultants
SEATTLE, WASHINGTON

Environmental Science Associates (ESA)
SACRAMENTO, CALIFORNIA

Summary

The Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD) and the Regional Air Quality Council (RAQC) are currently in the process of updating the State Implementation Plans (SIPs) for regions which includes Denver International Airport (DEN). The City and County of Denver Department of Aviation have prepared this report to provide information to the APCD specific to emissions associated with activity at DEN for inclusion in the SIPs which reflects current airport planning efforts. The emissions may be used in several SIPs, including a serious area ozone SIP for a change in United States Environmental Protection Agency (USEPA) ozone designation from moderate to serious non-attainment for the 2008 standard (75 ppb), a moderate area ozone SIP for an EPA ozone designation of moderate for the 2015 standard (70 ppb), and a regional haze SIP for a comprehensive revision to the 2011 regional haze plan for federal areas in Colorado that includes Rocky Mountain National Park.

Because most development at DEN triggers a federal action, before such airport improvements can be undertaken, the federal agency must first show that the project conforms with the applicable SIP. Inclusion of this information in the respective SIPs will facilitate future Clean Air Act General Conformity Determinations that airport staff anticipate being prepared during the life of the SIPs. Inclusion of the Airport emissions inventory in the SIP will provide a basis for direct comparison of these future projects.

This summary describes the assumptions and methodologies used to develop the Airport Emissions Inventory for aircraft operations and project construction at DEN and summarizes the inventory results. For aircraft operating emissions, modeled results are presented for the calendar years 2023 and 2028. Results for year 2020 were interpolated from the 2023 modeled result.

This Emissions Inventory focuses on emissions for: aircraft, auxiliary power units (APU), aircraft ground support equipment (GSE), and emissions from construction of anticipated airport projects. For construction emissions, total emissions are presented for each construction project. Annual emissions were estimated for the following pollutants: carbon monoxide (CO), volatile organic compounds (VOCs), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulate matter (PM₁₀), and fine particulate matter (PM_{2.5}). The emissions of these pollutants are reports in short-tons per year, consistent with the evaluation process required for airports, and is designed to enable APCD to translate annual emissions into other formats as needed.

Emissions associated with DEN aircraft operations were compiled for the years 2023 and 2028, as well as reasonably foreseeable construction projects occurring around that time period. The construction projects are as follows:

- **Future 16,000 ft long Runway and associated taxiways**
- **Pena Blvd - 3rd Lane Expansion Inbound and Outbound from Jackson Gap to I-70**
- **Cargo Expansion – 1.5 million square feet expansion including a new building and parking**
- **Parking Structure - 5 Acres or 1,800 Spaces**
- **Aircraft Rescue and Firefighting (ARFF) Station #5**
- **Parking Lot - 110 Acres**
- **New Maintenance Facility - Building & Parking (20 Acres or 871,200 Square Feet)**
- **DEN Real Estate West Approach – Building and grounds for hospitality, retail, and office uses along the Pena Blvd. corridor**
- **Deicing Pond Expansion, 3-4 cells, about 20 acres**
- **New 5,280-foot Taxiway**

AIRCRAFT OPERATING EMISSIONS RESULTS

The DEN SIP aircraft operating emissions inventories are presented in **Table ES-1** for the years 2020, 2023 and 2028.

TABLE ES-1 - AIRCRAFT OPERATING EMISSIONS INVENTORY

YEAR	Aircraft Operating Emissions (Tons/year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
2020	4,022.71	604.50	2,464.60	236.46	26.66	26.91
2023	4,400.07	661.21	2,695.80	258.63	29.16	29.43
2028	4,987.65	749.88	3,057.18	293.35	33.06	33.37

SOURCE: AEDT 2d; ESA, 2019. 2020 results were interpolated from the 2023 modeled result using aircraft operations. Aircraft operating refers to the operation of aircraft, auxiliary power units (APU) and airline ground support equipment (GSE) when the Airport could serve as high as 690,520 annual aircraft operations and over 79.0 million annual passengers. Note that AEDT calculates NOX and SOX rather than NO2 and SO2.

CONSTRUCTION EMISSIONS RESULTS

The DEN SIP construction emissions inventories are presented in **Table ES-2**.

TABLE ES-2 - ANNUAL CONSTRUCTION PROJECT EMISSIONS

	Construction Emissions (Tons/year)					
	CO	VOC	NO _x	SO ₂	PM _{2.5}	PM ₁₀
Annual Construction Emissions	146.58	105.64	204.44	0.75	10.08	19.49

SOURCES: ACEIT 1.0, ESA, 2019;

TOTAL AIRCRAFT OPERATING AND CONSTRUCTION EMISSIONS

The combination of the aircraft operating emissions and construction emissions are presented in **Table ES-3** for years 2020, 2023 and 2028.

TABLE ES-3 - AIRCRAFT OPERATING AND CONSTRUCTION EMISSIONS INVENTORY

Year	Aircraft Operating and Construction Emissions (Tons/year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
2020	4,169.29	710.14	2,669.04	237.21	36.74	46.40
2023	4,546.65	766.85	2,900.24	259.38	39.24	48.92
2028	5,134.23	855.52	3,261.62	294.10	43.14	52.86

SOURCE: AEDT 2d; ACEIT 1.0, ESA, 2019. 2020 results were interpolated from the 2023 modeled result using aircraft operations
 Note that AEDT calculates NO_x and SO_x rather than NO₂ and SO₂.

Note that aircraft operating emissions includes emissions associated with aircraft engines, auxiliary power units (APU), and ground support equipment (GSE).

Introduction

This document provides the air quality modeling approach and emissions inventory modeling results for the Denver International Airport (DEN). The purpose of this emissions inventory was to provide information to the City and County of Denver, as the airport operator, that could be used to contribute identifying airport-related emissions in the State Implementation Plans (SIP)s that are under preparation. For aircraft emissions, results are presented for calendar years 2020, 2023 and 2028. This emissions inventory focuses on emissions for: aircraft, including aircraft engines, auxiliary power units (APU), aircraft ground support equipment (GSE), and emissions from construction of anticipated airport projects. For construction emissions, total emissions are presented for each construction project and are summarized for the purpose of inclusion in the SIP on a facility level.

Airport Overview

DEN is a major air transportation hub operated by the City and County of Denver Department of Aviation and located east of the front range of the Rocky Mountains in Colorado. DEN opened on February 28, 1995, replacing Stapleton International Airport (formally named Denver Municipal Airport until 1944).

DEN is approximately 23 miles northeast of the downtown Denver Central Business District and is situated on over 34,000 acres (53 square miles) of land. As shown in **Figure 1**, the Airport is located primarily in the City and County of Denver, although portions of the DEN perimeter are in Adams County. Peña Boulevard serves as the main access route to the airport, linking to Interstate 70 (I-70), a major east-west freeway.

As shown in **Figure 2**, DEN contains six runways consisting of two sets of parallel runways oriented north/south (Runways 16L-34R, 16R-34L and Runways 17L-35R and 17R-35L) and two crosswind runways oriented in an east/west direction (Runways 7-25 and 8-26). The terminal complex is centrally located in the airfield. It has a landside terminal building (Jeppesen Terminal) and three satellite concourses (A, B, and C). The concourses were designed to allow for modular extension capability to accommodate future expansions.

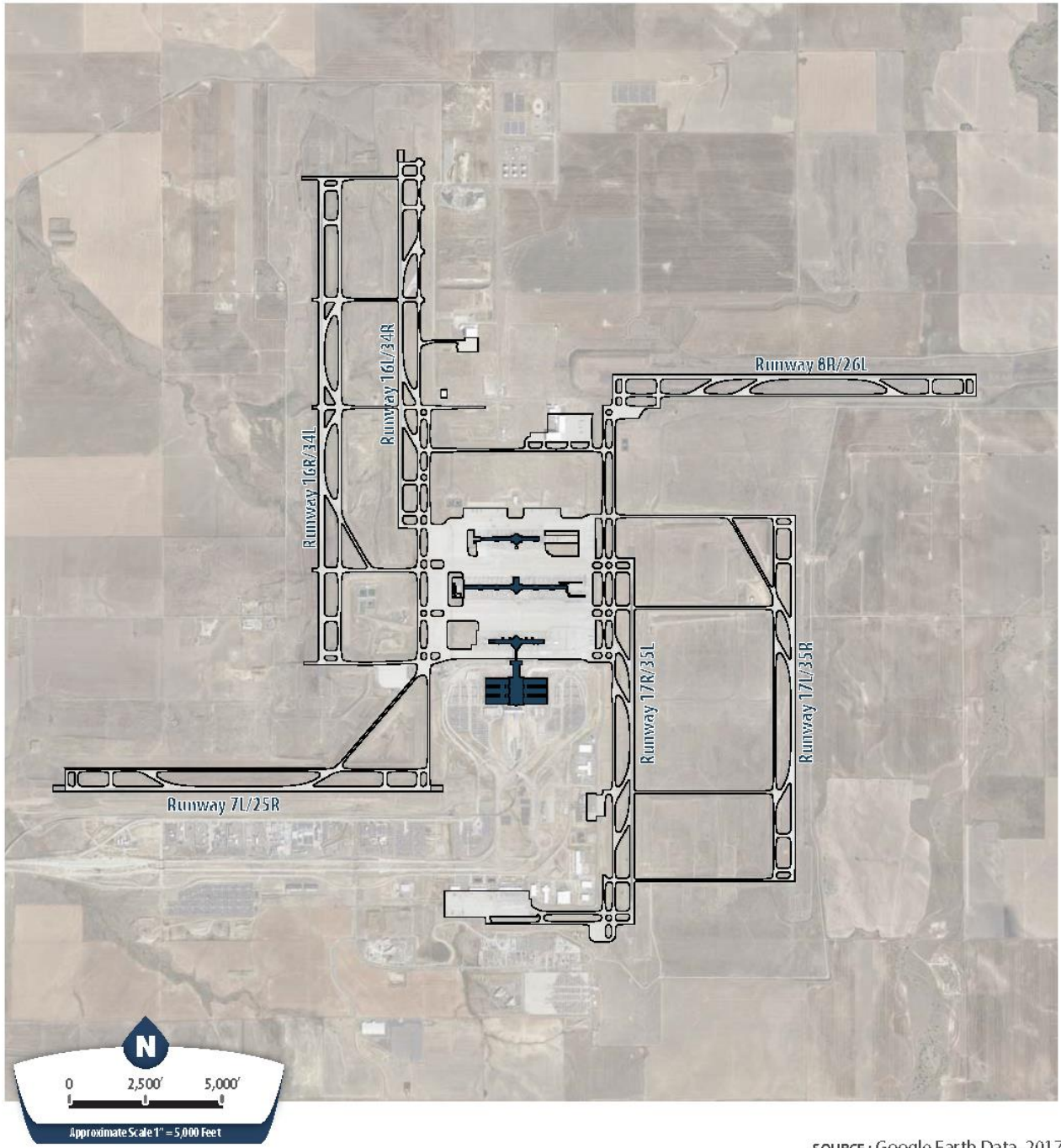


Figure 1 - Airport Location Map



SOURCE: Google Map Data, 2017.

Figure-2 – DEN Airport Layout



SOURCE : Google Earth Data, 2017.

Topography and weather influence air quality in a region by affecting the movement and chemical transformation of air pollutants as well as emissions characteristics of emission sources. The elevation of the City and County of Denver varies from approximately 4,800 feet to approximately 6,000 feet, with higher elevations located primarily in the southwest regions of the County farther away from DEN.¹ According to the 30-year weather normal data spanning the period 1981 through 2010, available from the National Oceanic and Atmospheric Administration, the average temperature at DEN from April through September was 63.7 degrees Fahrenheit (°F), while the average temperature from October through March was 37.1 °F.² From April through September, the monthly variation between low and high temperatures ranged from 28.2 °F to 30.5 °F, while the monthly variation from October through March ranged from 25.7 °F to 28.7 °F.

Air Quality Regulatory Setting

Air quality is regulated by federal, state, and local laws. On the federal level, air quality is governed by the federal Clean Air Act (CAA) administered by the United States Environmental Protection Agency (USEPA). Additionally, air quality in Colorado is governed and administered by the Colorado Department of Public Health and Environment (CDPHE). Within the City and County of Denver, emissions are addressed by the Denver Department of Public Health and Environment (DDPHE). Denver Regional Council of Governments (DRCOG) is the designated Metropolitan Planning Organization (MPO), which is the local agency responsible for surface traffic conditions in the area and is an agency that often has some air quality expertise because of the interface of surface transportation and air quality issues. The Regional Air Quality Council (RAQC) coordinates air quality planning initiatives across local government agencies, the private sector, stakeholder groups, and citizens of the Denver metropolitan area and the Denver Metro/North Front Range Non-Attainment Areas. The Federal Land Managers (FLM), tribes, and other states are consulted during development of an implementation plan or plan revision for regional haze.

¹ United States Geological Survey (2015). "Shuttle Radar Topography Mission (SRTM) | The Long-Term Archive." <https://lta.cr.usgs.gov/SRTM>. Last accessed: November 24, 2017.

² National Oceanic and Atmospheric Administration. "1981 – 2010 Normals | Data Tools | Climate Data Online (CDO) | National Climatic Data Center (NCDC)." <https://www.ncdc.noaa.gov/cdo-web/datatools/normals>. Last accessed: November 24, 2017.

FEDERAL

The USEPA is responsible for enforcing the CAA. The CAA was first enacted in 1955 and has been amended numerous times in subsequent years. The CAA requires the USEPA to establish National Ambient Air Quality Standards (NAAQS), and assigns primary responsibility to individual states to assure compliance with the NAAQS. NAAQS are designed to protect public health and welfare with an adequate margin of safety. Areas not meeting the NAAQS, referred to as nonattainment areas, are required to implement specific air pollution control measures reflected in the State Implementation Plan (SIP).

Under the authority granted by the CAA, USEPA has established NAAQS for the following pollutants: sulfur dioxide (SO₂), carbon monoxide (CO), particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM₁₀), particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers (PM_{2.5}), lead (Pb), nitrogen dioxide (NO₂), and ozone (O₃) using as precursor pollutants volatile organic compounds (VOC) and oxides of nitrogen (NO_x).³ **Table 1** presents the currently applicable NAAQS. These pollutants are collectively often referred to as “criteria” pollutants, as they represent the chemical compounds for which USEPA has criteria for protecting public health and welfare.

The CAA also specifies future dates for achieving compliance with the NAAQS and mandates that states submit and implement a State Implementation Plan (SIP) for non-attainment areas. SIPs represent the state’s plan for how these areas will achieve attainment and include pollution control measures with a demonstration of how the standards will be met.

The CAA also sets a national visibility goal of protecting visibility and remedying existing visibly impairment in mandatory class I federal areas (national parks and wilderness areas) that result from man-made air pollution. EPA’s visibility regulations establish a process for determining visibility impairment and developing and implementing plans to restore visibility.

STATE

Air quality issues in Colorado fall under the responsibilities of the CDPHE. The State has adopted the NAAQS, requiring all air sheds in the state to achieve and maintain NAAQS by the earliest practicable date.

³ Ozone is a secondary pollutant, meaning that it is formed from reactions of “precursor” compounds under certain conditions. The primary precursor compounds that lead to the formation of O₃ are VOC and NO_x.



TABLE 1 – CURRENT NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary/ Secondary	Averaging Time	Level	Form	
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year	
		1 hour	35 ppm		
Lead (Pb)	primary and secondary	Rolling 3-month average	0.15 µg/m ³ ⁽¹⁾	Not to be exceeded	
Nitrogen Dioxide (NO ₂)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	primary and secondary	1 year	53 ppb ⁽²⁾	Annual Mean	
Ozone (O ₃)	primary and secondary	8 hours	0.070 ppm ⁽³⁾	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years	
Particle Pollution (PM)	PM _{2.5}	primary	1 year	12.0 µg/m ³	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m ³	annual mean, averaged over 3 years
	PM ₁₀	primary and secondary	24 hours	35 µg/m ³	98th percentile, averaged over 3 years
		primary and secondary	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO ₂)	primary	1 hour	75 ppb ⁽⁴⁾	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year	

- (1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m³ as a calendar quarter average) also remain in effect.
- (2) The level of the annual NO₂ standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.
- (3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O₃ standards additionally remain in effect in some areas. Revocation of the previous (2008) O₃ standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.
- (4) The previous SO₂ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO₂ standards or is not meeting the requirements of a SIP call under the previous SO₂ standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Denver County, including the area surrounding DEN, is designated as:

- **Nonattainment for ozone (O₃)**
- **Maintenance for CO and PM₁₀**
- **Attainment for Pb, NO₂, PM_{2.5} and SO₂**

Denver is currently designated as moderate nonattainment for the 2008 (75 ppb) ozone standard. A moderate area ozone SIP was prepared and approved by EPA in July 2018. In August 2019, EPA proposed a change in designation for Denver to serious for the 2008 (75 ppb) ozone standard. The state and RAQC are in the process of developing a serious area ozone SIP in anticipation of the change in classification. Denver is currently designated as marginal nonattainment for the 2015 (70 ppb) ozone standard. Though no attainment demonstration plan is required for a marginal nonattainment area, the state and RAQC are preparing for a potential reclassification to moderate in late 2021 if the region fails to attain.

Because Denver was previously a nonattainment area for CO and PM₁₀, the State has prepared SIPs for CO, and PM₁₀. Denver was re-designated as a maintenance area for CO and PM₁₀ in 2002; therefore, the area is subject to a maintenance SIP for these pollutants.

Colorado has 12 Mandatory Class I Federal Areas that have been designated as impaired for visual air quality by the FLM responsible for that area. Colorado has a regional haze SIP in place and comprehensive periodic revisions to the plan are currently due in 2021, 2028, and every 10 years. The Air Pollution Control Division of CDPHE is in the process of developing the SIP revision and has identified DEN as an emissions source potentially impacting western class I areas, based on aircraft emissions associated with operations at DEN and the distance of those emissions to Rocky Mountain National Park.

Colorado is developing multiple SIPs, with different attainment years for specific pollutants. For instance, the moderate area 2008 ozone SIP is expected to use an attainment year of 2020. This emissions inventory was prepared by modeling aircraft operating emissions for years 2023 and 2028 and interpolating for year 2020 using annual aircraft operations.

Aircraft Operating Emissions

A key element in preparing an emissions inventory for aircraft are associated with identifying the types of aircraft operating at an airport and the frequency with which each aircraft type operates. Aircraft engines reflect the engines that power the movement of the aircraft as well as the engine used to power the avionics and heating/cooling, known as the auxiliary power unit (APU). Aircraft operations data was

obtained from the DEN Noise and Operations Management System (NOMS). In addition to these engines, on ground vehicles that service aircraft were evaluated, known as ground support equipment.

AIRCRAFT EMISSIONS SOURCES

Aircraft operations typically account for the great majority of total airport emissions. A variety of aircraft types operate at commercial airports, including large and small commercial jets, smaller commuter aircraft powered by turboprop engines, piston-engine general aviation aircraft, and other miscellaneous aircraft such as helicopters. In addition, military aircraft also occasionally operate at commercial airports.

Sources of aircraft emissions include aircraft engines as well as auxiliary power units (APUs) used to provide electricity, ventilation, and air conditioning to the aircraft at the gate. Emissions associated with aircraft are captured by the modes of the LTO cycle (taxi/idle/delay, engine start, approach, takeoff, and climbout) and APU emissions.

Under the CAA, the federal government has taken substantial steps to reduce emissions from all sources. Section 231(a)(2)(A) of the CAA directs the USEPA to propose, from time to time, aircraft engine emission standards applicable to the emission of any air pollutant from classes of aircraft engines which causes or contributes to air pollution that may reasonably be anticipated to endanger public health or welfare. Section 233 of the CAA vests the authority to promulgate emission standards for aircraft or aircraft engines and APUs with the USEPA; States and local agencies are preempted from adopting or enforcing any standard respecting aircraft engine emissions unless such standard is identical to USEPA's standards. In meeting its aircraft engine standard responsibilities, the USEPA has enacted aircraft engine standards that mirror the standards set by the International Civil Aviation Organization (ICAO).

Reducing aircraft engine NO_x emissions over the LTO cycle has long been a priority for the ICAO Committee on Aviation Environmental Protection (CAEP). CAEP first established standards for emissions of NO_x, hydrocarbons (HC), CO, and smoke in 1986. Since that time, the standard for allowable NO_x emissions has been reduced four times. At the CAEP meeting in February 2010, the nominal NO_x emission standard was reduced to less than 50 percent of the original standard.

In 2012 USEPA adopted two tiers of emissions standards for aircraft and APUs: (1) Tier 6 (or CAEP/6) and (2) stricter Tier 8 (or CAEP/8). Implementation of the Tier 6 standards will result in a 12 percent reduction in emissions levels below the current Tier 4 (CAEP/4) standards. The Tier 8 standards are expected to result in a further 15 percent reduction in NO_x emissions levels below the Tier 6 standards. The applicability of the tiers depends on the manufacturing and certification dates of the engine model.⁴

⁴ <http://www.epa.gov/otaq/aviation.htm#regs> "EPA adopts NO_x Emission Standards for Aircraft Gas Turbine Engines" USEPA Office of Transportation and Air Quality, June 2012.

Tier 6 Standards: If the engine model was manufactured and certified before July 18, 2012, the engine model would not be required to comply with the Tier 6 standards until December 31, 2012. Any engine model certified between July 18, 2012 and December 31, 2013, must comply by December 31, 2013.

Tier 8 Standards: Any engine model certified on or after January 1, 2014, must comply with the Tier 8 standards.

GROUND SUPPORT EQUIPMENT EMISSIONS

Airport ground support equipment (GSE) is comprised of a wide variety of vehicles used by airlines, fixed base operators, and airports to service aircraft during ground operations and for the airport operator to maintain runways and other airport facilities. Nationally, five types of equipment dominate the aircraft GSE population: aircraft tugs, baggage tugs, forklifts, belt loaders, and cargo tractors.

The USEPA has the authority under the CAA to establish emission standards for most stationary and some mobile sources. GSE are commonly classifiable under two subcategories of mobile sources: (1) non-road vehicles (i.e., engines and equipment that would not be expected to travel on public roadways) and (2) on-road motor vehicles (i.e., vehicles that are licensed to travel on public roadways, also known as ground access vehicles (GAVs)). Because of the similarities in emission reduction controls that exist for on-road GSE and airport fleet vehicles, the remainder of this section focuses on non-road vehicles, and the on-road vehicle, or GAV, discussion occurs later.

The emission standards developed by the USEPA to date have typically been much more stringent (i.e., having much lower allowable emission rates) for on-road vehicles than for non-road equipment due to the magnitude of contribution of these vehicles to local air quality. Many GSE types (e.g., catering trucks, cabin service trucks, and crew vans) are built with engines that meet the on-road emission standards. Other GSE types (e.g., belt loaders, aircraft tugs, and bag tugs) are typically built with non-road engines and therefore subject to non-road emission standards. With the exception of California, the CAA preempts states and local agencies from adopting or enforcing their own on-road and non-road emission standards.

The non-road engines associated with GSE generally fall into two broad classes: (1) compression-ignition (CI) engines and (2) spark-ignition (SI) engines. Typically, non-road CI engines are fueled with diesel while non-road SI engines are traditionally fueled with gasoline.

CI Engines: Federal emission standards for non-road CI engines have been established for non-methane hydrocarbons (NMHC), NO_x, particulate matter (PM), CO, and smoke output. The USEPA has organized these emissions standards into classes (or tiers) based on the date of manufacture and rated engine output (e.g., horsepower) with greater stringency (i.e., lower emissions) associated with increasing emission control levels (i.e., Tier 0 < 1 < 2 < 3 < 4).

The first federal standards (Tier 1) for new non-road diesel engines were adopted in 1994 for engines over 50 hp, to be phased-in from 1996 to 2000. In 1998, the USEPA introduced Tier 1 standards for equipment under 37 kW (50 hp) and increasingly more stringent Tier 2 and Tier 3 standards for all equipment with phase-in schedules from 2000 to 2008. The Tier 1-3 standards are met through advanced engine design, with no or only limited use of exhaust gas after-treatment (oxidation catalysts). Tier 3 standards for NO_x+HC are similar in stringency to the 2004 standards for highway engines.

In 2004, USEPA signed the final rule introducing Tier 4 emission standards, which are phased-in over the period of 2008-2015. The Tier 4 standards require that emissions of PM and NO_x be further reduced by about 90 percent. Such emission reductions can be achieved through the use of control technologies—including advanced exhaust gas after treatment—similar to those required by the 2007-2010 standards for highway engines.

SI Engines: The federal emission standards for SI non-road engines have been promulgated for equipment produced after 2004 and are also “tiered” to reflect increasing emission controls based on the date of manufacture and horsepower but include both exhaust emission standards and evaporative emission standards. SI non-road engines are traditionally fueled with gasoline or natural gas, but alternatives to these fuels are emerging.

The USEPA has also published voluntary emission standards for large SI non-road engines known as the “Blue Sky Series” for model years beginning in 2004. These standards, while they are voluntary, are intended to encourage manufacturers to develop innovative technologies to go beyond the required emission standards for these types of engines. Importantly, any manufacturer certifying a class of its engines to the Blue Sky Series standards is required to ensure that the engines adhere to the standards as if they were mandatory.

Whereas airport operators have limited authority to control aircraft GSE that are owned and operated by the airlines (other than incentives), they do have control over their own fleet vehicles. Specific to DEN, vehicles operating in the tunnels are required to be electric or CNG to reduce emissions in the tunnels and reduce the hazard of fires. For this emissions inventory, the AEDT Version 2d default GSE types were used for the purposes of aircraft operating emissions modeling. It is believed that the estimated emissions are therefore conservatively high because the use of CNG and electric GSE was unable to be accounted for due to limited data availability.

AIRCRAFT OPERATING EMISSIONS METHODOLOGY

The air quality modeling methodology for the DEN SIP inventory leveraged the methodology and data used for the DEN Concourse Expansion Environmental Assessment (EA) as well as prior emissions inventories prepared for earlier DEN SIP submissions.⁵ The Aviation Environmental Design Tool, version 2d, was used to calculate DEN aircraft, APU, and GSE operating emissions.⁶ AEDT is a modeling tool that calculates noise, fuel burn, and emissions associated with aviation operations. AEDT Version 2d was the latest version of AEDT available in July of 2019, when the DEN SIP inventory analysis began. For this project, AEDT was used to calculate criteria pollutant emissions from the operation of aircraft main engines, aircraft auxiliary power units (APUs), and airport ground support equipment (GSE).

AEDT Version 2d was used to estimate emissions of carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), coarse particulate matter (PM₁₀), fine particulate matter (PM_{2.5}), and sulfur oxides (SO_x) for DEN operations. Note that AEDT does not calculate lead emissions. Aircraft lead emissions are primarily associated with piston engines burning leaded aviation gasoline. Piston-engine aircraft, however, comprise less than three percent of operations at DEN. Aircraft, APU, and GSE emissions results are given in this document only for emissions calculated by AEDT.

AIRCRAFT OPERATIONAL COUNTS

The DEN NOMS data provides the basis for estimating aircraft emissions, including the date, time of day, operation type (departure or arrival), runway used, flight and/or tail number, aircraft type, airline, and destination/origin for almost every operation occurring at DEN. The DEN NOMS system recorded a total of 574,811 airport operations from June 1, 2016 through May 31, 2017, while the Federal Aviation Administration's (FAA) Air Traffic Activity Data System (ATADS), which reflect operations counts collected by DEN air traffic controllers, reported 580,449 airport operations at DEN during the same timeframe.⁷

An analysis of the NOMS data indicated that not all the data were complete for a small number of operations. The analysis identified approximately 385 operations with unknown aircraft types, and approximately 2,402 departures with unknown destinations. Due to the lack of information available to define aircraft types, these operations were omitted from the data set that was used for developing the emissions model inputs. Further research was required for departures with unknown destinations. While the DEN NOMS recorded 5,638 fewer operations than the FAA's ATADS, the FAA numbers were considered the official operational count for the purposes of calculating emissions. As a result, the NOMS destination and fleet data were proportionally scaled up to the 580,449 operations reflected in

⁵ Denver International Airport Concourse Expansion Final Environmental Assessment. May 2018.

⁶ Federal Aviation Administration (2017). "AEDT: Product Information." https://aedt.faa.gov/2d_information.aspx. Last accessed: August 1, 2019.

⁷ Federal Aviation Administration. Air Traffic Activity Data System. <https://aspm.faa.gov/opsnet/sys/Main.asp?force=atads>. Last accessed: August 1, 2019.

the FAA's ATADS database. This equates to an average of approximately 1,590 daily operations (defined as either an arrival or departure) at DEN during the period from June 1, 2016 through May 31, 2017.

The DEN NOMS data reported approximately five helicopter operations, which were excluded from the analysis due to the low number of operations in comparison with fixed-wing aircraft operational counts. Additionally, data for aircraft run-up operations were not available at the time of the study. Therefore, aircraft run-up operations were not modeled.

In order to forecast aircraft operational counts for the years 2023 and 2028, an April 2019 DEN aviation activity forecast was used.⁸ Use of the DEN forecast is appropriate for development of the SIP because the forecast better accounts for local conditions happening at DEN than the FAA Terminal Area Forecast (TAF). In developing DEN's aviation activity forecasts, considerable effort is expended in analyzing the factors affecting traffic activity at DEN. Separate base, low, and high forecasts are developed based on different assumptions regarding economic and traffic development. DEN's high-level forecasts assume a higher long-term trend in economic growth and more aggressive air service expansion market-specific changes.

The "High Case" forecast scenario was used to develop percent increases in operations for the year 2028 in comparison with the calendar year 2017 aircraft operational counts. The forecast did not contain the years 2028; however, annual operational counts were developed for that year by linearly interpolating between the nearest years given in the forecast. Operational counts are presented in **Table 2**.

The 2017 operational count shown in the aviation activity forecast document differed from the FAA ATADS 2017 operational count. To determine aircraft operational counts for the year 2028 for the purposes of DEN SIP inventory modeling, the percent increases shown in **Table 2** were applied to the FAA ATADS 2017 operational count of 580,449 annual operations. This resulted in an annual count of 778,370 operations for the year 2028. Approximately 10,000 of the calendar year 2017 operations were Beechcraft 1900D aircraft types that AEDT was not able to model at DEN due to deficiencies in the aircraft profile that has been observed at high-altitude airports. The FAA recommended a user-defined profile in lieu of an aircraft substitution and during the development of a user-defined profile, the noise contours were found to be nearly identical without the inclusion of the Beechcraft 1900D. The decision was made and noted to exclude this aircraft from the noise model. These operations (approximately 1.7% of the fleet mix) were eliminated from analysis, giving 570,454 year 2017 operations; 676,240 year 2023 operations; and 764,967 year 2028 operations. These adjusted operational counts were used for DEN SIP inventory modeling.

⁸ InterVISTAS. Denver International Airport Aviation Activity Forecast. Final Report. April 2019.

TABLE 2 – ANNUAL AIRCRAFT OPERATIONAL COUNTS

Calendar Year	Annual Operations	Percent Increase Vs. 2017
2017*	582,500	
2020	631,300	8.4%
2023	690,520	18.5%
2025	730,000	25.3%
2028	781,120	34.1%
2030	815,200	39.9%

SOURCE: InterVISTAS, 2019; ESA, 2019.

* The 2017 operational count differs from that presented in this DEN SIP inventory document due to the different methodology employed by the aviation activity forecast document.

AIRCRAFT FLEET MIX

The DEN NOMS data provided a comprehensive list of aircraft that currently operate at DEN. This list was used to determine specific equivalent AEDT aircraft for the purposes of calculating emissions. In determining the AEDT equivalent aircraft for the purposes of noise modeling, research was done to determine the specific airline fleet mixes and engine types across all aircraft types. An example of this would be the Boeing 757 (B-757). Through specific airline fleet mix analysis, it was determined that American Airlines operates B-757 aircraft with Rolls-Royce engines, while Delta Air Lines operates B-757 aircraft with Pratt & Whitney engines. Although both airlines utilize the same model of aircraft, each of these aircraft have distinct performance and emissions profiles and are identified separately in AEDT based on their engine type. It is from this specific airline fleet mix analysis that an overall AEDT fleet mix was developed as shown in Appendix A.

Although the AEDT aircraft database provides a large selection of aircraft to model, it does not contain every aircraft type needed for the study. For those aircraft types that do not exist within AEDT, aircraft substitutions were selected by the project team and all substitutions used were approved by the FAA in the development of the DEN Concourse Expansion EA. The complete AEDT fleet mix is shown in Appendix A.

The current AEDT aircraft fleet mix was kept constant for the analysis years 2023 and 2028. Detailed information on planned future fleet changes for each of the airlines is not generally available or known. However, aircraft fleet changes often change slowly, and the aircraft fleet is not expected to change significantly over the period of this analysis. The introduction of newer aircraft and retirement of older aircraft results in changes in the emissions profile at airports. Although, it has been observed that

airlines do not necessarily replace old aircraft with the same size new aircraft. At this time, specific changes to future aircraft fleet is not available for future years, and thus, the existing information was used.

STAGE LENGTHS

Once the specific airline fleet mix analysis was completed, departure destination information provided by the DEN NOMS was analyzed to determine departure stage lengths. An aircraft’s stage length (or trip length) refers to the distance an aircraft flies from its origin airport (DEN) to its intended destination. The stage length is important in environmental modeling since the longer the distance an aircraft flies to its destination, the greater its fuel load and overall weight and, as a result, the lower its climb rate will be when flying the departure profile. Stage lengths for aircraft departing DEN used in the AEDT include the following stage lengths:

Stage Length 1:	0 to 500 miles
Stage Length 2:	501 to 1,000 miles
Stage Length 3:	1,001 to 1,500 miles
Stage Length 4:	1,501 to 2,500 miles
Stage Length 5:	2,501 to 3,500 miles
Stage Length 6:	3,501 to 4,500 miles
Stage Length 7:	4,501 to 5,500 miles
Stage Length 8:	5,501 to 6,500 miles
Stage Length 9:	6,500+ miles

As noted previously, there were approximately 2,402 NOMS aircraft departures without destination information. Specific research on destinations flown by individual airlines was analyzed and applied to the unknown destinations. Where no consistent airline destination could be determined, the percentage of unknown departure operations was assumed to reflect a cross section of stage lengths similar to those operations with known destinations. The stage length information used to develop the DEN SIP aircraft operating emissions is included in Appendix A.

RUNWAY AND FLIGHT TRACK USE

Runway and flight track use were originally determined to support noise modeling for the DEN. If a certain runway is used predominantly for departures while another runway is used for arrivals, noise exposure levels will differ off each runway end to reflect the type of activity. Runway use was calculated separately for daytime (7:00 A.M. to 9:59:59 P.M.) and nighttime (10:00 P.M. to 6:59:59 A.M.) to meet FAA noise modeling requirements for the EA. Though less important for the calculation of emissions

inventories, the information was used as is for the DEN SIP inventory. **Table 3** shows the runway use percentages by day/night departures and arrivals.

TABLE 3 – RUNWAY USE PERCENTAGES

Runway	Day Departures	Night Departures	Day Arrivals	Night Arrivals	Total Runway Use Percentage
07	0.00%	0.00%	0.99%	0.34%	0.46%
08	35.45%	32.36%	0.00%	0.00%	17.56%
16L	0.01%	0.09%	22.11%	39.20%	11.98%
16R	0.31%	0.06%	16.15%	18.08%	8.32%
17L	6.28%	4.62%	0.09%	0.21%	3.10%
17R	9.60%	39.73%	8.78%	14.13%	11.14%
25	27.24%	1.26%	0.17%	0.04%	12.26%
26	0.00%	0.00%	1.67%	1.12%	0.81%
34L	13.03%	10.19%	0.02%	0.00%	6.37%
34R	7.88%	9.65%	5.50%	1.53%	6.58%
35L	0.19%	2.00%	26.28%	19.66%	12.98%
35R	0.01%	0.04%	18.24%	5.71%	8.45%
Total	100.00%	100.00%	100.00%	100.00%	100.00%

SOURCE: DEN NOMS Data, 2017; ESA, 2017

Note: Percentages may not equal 100% due to rounding.

Table 3 indicates that DEN most commonly operates Runways 08 and 25 for daytime departures and Runways 08 and 17R for nighttime departures as well as Runways 16L/R and 35L/R for nighttime arrivals. Runway use percentages by aircraft type were determined and can be found in Appendix A. Flight tracks and flight track use percentages were used in combination with runway use to allocate aircraft operations around the vicinity of DEN. In order to obtain this information, radar flight tracks to and from each runway end at DEN were used for the existing year. The flight track use percentages used in the modeling effort are on a runway-by-runway basis and are provided in Appendix A.

AIRCRAFT STARTUP AND TAXI ACTIVITY

Aircraft taxi-in and taxi-out times by aircraft type were used for the period June 1, 2016 through May 31, 2017.⁹ Taxi-in times were averaged across the time period, as were taxi-out times, to produce the following approximate airport-specific taxi times for existing condition emissions modeling:

- **Average taxi-in time: 8 minutes, 2 seconds**
- **Average taxi-out time: 13 minutes, 36 seconds**

Detailed information on how taxi times would change in the future was not available at the time of this document. Therefore, the same taxi-in and taxi-out times were used for the analysis years of 2023 and 2028. It is important to note that the emissions inventory for later years likely understates the aircraft operating emissions in the taxi-idle mode. DEN anticipates that in the future additional airfield capability will be needed to reduce delay and congestion from growing levels of aircraft operations. At this time, specific delay and taxi information is not available for these future years, and thus, the existing information was used.

AEDT was also used to estimate aircraft startup emissions. AEDT contains a startup emissions estimation methodology that requires no additional input from the AEDT user.

APU AND GSE ACTIVITY

AEDT Version 2d default GSE and APU equipment types were used for the purposes of aircraft operating emissions modeling. AEDT contains a database that assigns GSE and APU equipment types and operating parameters (such as operating times and load factors) to aircraft operations based on aircraft type and mode of operation (i.e. arrival or departure). The specific types and number and types of GSE operating at DEN was not available for this study. Similarly, the time of actual APU use for each of the aircraft types and operational profiles at DEN was not available and as such default values were used. Nonetheless, aircraft at DEN primarily park at contact gates with boarding bridges that are equipped with preconditioned air and ground power units to reduce the use of APUs. Also, vehicles operating in tunnels at DEN are required to be electric or CNG to reduce emissions in the tunnels and reduce the hazard of fires. As such, it is believed that the use of the AEDT Version 2d default GSE and APU parameters estimated emissions conservatively high.

⁹ Denver International Airport. "RE: Data Requests." Email from Keith P. Mays to Christopher Sequeira. August 14, 2017.

AIRCRAFT OPERATING EMISSIONS RESULTS

The DEN SIP aircraft operating emissions inventories are presented in **Table 4** for the year 2020, **Table 5** for 2023 and **Table 6** for year 2028. Note that AEDT calculates NOX and SOX rather than NO2 and SO2.

TABLE 4 – YEAR 2020 AIRCRAFT OPERATING EMISSIONS INVENTORY

	Aircraft Operating Emissions (Tons/Year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	3,030.19	566.25	2,264.43	231.64	22.26	22.26
GSE	885.39	31.39	101.33	4.82	4.40	4.64
APUs	107.14	6.87	98.85	-	-	-
Total	4,022.71	604.50	2,464.60	236.46	26.66	26.91

SOURCE: AEDT 2d; ESA, 2019. 2020 results were interpolated from the 2023 modeled result using aircraft operations.

Operating refers to the operation of aircraft, auxiliary power units (APU) and airline ground support equipment (GSE) when the Airport could serve as high as 690,520 annual aircraft operations and over 79.0 million annual passengers.

Values may not add to the total, due to rounding.

Note that AEDT calculates NOX and SOX rather than NO2 and SO2.

TABLE 5 – YEAR 2023 AIRCRAFT OPERATING EMISSIONS INVENTORY

	Aircraft Operating Emissions (Tons/Year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	3,314.44	619.37	2,476.85	253.37	24.35	24.35
GSE	968.44	34.33	110.83	5.27	4.81	5.08
APUs	117.19	7.51	108.12	-	-	-
Total	4,400.07	661.21	2,695.80	258.63	29.16	29.43

SOURCE: AEDT 2d; ESA, 2019

Operating refers to the operation of aircraft, auxiliary power units (APU) and airline ground support equipment (GSE) when the Airport could serve as high as 690,520 annual aircraft operations and over 79.0 million annual passengers.

Values may not add to the total, due to rounding.

Note that AEDT calculates NOX and SOX rather than NO2 and SO2.

TABLE 6 – YEAR 2028 AIRCRAFT OPERATING EMISSIONS INVENTORY

	Aircraft Operating Emissions (Tons/Year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	3,759.59	702.56	2,809.50	287.40	27.63	27.63
GSE	1,095.50	38.84	125.37	5.96	5.44	5.75
APUs	132.56	8.49	122.31	-	-	-
Total	4,987.65	749.88	3,057.18	293.35	33.06	33.37

SOURCE: AEDT 2d; ESA, 2019

Aircraft operating refers to the operation of aircraft, auxiliary power units (APU) and airline ground support equipment (GSE) when the Airport could serve as high as 781,120 annual aircraft operations and over 93.6 million annual passengers.

Values may not add to the total, due to rounding.

Note that AEDT calculates NOX and SOX rather than NO2 and SO2.

Construction Emissions

The project list used to generate the construction emissions inventory includes one or more representative projects from the Airport Master Plan and Capital Improvement Program (CIP) established for DEN. The projects selected for inclusion in the analysis are representative of projects expected to be undertaken during the period covered by the forthcoming SIP. Reasonably foreseeable construction projects occurring around that time period are as follows:

- **Future 16,000 ft long Runway and associated taxiways**
- **Pena Blvd - 3rd Lane Expansion Inbound and Outbound from Jackson Gap to I-70**
- **Cargo Expansion – 1.5 million square feet expansion including a new building and parking**
- **Parking Structure - 5 Acres or 1,800 Spaces**
- **Aircraft Rescue and Firefighting (ARFF) Station #5**
- **Parking Lot - 110 Acres**
- **New Maintenance Facility - Building & Parking (20 Acres or 871,200 Square Feet)**
- **DEN Real Estate West Approach – Building and grounds for hospitality, retail, and office uses immediately south of DEN’s south terminal**
- **Deicing Pond Expansion, 3-4 cells, about 20 acres**
- **New 5,280-foot Taxiway**

METHODOLOGY

This construction emissions inventory used the Airport Construction Emissions Inventory Tool (ACEIT), for calculating emissions associated with construction activity. This tool was released with the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP) Report 102, *Guidance for Estimating Airport Construction Emissions*.¹⁰ ACEIT contains construction emission factors from existing Environmental Protection Agency (EPA) regulatory models, such as the Motor Vehicle Emissions Simulator (MOVES) and NONROAD, as well as emission factors for fugitive emissions from EPA's *Compilation of Air Pollution Emission Factors (AP-42)*.¹¹ Through the user specification of high-level inputs such as project site weather and project cost, the ACEIT uses a series of assumptions to generate lists of emissions sources such as construction equipment and associated usage factors in order to calculate a construction emissions inventory.

ACEIT was created as a product of the TRB ACRP Project 02-33 ("*Guidance for Estimating Airport Construction Emissions*")¹² and was published along with ACRP Report 102.¹³ ACEIT facilitates the estimation of direct and indirect construction emissions by using emission factors from the EPA models MOVES 2010b (revised January 2013) and NONROAD 2008a (July 2009), EPA's AP-42 emission factor compilation, and other sources, in combination with user-specified project complexity data to estimate construction activity levels. ACEIT inputs were developed in order to describe the expected future construction activity without underestimating construction emissions levels. ACEIT requires a project location, average temperature, and maximum temperature variation as inputs. The project location was specified as the City and County of Denver, Colorado. The average temperature and maximum temperature variation, given previously, was specified separately for April through September ("summer," as defined by ACEIT); and October through December plus January through March ("winter," as defined by ACEIT). ACEIT features construction vehicle emission factors that generally reduce over time, under the assumption that construction equipment emissions control technology will continue to advance.

While ACEIT allows revision and customization of many of the assumed construction vehicle activity levels, ACEIT default activity levels were used for the DEN SIP inventory projects except for the future 16,000 ft long runway and associated taxiways. The future runway project model inputs were specified using preliminary engineering estimates prepared for the project that account for the extensive amount of grading required and large associated taxiway complex. Parameters specified in ACEIT for the runway

¹⁰ Kim, B., et al. (2014). *Guidance for Estimating Airport Construction Emissions*. ACRP Report 102. <https://doi.org/10.17226/22437>.

¹¹ Environmental Protection Agency. "AP-42: Compilation of Air Emission Factors." <https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors>. Last accessed: December 5, 2017.

¹² Transportation Research Board (2013). "Guidance for Estimating Airport Construction Emissions." <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3034>. Last accessed: December 4, 2017.

¹³ Transportation Research Board (2016). "Guidance for Estimating Airport Construction Emissions." <http://www.trb.org/Main/Blurbs/170234.aspx>. Last accessed: December 4, 2017.

project included concrete placement, excavation, fencing and subbase placement, with the remaining inputs using program defaults.

Analysis with ACEIT typically includes the consideration of emissions from construction employee trips to and from the worksites. This construction emissions inventory does not include employee trips because it is understood that those emissions are already being accounted for within the regional transportation models being referenced by CDPHE the RAQC for on-road vehicle emissions associated with worker commutes and transportation.

To reduce the likelihood of underestimating construction emissions levels, all construction activity was modeled using 2020 emission factors. 2020 is the first year of possible construction for projects included in the DEN SIP inventory. Construction projects were all conservatively assumed to occur in the same calendar year, with durations of less than or equal to one year. It is anticipated that ACEIT will be used by DEN for future conformity applicability assessments and determinations and therefore is an appropriate tool for estimating emissions for this inventory.

CONSTRUCTION EMISSIONS RESULTS

Construction criteria pollutant emissions are presented in **Table 7**, in tons per year. Note that ACEIT calculates SO₂ directly, rather than SOX.

TABLE 7 – TOTAL CONSTRUCTION EMISSIONS BY PROJECT

Project	Construction Emissions (Tons/year)					
	CO	VOC	NO _x	SO ₂	PM _{2.5}	PM ₁₀
Future Runway	102.89	37.81	167.14	0.59	8.21	14.00
Pena Blvd - 3rd Lane Expansion IB & OB from Jackson Gap to I-70	12.72	49.88	16.32	0.09	0.87	1.85
Cargo Expansion – Building and Parking Lot Combined	4.13	1.48	3.23	0.01	0.16	0.34
Parking Structure - 5 Acres and 1,800 Spaces	4.89	9.93	1.52	0.00	0.06	0.38
ARFF Station #5	1.36	0.38	1.63	0.004	0.08	0.13
Parking Lot - 110 Acres	5.67	1.49	0.50	0.002	0.01	0.03
New Maintenance Facility - Building and Parking Lot Combined	5.84	1.82	3.35	0.01	0.16	0.34
DEN Real Estate West Approach	2.34	0.75	3.01	0.01	0.15	0.31
Deicing Pond Expansion, 3 - 4 cells, 20 Acres	2.10	0.55	1.31	0.00	0.06	0.09
5,280-Foot Taxiway	4.62	1.56	6.43	0.02	0.31	2.02
Maximum Annual Emissions	146.58	105.64	204.44	0.75	10.08	19.49

SOURCES: ACEIT 1.0, ESA, 2019;
Values may not add to the total, due to rounding.

Total Emissions

Airports such as DEN have many air quality emissions sources present at their facilities, including: aircraft, GSE, ground access vehicles, stationary sources, aircraft rescue and firefighting training, unpaved roads, construction equipment, and other activities and equipment. This emissions inventory is focused on aircraft operations, including aircraft, GSE, and APUs and construction activities. It is understood that other sources of emissions will be accounted for in the SIP using regional models and other information sources.

The combination of the 2020 aircraft operating emissions and construction emissions are presented in **Table 8**.

TABLE 8 - YEAR 2020 AIRCRAFT OPERATING AND CONSTRUCTION EMISSIONS INVENTORY

Source	Emissions (Tons/year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	4,022.71	604.50	2,464.60	236.46	26.66	26.91
Construction	146.58	105.64	204.44	0.75	10.08	19.49
Total	4,169.29	710.14	2,669.04	237.21	36.74	46.40

SOURCE: AEDT 2d; ACEIT 1.0, ESA, 2019. 2020 results were interpolated from the 2023 modeled result using aircraft operations. Values may not add to the total, due to rounding. Note that AEDT calculates NO_x and SO_x rather than NO₂ and SO₂.

The combination of the 2023 aircraft operating emissions and construction emissions are presented in **Table 9**.

TABLE 9 - YEAR 2023 AIRCRAFT OPERATING AND CONSTRUCTION EMISSIONS INVENTORY

Source	Emissions (Tons/year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	4,400.07	661.21	2,695.80	258.63	29.16	29.43
Construction	146.58	105.64	204.44	0.75	10.08	19.49
Total	4,546.65	766.85	2,900.24	259.38	39.24	48.92

SOURCE: AEDT 2d; ACEIT 1.0, ESA, 2019. Values may not add to the total, due to rounding. Note that AEDT calculates NO_x and SO_x rather than NO₂ and SO₂.

The combination of the 2028 aircraft operating and construction emissions are presented in **Table 10**.

TABLE 10 - YEAR 2028 AIRCRAFT OPERATING AND CONSTRUCTION EMISSIONS INVENTORY

Source	Emissions (Tons/year)					
	CO	VOC	NO _x	SO _x	PM _{2.5}	PM ₁₀
Aircraft	4,987.65	749.88	3,057.18	293.35	33.06	33.37
Construction	146.58	105.64	204.44	0.75	10.08	19.49
Total	5,134.23	855.52	3,261.62	294.10	43.14	52.86

SOURCE: AEDT 2d; ACEIT 1.0, ESA, 2019. Values may not add to the total, due to rounding. Note that AEDT calculates NO_x and SO_x rather than NO₂ and SO₂.

Appendix A: Operations Information

Total Operations and Stage Length Percentages										
ANP ¹⁴ Aircraft	Total		Departure Stage Length Percentages							Grand Total
	2023 Operations	2028 Operations	1	2	3	4	5	6	7	
717200	1,387.15	1,569.15	37.63%	62.20%	0.17%	0.00%	0.00%	0.00%	0.00%	100%
727EM2	9.58	10.84	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
737300	16,474.38	18,635.91	17.29%	78.80%	3.89%	0.01%	0.00%	0.00%	0.00%	100%
737400	1,274.54	1,441.77	6.45%	92.86%	0.52%	0.17%	0.00%	0.00%	0.00%	100%
737500	4.79	5.42	50.01%	49.99%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
737700	103,479.70	117,056.81	11.64%	66.61%	21.01%	0.73%	0.00%	0.00%	0.00%	100%
737800	129,183.73	146,133.34	6.86%	61.32%	27.80%	4.02%	0.00%	0.00%	0.00%	100%
737N17	4.79	5.42	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
74720B	4.79	5.42	0.00%	0.00%	50.00%	50.00%	0.00%	0.00%	0.00%	100%
747400	1,698.58	1,921.45	0.13%	0.56%	1.13%	0.00%	0.00%	98.18%	0.00%	100%
7478	15.58	17.62	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
757300	6,148.70	6,955.44	0.12%	78.04%	21.42%	0.23%	0.19%	0.00%	0.00%	100%
757PW	2,411.32	2,727.70	12.31%	36.76%	50.84%	0.09%	0.00%	0.00%	0.00%	100%
757RR	3,901.48	4,413.37	8.29%	22.24%	27.82%	0.06%	41.59%	0.00%	0.00%	100%
767300	2,268.78	2,566.46	5.75%	92.14%	1.59%	0.41%	0.10%	0.00%	0.00%	100%
767400	142.55	161.25	6.52%	43.48%	46.77%	0.00%	3.23%	0.00%	0.00%	100%
767CF6	123.38	139.57	0.00%	92.41%	5.76%	0.00%	0.00%	1.83%	0.00%	100%
767JT9	32.34	36.58	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
777200	2,208.88	2,498.70	0.00%	44.08%	16.62%	0.00%	39.21%	0.00%	0.10%	100%
777300	2.39	2.71	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100%
7773ER	7.18	8.13	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100%
7878R	1,859.11	2,103.03	0.00%	53.12%	0.00%	0.14%	0.00%	0.00%	46.74%	100%
A300-622R	2,553.87	2,888.95	21.00%	78.65%	0.35%	0.00%	0.00%	0.00%	0.00%	100%
A300B4-203	440.82	498.66	8.71%	91.29%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A310-304	4.79	5.42	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A319-131	57,293.21	64,810.39	17.46%	61.98%	20.50%	0.06%	0.00%	0.00%	0.00%	100%
A320-211	27,116.31	30,674.12	11.62%	58.47%	29.91%	0.00%	0.00%	0.00%	0.00%	100%
A320-232	49,351.29	55,826.45	9.44%	65.23%	21.32%	4.01%	0.00%	0.00%	0.00%	100%
A321-232	23,394.52	26,464.01	4.44%	52.60%	42.95%	0.00%	0.00%	0.00%	0.00%	100%
A330-301	9.58	10.84	0.00%	0.00%	74.77%	25.23%	0.00%	0.00%	0.00%	100%
A330-343	455.20	514.92	0.00%	0.48%	0.00%	0.00%	1.50%	0.00%	98.02%	100%
A340-642	207.23	234.42	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100%
BEC58P	2,769.49	3,132.86	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
C130	7.18	8.13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
C17	1.20	1.35	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CIT3	23.96	27.10	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CL600	66,086.82	74,757.77	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA172	64.69	73.18	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA182	35.93	40.65	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA206	46.72	52.85	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA208	9,453.64	10,694.01	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA20T	7.18	8.13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA441	124.58	140.92	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA500	409.68	463.43	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA510	111.41	126.03	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA525C	141.35	159.90	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA55B	410.87	464.78	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA560E	85.04	96.20	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA560U	159.32	180.23	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA560XL	716.33	810.31	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA680	318.63	360.44	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA750	2,309.50	2,612.52	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
COMJET	45.52	51.49	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
COMSEP	35.93	40.65	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CRJ9-ER	52,629.87	59,535.20	52.39%	42.35%	5.25%	0.00%	0.00%	0.00%	0.00%	100%
DC1010	131.76	149.05	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DC1030	261.14	295.40	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%

¹⁴ ANP: Aircraft Noise and Performance database. ANP codes were input into AEDT 2d, which assigned default engine types based on the codes.

Total Operations and Stage Length Percentages

ANP ¹⁴ Aircraft	Total		Departure Stage Length Percentages							Grand Total
	2023 Operations	2028 Operations	1	2	3	4	5	6	7	
DC93LW	2.39	2.71	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DHC6	11,279.20	12,759.09	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DO328	8.38	9.48	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
ECLIPSE500	20.37	23.04	78.35%	21.65%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
EMB120	3,048.59	3,448.58	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
EMB145	30,507.51	34,510.26	61.76%	35.71%	2.54%	0.00%	0.00%	0.00%	0.00%	100%
EMB14L	225.20	254.75	57.53%	42.47%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
EMB170	38,787.23	43,876.32	26.44%	58.29%	15.27%	0.00%	0.00%	0.00%	0.00%	100%
EMB190	1,965.71	2,223.62	0.12%	0.37%	99.51%	0.00%	0.00%	0.00%	0.00%	100%
F10062	45.52	51.49	52.37%	26.19%	21.44%	0.00%	0.00%	0.00%	0.00%	100%
FAL20	229.99	260.16	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GASEPF	64.69	73.18	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GASEPV	73.07	82.66	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GIIB	2.39	2.71	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GIV	235.99	266.95	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GV	249.16	281.85	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
HS748A	2.39	2.71	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
IA1125	110.20	124.66	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
KC135R	1.20	1.35	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
LEAR35	488.73	552.86	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD11GE	1,079.29	1,220.89	0.44%	99.56%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD11PW	601.34	680.24	2.03%	97.97%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD81	2.39	2.71	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD82	1,568.02	1,773.75	0.44%	99.56%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD83	2,756.31	3,117.95	0.42%	99.32%	0.25%	0.00%	0.00%	0.00%	0.00%	100%
MD9028	9,382.96	10,614.06	0.07%	52.40%	47.53%	0.00%	0.00%	0.00%	0.00%	100%
SABR80	1.20	1.35	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
SF340	3,642.74	4,120.69	99.50%	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
Grand Total	676,240	764,967								

Day Departure Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
717200	0.00%	20.49%	0.00%	0.18%	3.85%	3.68%	39.05%	0.00%	28.20%	4.55%	0.00%	0.00%	100%
727EM2	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
737300	0.00%	37.95%	0.02%	0.23%	6.55%	10.44%	29.24%	0.00%	8.43%	7.15%	0.00%	0.00%	100%
737400	0.00%	17.42%	0.00%	0.56%	0.56%	18.54%	49.16%	0.00%	8.43%	0.84%	4.49%	0.00%	100%
737500	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
737700	0.00%	38.97%	0.02%	0.23%	6.82%	9.63%	26.80%	0.00%	9.51%	8.01%	0.01%	0.00%	100%
737800	0.00%	38.63%	0.02%	0.36%	7.24%	9.12%	24.40%	0.00%	12.78%	7.44%	0.00%	0.00%	100%
737N17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
74720B	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
747400	0.00%	57.20%	0.00%	0.72%	2.74%	2.31%	4.61%	0.00%	29.54%	2.74%	0.14%	0.00%	100%
7478	0.00%	33.33%	0.00%	16.67%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	100%
757300	0.00%	27.65%	0.00%	0.42%	4.56%	7.61%	39.73%	0.00%	14.64%	5.40%	0.00%	0.00%	100%
757PW	0.00%	53.29%	0.00%	0.15%	6.59%	14.37%	8.53%	0.00%	7.63%	6.74%	2.69%	0.00%	100%
757RR	0.00%	31.92%	0.00%	2.12%	4.32%	7.86%	26.89%	0.00%	18.26%	6.86%	1.70%	0.07%	100%
767300	0.00%	61.16%	0.00%	0.00%	1.49%	13.99%	3.87%	0.00%	4.32%	3.27%	11.76%	0.15%	100%
767400	0.00%	41.18%	0.00%	0.00%	3.92%	15.69%	19.61%	0.00%	13.73%	5.88%	0.00%	0.00%	100%
767CF6	0.00%	25.00%	0.00%	0.00%	0.00%	37.50%	12.50%	0.00%	0.00%	12.50%	12.50%	0.00%	100%
767JT9	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
777200	0.00%	13.22%	0.00%	1.65%	1.87%	5.29%	60.13%	0.00%	15.75%	1.98%	0.11%	0.00%	100%
777300	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
7773ER	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	100%
7878R	0.00%	22.43%	0.00%	5.61%	3.39%	13.17%	27.25%	0.00%	24.51%	3.52%	0.13%	0.00%	100%
A300-622R	0.00%	31.55%	0.32%	0.32%	4.73%	23.66%	19.24%	0.00%	6.94%	1.58%	11.67%	0.00%	100%
A300B4-203	0.00%	29.55%	0.00%	0.00%	7.95%	33.52%	17.61%	0.00%	5.11%	0.00%	6.25%	0.00%	100%
A310-304	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A319-131	0.00%	35.85%	0.01%	0.27%	6.52%	8.94%	27.03%	0.00%	15.18%	6.19%	0.00%	0.00%	100%
A320-211	0.00%	32.78%	0.01%	0.27%	4.18%	9.77%	34.58%	0.00%	13.55%	4.85%	0.00%	0.00%	100%
A320-232	0.00%	33.87%	0.02%	0.24%	6.25%	11.03%	29.41%	0.00%	12.60%	6.57%	0.00%	0.01%	100%
A321-232	0.00%	45.45%	0.01%	0.36%	7.90%	14.27%	16.92%	0.00%	10.22%	4.86%	0.01%	0.00%	100%
A330-301	0.00%	66.67%	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A330-343	0.00%	53.16%	0.00%	0.00%	3.16%	2.63%	6.32%	0.00%	33.16%	1.58%	0.00%	0.00%	100%
A340-642	0.00%	51.16%	0.00%	0.00%	3.49%	4.65%	3.49%	0.00%	37.21%	0.00%	0.00%	0.00%	100%
BEC58P	0.00%	52.47%	0.00%	0.00%	7.27%	13.77%	8.83%	0.00%	7.79%	6.49%	2.08%	1.30%	100%
C130	0.00%	33.33%	0.00%	0.00%	0.00%	33.33%	16.67%	0.00%	0.00%	16.67%	0.00%	0.00%	100%
C17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100%
CIT3	0.00%	20.00%	0.00%	0.00%	10.00%	10.00%	30.00%	0.00%	10.00%	0.00%	20.00%	0.00%	100%
CL600	0.00%	28.36%	0.00%	0.24%	5.48%	8.31%	30.85%	0.00%	13.61%	13.11%	0.03%	0.00%	100%
CNA172	0.00%	20.00%	0.00%	0.00%	0.00%	40.00%	40.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA182	0.00%	33.33%	0.00%	0.00%	33.33%	16.67%	0.00%	0.00%	16.67%	0.00%	0.00%	0.00%	100%
CNA206	0.00%	23.53%	0.00%	0.00%	0.00%	52.94%	17.65%	0.00%	0.00%	0.00%	5.88%	0.00%	100%
CNA208	0.00%	26.83%	0.00%	0.34%	1.94%	11.45%	36.95%	0.00%	13.38%	8.18%	0.89%	0.03%	100%
CNA20T	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
CNA441	0.00%	40.91%	0.00%	0.00%	4.55%	13.64%	15.91%	0.00%	15.91%	6.82%	2.27%	0.00%	100%
CNA500	0.00%	28.57%	0.00%	0.00%	4.08%	25.17%	23.81%	0.00%	13.61%	1.36%	3.40%	0.00%	100%
CNA510	0.00%	21.95%	0.00%	0.00%	2.44%	21.95%	24.39%	0.00%	19.51%	7.32%	2.44%	0.00%	100%
CNA525C	0.00%	20.00%	0.00%	0.00%	3.64%	23.64%	29.09%	0.00%	16.36%	1.82%	5.45%	0.00%	100%
CNA55B	0.00%	21.47%	0.00%	0.00%	2.45%	19.63%	33.74%	0.00%	12.27%	1.84%	8.59%	0.00%	100%
CNA560E	0.00%	33.33%	0.00%	0.00%	2.78%	22.22%	22.22%	0.00%	8.33%	5.56%	5.56%	0.00%	100%
CNA560U	0.00%	19.35%	0.00%	0.00%	6.45%	25.81%	30.65%	0.00%	14.52%	0.00%	3.23%	0.00%	100%
CNA560XL	0.00%	27.05%	0.00%	0.36%	3.56%	21.00%	30.60%	0.00%	12.46%	1.42%	3.56%	0.00%	100%
CNA680	0.00%	32.28%	0.00%	0.00%	3.15%	23.62%	22.05%	0.00%	13.39%	2.36%	3.15%	0.00%	100%
CNA750	0.00%	25.57%	0.00%	0.31%	1.25%	7.20%	26.51%	0.00%	35.39%	3.03%	0.73%	0.00%	100%
COMJET	0.00%	25.57%	0.00%	0.31%	1.25%	7.20%	26.51%	0.00%	35.39%	3.03%	0.73%	0.00%	100%
COMSEP	0.00%	20.00%	0.00%	10.00%	10.00%	20.00%	10.00%	0.00%	30.00%	0.00%	0.00%	0.00%	100%
CRJ9-ER	0.00%	33.69%	0.00%	0.20%	6.71%	9.70%	28.75%	0.00%	14.50%	6.44%	0.00%	0.00%	100%
DC1010	0.00%	61.11%	0.00%	0.00%	3.70%	12.96%	3.70%	0.00%	7.41%	0.00%	11.11%	0.00%	100%
DC1030	0.00%	50.48%	0.00%	0.00%	0.00%	25.71%	0.95%	0.00%	4.76%	0.00%	16.19%	1.90%	100%
DC93LW	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DHC6	0.00%	18.26%	0.00%	0.23%	3.31%	18.75%	40.40%	0.00%	13.20%	3.80%	2.05%	0.00%	100%
DO328	0.00%	57.14%	0.00%	0.00%	0.00%	0.00%	28.57%	0.00%	0.00%	14.29%	0.00%	0.00%	100%
ECLIPSE500	0.00%	42.86%	0.00%	0.00%	14.29%	14.29%	0.00%	0.00%	14.29%	14.29%	0.00%	0.00%	100%
EMB120	0.00%	48.94%	0.00%	0.24%	8.90%	10.87%	16.94%	0.00%	9.14%	4.96%	0.00%	0.00%	100%
EMB145	0.00%	33.42%	0.00%	0.24%	7.46%	7.82%	23.37%	0.00%	14.04%	13.64%	0.01%	0.00%	100%
EMB14L	0.00%	43.48%	0.00%	0.00%	8.70%	8.70%	10.87%	0.00%	9.78%	18.48%	0.00%	0.00%	100%

Day Departure Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
EMB170	0.00%	30.71%	0.00%	0.28%	6.89%	8.88%	32.79%	0.00%	13.86%	6.59%	0.00%	0.00%	100%
EMB190	0.00%	68.60%	0.00%	0.12%	6.40%	2.34%	0.86%	0.00%	8.37%	13.30%	0.00%	0.00%	100%
F10062	0.00%	29.41%	0.00%	0.00%	5.88%	23.53%	35.29%	0.00%	5.88%	0.00%	0.00%	0.00%	100%
FAL20	0.00%	38.46%	0.00%	0.00%	4.40%	16.48%	21.98%	0.00%	13.19%	4.40%	1.10%	0.00%	100%
GASEPF	0.00%	53.33%	0.00%	0.00%	0.00%	13.33%	20.00%	0.00%	6.67%	0.00%	6.67%	0.00%	100%
GASEPV	0.00%	40.00%	0.00%	0.00%	6.67%	13.33%	13.33%	0.00%	6.67%	20.00%	0.00%	0.00%	100%
GIIB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100%
GIV	0.00%	25.25%	0.00%	0.00%	2.02%	25.25%	21.21%	0.00%	17.17%	5.05%	4.04%	0.00%	100%
GV	0.00%	26.80%	0.00%	0.00%	6.19%	12.37%	31.96%	0.00%	10.31%	9.28%	3.09%	0.00%	100%
HS748A	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
IA1125	0.00%	35.71%	0.00%	0.00%	4.76%	23.81%	26.19%	0.00%	4.76%	2.38%	2.38%	0.00%	100%
KC135R	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
LEAR35	0.00%	39.66%	0.00%	0.00%	3.35%	16.76%	19.55%	0.00%	10.61%	3.91%	6.15%	0.00%	100%
MD11GE	0.00%	49.64%	0.00%	0.24%	3.37%	18.80%	8.19%	0.00%	6.51%	2.89%	10.36%	0.00%	100%
MD11PW	0.00%	56.63%	0.00%	0.00%	3.57%	13.78%	6.63%	0.00%	2.55%	4.59%	11.22%	1.02%	100%
MD81	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
MD82	0.00%	53.03%	0.00%	0.47%	6.22%	11.04%	5.91%	0.00%	13.84%	9.49%	0.00%	0.00%	100%
MD83	0.00%	51.25%	0.00%	0.36%	6.49%	10.94%	7.12%	0.00%	15.93%	7.92%	0.00%	0.00%	100%
MD9028	0.00%	52.02%	0.03%	0.36%	3.28%	4.43%	7.95%	0.00%	17.89%	14.04%	0.00%	0.00%	100%
SABR80	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
SF340	0.00%	50.40%	0.00%	0.65%	4.97%	6.34%	10.08%	0.00%	13.97%	13.46%	0.07%	0.07%	100%
Grand Total	0.00%	35.68%	0.01%	0.31%	6.33%	9.59%	27.05%	0.00%	12.96%	7.89%	0.19%	0.01%	100%

Note: Aircraft with a total of 0% means there were no daytime departures recorded in DEN NOMS data.

Night Departure Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
717200	0.00%	57.14%	0.00%	0.00%	0.00%	28.57%	14.29%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
727EM2	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
737300	0.00%	32.70%	0.27%	0.00%	6.22%	39.73%	0.68%	0.00%	7.57%	12.84%	0.00%	0.00%	100%
737400	0.00%	60.44%	0.55%	0.00%	2.75%	18.13%	0.55%	0.00%	3.30%	5.49%	8.79%	0.00%	100%
737500	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
737700	0.00%	31.71%	0.09%	0.04%	4.39%	40.11%	0.72%	0.00%	9.77%	13.12%	0.04%	0.02%	100%
737800	0.00%	26.89%	0.10%	0.03%	4.62%	45.48%	0.61%	0.00%	11.25%	10.88%	0.13%	0.00%	100%
737N17	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
74720B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
747400	0.00%	46.67%	0.00%	0.00%	0.00%	13.33%	0.00%	0.00%	26.67%	0.00%	13.33%	0.00%	100%
7478	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
757300	0.00%	3.57%	0.00%	0.00%	9.52%	59.52%	0.60%	0.00%	15.48%	11.31%	0.00%	0.00%	100%
757PW	0.00%	44.27%	0.00%	0.00%	1.86%	29.10%	0.62%	0.00%	4.02%	6.81%	13.31%	0.00%	100%
757RR	0.00%	41.75%	0.00%	0.00%	3.61%	25.26%	0.00%	0.00%	3.09%	5.67%	20.62%	0.00%	100%
767300	0.00%	44.36%	0.00%	0.00%	3.11%	29.96%	0.39%	0.00%	1.56%	2.33%	18.29%	0.00%	100%
767400	0.00%	11.11%	0.00%	0.00%	0.00%	77.78%	0.00%	0.00%	11.11%	0.00%	0.00%	0.00%	100%
767CF6	0.00%	2.33%	0.00%	0.00%	9.30%	65.12%	0.00%	0.00%	4.65%	0.00%	18.60%	0.00%	100%
767JT9	0.00%	16.67%	0.00%	0.00%	8.33%	58.33%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	100%
777200	0.00%	41.67%	0.00%	0.00%	0.00%	8.33%	0.00%	0.00%	33.33%	16.67%	0.00%	0.00%	100%
777300	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
7773ER	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
7878R	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	100%
A300-622R	0.00%	23.60%	0.15%	0.00%	1.77%	42.92%	0.15%	0.00%	4.13%	1.62%	25.66%	0.00%	100%
A300B4-203	0.00%	12.50%	0.00%	0.00%	0.00%	62.50%	0.00%	0.00%	0.00%	0.00%	25.00%	0.00%	100%
A310-304	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
A319-131	0.00%	33.43%	0.04%	0.00%	5.70%	37.90%	0.79%	0.00%	13.77%	8.15%	0.24%	0.00%	100%
A320-211	0.00%	38.74%	0.15%	0.05%	4.35%	36.07%	0.74%	0.00%	11.58%	8.07%	0.25%	0.00%	100%
A320-232	0.00%	36.50%	0.05%	0.00%	4.50%	37.19%	0.45%	0.00%	9.84%	11.37%	0.05%	0.05%	100%
A321-232	0.00%	35.02%	0.15%	0.11%	4.31%	41.54%	0.41%	0.00%	10.73%	7.48%	0.26%	0.00%	100%
A330-301	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A330-343	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
A340-642	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
BEC58P	0.00%	53.71%	0.14%	0.00%	5.57%	23.57%	1.86%	0.00%	1.71%	3.29%	8.86%	1.29%	100%
C130	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
C17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CIT3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CL600	0.00%	41.42%	0.09%	0.00%	2.53%	26.15%	1.69%	0.00%	10.97%	17.06%	0.09%	0.00%	100%
CNA172	0.00%	0.00%	0.00%	66.67%	0.00%	16.67%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	100%
CNA182	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA206	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA208	0.00%	35.14%	0.00%	0.16%	4.27%	38.10%	1.31%	0.00%	9.69%	10.51%	0.82%	0.00%	100%
CNA20T	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA441	0.00%	66.67%	0.00%	0.00%	16.67%	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA500	0.00%	33.33%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	5.56%	0.00%	11.11%	0.00%	100%
CNA510	0.00%	0.00%	0.00%	0.00%	0.00%	66.67%	0.00%	0.00%	0.00%	0.00%	33.33%	0.00%	100%
CNA525C	0.00%	0.00%	0.00%	0.00%	33.33%	66.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA55B	0.00%	40.00%	0.00%	0.00%	0.00%	40.00%	0.00%	0.00%	10.00%	0.00%	10.00%	0.00%	100%
CNA560E	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA560U	0.00%	33.33%	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	33.33%	0.00%	0.00%	100%
CNA560XL	0.00%	38.46%	0.00%	0.00%	0.00%	53.85%	0.00%	0.00%	0.00%	0.00%	7.69%	0.00%	100%
CNA680	0.00%	0.00%	0.00%	0.00%	20.00%	40.00%	0.00%	0.00%	20.00%	0.00%	20.00%	0.00%	100%
CNA750	0.00%	40.00%	0.00%	0.00%	0.00%	30.00%	0.00%	0.00%	20.00%	0.00%	10.00%	0.00%	100%
COMJET	0.00%	40.00%	0.00%	0.00%	0.00%	30.00%	0.00%	0.00%	20.00%	0.00%	10.00%	0.00%	100%
COMSEP	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CRJ9-ER	0.00%	23.70%	0.00%	0.00%	4.07%	44.12%	0.71%	0.00%	14.32%	13.00%	0.09%	0.00%	100%
DC1010	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DC1030	0.00%	75.00%	0.00%	0.00%	0.00%	25.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
DC93LW	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
DHC6	0.00%	29.39%	0.05%	0.10%	6.56%	40.91%	6.61%	0.00%	6.97%	3.67%	5.73%	0.00%	100%
DO328	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
ECLIPSE500	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
EMB120	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
EMB145	0.00%	24.55%	0.00%	0.00%	5.42%	39.71%	2.53%	0.00%	13.72%	14.08%	0.00%	0.00%	100%
EMB14L	0.00%	50.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%

Night Departure Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
EMB170	0.00%	9.52%	0.00%	0.23%	4.88%	58.16%	1.36%	0.00%	17.69%	8.16%	0.00%	0.00%	100%
EMB190	0.00%	42.86%	0.00%	0.00%	14.29%	28.57%	0.00%	0.00%	0.00%	14.29%	0.00%	0.00%	100%
F10062	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
FAL20	0.00%	12.50%	0.00%	0.00%	0.00%	62.50%	0.00%	0.00%	12.50%	0.00%	12.50%	0.00%	100%
GASEPF	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
GASEPV	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
GIIB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
GIV	0.00%	33.33%	0.00%	0.00%	0.00%	33.33%	33.33%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GV	0.00%	20.00%	0.00%	0.00%	0.00%	40.00%	0.00%	0.00%	20.00%	0.00%	20.00%	0.00%	100%
HS748A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
IA1125	0.00%	0.00%	0.00%	0.00%	0.00%	75.00%	0.00%	0.00%	0.00%	0.00%	25.00%	0.00%	100%
KC135R	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
LEAR35	0.00%	40.00%	5.00%	0.00%	0.00%	45.00%	0.00%	0.00%	5.00%	0.00%	5.00%	0.00%	100%
MD11GE	0.00%	25.00%	2.78%	0.00%	0.00%	47.22%	2.78%	0.00%	2.78%	0.00%	19.44%	0.00%	100%
MD11PW	0.00%	52.08%	0.00%	0.00%	4.17%	18.75%	0.00%	0.00%	6.25%	0.00%	18.75%	0.00%	100%
MD81	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
MD82	0.00%	14.29%	0.00%	0.00%	0.00%	78.57%	0.00%	0.00%	7.14%	0.00%	0.00%	0.00%	100%
MD83	0.00%	15.38%	0.00%	0.00%	11.54%	65.38%	0.00%	0.00%	0.00%	3.85%	3.85%	0.00%	100%
MD9028	0.00%	61.74%	0.00%	0.00%	3.52%	15.94%	0.50%	0.00%	7.89%	10.40%	0.00%	0.00%	100%
SABR80	0.00%	40.00%	5.00%	0.00%	0.00%	45.00%	0.00%	0.00%	5.00%	0.00%	5.00%	0.00%	100%
SF340	0.00%	50.85%	0.00%	0.00%	6.78%	13.56%	0.00%	0.00%	6.78%	22.03%	0.00%	0.00%	100%
Grand Total	0.00%	32.49%	0.09%	0.06%	4.59%	39.71%	1.11%	0.00%	10.23%	9.75%	1.93%	0.04%	100%

Note: Aircraft with a total of 0% means there were no nighttime departures recorded in DEN NOMS data.

Day Arrival Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
717200	0.38%	0.00%	24.18%	20.73%	0.19%	3.84%	0.00%	0.96%	0.19%	6.14%	35.70%	7.68%	100%
727EM2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
737300	0.89%	0.00%	27.15%	15.95%	0.05%	5.04%	0.18%	1.00%	0.00%	4.21%	31.72%	13.81%	100%
737400	0.79%	0.00%	2.91%	16.40%	0.26%	33.86%	0.00%	1.06%	0.00%	4.23%	32.80%	7.67%	100%
737500	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
737700	0.94%	0.00%	23.50%	17.52%	0.05%	6.46%	0.16%	1.33%	0.02%	7.28%	26.36%	16.37%	100%
737800	0.88%	0.01%	23.88%	15.44%	0.11%	7.77%	0.21%	1.81%	0.01%	6.28%	23.85%	19.75%	100%
737N17	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
74720B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	100%
747400	0.59%	0.00%	17.89%	4.84%	0.00%	17.01%	0.00%	3.23%	0.00%	1.76%	11.44%	43.26%	100%
7478	0.00%	0.00%	0.00%	40.00%	0.00%	20.00%	0.00%	20.00%	20.00%	0.00%	0.00%	0.00%	100%
757300	0.65%	0.00%	25.05%	19.15%	0.08%	3.76%	0.08%	1.74%	0.04%	4.61%	21.82%	23.03%	100%
757PW	0.31%	0.00%	27.44%	3.26%	0.16%	16.12%	0.00%	1.71%	0.16%	2.33%	28.84%	19.69%	100%
757RR	1.08%	0.00%	26.95%	12.04%	0.00%	12.31%	0.00%	2.43%	0.00%	2.52%	17.34%	25.34%	100%
767300	0.65%	0.00%	6.45%	0.22%	0.22%	34.19%	0.00%	1.29%	0.00%	0.22%	30.11%	26.67%	100%
767400	0.00%	0.00%	35.29%	3.92%	0.00%	13.73%	0.00%	1.96%	0.00%	0.00%	25.49%	19.61%	100%
767CF6	0.00%	0.00%	0.00%	0.00%	0.00%	55.56%	0.00%	0.00%	0.00%	0.00%	35.56%	8.89%	100%
767JT9	0.00%	0.00%	0.00%	0.00%	0.00%	77.78%	0.00%	0.00%	0.00%	0.00%	11.11%	11.11%	100%
777200	0.52%	0.00%	20.59%	21.80%	0.00%	0.87%	0.17%	1.73%	0.00%	7.09%	34.60%	12.63%	100%
777300	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100%
7773ER	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	50.00%	100%
7878R	1.42%	0.00%	19.10%	14.45%	0.00%	11.10%	0.00%	1.94%	0.00%	6.97%	42.19%	2.84%	100%
A300-622R	0.23%	0.00%	1.59%	7.27%	0.23%	33.86%	0.00%	1.82%	0.00%	1.36%	35.68%	17.95%	100%
A300B4-203	0.63%	0.00%	0.00%	2.53%	1.27%	39.24%	0.00%	1.27%	0.00%	1.90%	39.24%	13.92%	100%
A310-304	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A319-131	1.03%	0.00%	23.72%	15.97%	0.09%	7.49%	0.14%	1.81%	0.01%	4.32%	25.99%	19.41%	100%
A320-211	0.65%	0.00%	22.73%	17.01%	0.06%	7.88%	0.17%	1.43%	0.01%	4.58%	27.20%	18.29%	100%
A320-232	1.17%	0.00%	23.45%	18.02%	0.13%	5.41%	0.20%	1.52%	0.02%	4.59%	28.37%	17.14%	100%
A321-232	0.70%	0.00%	28.45%	8.07%	0.11%	10.26%	0.29%	1.61%	0.00%	1.34%	28.38%	20.80%	100%
A330-301	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
A330-343	0.00%	0.00%	22.40%	7.65%	0.00%	10.38%	0.00%	4.92%	0.00%	1.09%	11.48%	42.08%	100%
A340-642	0.00%	0.00%	15.85%	8.54%	0.00%	9.76%	0.00%	1.22%	0.00%	3.66%	6.10%	54.88%	100%
BEC58P	0.00%	0.00%	2.26%	0.49%	0.88%	46.42%	0.00%	1.28%	0.00%	1.47%	9.32%	37.88%	100%
C130	0.00%	0.00%	0.00%	40.00%	0.00%	20.00%	0.00%	20.00%	20.00%	0.00%	0.00%	0.00%	100%
C17	0.00%	0.00%	0.00%	40.00%	0.00%	20.00%	0.00%	20.00%	20.00%	0.00%	0.00%	0.00%	100%
CIT3	0.00%	0.00%	0.00%	0.00%	0.00%	60.00%	0.00%	0.00%	0.00%	0.00%	20.00%	20.00%	100%
CL600	1.25%	0.00%	19.94%	21.14%	0.05%	5.93%	0.16%	1.77%	0.03%	7.54%	26.61%	15.58%	100%
CNA172	0.00%	0.00%	12.50%	0.00%	0.00%	37.50%	0.00%	0.00%	0.00%	25.00%	25.00%	0.00%	100%
CNA182	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	12.50%	37.50%	100%
CNA206	0.00%	0.00%	0.00%	7.69%	0.00%	46.15%	0.00%	0.00%	0.00%	7.69%	30.77%	7.69%	100%
CNA208	0.98%	0.00%	14.30%	17.59%	0.03%	18.79%	0.20%	1.69%	0.03%	3.32%	23.08%	19.99%	100%
CNA20T	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA441	0.00%	0.00%	0.00%	4.44%	0.00%	44.44%	0.00%	6.67%	0.00%	0.00%	28.89%	15.56%	100%
CNA500	0.00%	0.00%	1.50%	4.51%	0.75%	38.35%	0.75%	0.75%	0.00%	3.76%	36.84%	12.78%	100%
CNA510	2.44%	0.00%	0.00%	7.32%	0.00%	34.15%	0.00%	0.00%	0.00%	0.00%	46.34%	9.76%	100%
CNA525C	0.00%	0.00%	0.00%	1.82%	0.00%	36.36%	0.00%	0.00%	0.00%	5.45%	47.27%	9.09%	100%
CNA55B	0.65%	0.00%	1.29%	3.87%	0.00%	35.48%	0.00%	0.00%	0.00%	1.29%	48.39%	9.03%	100%
CNA560E	0.00%	0.00%	5.88%	2.94%	0.00%	35.29%	0.00%	5.88%	0.00%	2.94%	32.35%	14.71%	100%
CNA560U	0.00%	0.00%	2.17%	6.52%	0.00%	45.65%	0.00%	2.17%	0.00%	2.17%	34.78%	6.52%	100%
CNA560XL	0.37%	0.00%	1.85%	5.17%	0.00%	39.11%	0.00%	0.37%	0.00%	1.85%	39.48%	11.81%	100%
CNA680	0.82%	0.00%	2.46%	6.56%	0.00%	44.26%	0.00%	1.64%	0.00%	1.64%	34.43%	8.20%	100%
CNA750	0.22%	0.00%	15.15%	8.23%	0.00%	27.44%	0.00%	2.09%	0.00%	7.03%	33.26%	6.59%	100%
COMJET	0.22%	0.00%	15.15%	8.23%	0.00%	27.44%	0.00%	2.09%	0.00%	7.03%	33.26%	6.59%	100%
COMSEP	0.00%	0.00%	0.00%	0.00%	12.50%	37.50%	0.00%	0.00%	0.00%	12.50%	25.00%	12.50%	100%
CRJ9-ER	1.38%	0.01%	20.33%	20.04%	0.09%	6.16%	0.14%	1.55%	0.01%	6.27%	29.09%	14.94%	100%
DC1010	0.00%	0.00%	0.00%	0.00%	0.00%	36.96%	0.00%	2.17%	0.00%	2.17%	32.61%	26.09%	100%
DC1030	0.00%	0.00%	2.60%	0.00%	0.00%	32.47%	0.00%	0.00%	0.00%	0.00%	45.45%	19.48%	100%
DC93LW	0.60%	0.00%	34.34%	4.33%	0.03%	5.12%	0.00%	1.84%	0.00%	0.60%	15.68%	37.48%	100%
DHC6	1.12%	0.00%	4.43%	8.82%	0.16%	37.33%	0.07%	0.68%	0.00%	3.73%	30.73%	12.93%	100%
DO328	0.59%	0.00%	2.94%	5.29%	0.00%	37.06%	0.59%	1.18%	0.00%	1.18%	35.29%	15.88%	100%
ECLIPSE500	0.00%	0.00%	0.00%	0.00%	0.00%	37.50%	0.00%	0.00%	0.00%	12.50%	37.50%	12.50%	100%
EMB120	0.65%	0.00%	10.24%	3.90%	0.08%	30.22%	0.32%	2.27%	0.00%	0.89%	25.02%	26.40%	100%
EMB145	1.29%	0.00%	24.17%	12.86%	0.12%	8.83%	0.22%	2.51%	0.01%	4.62%	22.32%	23.06%	100%
EMB14L	0.00%	0.00%	19.54%	14.94%	0.00%	12.64%	0.00%	2.30%	0.00%	4.60%	17.24%	28.74%	100%

Day Arrival Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
EMB170	1.13%	0.01%	20.08%	21.09%	0.06%	5.32%	0.22%	1.63%	0.02%	6.91%	30.10%	13.43%	100%
EMB190	0.50%	0.00%	34.45%	10.82%	0.00%	2.61%	0.12%	1.24%	0.00%	1.37%	4.10%	44.78%	100%
F10062	12.50%	0.00%	6.25%	0.00%	0.00%	31.25%	0.00%	0.00%	0.00%	0.00%	43.75%	6.25%	100%
FAL20	2.99%	0.00%	0.00%	2.99%	0.00%	46.27%	0.00%	1.49%	0.00%	0.00%	40.30%	5.97%	100%
GASEPF	0.00%	0.00%	0.00%	0.00%	0.00%	35.71%	0.00%	7.14%	0.00%	0.00%	35.71%	21.43%	100%
GASEPV	0.00%	0.00%	0.00%	0.00%	0.00%	47.06%	0.00%	0.00%	0.00%	5.88%	29.41%	17.65%	100%
GIIB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
GIV	0.00%	0.00%	2.30%	1.15%	0.00%	40.23%	0.00%	2.30%	0.00%	1.15%	40.23%	12.64%	100%
GV	0.00%	0.00%	2.04%	3.06%	0.00%	34.69%	0.00%	2.04%	0.00%	0.00%	46.94%	11.22%	100%
HS748A	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
IA1125	0.00%	0.00%	0.00%	2.50%	0.00%	35.00%	0.00%	2.50%	0.00%	5.00%	45.00%	10.00%	100%
KC135R	0.00%	0.00%	0.00%	40.00%	0.00%	20.00%	0.00%	20.00%	20.00%	0.00%	0.00%	0.00%	100%
LEAR35	0.59%	0.00%	2.94%	5.29%	0.00%	37.06%	0.59%	1.18%	0.00%	1.18%	35.29%	15.88%	100%
MD11GE	0.00%	0.00%	1.16%	0.39%	0.00%	38.61%	0.00%	1.54%	0.00%	0.00%	44.79%	13.51%	100%
MD11PW	0.00%	0.00%	1.16%	0.00%	0.00%	35.47%	0.00%	1.74%	0.00%	0.58%	28.49%	32.56%	100%
MD81	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100%
MD82	1.27%	0.00%	36.93%	2.38%	0.00%	6.97%	0.00%	3.17%	0.00%	0.16%	14.58%	34.55%	100%
MD83	0.27%	0.00%	37.81%	2.33%	0.00%	7.80%	0.00%	2.51%	0.00%	0.72%	14.25%	34.32%	100%
MD9028	0.60%	0.00%	34.34%	4.33%	0.03%	5.12%	0.00%	1.84%	0.00%	0.60%	15.68%	37.48%	100%
SABR80	0.59%	0.00%	2.94%	5.29%	0.00%	37.06%	0.59%	1.18%	0.00%	1.18%	35.29%	15.88%	100%
SF340	0.21%	0.00%	20.48%	2.89%	0.14%	24.56%	0.00%	4.01%	0.00%	0.91%	16.12%	30.68%	100%
Grand Total	1.00%	0.00%	22.35%	16.20%	0.09%	8.50%	0.17%	1.67%	0.02%	5.53%	26.18%	18.29%	100%

Note: Aircraft with a total of 0% means there were no daytime arrivals recorded in DEN NOMS data.

Night Arrival Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
717200	0.00%	0.00%	51.11%	24.44%	0.00%	2.22%	0.00%	0.00%	0.00%	2.22%	15.56%	4.44%	100%
727EM2	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
737300	1.00%	0.00%	52.41%	11.81%	0.00%	7.99%	0.00%	0.83%	0.00%	1.33%	20.30%	4.33%	100%
737400	0.00%	0.00%	8.73%	1.59%	0.00%	61.90%	0.00%	3.17%	0.00%	0.00%	9.52%	15.08%	100%
737500	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
737700	0.49%	0.00%	41.87%	17.90%	0.00%	9.72%	0.00%	1.00%	0.00%	1.69%	21.77%	5.55%	100%
737800	0.31%	0.00%	46.29%	17.82%	0.02%	7.73%	0.09%	1.18%	0.00%	1.32%	18.98%	6.26%	100%
737N17	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
74720B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
747400	0.00%	0.00%	14.29%	28.57%	0.00%	14.29%	0.00%	0.00%	0.00%	0.00%	42.86%	0.00%	100%
7478	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
757300	0.00%	0.00%	41.18%	27.94%	0.00%	2.94%	0.00%	0.00%	0.00%	0.00%	22.06%	5.88%	100%
757PW	0.30%	0.00%	16.77%	1.50%	0.30%	52.99%	0.00%	0.60%	0.00%	0.00%	24.25%	3.29%	100%
757RR	0.00%	0.00%	16.63%	18.09%	2.91%	33.47%	0.00%	1.66%	0.00%	1.25%	24.32%	1.66%	100%
767300	0.00%	0.00%	0.67%	0.22%	2.92%	70.11%	0.00%	0.90%	0.00%	0.00%	22.25%	2.92%	100%
767400	0.00%	0.00%	16.67%	0.00%	16.67%	16.67%	0.00%	16.67%	0.00%	0.00%	33.33%	0.00%	100%
767CF6	0.00%	0.00%	0.00%	0.00%	0.00%	66.67%	0.00%	0.00%	0.00%	0.00%	0.00%	33.33%	100%
767JT9	0.00%	0.00%	0.00%	0.00%	0.00%	40.00%	0.00%	0.00%	0.00%	0.00%	60.00%	0.00%	100%
777200	0.62%	0.00%	39.25%	32.09%	0.00%	0.31%	0.00%	0.62%	0.00%	2.80%	23.05%	1.25%	100%
777300	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
7773ER	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
7878R	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
A300-622R	0.00%	0.00%	1.75%	0.00%	1.75%	66.67%	0.00%	0.97%	0.00%	0.00%	26.90%	1.95%	100%
A300B4-203	0.00%	0.00%	0.00%	0.00%	0.00%	72.22%	0.00%	0.00%	0.00%	0.00%	27.78%	0.00%	100%
A310-304	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
A319-131	0.24%	0.00%	44.70%	15.75%	0.04%	9.02%	0.00%	1.29%	0.00%	1.33%	22.71%	4.91%	100%
A320-211	0.44%	0.00%	44.37%	20.08%	0.00%	7.50%	0.00%	1.10%	0.00%	1.84%	19.25%	5.44%	100%
A320-232	0.19%	0.00%	49.58%	14.41%	0.00%	7.25%	0.00%	1.27%	0.00%	1.08%	18.74%	7.49%	100%
A321-232	0.34%	0.00%	51.60%	9.60%	0.00%	7.71%	0.00%	1.12%	0.00%	1.21%	22.55%	5.87%	100%
A330-301	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
A330-343	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
A340-642	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
BEC58P	0.00%	0.00%	6.25%	0.00%	2.08%	56.25%	0.00%	0.00%	0.00%	2.08%	20.83%	12.50%	100%
C130	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
C17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CIT3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CL600	0.44%	0.00%	30.47%	35.25%	0.13%	9.65%	0.00%	1.15%	0.00%	3.41%	13.20%	6.29%	100%
CNA172	0.00%	0.00%	0.00%	40.00%	20.00%	20.00%	0.00%	0.00%	0.00%	0.00%	20.00%	0.00%	100%
CNA182	0.00%	0.00%	0.00%	40.00%	20.00%	20.00%	0.00%	0.00%	0.00%	0.00%	20.00%	0.00%	100%
CNA206	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA208	0.16%	0.00%	13.10%	10.54%	0.64%	48.88%	0.00%	0.48%	0.00%	0.80%	22.36%	3.04%	100%
CNA20T	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA441	0.00%	0.00%	20.00%	0.00%	0.00%	60.00%	0.00%	0.00%	0.00%	0.00%	20.00%	0.00%	100%
CNA500	0.00%	0.00%	4.76%	0.00%	0.00%	61.90%	0.00%	0.00%	0.00%	0.00%	23.81%	9.52%	100%
CNA510	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
CNA525C	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA55B	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
CNA560E	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CNA560U	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	66.67%	0.00%	100%
CNA560XL	0.00%	0.00%	0.00%	0.00%	0.00%	42.86%	0.00%	0.00%	0.00%	0.00%	57.14%	0.00%	100%
CNA680	0.00%	0.00%	0.00%	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	0.00%	33.33%	33.33%	100%
CNA750	0.00%	0.00%	0.00%	16.67%	0.00%	66.67%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	100%
COMJET	0.00%	0.00%	0.00%	16.67%	0.00%	66.67%	0.00%	0.00%	0.00%	0.00%	16.67%	0.00%	100%
COMSEP	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
CRJ9-ER	0.61%	0.00%	32.70%	28.68%	0.06%	13.23%	0.11%	1.06%	0.00%	2.23%	15.12%	6.19%	100%
DC1010	0.00%	0.00%	0.00%	0.00%	0.00%	28.57%	0.00%	0.00%	0.00%	0.00%	71.43%	0.00%	100%
DC1030	0.00%	0.00%	0.00%	0.00%	3.23%	64.52%	0.00%	0.00%	0.00%	0.00%	32.26%	0.00%	100%
DC93LW	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
DHC6	0.37%	0.00%	12.92%	21.40%	0.00%	49.82%	0.37%	1.11%	0.00%	0.00%	13.28%	0.74%	100%
DO328	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
ECLIPSE500	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
EMB120	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
EMB145	0.00%	0.00%	45.86%	21.04%	0.18%	8.09%	0.18%	1.80%	0.00%	0.36%	9.17%	13.31%	100%
EMB14L	0.00%	0.00%	50.00%	25.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	25.00%	100%

Night Arrival Runway Use Percentages

ANP Aircraft	07	08	16L	16R	17L	17R	25	26	34L	34R	35L	35R	Grand Total
EMB170	0.06%	0.00%	39.40%	23.49%	0.06%	8.37%	0.12%	1.20%	0.00%	1.81%	19.10%	6.39%	100%
EMB190	0.00%	0.00%	40.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	20.00%	30.00%	100%
F10062	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
FAL20	0.00%	0.00%	0.00%	16.67%	8.33%	50.00%	0.00%	0.00%	0.00%	0.00%	25.00%	0.00%	100%
GASEPF	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
GASEPV	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100%
GIIB	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
GIV	0.00%	0.00%	33.33%	0.00%	0.00%	66.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100%
GV	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100%
HS748A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
IA1125	0.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	0.00%	50.00%	0.00%	100%
KC135R	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
LEAR35	0.00%	0.00%	17.65%	0.00%	0.00%	70.59%	0.00%	0.00%	0.00%	0.00%	11.76%	0.00%	100%
MD11GE	0.00%	0.00%	1.67%	0.00%	1.11%	76.67%	0.00%	0.56%	0.00%	0.00%	18.89%	1.11%	100%
MD11PW	0.00%	0.00%	1.35%	0.00%	1.35%	63.51%	0.00%	1.35%	0.00%	0.00%	29.73%	2.70%	100%
MD81	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
MD82	5.88%	0.00%	52.94%	29.41%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	11.76%	0.00%	100%
MD83	0.00%	0.00%	58.33%	12.50%	0.00%	8.33%	0.00%	4.17%	0.00%	0.00%	4.17%	12.50%	100%
MD9028	0.00%	0.00%	51.25%	9.38%	0.00%	5.63%	0.00%	1.25%	0.00%	2.50%	21.88%	8.13%	100%
SABR80	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0%
SF340	0.00%	0.00%	0.00%	0.00%	0.00%	55.56%	0.00%	0.00%	0.00%	0.00%	44.44%	0.00%	100%
Grand Total	0.34%	0.00%	39.21%	18.09%	0.21%	14.12%	0.04%	1.12%	0.00%	1.53%	19.66%	5.70%	100%

Note: Aircraft with a total of 0% means there were no nighttime arrivals recorded in DEN NOMS data.

DEPARTURES FLIGHT TRACK UTILIZATION				YEAR ARRIVALS FLIGHT TRACK UTILIZATION			
Runway	Track ID	Day%	Night%	Runway	Track ID	Day%	Night%
08	08D1	73.08%	66.83%	07	07A1	8.43%	2.95%
	08D2	14.47%	25.26%		07A2	20.39%	17.73%
	08D3	0.06%	1.77%		07A3	31.85%	53.39%
	08D4	12.29%	5.58%		07A4	39.33%	25.94%
	08D5	0.00%	0.07%	Total		100.00%	100.00%
	08D6	0.02%	0.16%	08	08A1	100.00%	
	08D7	0.01%	0.12%	Total		100.00%	
	08D8	0.07%	0.21%	16L	16LA1	0.05%	1.37%
Total	100.00%	100.00%	16LA2		44.80%	34.40%	
16L	16LD1	0.00%	31.34%		16LA3	19.66%	19.84%
	16LD2	43.27%	13.59%		16LA4	30.88%	28.25%
	16LD3	16.63%	10.26%		16LA5	4.61%	15.38%
	16LD4	36.77%	13.70%		16LA6	0.00%	0.76%
	16LD5	0.00%	17.36%	Total		100.00%	100.00%
	16LD6	3.33%	13.77%	16R	16RA1	10.54%	11.94%
Total	100.00%	100.00%	16RA2		37.20%	41.08%	
16R	16RD1	19.95%	16.43%		16RA3	0.16%	1.96%
	16RD2	1.05%	0.00%		16RA4	52.10%	45.02%
	16RD3	22.71%	10.84%	Total		100.00%	100.00%
	16RD4	12.92%	25.46%	17L	17LA1	3.94%	58.69%
	16RD5	13.03%	10.87%		17LA2	35.04%	7.96%
	16RD6	3.61%	5.53%		17LA3	61.02%	33.34%
	16RD7	9.90%	12.72%		Total		100.00%
	16RD8	16.82%	18.15%	17R	17RA1	2.43%	22.78%
Total	100.00%	100.00%	17RA2		18.02%	15.89%	
17L	17LD1	50.73%	27.48%		17RA3	7.02%	2.98%
	17LD2	0.78%	2.18%		17RA4	71.26%	51.56%
	17LD3	1.44%	3.71%		17RA5	1.27%	6.79%
	17LD4	0.00%	1.47%	Total		100.00%	100.00%
	17LD5	0.00%	0.35%	25	25A1	44.38%	82.08%
	17LD6	0.14%	1.82%		25A2	55.62%	17.92%
	17LD7	38.19%	31.81%		Total		100.00%
	17LD8	0.02%	8.90%	26	26A1	37.64%	32.93%
	17LD9	1.24%	0.14%		26A2	20.86%	13.51%
	17LD10	1.81%	5.73%		26A3	29.94%	38.98%

DEPARTURES FLIGHT TRACK UTILIZATION				YEAR ARRIVALS FLIGHT TRACK UTILIZATION			
Runway	Track ID	Day%	Night%	Runway	Track ID	Day%	Night%
17R	17LD11	3.33%	8.60%	Total	26A4	11.56%	14.58%
	17LD12	2.33%	7.80%		100.00%	100.00%	
	Total	100.00%	100.00%	34L	34LA1	73.66%	
	17RD1	14.16%	16.83%		34LA2	26.34%	
	17RD2	0.00%	0.53%	Total	100.00%	100.00%	
	17RD3	0.00%	0.87%	34R	34RA1	0.18%	2.38%
	17RD4	0.21%	0.58%		34RA2	77.13%	71.46%
	17RD5	0.19%	0.38%		34RA3	2.87%	5.00%
	17RD6	0.13%	0.39%		34RA4	19.82%	21.16%
	17RD7	0.21%	0.57%		Total	100.00%	100.00%
	17RD8	0.00%	0.29%		35L	35LA1	0.19%
	17RD9	0.12%	0.22%	35LA2		5.18%	13.18%
	17RD10	0.58%	2.34%	35LA3		20.09%	20.14%
	17RD11	52.10%	30.29%	35LA4		32.78%	29.89%
17RD12	0.02%	9.87%	35LA5	41.76%		29.92%	
17RD13	2.30%	0.34%	Total	100.00%	100.00%		
17RD14	29.97%	36.49%	35R	35RA1	0.60%	1.32%	
Total	100.00%	100.00%		35RA2	0.75%	1.59%	
25D1	0.48%	2.62%		35RA3	59.98%	56.78%	
25D2	0.01%	3.76%		35RA4	0.19%	2.97%	
25D3	0.45%	3.21%		35RA5	34.25%	28.55%	
25D4	14.44%	18.90%		35RA6	4.22%	8.78%	
25D5	15.95%	17.56%	Total	100.00%	100.00%		
25D6	68.67%	53.95%	34L	34LD1	0.03%	8.64%	
Total	100.00%	100.00%		34LD2	1.09%	0.19%	
34LD3	26.23%	5.75%		34LD4	40.19%	16.03%	
34LD5	0.27%	0.69%		34LD6	0.01%	2.35%	
34LD7	0.00%	1.82%		34LD8	4.37%	15.27%	
34LD9	0.06%	4.73%		34LD10	0.89%	0.00%	

DEPARTURES FLIGHT TRACK UTILIZATION				YEAR ARRIVALS FLIGHT TRACK UTILIZATION			
Runway	Track ID	Day%	Night%	Runway	Track ID	Day%	Night%
	34LD11	26.85%	44.53%				
Total		100.00%	100.00%				
	34RD1	0.11%	14.19%				
	34RD2	4.05%	1.50%				
	34RD3	37.10%	18.03%				
	34RD4	53.70%	27.33%				
	34RD5	0.44%	0.82%				
	34RD6	0.02%	2.40%				
34R	34RD7	0.00%	1.51%				
	34RD8	0.48%	5.45%				
	34RD9	0.01%	7.26%				
	34RD10	0.27%	0.03%				
	34RD11	2.04%	11.65%				
	34RD12	0.79%	5.13%				
	34RD13	0.99%	4.69%				
Total		100.00%	100.00%				
	35LD1	0.86%	1.53%				
	35LD2	15.85%	17.13%				
	35LD3	32.30%	13.43%				
	35LD4	1.97%	2.37%				
	35LD5	1.32%	0.00%				
	35LD6	4.60%	17.78%				
35L	35LD7	5.25%	4.51%				
	35LD8	11.43%	3.96%				
	35LD9	4.79%	1.72%				
	35LD10	1.97%	1.55%				
	35LD11	0.00%	20.02%				
	35LD12	7.40%	2.60%				
	35LD13	12.25%	13.40%				
Total		100.00%	100.00%				
	35RD1	58.47%	91.30%				
35R	35RD2	20.72%	8.70%				
	35RD3	20.81%	0.00%				
Total		100.00%	100.00%				