TECHNICAL SUPPORT DOCUMENT
FOR NON-ROAD MOBILE SOURCES:
PM10 EMISSIONS INVENTORY
FOR PM10 SIP 2011 BASELINE YEAR
AND PROJECTION YEARS 2019, 2024, 2018 AND 2030

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Utah Division of Air Quality
Planning Branch/Mobile Sources

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III. Introduction

This report discusses the non-road mobile source emission inventories of the PM10 SIP 2011 base year and projection year (2019, 2024, 2028 and 2030) inventories for the domain comprising the four major counties (Davis, Salt Lake, Utah and Weber Counties) along the Wasatch Front in Utah. The inventory includes emissions of carbon monoxide (CO), nitrogen oxides (NOx), PM10 and PM2.5 exhaust, sulfur dioxide (SO2) and volatile organic compounds (VOC) from miscellaneous non-road engines (EPA NONROAD Model), aircraft and locomotives. In addition, ammonia (NH3) emissions from locomotives are included. The EPA NONROAD Model and the EDMS aircraft model do not produce ammonia emissions.

For this SIP, January 2011 was chosen as the base year and month to be inventoried. However, final emissions were expressed in units of tons per year.

Non-road mobile sources are comprised of three main source categories: 1) miscellaneous non-road engines, 2) aircraft and 3) locomotives. Miscellaneous non-road engine emissions were computed by the EPA NONROAD Model, Version 2008.1.0.

Aircraft activity was obtained from the U.S. Bureau of Transportation Statistics (BTS), the Utah Division of Aeronautics, and from U.S. military installation reports. Aircraft emissions were estimated by applying aircraft numbers of landings and takeoffs (LTOs) to the *Emissions Dispersion Modeling System (EDMS) model*, version 5.1.4.1.

Locomotive fuel consumption was obtained from the railroad companies operating in Utah. Emissions were estimated by applying EPA emission factors to the total amount of diesel fuel used by locomotives.

Temperature data was taken from the PM2.5 episode that ran from Monday, December 7, 2009 through Saturday, January 23, 2010 inclusive.

For most pollutants, the majority of non-road mobile source emissions come from miscellaneous non-road engines. However, aircraft and diesel locomotives contribute about 33% of non-road mobile source NOx in 2011, and about 50% in projection years.

As for PM10 and PM2.5, combined emissions from aircraft and locomotives comprise about 15% of total non-road mobile source PM10 and PM2.5 in 2011, and about 30% in 2030.

IV. EPA NONROAD Model (Version 2008.1.0, December 2008) (1)

Non-road mobile sources in the EPA NONROAD Model include equipment from twelve categories. Categories and examples of equipment under each category are shown:

Agricultural equipment: balers, combines, irrigation sets and tractors
Airport equipment: airport ground support equipment including baggage tugs and terminal tractors
Commercial equipment: air compressors, generators and pumps
Industrial equipment: forklifts and sweepers
Construction and mining equipment: backhoes, graders and trenchers
Lawn and garden equipment: lawnmowers and leaf blowers

Logging equipment: chain saws and shredders
Pleasure craft: personal watercraft and power boats
Railroad equipment: railway maintenance equipment
Recreational equipment, such as all-terrain vehicles and off-road motorcycles;
Underground mining equipment
Limited oil field equipment

Commercial marine equipment, locomotives, and aircraft are not included in the EPA NONROAD Model (there are small emissions from personal watercraft in the NONROAD Model).

NONROAD output includes the pollutants carbon monoxide (CO), nitrogen oxides (NOx), PM10 and PM2.5 exhaust, sulfur dioxide (SO2), volatile organic compounds (VOC) and carbon dioxide (CO2). The model can output emissions by category and equipment type, fuel and engine type (e.g., 2-stroke and 4-stroke gasoline, horsepower rating and SCC code).

Fuel types include gasoline, diesel, compressed natural gas (CNG) and liquefied petroleum gas (LPG).

EPA NONROAD Model: Time Period Input Settings

The following selections were made under "Period" in the input files:

Year: 2011
Period: Month
Month: January
Type: Period Total

These inputs result in emissions units of tons per month (January). Monthly emissions were annualized by multiplying January emissions by a factor of (365.25/31), which is slightly more than twelve. The result can be considered a "winter annual inventory". This makes reporting units of the non-road inventory consistent with those of the point and non-point inventories (tons per year). The CMAQ air dispersion model is capable of converting these "winter annual" inventories into winter daily inventories.

Fuel Properties

Non-road gasoline fuel-related inputs were reported by the Utah Petroleum Association. These inputs include Reid Vapor Pressure (RVP) and sulfur content for gasoline, LPG/CNG and diesel.

Gasoline Fuel-related Inputs

Year	Counties	Month	RVP*	Oxygen Wt %	Gasoline Sulfur Content (ppm)	CNG/LPG Sulfur Content (ppm)	EtOH Blend Market Share	EtOH Volume Percent
2011	Davis Salt Lake Utah Weber	Jan	12.50	3.5	30	30	100	10

2019	"	"	"	"	30	"	"	"
2024	"	"	"	"	10	"	"	"
2028	"	"	"	"	10	"	"	"
2030	"	"	"	"	10	"	"	"

UDAQ chose to use a gasoline sulfur content of 30 ppm to model calendar year 2019 emissions. The reason for this is that virtually all of Utah is served by local refiners. It is not known now whether these refiners will be given extra time to comply with the requirement to provide 10-ppm sulfur gasoline. Thus it is conservative to assume that gasoline sulfur content could still be 30 ppm in 2019 in Utah.

The EPA NONROAD model is insensitive to Reid Vapor Pressures higher than 12.50 (emissions are the same at an RVP of 12.50 as at higher RVP).

Sulfur Content of Non-road Diesel (2)

Beginning June 1, 2007, refiners were required to produce non-road, locomotive and marine (NRLM) diesel fuel with a maximum sulfur content of 500 ppm. From June 1, 2010, the sulfur content for non-road diesel fuel was reduced to a maximum of 15 ppm with the exception of locomotive diesel fuel, which was required to contain a maximum of 15 ppm sulfur by June 2012.

Nationwide average fuel properties are used for EPA NONROAD model input values.

Table 1. Diesel Sulfur Content (3)

Year	Diesel Sulfur (ppm)	Marine Sulfur (ppm)
2011	15	236
2019	15	55
2024	15	55
2028	15	55
2030	15	55

Average Daily Minimum and Maximum Temperatures by County

The minimum and maximum temperature is the average of daily lows and highs for PM10 episode that ran from Monday, Dec 7, 2009 through Saturday, January 23, 2010 inclusive.

Table 2. Dec 7, 2009 – Jan 23, 2010 Average Daily Max and Min Temperatures

County	FIPS	Minimum (F)	Maximum (F)	Average (F)
Davis	49011	24.93	34.52	29.73
Salt Lake	49035	23.88	32.55	28.22
Utah	49049	22.76	30.86	26.81
Weber	49057	21.27	34.41	27.84

Snowmobile Adjustments (EPA NONROAD Model)

UDAQ reviewed the PM2.5 SIP inventories from the EPA NONROAD model for the 2008 base

year and projection years 2014, 2017 and 2019. These showed that, in several counties, VOC emissions from snowmobiles comprised anywhere from 42.5 to 99.1 of VOC emissions from equipment in the NONROAD model. At the same time, other counties in the domain showed zero VOC emissions from snowmobiles in the EPA NONROAD model.

Questioning the accuracy of the output, UDAQ obtained recent survey data on snowmobile activity from two agencies (4, 5). The survey data showed that the true number of snowmobiles by county were very different from the allocation in the NONROAD database.

Therefore, the NONROAD default database was adjusted to change the number of snowmobiles in the base and future years. In addition, snowmobiles were reallocated among the counties. Lastly, snowmobile activity was expanded to cover the months of December through April.

Details of these adjustments to the NONROAD default database are discussed in the Appendix.

V. Aircraft

The aircraft source category includes all aircraft types used for public, private, and military purposes. The aircraft emissions inventories are grouped by type of operation rather than aircraft type. Four types of aircraft activity, shown in Table 7, are included: commercial, air taxi, general aviation and military aircraft.

Table 3. Aircraft Operational Types

SCC	Operation Type	Source of Data	Source of Emission Factor
2275000000	Air Carrier/ Commercial	Bureau of Transportation Statistics	EDMS 5.1.4.1
2275000000	Air Taxi	UT Division of Aeronautics	EDMS 5.1.4.1
2275000000	General Aviation	"	EDMS 5.1.4.1
227000000	Military	UT Division of Aeronautics and Military Installation Reports	EDMS 5.1.4.1 and Military Installation Reports

Commercial Aircraft Operations (Air Carriers)

Commercial aircraft landings and takeoffs can be downloaded from the Bureau of Transportation Statistics (BTS) "Transtats" website at http://www.transtats.bts.gov/. (6)

Under "Aviation", one chooses "Air Carrier Statistics - Form 41 Traffic - All Carriers", and then

"T-100 Domestic Segment—All Carriers".

Next, choose the state, calendar year and month. For this SIP, calendar year and month were January 2011.

The downloaded file of Utah commercial aircraft activity for January 2011 includes the following information:

Aircraft Type
Origin City Name
Destination City Name
Departures Performed

Each "departure performed" is either an arrival or a departure. One landing-takeoff cycle (LTO) consists of one departure and one arrival pair. There were 18,930 "departures performed", or 9,465 LTO cycles, that took place in January 2011 where the origin or destination was one of the four major counties in Utah (Davis, Salt Lake, Utah and Weber Counties).

In order to convert January 2011 activity to annual activity for the CMAQ air dispersion model, the number of LTOs was multiplied by the factor (365.25/31), which is approximately twelve. Thus the annual number of commercial aircraft LTOs in 2011 in the four major counties was 111,519 LTOs. Resulting units of aircraft emissions were thus tons per year.

Air Taxi, General Aviation and Military Aircraft Operations (7)

The number of aircraft operations (LTOs) for these modes are provided by Utah Department of Transportation (Division of Aeronautics) for the small airports in Utah. Data covered the entire calendar year of 2011. It was not possible to determine monthly aircraft operations, so these data were used to obtain 2011 annual emissions in units of tons per year.

For this SIP, only the airports in Davis, Salt Lake, Utah and Weber Counties were included. Data from the Division of Aeronautics includes recommended aircraft types that best represent air taxi, general aviation and military aircraft operations.

FAA posts an "Airport Master Record" form for each airport operating in the U.S. The website for this is "Airport IQ 5010", located at http://www.gcr1.com/5010web/ .

Each form reports the general type and numbers of aircraft and helicopters based at that airport.

For extremely small airports, if the Airport Master Record showed zero based aircraft and zero operations, then that airport was not included in the inventory. Discussion with the Utah Division of Aeronautics stated that these airports would have extremely small emissions.

Aircraft Emission Factors and Emissions

The FAA model Emissions and Dispersion Modeling System (EDMS), version 5.1.4.1, was used to obtain emission factors for each aircraft type and the corresponding number of LTOs. (8) EDMS now provides emission factors for each aircraft type for CO, NOx, PM10, PM2.5, SO2 and VOC. (Older versions of EDMS often did not provide PM10 and PM2.5 EFs for some aircraft.)

EDMS was run for all aircraft types that showed activity during the 2011 base year.

For the projection years, UDAQ ran sensitivity tests using EDMS for each projection year and ran nine different aircraft types through the model. It was found that the emission factors did not change with calendar year at all.

For the above reason, since aircraft activity (number of LTOs) increases each year, the aircraft inventory grows each projection year.

Number of Aircraft Operations (LTOs)

The sum of the number of aircraft operations in the four core counties (Davis, Salt Lake, Utah and Weber) are shown below:

Commercial (air carrier)	111,526
Air Taxi	110,914
General Aviation	292,583
Military	14,220
Total	529,242

Aircraft Operations Scaling Factors (9)

The Utah Division of Aeronautics was unable to provide projections for aircraft operations. Therefore, UDAQ obtained, from the Federal Aviation Administration website, scaling factors for aircraft operations from calendar years 2000 – 2030 for air carrier, air taxi, general aviation and military operations. The scaling factors are greater than 1.0000, so the future year projections of numbers of LTOs were greater than in 2011 and increase each year.

The scaling factor for military aircraft operations from FAA is 1.0000 from 2000 through 2030.

Number of LTOs by County in Projection Years

The 2011 base year number of aircraft operations were multiplied by the scaling factors discussed above to obtain the number of aircraft operations in the projection years.

In 2030, the projected numbers of LTOs in the four core counties are shown below:

Commercial (air carrier)	167,130	
Air Taxi	147,629	
General Aviation	367,045	
Military	14,135	(number of LTOs decreased at HAFB starting in 2014)
Total	695,559	

Airport Ground Support Equipment (GSE)

The EPA NONROAD model includes Airport Ground Support Equipment (GSE). The model produces 3 SCC categories for GSE:

226-500-8005 4-stroke
226-700-8005 LPG
227-000-8005 Diesel

Review of output from the EPA NONROAD Model showed that some airport GSE was not included. For example, the output file for Davis County showed zero emissions of airport GSE. However, there is a large military air base, Hill Air Force Base, located in Davis County.

For this reason, UDAQ requested the inventory of airport GSE from HAFB and added in the emissions.

In addition, the military installation Dugway Proving Ground is located in Tooele County. However, the aircraft GSE emissions from operations at this facility are about 0.01% to 0.1% of the total non-road inventory—truly negligible, so these are not included in the inventory.

VI. Locomotives

Locomotive diesel engines are significant contributors to air pollution; they emit especially large amounts of nitrogen oxides (NOx) and some PM10.

Annual emissions from locomotives were calculated based on diesel fuel usage provided by individual railroad companies that operate in Utah. As of 2011, these companies include: AMTRAK, Salt Lake Garfield & Western Railway, Union Pacific Railroad Company (UPRR), Utah Railway Company, and Utah Transit Authority (UTA)—the commuter rail or "Front Runner" operating along the Wasatch Front from Provo in Utah County to Pleasant View in Weber County to the north and back.

Note that fuel consumption from Burlington Northern Santa Fe Railroad (BNSF) is reported in the Union Pacific Railroad (UPRR) report.

The three main railroads operating here based on annual diesel fuel consumption are Union Pacific Railroad (UPRR), Utah Railway Railroad and the Utah Transit Authority commuter rail.

Railway operations from these companies fall into two categories: line-haul and yard/switch operations, except for AMTRAK and the UTA Front Runner, which are passenger railroads.

Emissions from yard locomotives are from idling and some line-haul activity.

About 75% of diesel locomotive emissions come from UPRR. Currently 70% of UPRR yard locomotives, including those in Utah, are retrofitted with Automatic Engine Stop/Start (AESS) units. Commuter rail operated by UTA were also included in the inventory. It started operations on April 26, 2008.

Locomotive Emission Factors

All of the criteria pollutants--CO, NOx, PM10, PM2.5, SO2, VOC and NH3-- are included in the locomotive inventory. The emissions were estimated by applying emission factors to the total amount of distillate fuel oil used by locomotives.

The EPA guidance document "Emission Factors for Locomotives" (EPA-420-F-09-025), April 2009, gives emission factors for the criteria pollutants for line-haul, passenger, switch or yard and small locomotives. See http://www.epa.gov/nonroad/locomotv/420f09025.pdf. (10)

In general, the emission factors for locomotives change each calendar year. This is the case for NOx, PM10, PM2.5 and VOC, as seen in the above guidance document.

For SO2, the emission factor changes with diesel sulfur content.
The above EPA guidance document does not include emission factors for ammonia (NH3). Emission factors for ammonia were obtained from a document by Eastern Regional Technical Advisory Committee (ERTAC). (11)

UDAQ requested each railroad to report the sulfur content of its diesel locomotive fuel. The Tier IV non-road rule requires locomotives to operate on 15-ppm sulfur diesel fuel beginning June 2012. However, in calendar year 2011, locomotive diesel sulfur content could be as high as 500 ppm.

The sulfur content of locomotive diesel fuel by railroad is shown below. If the railroad did not know its sulfur content, or if no reply was received, UDAQ assumed the sulfur content was 500 ppm:

Railroad	Locomotive Diesel Sulfur Content (ppm)
AMTRAK	15
Salt Lake Garfield & Western	500

Union Pacific Railroad (includes Burlington Northern and Santa Fe)	221
Utah Railway	15
Utah Transit Authority (commuter rail)	15

For CO, the emission factor does not change with calendar year.

Emission factors are also different for line-haul, passenger, small and switch (yard) locomotives.

The emission factor for PM2.5 emissions is 0.97 times the EF for PM10.

Locomotive Fuel Consumption Scaling Factors

The railroads were unable to provide UDAQ with projections of fuel consumption. Therefore, UDAQ obtained, from U.S. DOE, Energy Efficiency & Renewable Energy (EERE), scaling factors from the document "Freight Transportation Demand: Energy-Efficient Scenarios for a Low-Carbon Future". (12)

VII. Summary of Emission Inventories

Summaries of non-road mobile source emission inventories by calendar year, county and pollutant are found on the following five pages. Units of emissions are tons per year.

Table 4

2011 PM10 Base Year
Emissions
EPA NONROAD Model, Aircraft and Locomotives

EPA NONROAD Model--Tons per Year, 2011

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	4,823	896.9	82.11	78.93	2.259	504.8
Salt Lake	49035	24,851	2,993	275.5	263.7	5.321	1,957
Utah	49049	7,461	1,277	125.6	120.4	2.118	901.0
Weber	49057	6,756	598.4	86.75	81.79	1.468	1,697
SUM		**43,890**	**5,765**	**570.0**	**544.8**	**11.17**	**5,060**

Aircraft Emissions (EDMS v. 5.1.4.1)--Tons per Year, 2011

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	993.7	68.23	18.61	16.94	4.616	49.16
Salt Lake	49035	6,224	832.8	32.49	32.49	111.5	666.0
Utah	49049	2,913	8.581	8.571	8.571	4.804	148.9
Weber	49057	1,666	4.502	5.183	5.183	2.759	79.34
SUM		**11,797**	**914.1**	**64.85**	**63.18**	**123.7**	**943.5**

Locomotive Emissions (reported by railroad companies)--Tons per Year, 2011

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC	NH3
Davis	49011	84.83	494.4	14.14	13.71	3.208	25.09	0.2653
Salt Lake	49035	92.84	614.7	16.17	15.68	4.693	33.56	0.2865
Utah	49049	64.75	371.6	10.77	10.45	3.617	19.28	0.2023
Weber	49057	74.82	443.1	12.57	12.19	3.753	23.30	0.2331
SUM		**317.2**	**1,924**	**53.65**	**52.03**	**15.27**	**101.2**	**0.9872**

All NR Emissions--Tons per Year, 2011

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	5,902	1,460	114.9	109.6	10.083	579.0
Salt Lake	49035	31,168	4,440	324.2	311.9	121.5	2,657
Utah	49049	10,438	1,657	145.0	139.4	10.538	1,069
Weber	49057	8,496	1,046	104.5	99.17	7.980	1,799
SUM		**56,004**	**8,603**	**688.5**	**660.0**	**150.1**	**6,104**

Table 5

2019 PM10 Projection Year
Emissions
EPA NONROAD Model, Aircraft and Locomotives

EPA NONROAD Model--Tons per Year, 2019

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	4,456	543.5	47.33	45.15	3.726	362.3
Salt Lake	49035	23,654	1,678	177.6	168.6	5.634	1,572
Utah	49049	6,729	705.3	73.62	70.06	2.121	637.0
Weber	49057	5,026	350.0	49.14	46.19	1.3540	863.6
SUM		**39,865**	**3,277**	**347.7**	**330.0**	**12.84**	**3,435**

Aircraft Emissions (EDMS v. 5.1.4.1)--Tons per Year, 2019

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	1,075	67.63	18.67	17.02	4.692	50.82
Salt Lake	49035	6,827	942.7	35.97	35.97	125.7	728.5
Utah	49049	3,196	9.500	9.401	9.401	5.279	163.1
Weber	49057	1,829	4.980	5.686	5.686	3.032	86.91
SUM		**12,927**	**1,025**	**69.73**	**68.07**	**138.7**	**1,029**

Locomotive Emissions (reported by railroad companies)--Tons per Year, 2019

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC	NH3
Davis	49011	101.0	388.5	9.335	9.055	0.3560	14.62	0.3158
Salt Lake	49035	141.2	687.8	15.88	15.41	0.4913	31.88	0.4359
Utah	49049	98.43	384.7	9.215	8.939	0.3467	14.72	0.3076
Weber	49057	96.73	405.4	9.655	9.365	0.3396	16.64	0.3013
SUM		**437.3**	**1,866**	**44.09**	**42.76**	**1.534**	**77.86**	**1.361**

EPA NONROAD Model, Aircraft and Locomotive Emissions--TPY, 2019

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	5,632	999.7	75.34	71.22	8.774	427.8
Salt Lake	49035	30,622	3,309	229.5	220.0	131.8	2,332
Utah	49049	10,024	1,099	92.24	88.40	7.747	814.8
Weber	49057	6,951	760.4	64.48	61.24	4.725	967.2
SUM		**53,229**	**6,168**	**461.5**	**440.8**	**153.0**	**4,542**

Table 6

2024 PM10 Projection Year
Emissions
EPA NONROAD Model, Aircraft and Locomotives

EPA NONROAD Model--Tons per Year, 2024

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	4,634	460.4	35.77	33.92	3.555	350.1
Salt Lake	49035	25,148	1,383	145.3	137.0	4.751	1,614
Utah	49049	6,953	558.3	55.62	52.61	1.858	599.8
Weber	49057	4,715	289.4	35.48	33.28	0.9913	619.2
SUM		**41,450**	**2,691**	**272.2**	**256.8**	**11.16**	**3,183**

Aircraft Emissions (EDMS v. 5.1.4.1)--Tons per Year, 2024

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	1,132	67.70	18.83	17.18	4.769	52.17
Salt Lake	49035	7,358	1,070	39.40	39.40	141.7	785.6
Utah	49049	3,391	10.32	9.973	9.973	5.630	172.9
Weber	49057	1,940	5.396	6.033	6.033	3.230	92.15
SUM		**13,821**	**1,153**	**74.24**	**72.59**	**155.3**	**1,103**

Locomotive Emissions (reported by railroad companies)--Tons per Year, 2024

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC	NH3
Davis	49011	110.4	323.7	6.885	6.679	0.3893	11.14	0.3454
Salt Lake	49035	154.3	641.2	13.85	13.43	0.5369	29.31	0.4764
Utah	49049	107.6	321.1	6.833	6.628	0.3792	11.28	0.3364
Weber	49057	105.5	353.4	7.612	7.383	0.3705	13.97	0.3287
SUM		**477.9**	**1,639**	**35.18**	**34.12**	**1.676**	**65.70**	**1.487**

EPA NONROAD Model, Aircraft and Locomotive Emissions--TPY, 2024

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	5,876	851.8	61.49	57.78	8.713	413.4
Salt Lake	49035	32,660	3,094	198.6	189.8	146.9	2,429
Utah	49049	10,452	889.7	72.43	69.21	7.867	784.0
Weber	49057	6,761	648.2	49.12	46.70	4.591	725.3
SUM		**55,749**	**5,484**	**381.6**	**363.5**	**168.1**	**4,352**

Table 7

2028 PM10 Projection Year
Emissions
EPA NONROAD Model, Aircraft and Locomotives

EPA NONROAD Model--Tons per Year, 2028

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	4,840	443.8	31.61	29.86	3.619	355.0
Salt Lake	49035	26,593	1,302	134.7	126.5	5.012	1,680
Utah	49049	7,238	514.4	49.08	46.24	1.949	598.3
Weber	49057	4,652	267.4	30.06	28.16	1.021	516.1
SUM		**43,323**	**2,528**	**245.5**	**230.8**	**11.60**	**3,149**

Aircraft Emissions (EDMS v. 5.1.4.1)--Tons per Year, 2028

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	1,182	67.76	18.97	17.32	4.837	53.37
Salt Lake	49035	7,880	1,180	42.59	42.59	155.8	841.7
Utah	49049	3,563	11.04	10.48	10.48	5.941	181.5
Weber	49057	2,039	5.762	6.339	6.339	3.405	96.78
SUM		**14,664**	**1,265**	**78.38**	**76.73**	**169.9**	**1,173**

Locomotive Emissions (reported by railroad companies)--Tons per Year, 2028

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC	NH3
Davis	49011	118.2	267.3	5.457	5.293	0.4167	8.762	0.3697
Salt Lake	49035	165.0	598.5	12.69	12.31	0.5742	27.57	0.5095
Utah	49049	115.2	265.6	5.429	5.266	0.4058	8.897	0.3601
Weber	49057	112.6	306.6	6.505	6.310	0.3954	12.07	0.3508
SUM		**511.0**	**1,438**	**30.08**	**29.18**	**1.792**	**57.30**	**1.590**

EPA NONROAD Model, Aircraft and Locomotive Emissions--TPY, 2028

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	6,140	778.8	56.04	52.47	8.873	417.1
Salt Lake	49035	34,638	3,081	190.0	181.4	161.3	2,549
Utah	49049	10,916	791.1	64.99	61.99	8.296	788.7
Weber	49057	6,803	579.7	42.90	40.81	4.821	625.0
SUM		**58,498**	**5,230**	**353.9**	**336.7**	**183.3**	**4,380**

Table 8

2030 PM10 Projection Year
Emissions
EPA NONROAD Model, Aircraft and Locomotives

EPA NONROAD Model--Tons per Year, 2030

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	4,952	444.2	30.27	28.54	3.653	360.1
Salt Lake	49035	27,343	1,289	131.8	123.6	5.150	1,718
Utah	49049	7,393	505.1	46.95	44.16	1.998	602.0
Weber	49057	4,633	260.1	27.96	26.18	1.036	474.3
SUM		**44,321**	**2,498**	**237.0**	**222.5**	**11.84**	**3,154**

Aircraft Emissions (EDMS v. 5.1.4.1)--Tons per Year, 2030

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	1,208	67.79	19.04	17.39	4.873	53.99
Salt Lake	49035	8,175	1,238	44.32	44.32	163.2	873.4
Utah	49049	3,652	11.42	10.74	10.74	6.103	186.1
Weber	49057	2,089	5.953	6.497	6.497	3.496	99.19
SUM		**15,124**	**1,323**	**80.61**	**78.95**	**177.7**	**1,213**

Locomotive Emissions (reported by railroad companies)--Tons per Year, 2030

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC	NH3
Davis	49011	122.2	240.5	4.389	4.257	0.4307	7.986	0.3821
Salt Lake	49035	170.4	579.0	11.80	11.45	0.5932	27.16	0.5263
Utah	49049	119.1	239.4	4.392	4.260	0.4194	8.114	0.3721
Weber	49057	116.2	284.1	5.546	5.380	0.4080	11.57	0.3620
SUM		**527.9**	**1,343**	**26.13**	**25.35**	**1.851**	**54.82**	**1.643**

EPA NONROAD Model, Aircraft and Locomotive Emissions--TPY, 2030

County	FIPs	CO	NOX	PM10	PM2.5	SO2	VOC
Davis	49011	6,282	752.6	53.70	50.19	8.956	422.1
Salt Lake	49035	35,689	3,106	187.9	179.4	168.9	2,619
Utah	49049	11,164	755.9	62.08	59.16	8.520	796.2
Weber	49057	6,839	550.2	40.00	38.06	4.94	585.1
SUM		**59,973**	**5,164**	**343.7**	**326.8**	**191.4**	**4,422**

IX. APPENDIX ITEMS

A. Snowmobile Adjustments to EPA NONROAD Model Database

1. Reallocation of Snowmobile Counts in NONROAD Database (File "UT_SNOWM.ALO")

Snowmobile counts were reallocated among the counties based on survey data. This was done by modifying the file "UT_SNOWM.ALO" found in the following folder of the NONROAD database: C:\NONROAD\DATA\ALLOCATE\UT_SNOWM.ALO.

2. Utah Snowmobile Population Changed in NONROAD Database (File "UT.POP")

The NONROAD file "UT.POP" shows the default number of snowmobiles in Utah as of calendar year 1999.

UDAQ obtained counts of registered snowmobiles by county from the Utah Tax Commission for calendar years 2008 through 2014.

From the above data, the Utah snowmobile population for calendar year 1999 was estimated. From Tax Commission data, it was found that Utah had about 36,100 snowmobiles in 1999. The default value in the NR file "UT.POP" showed only 25,729 snowmobiles in Utah.

Therefore, the counts of snowmobiles in the UT.POP file were changed.

3. Utah Snowmobile Counts in Future Years

The NR file "NATION.GRW" determines counts of equipment in future years. Because the snowmobile count in the base year (1999) was changed in the NR model, it was necessary to adjust snowmobile counts in future years. This was done by changing the growth numbers in the "NATION.GRW" file.

4. Snowmobile Seasonality Changed

The NR default file "SEASON.DAT" shows that snowmobile occurs evenly over the months of January, February and December, as denoted by the values (0.333, 0.333 and 0.333).

Snowmobile surveys showed that actual activity in Utah is spread evenly over the months from December through April.

Therefore, the SEASON.DATA values were changed to (0.200, 0.200, 0.200, 0.200 and 0.200) for the respective months of December through April.

5. No Additional Changes to the NONROAD Database

No other changes were made to the NONROAD default database.

Details of Adjustments to Snowmobile Data in EPA NONROAD Model Database

1. EPA NONROAD Model: Changes to Underlying Database for Snowmobiles

The following files in the NONROAD database were changed, as discussed in the body of the report:

1) Path and File Name: C:\NONROAD\DATA\ALLOCATE\UT_SNOWM.ALO

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/INDICATORS/

Counts show the relative numbers of snowmobiles by county.
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			Original Count	Revised Count	
SNM	49000	2002	1,891	1,891	UT
SNM	49001	2002	0	0	Beaver
SNM	49003	2002	0	0	Box Elder
SNM	49005	2002	10	226	Cache
SNM	49007	2002	0	96	Carbon
SNM	49009	2002	0	58	Daggett
SNM	49011	2002	0	0	Davis
SNM	49013	2002	67	16	Duchesne
SNM	49015	2002	0	55	Emery
SNM	49017	2002	217	19	Garfield
SNM	49019	2002	0	0	Grand
SNM	49021	2002	0	64	Iron
SNM	49023	2002	0	24	Juab
SNM	49025	2002	0	0	Kane
SNM	49027	2002	0	0	Millard
SNM	49029	2002	135	0	Morgan
SNM	49031	2002	724	18	Piute
SNM	49033	2002	512	226	Rich
SNM	49035	2002	0	0	Salt Lake
SNM	49037	2002	0	0	San Juan
SNM	49039	2002	43	100	Sanpete
SNM	49041	2002	52	18	Sevier
SNM	49043	2002	31	330	Summit
SNM	49045	2002	0	0	Tooele
SNM	49047	2002	38	48	Uintah
SNM	49049	2002	3	29	Utah
SNM	49051	2002	59	349	Wasatch
SNM	49053	2002	0	0	Washington
SNM	49055	2002	0	0	Wayne
SNM	49057	2002	0	226	Weber

2) Path and File Name: C:\NONROAD\DATA\POP\UT.POP

Based on estimated snowmobile counts obtained from the Utah Tax Commission for calendar year 1999, the populations of snowmobiles were adjusted upwards as follows:

FIPS	Year	SCC	Equipment Description	HP Min	HP Max	Original Population	Revised Population
49000	1999	2260001020	2-Str Snowm	1	3	103.4	145.1

49000	1999	2260001020	2-Str Snowm	3	6	61.0	85.6	
49000	1999	2260001020	2-Str Snowm	11	16	65.6	91.9	
49000	1999	2260001020	2-Str Snowm	16	25	5,219.0	7,322.7	
49000	1999	2260001020	2-Str Snowm	25	40	5,268.0	7,391.5	
49000	1999	2260001020	2-Str Snowm	40	50	2,364.8	3,318.0	
49000	1999	2260001020	2-Str Snowm	50	75	8,331.3	11,689.6	
49000	1999	2260001020	2-Str Snowm	75	100	3,424.1	4,804.3	
49000	1999	2260001020	2-Str Snowm	100	175	892.0	1,251.6	
SUM						25,729.1	36.100.0	

3) Path and File Name: C:\NONROAD\DATA\GROWTH\NATION.GRW

The 1999 base year population of snowmobiles in Utah was changed. Therefore, snowmobile growth factors in future years were also changed.

However, data from Utah Tax Commission showed snowmobile counts actually decreased over calendar years 2005 through 2014. Therefore, growth factors also decrease over calendar years as follows:

Snowmobile Indicator Code: 098
SCC: 226001020
Type: 2-Stroke Snowmobile

Calendar Year	Indicator Code	Original Growth Indicator Value	Revised Growth Indicator Value	Utah Actual Snow-mobile Counts
1970	098	500	500	
1990	"	1,000	353	
1996	"	1,000	309	
1997	"	1,063	302	
1998	"	1,121	294	
1999	"	1,172	287	
2000	"	1,213	280	
2001	"	1,256	272	
2002	"	1,307	265	
2003	"	1,364	258	
2004	"	1,427	250	
2005	"	1,496	243	28,248
2006	"	1,567	236	28,222
2007	"	1,635	228	29,241
2008	"	1,696	221	30,782
2009	"	1,749	214	28,768
2010	"	1,800	206	26,294
2011	"	1,852	199	26,167
2012	"	1,908	192	22,144
2013	"	1,967	184	23,184
2014	"	2,026	177	20,993
2015	"	2,083	170	
2016	"	2,135	162	
2017	"	2,184	155	
2018	"	2,229	148	
2019	"	2,271	140	
2020	"	2,310	133	
2021	"	2,345	126	
2022	"	2,377	118	
2023	"	2,406	111	
2024	"	2,431	103	
2025	"	2,454	96	

2026	"	2,473	89
2027	"	2,490	81
2028	"	2,505	74
2029	"	2,517	67
2030	"	2,526	59

B. Locomotive Scaling Factors

Scaling factors were used to estimate locomotive fuel consumption in the projection years.

Section 2.3, "Economic Factors and Trends", includes projections of railroad freight ton-miles from 1980 through 2030. These data were used to estimate future year locomotive fuel consumption for line-haul freight locomotives.

From the above report, national rail freight ton-miles by calendar year are shown:

Calendar Year	Ton-Miles (Billions)
2010	1,700
2015	1,950
2020	2,100
2025	2,300
2030	2,450

These data can be used to approximate locomotive fuel consumption scaling factors since no better data could be found:

	Freight Locomotive Scaling Factors (from 2011)	Scaling Factors (from 2014)
2019	1.1675	1.0985
2024	1.2722	1.1970
2028	1.3560	1.2758
2030	1.3978	1.3152

For passenger locomotives, scaling factors were obtained from AMTRAK in its report, "AMTRAK Fleet Strategy", version 3.1. (13)

	Passenger Locomotive Scaling Factors (from 2011)	Scaling Factors (from 2014)
2019	1.1717	1.1041
2024	1.2936	1.2190
2028	1.4002	1.3195
2030	1.4568	1.3728

X. References

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4. Utah Railway, 2011 fuel consumption, Stephen Green, stgreene@gwrr.com.

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