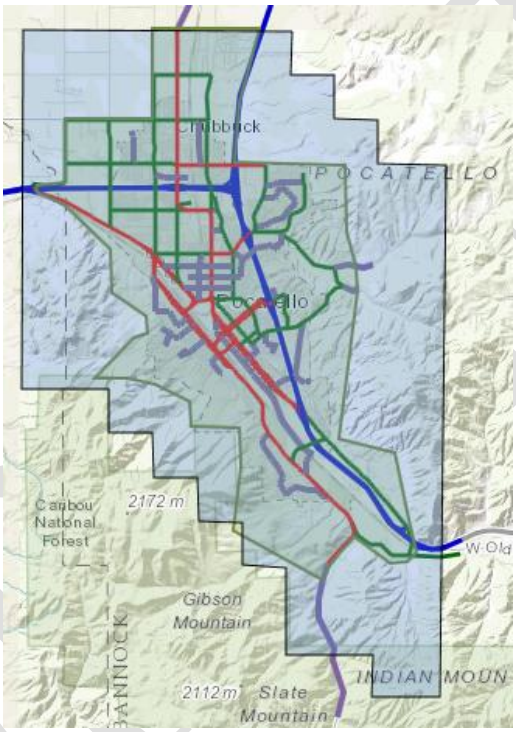
# Portneuf Valley $PM_{10}$ Maintenance Plan Amendment

Transition from MOBILE6 Model to MOVES Model
and to Revise Road Dust Methodology

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**February 2014**

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# Acronyms, Abbreviations, and Symbols

| | |
|---|---|
| ATR | automatic traffic recorder |
| AP-42 | Compilation of Air Pollutant Emission Factors |
| BTPO | Bannock Transportation Planning Organization |
| EPA | United States Environmental Protection Agency |
| FR | Federal Register |
| DEQ | Idaho Department of Environmental Quality |
| ITD | Idaho Transportation Department |
| MOBILE6 | Vehicle Emissions Modeling Software |
| MOVES | Motor Vehicle Emission Simulator |
| MVEB | motor vehicle emissions budget |
| NAAQS | National Ambient Air Quality Standards |
| NEI | National Emission Inventory |
| $NH_4NO_3$ | ammonium nitrate |
| $NO_x$ | nitrogen oxides |
| $PM_{2.5}$ | particulate matter under 2.5 microns in size |
| $PM_{10}$ | particulate matter under 10 microns in size |
| PVNAA | Portneuf Valley Nonattainment Area |
| SIP | State Implementation Plan |
| TDM | Travel Demand Model |
| TIP | Transportation Improvement Program |
| TPY | tons per year |
| VOC | volatile organic compounds |

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# Introduction

The purpose of this amendment is to revise the *Portneuf Valley $PM_{10}$ Nonattainment Area State Implementation Plan, Maintenance Plan, and Redesignation Request* (DEQ 2004) motor vehicle emissions budget (MVEB) by incorporating emission estimates made with the Motor Vehicle Emission Simulator (MOVES), the latest United States Environmental Protection Agency (EPA)-required motor vehicle emissions factor model (EPA 2009, 2011a) and with an updated road dust estimation method (EPA 2011b). The revisions in this amendment only change emission related to the MVEB and no changes are made to the point or area source emissions.

Currently, the area's existing MVEB is based on the MOBILE5 model, the predecessor to the MOVES model and an old (1995) road dust estimation method (EPA 1995). This amendment updates the MVEB submitted with the original State Implementation Plan (SIP), approved by EPA in July 2006, using these latest EPA-approved methods, which are now required for conformity demonstrations. No change in activity or control measures is included; this is simply a change to the latest EPA-mandated road dust and on-road mobile emissions methods/model, and the most current planning assumptions. The updated MVEB is demonstrated to be equivalent to the MVEB in the 2004 SIP in terms of particulate matter under 10 microns in size ($PM_{10}$) contribution to the airshed.

# Background

In areas that are not meeting the National Ambient Air Quality Standards (NAAQS), the Clean Air Act requires the state to develop a SIP containing emission control measures to reduce emissions enough to return the area to compliance with NAAQS. As part of developing control measures, a MVEB is developed that sets emission limits for all current and future transportation projects. Once the MVEB is established in the SIP, Metropolitan Planning Organizations estimate the regional vehicle emissions from all the local proposed road projects in the Transportation Improvement Program (TIP) and compare those emissions with the SIP's MVEB. This process is known as *transportation conformity*.

In March 2013, MOVES replaced MOBILE6 as EPA's official motor vehicle emissions factor model required for all regional emission analysis in support of transportation conformity. The Bannock Transportation Planning Organization (BTPO) addresses the MVEB for the Portneuf Valley attainment area.

In general, the MOVES model calculates higher nitrogen oxides ($NO_x$) and particulate matter under 2.5 microns in size ($PM_{2.5}$) emissions than the previous MOBILE6 model when the activity levels are held constant. Because of the higher emissions estimates resulting from MOVES, it is difficult to show conformity with SIPs that contain MVEB developed using MOBILE6, even when there has been no increase in actual emissions.

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# Emission Calculations

EPA approved the Portneuf Valley $PM_{10}$ maintenance plan and designated the area in attainment on July 13, 2006 (71 FR 39574). This approved plan established MVEBs for on-road sources. DEQ has updated the existing MVEBs in the $PM_{10}$ maintenance plan for the Portneuf Valley using the newer EPA-approved emissions model (MOVES2010b) and the latest paved road dust emission method as detailed in AP-42. This amendment to the SIP will revise the MVEBs to reflect both new methods now required by EPA.

In addition to the on-road mobile emissions estimated by the MOBILE6/MOVES models, paved road dust $PM_{10}$ emissions are included in the MVEB. The 2004 SIP attainment demonstration used to establish the existing MVEB included paved road dust estimates made using EPA's 1996 AP-42 emission estimation guidance and incorporated locally determined road silt loading information developed in a 1996/1997 study by Light (1998).

In January 2011, EPA revised its AP-42 paved road dust estimation method (EPA 2011b), and DEQ used the new estimation guidance to update estimates of paved road dust emissions. A survey of the Pocatello and Chubbuck city road departments indicated that major changes in the use of wintertime antiskid treatments occurred between 1997 and 2012, including higher salt-to-sand ratios in the antiskid treatments, pre storm brine application to reduce the amount of antiskid materials required, and a greater number of sweepers to clean up the antiskid materials that are used (Appendix A). Based on this survey, silt loadings based on traffic volume were used as recommended by EPA (EPA 2011b) to account for wintertime antiskid treatment rather than the silt loading measured in the area 15 years earlier. As a result of the reduced sand usage and the updated emission estimation methods, a significant reduction in paved road dust is estimated for years 2011 and 2020. The paved road dust reductions are greater than the increase in direct exhaust $PM_{10}$ and secondary $PM_{10}$ due to precursor $NO_x$ that occurred when MOVES replaced MOBILE6. The net effect is a reduced on-road mobile emissions inventory.

# Description of Modeling Used

On March 2, 2010, EPA released a new mobile source emissions model called the Motor Vehicles Emissions Simulator 2010 (MOVES2010). The EPA provided a 2-year grace period to transportation planning organizations, ending March 2, 2012, during which the older MOBILE6 emissions could still be used to model emissions for transportation projects to meet the requirements of transportation conformity (75 FR 9411).

On October 13, 2011, EPA proposed a 1-year extension to the 2-year grace period because states and localities needed more time to transition to using MOVES2010a and to develop the technical capacity to use MOVES2010a (76 FR 63575). EPA finalized the extension on February 27, 2012 (77 FR 11394). The 1-year extension provides additional time that may be critical for nonattainment and maintenance areas to learn and apply MOVES2010a for regional conformity analyses. Any new transportation conformity analysis started after March 2, 2013, must use the MOVES model.

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The EPA issued the MOVES2010b version of the model and its associated guidance in April 2012, and it is the version in effect throughout the period of this SIP revision analysis and is the version used by DEQ.

## Planning Assumptions

To operate the MOVES model at the county-level as required by EPA for SIP-level emission inventories, DEQ developed an input database for each specific combination of inputs. This section discusses the assumptions, sources of input information, and calculation methodologies involved in developing SIP-level MOVES input databases.

In November 2012, DEQ completed statewide on-road emission estimates in support of the 2011 National Emission Inventory (NEI). This comprehensive project (DEQ 2012) gathered detailed information from the statewide motor vehicle registration database to describe the motor vehicle source population (ITD 2012a) and traffic counts by vehicle length from every permanent automatic traffic recorder (ATR) in the state (ITD 2012b). In addition, telephone and e-mail surveys filled in the bus and refuse truck source population data that may be unreliable in the registration database and in the national defaults. In view of this *SIP-level* detail in the NEI MOVES inputs, the Bannock County source population and temporal profiles developed for the NEI were used along with BTPO's Travel Demand Model (TDM) for the Portneuf Valley Nonattainment Area (PVNAA) (Parsons 2012) to develop local inputs for the Portneuf Valley. The use of the Bannock County inputs from the NEI statewide database, which was extensively quality assured and found to be consistent with other counties in Idaho of similar population ensures that the Portneuf Valley results are robust and internally consistent with the rest of Idaho.

## Existing MVEB

The 2004 PVNAA SIP established MVEB for 2005, 2010, and 2020 (DEQ 2004). The existing MVEBs were developed consistent with the emissions inventory and attainment demonstration that showed future compliance with NAAQS for $PM_{10}$. The existing MVEBs established in the 2003 SIP are shown in Table 1.

**Table 1. Existing MVEB established in 2004 PVNAA SIP.**

| Year | $PM_{10}$ (TPY) | $NO_x$ (TPY) | VOC (TPY) |
|---|---|---|---|
| 2005 | 897 | 1,575 | 983 |
| 2010 | 1,120 | 1,085 | 716 |
| 2020 | 1,364 | 514 | 585 |

*Notes*: motor vehicle emission budget (MVEB); Portneuf Valley Nonattainment Area (PVNAA); State Implementation Plan (SIP); particulate matter with a diameter less than 10 microns ($PM_{10}$); tons per year (TPY); nitrogen oxides ($NO_x$); volatile organic compound (VOC)

The existing budgets include on-road mobile emissions computed using MOBILE6, paved road dust emissions computed using the 1995 version of the AP-42 paved road dust emission factor methodology that incorporated locally determined silt loading factors, and a small amount of

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unpaved road dust emissions from the few remaining unpaved roads in the area. No significant unpaved roads remain in the PVNAA in 2013.

## Input Data

The on-road mobile emission inventory for the PVNAA was updated for 2011 and 2020 as described in Appendix A (DEQ 2013). Emissions estimates for 2010 were not made because (a) 2010 had passed and conformity for 2010 and prior years was already completed using MOBILE6, and (b) newer information was available for 2011 as a result of the 2011 NEI project. DEQ used SIP-quality, county-level MOVES inputs for the 2011 NEI so that it would be adequate for SIP documentation purposes. Early in 2013, DEQ updated the 2011 NEI inputs to reflect activity data from the Portneuf Valley TDM developed by BTPO. As a result, the more recent 2011 emissions will be used to replace the existing 2010 MVEBs since 2010 is no longer of interest and the recent model year is more relevant and timely. The SIP-level MOVES inputs developed for the 2011 NEI include source population data from the Idaho Department of Motor Vehicles, traffic temporal information from permanent ATRs, and bus and refuse truck local survey information (DEQ 2013).

## Budgets and Safety Margins

The following demonstrates that the revised MVEB resulting from EPA-mandated changes in the on-road and paved road dust emission models results in lower net $PM_{10}$ in the airshed.

It should be noted that actual on-road activity levels are not changing significantly beyond normal growth, and this demonstration reflects only changes in the estimated AP-42 road dust emissions and in the on-road mobile modeling emission estimates. This section and Appendix B describe how DEQ calculated the overall *net* effect of these emission calculation changes for total $PM_{10}$.

The net effective $PM_{10}$ contribution is the combination of direct $PM_{10}$ emissions plus the $NO_x$ that has been converted to the secondary aerosol composed of ammonium nitrate ($NH_4NO_3$). Since the actual conversion rate of $NO_x$ to $NH_4NO_3$ cannot be estimated without difficult and time-consuming photochemical modeling, DEQ followed the most conservative possible approach and estimated 100% conversion. Since VOCs only act similar to a *catalyst* in facilitating the $NH_4NO_3$ formation chemistry and do not directly form new $PM_{10}$ separate from the nitrate formation, they are not included in calculating the *net* effective $PM_{10}$ contribution to the airshed (Appendix B). Table 2 shows the comparison of total $PM_{10}$ (direct $PM_{10}$ + 100% conversion of $NO_x$ to $NH_4NO_3$) using the existing MVEB in the 2004 SIP and a MVEB developed in 2013 with MOVES and the new AP-42 road dust calculations. The 2013 estimates show an increase in secondary particulate formation and a decrease in direct $PM_{10}$, but the total $PM_{10}$ still remains below that in the existing 2010 and 2020 MVEBs from the SIP, which demonstrated compliance with the $PM_{10}$ NAAQS.

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**Table 2. Comparison of 2013 on-road emissions with existing 2004 MVEBs in terms of net $PM_{10}$, including primary and secondary particulate, assuming 100% $NO_x$ conversion.**

| | Existing SIP MVEB with 100% $NO_x$ Conversion Rate | 2013 Estimates with 100% $NO_x$ Conversion Rate | Difference, Existing SIP MVEB—2013 Estimates |
|---|---|---|---|
| **Year** | **2010** | **2011** | **2010/2011** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 2,745 | 3,347 | -602 |
| Primary $PM_{10}$ | 1,120 | 382 | 738 |
| Total $PM_{10}$ | 3,865 | 3,729 | 136 |
| **Year** | **2020** | **2020** | **2020** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 1,300 | 1,647 | -347 |
| Primary $PM_{10}$ | 1,364 | 379 | 986 |
| Total $PM_{10}$ | 2,664 | 2,026 | 639 |

*Notes*: motor vehicle emission budget (MVEB); particulate matter with a diameter less than 10 microns ($PM_{10}$); nitrogen oxides ($NO_x$); State Implementation Plan (SIP); volatile organic compound (VOC)

If the updated emissions estimates are used directly as MVEBs, then minor model input differences in future conformity tests could potentially cause the TIP emissions estimates to exceed the updated budgets. To avoid this potential problem, *safety factors* are typically built into the MVEBs to the extent that can be tolerated while still demonstrating future year NAAQS compliance in the attainment demonstration, or in this case, while still showing equivalence with the existing MVEB.

It was determined a safety margin of 3.1% could be added to revised 2011 MVEBs and 31.5% could be added to the revised 2020 MVEBs without exceeding the total $PM_{10}$ in the existing MVEBs. Since the existing SIP MVEB is consistent with an overall emission inventory and the approved attainment demonstration model showing future year compliance with the NAAQS (DEQ 2004), the revised *model change* MVEBs will remain consistent with the attainment demonstration as long as long as they are equivalent to the existing MVEBs in terms of the net $PM_{10}$ quantity added to the airshed.

## Revised MVEB for the Period 2011–2020

The analysis above demonstrates that model changes resulting from the use of the MOVEs2010b model and the 2011 AP-42 paved road dust method results in new MVEBs that are equivalent to the existing (2004 SIP) MVEBs in terms of $PM_{10}$ contributions to the PVNAA airshed.

The resulting revised MVEB for this period is shown in Table 3. Conformity tests for any TIPs conducted from the approval of the MVEBs in this EIP revision through 2019 will be required to meet the budget shown for 2011. This is a conservative budget because, as noted in Appendix B, the 2011 MVEB includes the maximum (2011) MOVES direct $PM_{10}$ emissions plus the maximum (2020) paved road dust emissions for the period. Any TIP conducted in 2020 and beyond will be required to meet the budget shown for 2020.

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**Table 3. Revised motor vehicle emission budgets for the PVNAA.**

| Year | $PM_{10}$ (TPY) | $NO_x$ (TPY) | VOC (TPY) |
|---|---|---|---|
| 2005 | N/A | N/A | N/A |
| 2011 | 415 | 1,364 | 903 |
| 2020 | 498 | 856 | 651 |

*Notes*: Portneuf Valley Nonattainment Area (PVNAA); particulate matter with a diameter less than 10 microns ($PM_{10}$); tons per year (TPY); nitrogen oxides ($NO_x$); volatile organic compound (VOC); not applicable (N/A)

# Emission Inventory Growth and Control Assumptions Unchanged

This report demonstrates that MVEBs updated using MOVES and the 2011 road dust methodology are equivalent to the existing MVEBs in the 2004 SIP. The other portions of the emissions inventory are unchanged by this modification, and the growth and control strategy assumptions used in the 2004 SIP are still valid. The emissions inventory developed for the 2004 SIP is reproduced in Appendix C, with the new MVEBs provided for comparison.

Control strategy assumptions for source categories other than on-road vehicle are not changed as part of this revision and are unchanged since the SIP was published in 2004. In addition, the growth assumptions used in the 2004 SIP to project emissions for the future years are still valid. The 2004 SIP analysis used the population growth from 1990 to 2000 (1.4% per year) to forecast population and household growth to the future year attainment dates, including 2010 and 2020, for generally all the anthropogenic area source categories. (Agriculture and stationary sources were assumed to remain level.) Subsequent census data indicate that combined population growth for Chubbuck and Pocatello, the population centers of the PVNAA, actually averaged 1.2% per year between 2000 and 2010, and is estimated to average only 0.6% for each city in 2011 and 2012 (US Census 2013). This is lower than the growth rates assumed in the SIP to occur for every year after 2000. The cities of Chubbuck and Pocatello represent nearly the entire populated portion of the PVNAA, so it is clear that growth assumptions used in the 2004 SIP are still valid.

# Conclusion

The revised MVEB included in Table 3 will apply to future transportation conformity determinations. With these proposed changes to the MVEB, the SIP will continue to show maintenance of the 24-hour $PM_{10}$ standard because it is equivalent to the MVEB used in the 2004 attainment demonstration. This SIP amendment will lead to an equitable and more relevant result when evaluating transportation impacts on the area's air quality.

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# Appendix A. Development of the Year 2011 and Year 2020 Mobile Source Emissions Inventories and Conformity Test for the Portneuf Valley Nonattainment Area, Idaho

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# Development of the Year 2011 and Year 2020 Mobile Source Emissions Inventories and Conformity Test for the Portneuf Valley Nonattainment Area, Idaho

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# Abbreviations, Acronyms, and Symbols

| | |
|---|---|
| ADT | average daily traffic |
| ATR | automatic traffic recorder |
| AVFT | alternative vehicle fuels and technology |
| BTPO | Bannock Transportation Planning Organization |
| CO | carbon monoxide |
| DEQ | Idaho Department of Environmental Quality |
| DMV | Idaho Department of Motor Vehicles |
| E10 | fuel blend of 10% ethanol and 90% gasoline |
| EPA | United States Environmental Protection Agency |
| FHWA | Federal Highway Administration |
| HPMS | Highway Performance Monitoring System |
| I/M | inspection and maintenance |
| ITD | Idaho Transportation Department |
| MOVES | Motor Vehicle Emissions Simulator |
| mph | miles per hour |
| MVEB | motor vehicle emission budget |
| NEI | National Emission Inventory |
| $NH_3$ | ammonia |
| $NO_x$ | nitrogen oxides |
| $PM_{10}$ | particulate matter with a diameter less than 10 microns |
| $PM_{2.5}$ | particulate matter with a diameter less than 2.5 microns |
| PVNAA | Portneuf Valley Nonattainment Area |
| SIP | State Implementation Plan |
| $SO_2$ | sulfur dioxide |
| TDM | Travel Demand Model |
| TVRDS | Treasure Valley Road Dust Study |
| VHT | vehicle hours traveled |
| VIN | vehicle identification number |
| VMT | vehicle miles traveled |
| VOC | volatile organic compound |

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# 1 Introduction

On-road mobile emission inventories for the Portneuf Valley Nonattainment Area (PVNAA) are required for the State Implementation Plan (SIP) ten-year update documentation and for future conformity determinations to be made by the Bannock Transportation Planning Organization (BTPO), the metropolitan planning organization for Bannock County, Idaho. While current motor vehicle budgets established by the current SIP for particulate matter with a diameter less than 10 microns ($PM_{10}$) (DEQ 2004) were developed using the MOBILE motor vehicle emissions model, all future SIP documentation and conformity determinations after March 2, 2013, must be developed using the United States Environmental Protection Agency's (EPA's) new Motor Vehicle Emission Simulator (MOVES) model. The purpose of the PVNAA on-road emission inventory described in this report is to support the SIP maintenance plan ten-year update and conformity determinations to be made after March 2, 2013. Conformity determinations made prior to March 2, 2013, must be made using the same methodologies used to develop the motor vehicle emission budgets (MVEB) currently in effect as established in the 2004 *Portneuf Valley $PM_{10}$ State Implementation Plan, Maintenance Plan, and Redesignation Request* (DEQ 2004).

The Motor Vehicle Emissions Simulator (MOVES2010b) (EPA 2011a) is the current EPA-designated model for on-road mobile emission inventory development for SIP maintenance plans and for Federal Highway Administration (FHWA) transportation conformity determinations. The on-road mobile source emissions inventory was developed using MOVES2010b according to EPA guidance *Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b* (EPA 2012).

The paved road dust emissions were developed using the latest EPA-recommended *AP-42, Compilation of Air Pollutant Emission Factors* method (EPA 2011b). There are no significant unpaved roads in the PVNAA, thus unpaved road emissions were not estimated.

This report details the methodologies and results for the MOVES on-road emissions modeling and paved road dust computations used to develop the 2011 and 2020 on-road emission inventories.

# 2 Methodology: MOVES Input Database Development

To operate the MOVES model at the county-level as required by EPA for SIP-level emission inventories, the Idaho Department of Environmental Quality (DEQ) developed an input database for each specific combination of inputs. This section discusses the assumptions, sources of input information, and calculation methodologies involved in developing SIP-level MOVES input databases.

In November 2012, DEQ completed statewide on-road emission estimates in support of the 2011 National Emission Inventory (NEI). This comprehensive project (DEQ 2012) gathered detailed information from the statewide motor vehicle registration database to describe the motor vehicle source population and traffic counts by length from every permanent automatic traffic recorder (ATR) in the state. In addition telephone and e-mail surveys filled in the bus and refuse truck source population data that may be unreliable in the registration database and in the national

defaults. In view of this *SIP-level* detail in the NEI MOVES inputs, the Bannock County source population and temporal profiles developed for the NEI were used along with BTPO's Travel Demand Model (TDM) (Parsons 2012) to develop local inputs for the PVNAA. The use of the Bannock County inputs from the NEI statewide database, which was extensively quality assured and found to be consistent with other counties in Idaho of similar population ensures that the PVNAA results are robust and internally consistent with the rest of Idaho.

Based on similarity of geographic features, vehicle travel patterns, and data sources, DEQ grouped all 44 Idaho counties into three groups: Northern Idaho, Southern Idaho, and Treasure Valley to use the ATR data in developing the statewide 2011 NEI inputs (Table 1). A majority of PVNAA resides in Bannock County and belongs to the southern Idaho group. Because all of the urban southern Idaho group ATR sites except one reside in PVNAA and nearly all roads in PVNAA are urban roads, the southern Idaho group ATR data represent PVNAA very well.

**Table 1. Idaho county groups for MOVES modeling purposes.**

| County Group | County ID | County Name | County Group | County ID | County Name |
|---|---|---|---|---|---|
| Northern Idaho | 16009 | Benewah | Southern Idaho (continued) | 16031 | Cassia |
| | 16017 | Bonner | | 16033 | Clark |
| | 16021 | Boundary | | 16037 | Custer |
| | 16035 | Clearwater | | 16039 | Elmore |
| | 16049 | Idaho | | 16041 | Franklin |
| | 16055 | Kootenai | | 16043 | Fremont |
| | 16057 | Latah | | 16045 | Gem |
| | 16061 | Lewis | | 16047 | Gooding |
| | 16069 | Nez Perce | | 16051 | Jefferson |
| | 16079 | Shoshone | | 16053 | Jerome |
| Treasure Valley | 16001 | Ada | | 16059 | Lemhi |
| | 16027 | Canyon | | 16063 | Lincoln |
| Southern Idaho | 16003 | Adams | | 16065 | Madison |
| | 16005 | Bannock | | 16067 | Minidoka |
| | 16007 | Bear Lake | | 16071 | Oneida |
| | 16011 | Bingham | | 16073 | Owyhee |
| | 16013 | Blaine | | 16075 | Payette |
| | 16015 | Boise | | 16077 | Power |
| | 16019 | Bonneville | | 16081 | Teton |
| | 16023 | Butte | | 16083 | Twin Falls |
| | 16025 | Camas | | 16085 | Valley |
| | 16029 | Caribou | | 16087 | Washington |
| *Note*: Motor Vehicle Emission Simulator (MOVES) | | | | | |

The required MOVES inputs, grouped by common data source, are shown in Figure 1. For example, *VMT Related* inputs such as road type distribution and monthly, daily, and hourly traffic profiles (top box) require detailed information from the Idaho Transportation Department (ITD) traffic counts and vehicle miles traveled (VMT) statistics to characterize the VMT within the modeling domain, while the *Source Related* inputs are derived primarily from the statewide vehicle registration database.

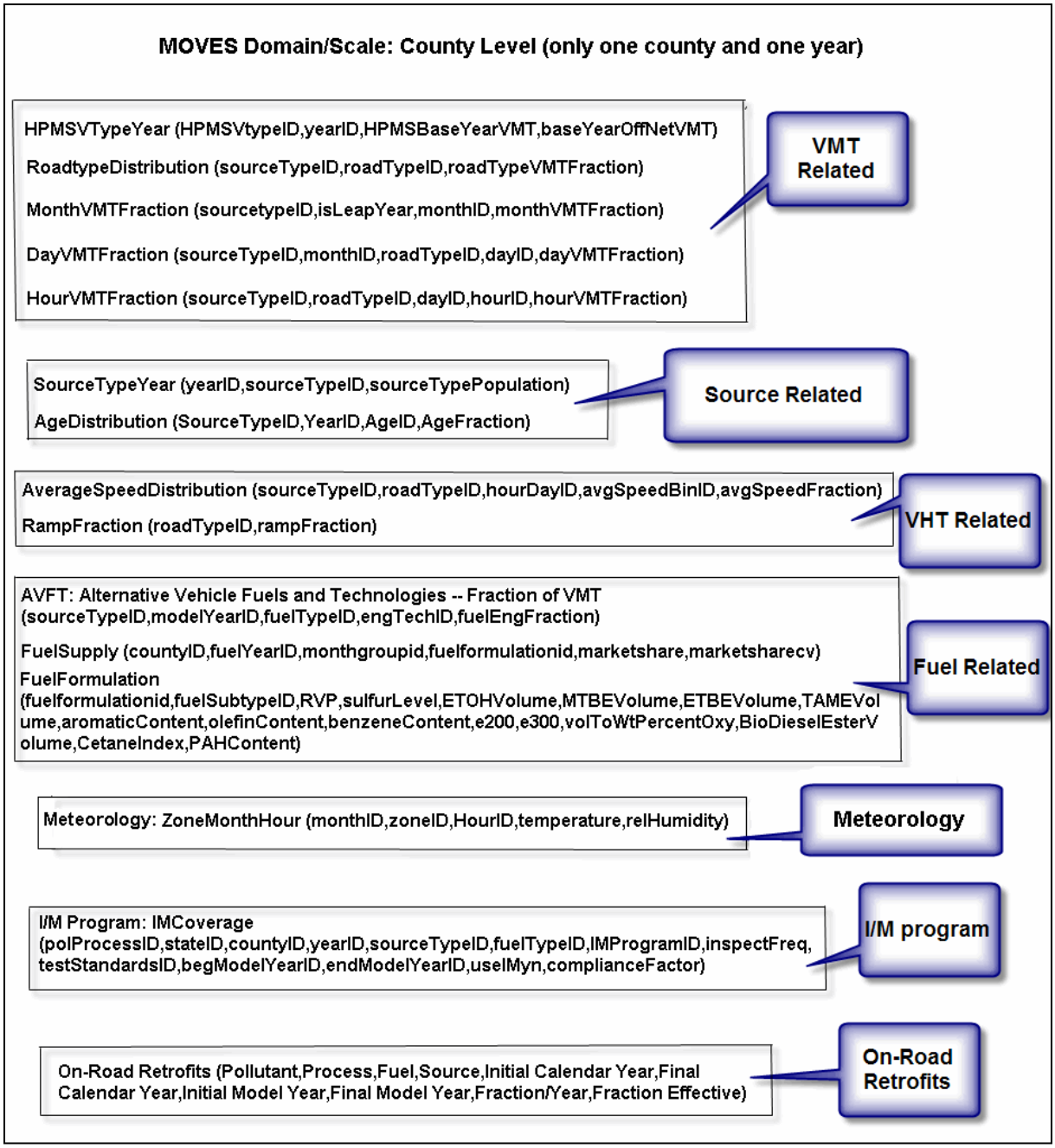


**Figure 1. Motor Vehicle Emission Simulator input files and groups.**

County-level input files were prepared for each category, using a combination of (primarily) local data and selected MOVES national defaults in those cases where local data are not available or are suspected to be less reliable. This section discusses the creation of each input in turn. The input files under discussion are listed after each section heading for clarification. For reference, MOVES road types and source types (vehicles) are defined in Table 2 and Table 3, respectively.

**Table 2. MOVES road type descriptions.**

| Road Type | Description |
|---|---|
| 1 | Off-network |
| 2 | Rural restricted access |
| 3 | Rural unrestricted access |
| 4 | Urban restricted access |
| 5 | Urban unrestricted access |

*Note*: Motor Vehicle Emission Simulator (MOVES)

**Table 3. MOVES source type descriptions.**

| MOVES Source Type | Description |
|---|---|
| 11 | Motorcycle |
| 21 | Passenger car |
| 31 | Passenger truck |
| 32 | Light commercial truck |
| 41 | Intercity bus |
| 42 | Transit bus |
| 43 | School bus |
| 51 | Refuse truck |
| 52 | Single unit short-haul truck |
| 53 | Single unit long-haul truck |
| 54 | Motor home |
| 61 | Combination short-haul truck |
| 62 | Combination long-haul truck |

*Note*: Motor Vehicle Emission Simulator (MOVES)

## 2.1 VMT-Related Inputs

VMT inputs describe the distance traveled on different roadways by the various source types (vehicles). VMT-related inputs include road type distribution and VMT (annual, monthly, daily, and hourly estimates). The road type VMT distribution data set was developed from the BTPO TDM, and the monthly, weekday/weekend, and hourly VMT profiles were developed from permanent ATRs.

### 2.1.1 Annual VMT

*HPMSVTypeYear(HPMSVtypeID, yearID, HPMSBaseYearVMT, baseYearOffNetVMT)*

Annual VMT describes the total vehicle miles traveled for each Highway Performance Monitoring System (HPMS) vehicle type, for each county in the domain. To generate the annual VMT inputs, ITD ATR data were used to generate a weekday/weekend ratio and fleet mix for each road type, which were then applied to BTPO TDM annual average weekday VMT outputs to estimate annual VMT.

Comparing annual VMT attributed to local roads from the TDM output to ITD's annual local road VMT from fuels sales data indicated that the TDM does not underestimate VMT from local

roads (as TDMs often do). Thus, a local road scale-up factor of 1.00 was used (i.e., no VMT adjustment for the local roads). The final TDM-based VMT are summarized in Table 4.

**Table 4. Travel Demand Model-based annual vehicle miles traveled.**

| Year | Vehicle Miles Traveled |
|---|---|
| 2011 | 409,399,732 |
| 2020 | 454,338,514 |

### 2.1.2 Road Type

*RoadtypeDistribution(sourceTypeID, roadTypeID, roadTypeVMTFraction)*

The road type distribution describes the fraction of fleet miles driven on each of the four applicable MOVES road types (rural restricted, rural unrestricted, urban restricted, and urban unrestricted) within the modeling domain for each source (vehicle) type. Road type distribution inputs were derived from TDM outputs provided by BTPO and ITD ATR data. A crosswalk table in Appendix A shows the relationships between BTPO TDM road types, the HPMS/FHWA road types, and the MOVES roadway types. The ATR-based traffic data and TDM outputs were used to allocate the annual VMT for each source type to road types. When the annual road distributions were complete for the FHWA road types, the distributions were aggregated into the four MOVES road types.

Year 2020 road type distribution was developed from the same ITD ATR data set along with year 2020 VMT from the TDM.

### 2.1.3 Monthly, Daily, and Hourly VMT

*MonthVMTFraction(sourcetypeID, isLeapYear, monthID, monthVMTFraction)*
*DayVMTFraction(sourceTypeID, monthID, roadTypeID, dayID, dayVMTFraction)*
*HourVMTFraction(sourceTypeID, roadTypeID, dayID, hourID, hourVMTFraction)*

Temporal distribution profiles further divided the source type annual VMT into finer time increments. Temporal profiles were derived from ATR data and annual VMT by FHWA road type based on BTPO's TDM.

ATR data contain hourly vehicle counts for each of five length categories or *bins*. Hourly counts for each length bin were converted to temporal distributions for each MOVES vehicle type and roadway type using a crosswalk scheme developed based on discussions with ITD and 2009–2011 Idaho statewide vehicle classification data (Scott Fugit, ITD, pers.comm. 2012). The final crosswalk table, which maps ATR length bins to MOVES vehicle types, is provided in Appendix B, and the 2009–2011 classification data are provided in Appendix C. Neither ATR data nor FHWA vehicle classification data distinguish between personal or commercial light-duty truck trips, and long- or short-haul heavy duty truck trips, so it was necessary to use national default fractions available in the MOVES model to make the final splits from FHWA classes to MOVES vehicle types in these categories. For each ATR site, a full year of ATR data were processed. Hourly, weekday/weekend, and monthly statistics were calculated for each vehicle type. Finally, ATR sites were grouped based on MOVES road types, and each site was weighted equally in constructing the final temporal profiles.

Year 2020 temporal profiles for each road type were developed from the same ITD ATR data set along with year 2020 VMT.

## 2.2 Source-Related Inputs

This group of inputs includes source type population and age distribution. Source-related inputs describe and group the vehicles in the modeling domain and are compiled using a variety of data sources (Table 5). The fleet mix distribution is a key component of on-road mobile source emissions. The majority of vehicles are well characterized by the Idaho Department of Motor Vehicle (DMV) registration database (Bob Thompson, ITD, pers.comm. 2012). The database is screened to ensure that only vehicles with current registrations are included, and vehicle types and ages are obtained from the vehicle identification number (VIN) to avoid data entry errors that may occur in manually entered fields.

**Table 5. Crosswalk between MOVES source types and data sources for source-related MOVES input parameters.**

| MOVES Source Type | Source-Related Input Data Source |
|---|---|
| Motorcycle | ITD—DMV registration database |
| Passenger car | ITD—DMV registration database |
| Passenger truck | ITD—DMV registration database |
| Light commercial truck | ITD—DMV registration database |
| Intercity bus | Telephone and e-mail survey |
| Transit bus | Telephone and e-mail survey |
| School bus | Idaho Department of Education |
| Refuse truck | Telephone and e-mail survey, MOVES default database |
| Single unit short-haul truck | MOVES default database, annual local VMT |
| Single unit long-haul truck | MOVES default database, annual local VMT |
| Motor home | ITD—DMV registration database |
| Combination short-haul truck | MOVES default database, annual local VMT |
| Combination long-haul truck | MOVES default database, annual local VMT |

*Notes*: Idaho Motor Vehicle Emissions Stimulator (MOVES); Idaho Transportation Department (ITD); Idaho Department of Motor Vehicles (DMV); vehicle miles traveled (VMT)

### 2.2.1 Source Type Population

*SourceTypeYear(yearID, sourceTypeID, sourceTypePopulation)*

The source type population input describes the types and numbers of vehicles that make up the fleet. Six sources of data were used to develop the source type population inputs as shown in Table 5.

Direct population and age data were obtained from service providers via telephone and e-mail surveys for transit and intercity buses and refuse trucks. School bus data were obtained from the Idaho Department of Education. For motorcycle, passenger car, passenger truck, light commercial truck, and motor home source types, VIN-decoded registration data were used to determine vehicle populations.

For all other heavy duty truck source types many of the vehicles are registered in other states so local registration data are not complete, and therefore, the heavy duty truck populations are derived from MOVES national defaults. Thus, for single and combination haul trucks, a factor was used to estimate the county level source type populations using local activity data, MOVES national default activity data, and MOVES national default source type populations as shown in Equation 1.

$$Population_{Local}^{SourceType} = VMT_{Local}^{SourceType}\left(\frac{Population_{NatlDefault}^{SourceType}}{VMT_{NatlDefault}^{SourceType}}\right)$$

**Equation 1. Equation used to estimate vehicle population for source types without local data.**

The 2010 census indicates that 89.3% of the PVNAA human population resides in Bannock County. Thus, the Bannock County source type population from the 2011 NEI was adjusted using this human population ratio as surrogate to produce the PVNAA source type population. A very small, sparsely populated sliver of the PVNAA is located in Power County; however, this is a negligible portion of the total PVNAA population and that portion of the source population is also assumed to have similar characteristics to Bannock County.

DEQ assumed the "VMT per vehicle population" is approximately constant from year to year, allowing 2020 source type populations to be estimated using Equation 2 shown below:

$$Population_{year\ 2020}^{SourceType} = VMT_{year\ 2020}^{SourceType}\left(\frac{Population_{year\ 2011}^{SourceType}}{VMT_{year\ 2011}^{SourceType}}\right)$$

**Equation 2. Equation used to estimate vehicle population for 2020.**

### 2.2.2 Age Distribution

*AgeDistribution(SourceTypeID, YearID, AgeID, AgeFraction)*

Age distributions characterize the age profile of each vehicle source type. Age distributions were developed for Bannock County using VIN-decoded vehicle registration data, refuse truck, transit and intercity bus fleet data from service providers, school bus fleet data from the Idaho Department of Education, and MOVES defaults for heavy duty haul truck source types. Because the majority of PVNAA is in Bannock County, age distributions developed for Bannock County were used for PVNAA directly.

The same age distribution developed for 2011 was used for 2020, based on the approximation that age distribution do not change significantly from year to year.

## 2.3 VHT-Related Inputs

Vehicle hours traveled (VHT) inputs characterize the time spent and average speeds of vehicles travelling on specific road types. This group of inputs includes ramp fractions and average speed distribution.

### 2.3.1 Ramp Fractions

*RampFraction(roadTypeID, rampFraction)*

Ramp fraction defines the portion of VHT on roadways that contain entrance and exit ramps for restricted access roadways. Ramps are treated separately from the remainder of the freeway VHT because the sudden acceleration and deceleration that occurs on ramps results in significantly higher emissions.

Both 2011 and 2020 ramp fractions for urban freeways were calculated by aggregating VHT on ramps and restricted access roadways from the TDM outputs then dividing ramp VHT by total restricted access roadway VHT to get the fraction of restricted access VHT attributed to ramps.

### 2.3.2 Average Speed Distribution

*AverageSpeedDistribution(sourceTypeID, roadTypeID, hourDayID, avgSpeedBinID, avgSpeedFraction)*

The average speed distribution allocates the different source types (vehicles) for each roadway type to 16 speed bins ranging from 0 to >72.5 miles per hour (mph) (Table 6). This input reflects levels of congestion on roadways. Average speed distributions were developed from TDM average daily traffic counts for each roadway segment and hourly traffic count statistics developed from detailed ATR traffic count data provided by ITD.

**Table 6. MOVES speed bins.**

| avgSpeedBinID | avgBinSpeed | avgSpeedBinDesc |
|---|---|---|
| 1 | 2.5 | Speed <2.5 miles per hour (mph) |
| 2 | 5 | 2.5 mph ≤ speed <7.5 mph |
| 3 | 10 | 7.5 mph ≤ speed <12.5 mph |
| 4 | 15 | 12.5 mph ≤ speed <17.5 mph |
| 5 | 20 | 17.5 mph ≤ speed <22.5 mph |
| 6 | 25 | 22.5 mph ≤ speed <27.5 mph |
| 7 | 30 | 27.5 mph ≤ speed <32.5 mph |
| 8 | 35 | 32.5 mph ≤ speed <37.5 mph |
| 9 | 40 | 37.5 mph ≤ speed <42.5 mph |
| 10 | 45 | 42.5 mph ≤ speed <47.5 mph |
| 11 | 50 | 47.5 mph ≤ speed <52.5 mph |
| 12 | 55 | 52.5 mph ≤ speed <57.5 mph |
| 13 | 60 | 57.5 mph ≤ speed <62.5 mph |
| 14 | 65 | 62.5 mph ≤ speed <67.5 mph |
| 15 | 70 | 67.5 mph ≤ speed <72.5 mph |
| 16 | 75 | 72.5 mph ≤ speed |

The hourly ATR-based traffic count profiles for each roadway type were used to estimate hourly volume on each segment. The Akcelik volume delay function (Equation 3) was then used to develop the average speed distribution database for each hour. This is the same volume delay function used in the BTPO's TDM (Parsons 2012) so the emissions model is internally consistent with the TDM.

$$R = R_0 + D_0 + 0.25T\left[(x-1) + \sqrt{\left((x-1)^2 + \frac{16J \cdot X \cdot L^2}{T^2}\right)}\right]$$

Where:

$R$ = Link traversal time
$R_0$ = Free flow link traversal time
$D_0$ = zero flow control delay
$T$ = expected duration of demand
$X$ = flow to capacity ratio
$J$ = calibration parameter
$L$ = Link length

**Equation 3. Akcelik volume delay function.**

Both 2011 and 2020 average speed distributions were developed for all four MOVES road types using TDM outputs developed by BTPO and hourly temporal profiles based on the detailed ATR data provided by ITD.

## 2.4 Fuel-Related Inputs

This group of inputs includes data regarding fuel supply, fuel formulation, and alternative vehicle fuels and technology (AVFT).

### 2.4.1 Fuel Supply

*FuelSupply(countyID, fuelYearID, monthgroupid, fuelformulationid, marketshare, marketsharecv)*

Fuel supply inputs designate the fuel formulations used by the model for each model year for each source type.

National default fuel supply inputs were used for all source types except the E10 market share. By the end of 2011, the E10 market share in Idaho is known to have been virtually 100%, but to account for a small number of suppliers who were still selling gasoline with no ethanol in 2011, a nominal market share of 99% was used for E10 with 1% assigned for ethanol-free gasoline for 2011.

For 2020, national default fuel supply was used (i.e., 100% E10 market share).

### 2.4.2 Fuel Formulation

*FuelFormulation(fuelFormulationID,fuelSubtypeID,RVP,sulfurLevel,ETOHVolume,MTBEVolume,ETBEVolume,TAMEVolume,aromaticContent,olefinContent,benzeneContent,e200,e300,BioDieselEsterVolume,CetaneIndex,PAHContent,T50,T90)*

MOVES national default fuel formulations were judged to be reasonable and alternative local data are not readily available. Therefore, national default fuel formulations were used for all source types for both 2011 and 2020.

### 2.4.3 Alternative Vehicle Fuels and Technology

*AVFT(sourceTypeID, modelYearID, fuelTypeID, engTechID, fuelEngFraction)*

AVFT input files in MOVES allow the user to assign source type activity by model year to vehicles with different fuel and/or engine technologies. PVNAA vehicles were modeled using a custom AVFT input file derived from VIN-decoded registration data for Bannock County. For vehicle types not included in the registration data, AVFT files were developed from local data available from the telephone and e-mail surveys shown in Table 5. National default AVFT was used as a supplement when no local data was available.

In 2020, the same vehicle age distribution was assumed to occur as that found in 2011 so vehicle age *zero* was changed from model year 2011 to model year 2020. To match the shift in the age distribution, AVFT for 2020 was similarly shifted.

## 2.5 Meteorology

*ZoneMonthHour(monthID, zoneID, HourID, temperature, relHumidity)*

The meteorology inputs include the average hourly temperature and relative humidity data for PVNAA. The meteorological observation data for 2011 at the Pocatello Regional Airport National Weather Service station, KPIH, obtained from MESOWEST (2012) an on-line data source described by Horel et. al (2002) were used to generate the meteorology input. For any time periods in which KPIH data are missing, data sets from nearby ITD stations, ITD25, and ITD46 (MESOWEST 2012), were used to gap-fill the original data set.

For the future year 2020 projections, the same meteorology input from 2011 was used.

## 2.6 Inspection and Maintenance Programs

*IMCoverage(polProcessID, stateID, countyID, yearID, sourceTypeID, fuelTypeID, IMProgramID, inspectFreq, testStandardsID, begModelYearID, endModelYearID, useIMyn, complianceFactor)*

There are no inspection and maintenance (I/M) programs in place in PVNAA during 2011, and no need for an I/M program is anticipated in the foreseeable future. Thus, no I/M program is designated in the model for both 2011 and 2020.

## 2.7 On-Road Retrofits

*On-roadRetrofits(Pollutant, Process, Fuel, Source, InitialCalendarYear, FinalCalendarYear, InitialModelYear, FinalModelYear, Fraction/Year, FractionEffective)*

Because adequate local data were not available to prepare local on-road retrofit inputs, the PVNAA was modeled without local on-road retrofits.

# 3 Methodology: Paved Road Dust

Fugitive dust from paved and unpaved roads can be a significant source of $PM_{10}$ emissions. Because there are no unpaved roads in PVNAA, unpaved road dust is assumed to be negligible. This section will focus on paved road dust.

In general, the factors that affect paved road dust emissions include the weight of the vehicles that drive on the roadway surface, vehicle speed, fine particle (silt) loading on the roadway surface available for entrainment, and precipitation on the roadway that decreases road dust emissions. A new emission factor equation for paved roads was published in January 2011 by EPA as the agency's recommended method in *AP-42 Compilation of Air Pollutant Emission Factors* (EPA 2011b, section 13.2.1). This section of the report discusses data collection and calculation using the new AP-42 method.

Paved road dust emissions were computed on a daily basis following the most recent AP-42 guidance (EPA 2011b) for emission factor calculation. The emissions for each day type (weekend/weekday), each month and each roadway type are the product of the emission factor and the VMT in each day type, each month, and on each roadway type. Therefore, for each day type, each month, and each roadway type in PVNAA, VMT, road surface silt loading, average weight of the vehicles traveling the road, and the number of hours with at least (0.01 inches) of precipitation must be determined. The following sections discuss these inputs in detail. For the purposes of paved road dust calculations, winter season is defined as November 1–February 29, and the summer or *nonwinter* season is defined as April 1–October 31. The annual emission estimates include all 12 months. Note, road dust categories are computed only for local roads, arterials and freeways; however, VMT are available for the HPMS roadway types. Table 7 shows the roadway type definitions and the crosswalk relationship between the road dust roadways and HPMS roadway types.

**Table 7. Roadway type definitions in road dust calculation.**

| Road Type for Road Dust | Road Type for Road Dust | HPMS Road Type ID | HPMS Road Type |
|---|---|---|---|
| 11 | Rural interstate | 11 | Rural interstate |
| 13 | Rural arterial | 13 | Rural principal arterial |
| | | 15 | Rural minor arterial |
| | | 17 | Rural major collector |
| | | 19 | Rural minor collector |
| 21 | Rural local | 21 | Rural local |
| 23 | Urban interstate | 23 | Urban interstate |
| | | 25 | Urban freeway/ expressway |
| 27 | Urban arterial | 27 | Urban principal arterial |
| | | 29 | Urban minor arterial |
| | | 31 | Urban collector |
| 33 | Urban local | 33 | Urban local |

*Note*: Highway Performance Monitoring System (HPMS)

## 3.1 Vehicle Miles Traveled

The VMT was generated using TDM outputs in conjunction with ITD ATR data to produce VMT for each day type, each month, and each roadway type. The annual VMT totals used in the road dust calculations are the same as those used in the MOVES modeling, summarized in Table 4, section 2.1.1.

## 3.2 Road Dust Emission Factor

Paved road dust emissions were computed on a daily basis using the January 2011 *AP-42 Compilation of Air Pollutant Emission Factors* (EPA 2011b, section 13.2.1, Equation 2), as shown in Equation 4 below. This new version of EPA's road dust methodology is now required for use in SIP and conformity demonstrations. The form of the emission factor equation (Equation 4) accounts for the dust suppression effect of precipitation that occurs during each averaging period.

$$E_{ext} = [\, k\,(sL)^{0.91} \times (W)^{1.02} \,] \times \left(1 - \frac{P}{4N}\right)$$

**Equation 4. Paved road dust emission factor.**

where

$E_{ext}$ = $PM_{10}$ or $PM_{2.5}$ emission factor in the same units as k

k = particle size multiplier (1.0 for $PM_{10}$) (grams/VMT)

sL = road surface silt loading (grams per square meter)

W = average weight of the vehicles traveling the road (tons)

P = number of *wet* days with at least 0.01 inches of precipitation during the averaging period (daily)

N = number of days in the averaging period (e.g., 28, 29, 30, or 31 for monthly)

### 3.2.1 Particle Size Multipliers

The particle size multiplier variable, "k" in Equation 4 is used to define the fraction of total $PM_{10}$ emissions that will be classified as $PM_{2.5}$ emissions; however, it does not influence the total $PM_{10}$ emission quantities. The Treasure Valley Road Dust Study (TVRDS) conducted in 2002 (Etemezian et al. 2002) concluded that 5.7% of the total $PM_{10}$ emissions were in the $PM_{2.5}$ size category. The TVRDS was conducted in Ada and Canyon counties but since the data were collected in Idaho, it is assumed to better reflect reality for Idaho-specific soils and urban areas than the default value (25%) recommended in the guidance (EPA 2011b) and is therefore applied to PVNAA. This is a minor issue for a $PM_{10}$ motor vehicle budget because the $PM_{2.5}$ is less important than the total $PM_{10}$ emission rate upon which the budget is based.

### 3.2.2 Silt Loading

General default silt loadings are available by the average daily traffic (ADT) category in the January 2011 emission factor methodology for paved roads (EPA 2011b). The VMT-weighted silt loading factors are necessary for each roadway type using Equation 5.

$$sL = \sum_{i=1}^{4} a_i \, U_i$$

**Equation 5. VMT-weighted silt loading.**

where

sL = VMT-weighted silt loading factor

i = index from 1 to 4, which represent average daily traffic volume (ADT) categories <500, 500–5,000, 5,000–10,000, and >10,000, respectively

a = Fraction of VMT on roadway in ADT category "i"

U = Ubiquitous baseline silt loading for the summer season or ubiquitous winter baseline silt loading for the winter season, for ADT category "i"

The resulting VMT-weighted silt loadings for both summer and winter season by roadway type are shown in Table 8. These silt loadings were used for both 2011 and 2020 road dust computations.

It should be noted that silt loadings were measured in the Pocatello and Chubbuck area in 1996/1997 (Light 1998) and were used in the 2004 SIP and subsequent conformity determinations since then. However, significant changes in the antiskid treatment have occurred in the PVNAA since 1996 resulting from reduced sand usage and improved road dust sweeping capacity. The differences are generally summarized in Table 9, based on information obtained from the Pocatello and Chubbuck road departments (Randy Ghezzi pers. comm. 2013 and Bryan Hall pers. comm. 2013, respectively). The changes reduced the amount of silt on roadways by using brine pretreatment, estimated to reduce the amount of sand consumption by 50% when used, by replacing some of the sand with road salt, which does not produce silt, and by doubling

the street sweeping capacity in both cities. Significant changes resulted in the 15 years between 1996 and 2011 from the SIP-related road sanding agreements and additional ongoing efforts. DEQ believes the local road silt levels in the PVNAA are lower than they were in 1996/1997 and are better represented by the more explicit new EPA method (EPA 2011b), which used *ubiquitous winter* silt loadings with initial peak antiskid silt loading contributions following storms. Thus, DEQ now uses the new EPA method, which scales up to the number of winter storms and to the traffic level on each roadway to make the current paved road dust emission estimates.

**Table 8. Silt loadings used for paved road emission factor calculation.**

| Road Type | Season | Silt Loading Factor |
|---|---|---|
| Rural interstate | Winter | 0.0740 |
| Rural interstate | Summer | 0.0359 |
| Rural arterial | Winter | 0.6550 |
| Rural arterial | Summer | 0.2030 |
| Rural local | Winter | 2.4 |
| Rural local | Summer | 0.6 |
| Urban interstate | Winter | 0.0554 |
| Urban interstate | Summer | 0.0282 |
| Urban arterial | Winter | 0.1669 |
| Urban arterial | Summer | 0.0713 |
| Urban local | Winter | 2.4 |
| Urban local | Summer | 0.6 |

**Table 9. Antiskid improvements to lower silt loadings in Pocatello and Chubbuck.**

| | 1996 | 2013 |
|---|---|---|
| **Pocatello (Ghezzi pers.comm. 2013)** | | |
| Sand:salt ratio | 15:1 | 4:1 |
| Number of street sweepers | 2 | 4 |
| Salt brine pretreatment | 0 | 33,000 gallons |
| **Chubbuck (Hall pers. comm. 2013)** | | |
| Sand:salt ratio | 5:1 | 3:1 |
| Number of street sweepers | 1 | 2 |
| Salt brine pretreatment | 0 | 30 gallons/lane mile |

### 3.2.3 Average Vehicle Weight by Roadway Type

Average vehicle weight for each roadway type is derived from the vehicle type fraction on each roadway type and average vehicle weight by vehicle type. ITD ATR data were used to determine the vehicle type fractions traveling on each roadway type. The ATR data identify motorcycles, passenger vehicles, and three classes of heavy-duty vehicles by length measurement; however, the FHWA vehicle classification statistics for Idaho by roadway type (Appendix C) are needed to provide greater detail in vehicle classification. The average vehicle weight for each vehicle type was obtained from the MOVES default database (EPA 2011a) as shown in Table 10. Source type descriptions are provided in Table 3.

**Table 10. Average vehicle weight by vehicle type.**

| SourceType ID | HPMS Vtype ID | SourceType Name | Source Mass (Metric Tons) |
|---|---|---|---|
| 11 | 10 | Motorcycle | 0.285 |
| 21 | 20 | Passenger car | 1.479 |
| 31 | 30 | Passenger truck | 1.867 |
| 32 | 30 | Light commercial truck | 2.060 |
| 41 | 40 | Intercity bus | 19.594 |
| 42 | 40 | Transit bus | 16.556 |
| 43 | 40 | School bus | 9.070 |
| 51 | 50 | Refuse truck | 20.684 |
| 52 | 50 | Single unit short-haul truck | 7.642 |
| 53 | 50 | Single unit long-haul truck | 6.250 |
| 54 | 50 | Motor home | 6.735 |
| 61 | 60 | Combination short-haul truck | 29.328 |
| 62 | 60 | Combination long-haul truck | 31.404 |

*Note*: Highway Performance Monitoring System (HPMS)

### 3.2.4 Precipitation Data

The number of days with more than a *trace* of precipitation (≥0.01 inches) is required in the road dust calculation. The precipitation data were gathered from two sources, MESOWEST (MESOWEST 2012) described by Horel et al. (2002) and the Western Regional Climate Center (WRCC 2012). The detailed process used to derived the precipitation data were documented in the 2012 DEQ report, *Development of the 2011 Paved Road Dust Inventory for the National Emission Inventory* (DEQ 2012). Because the majority of the PVNAA resides in Bannock County, the data for Bannock County, based primarily on the Pocatello Airport National Weather Service station were used to represent the PVNAA. The days per month with more than a trace amount of precipitation during 2011 are shown in Table 11. For the future year 2020, the same meteorology inputs were used.

**Table 11. Number of days with greater than 0.01 inches of precipitation for each month in 2011.**

| County | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bannock | 8 | 6 | 16 | 18 | 14 | 9 | 3 | 3 | 2 | 8 | 7 | 4 |

# 4 Results

On-road mobile source and paved road dust emissions estimate results are presented in this section.

## 4.1 On-Road Mobile Source Emission Estimates

On-road mobile source annual emission totals are shown in Table 12. The emission results include estimates for nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), volatile organic compounds (VOC), carbon monoxide (CO), particular matter and ammonia ($NH_3$). The $PM_{10}$ and $PM_{2.5}$

emission estimates in Table 11 include particulate matter from direct exhaust, brake wear, and tire wear and does not include paved road dust.

**Table 12. Annual on-road emissions in PVNAA.**

| Year | $NO_x$ | $SO_2$ | VOC | CO | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
|---|---|---|---|---|---|---|---|
| | (tons per year) | | | | | | |
| 2011 | 1,323 | 4.4 | 876 | 9,529 | 64.8 | 51.4 | 17.9 |
| 2020 | 651 | 4.0 | 495 | 6,643 | 41.0 | 27.6 | 12.7 |

*Notes:* Portneuf Valley Nonattainment Area (PVNAA); nitrogen oxides ($NO_x$); sulfur dioxide ($SO_2$); volatile organic compound (VOC); carbon monoxide (CO); particulate matter with a diameter less than 10 microns ($PM_{10}$); particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$); ammonia ($NH_3$)

## 4.2 Paved Road Dust Emission Estimates

Paved road dust annual emissions for the PVNAA are shown in Table 13.

**Table 13. Annual paved road dust emissions in PVNAA.**

| Year | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|
| | (tons per year) | |
| 2011 | 316.9 | 18.1 |
| 2020 | 337.5 | 19.2 |

*Notes*: particulate matter with a diameter less than 10 microns ($PM_{10}$); particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$)

# 5 Quality Control and Quality Assurance

Quality control was achieved by a quality assurance check of each set of inputs and the final result for both on-road MOVES modeling and paved road dust calculation. In general, each input was checked for internal consistency, compared with Bannock County, where majority of PVNAA resides, and assessed for reasonableness. Input and output data were graphed and analyzed to ensure that the expected vehicle population, roadway activity, and seasonal patterns were obtained and that differences between PVNAA and Bannock County for 2011 and 2020 on inputs and output data sets were understood and justified.

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# Appendix A. Crosswalk between BTPO TDM Road Types, FHWA Roadway Types, and MOVES Roadway Types

| BTPO Road Type ID | BTPO Road Type Descriptions | Area Type | FHWA Road Type Code | FHWA Road Type Description | MOVES Road Type | MOVES Road Type Description |
|---|---|---|---|---|---|---|
| Parked vehicles and extended idle are not included in BTPO or FHWA road types | | | | | 1 | Off Network |
| 6 | Interstate | Rural | 01 | Rural Principal Arterial—Interstate | 2 | Rural Restricted Access |
| 5 | Ramp | Rural | | | | |
| 4 | Principal arterial | Rural | 02 | Rural Principal Arterial—Other | 3 | Rural Unrestricted Access |
| 3 | Minor arterial | Rural | 06 | Rural Minor Arterial | | |
| 2 | Collector | Rural | 07 | Rural Major Collector | | |
| | | Rural | 08 | Rural Minor Collector | | |
| 1 | Local | Rural | 09 | Rural Local | | |
| 0 | Centroid connector | Rural | | | | |
| 6 | Interstate | Urban | 11 | Urban Principal Arterial—Interstate | 4 | Urban Restricted Access |
| 5 | Ramp | Urban | | | | |
| | | Urban | 12 | Urban Principal Arterial—Other Freeways or Expressways | | |
| 4 | Principal arterial | Urban | 14 | Urban Principal Arterial—Other | 5 | Urban Unrestricted Access |
| 3 | Minor arterial | Urban | 16 | Urban Minor Arterial | | |
| 2 | Collector | Urban | 17 | Urban Collector | | |
| 1 | Local | Urban | 19 | Urban Local | | |
| 0 | Centroid connector | Urban | | | | |

# Appendix B. Crosswalk between ATR Length Bins, FHWA Vehicle Classes, and MOVES Source Types

| ATR Length Bin | ATR Length Bin Range | FHWA Vehicle Class | FHWA Vehicle Class Description | MOVES Source Type ID | MOVES Source Types |
|---|---|---|---|---|---|
| 1 | 0–5.9 ft | 1 | Motorcycles | 11 | Motorcycle |
| 2 | 6–22.9 ft | 2 | Passenger Cars | 21 | Passenger Car |
| | | 3 | Other Two-Axle, Four-Tire, Single-Unit Vehicles | 31 | Passenger Truck |
| | | | | 32 | Light Commercial Truck |
| 3 | 23–39.9 ft | 4 | Buses | 41 | Intercity Bus |
| | | | | 42 | Transit Bus |
| | | | | 43 | School Bus |
| | | 5 | Two-Axle, Six-Tire, Single-Unit Trucks | 51 | Refuse Truck |
| | | | | 52 | Single Unit Short-haul Truck |
| | | | | 53 | Single Unit Long-haul Truck |
| | | | | 54 | Motor Home |
| | | 6 | Three-Axle, Single-Unit Trucks | 51 | Refuse Truck |
| | | | | 52 | Single Unit Short-haul Truck |
| | | | | 53 | Single Unit Long-haul Truck |
| | | | | 54 | Motor Home |
| | | 7 | Four-or-More Axle, Single-Unit Trucks | 51 | Refuse Truck |
| | | | | 52 | Single Unit Short-haul Truck |
| | | | | 53 | Single Unit Long-haul Truck |
| | | | | 54 | Motor Home |
| 4 | 40–69.9 ft | 8 | Four-or-Less Axle, Single-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |
| | | 9 | Five-Axle, Single-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |
| | | 10 | Six-or-More Axle, Single-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |
| 5 | >70 ft | 11 | Five-or-Less Axle, Multi-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |
| | | 12 | Six-Axle, Multi-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |
| | | 13 | Seven-or-More Axle, Multi-Trailer Trucks | 61 | Combination Short-haul Truck |
| | | | | 62 | Combination Long-haul Truck |

# Appendix C. ITD Statewide Vehicle Classification Data

CLASSIFICATION DATA 2009 THROUGH 2011
MANUAL AND DIAMOND SCALE
ALL LOCATIONS

15:49 MONDAY, APRIL 16, 2012 1

| PERCENTAGES | SCHEME F CATEGORIES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MTRCYC | CAR | PU/VAN | BUS | 2 AX TRK | 3 AX TRK | 4 OR + AX 1 UNIT | 4 OR - AX TRK/TR-LR | 5 AX TRK/TR-LR | 6 OR + AX TRK/TR-LR | 5 OR - AX MULTI TRLR | 6 AX MULTI TRLR | 7 OR + AX MULTI TRLR |
| FNCT_CD | | | | | | | | | | | | | |
| RURAL INTERSTATE | 0.52 | 33.14 | 31.58 | 0.32 | 4.82 | 0.66 | 0.05 | 3.86 | 17.48 | 3.37 | 0.40 | 0.43 | 3.38 |
| RURAL PRINCIPAL ARTERIAL | 1.88 | 44.08 | 37.27 | 0.48 | 5.99 | 0.84 | 0.07 | 1.80 | 4.74 | 1.87 | 0.08 | 0.08 | 0.83 |
| RURAL MINOR ARTERIAL | 1.44 | 44.01 | 41.17 | 0.22 | 6.36 | 1.41 | 0.07 | 1.26 | 2.05 | 1.29 | 0.09 | 0.04 | 0.59 |
| RURAL MAJOR COLLECTOR | 1.24 | 44.78 | 42.08 | 0.81 | 5.94 | 2.00 | 0.04 | 0.64 | 1.52 | 0.76 | 0.02 | 0.01 | 0.15 |
| RURAL MINOR COLLECTOR | 1.81 | 26.87 | 48.30 | 2.49 | 4.20 | 3.85 | 0.00 | 0.91 | 4.08 | 5.10 | 0.00 | 0.11 | 2.27 |
| LOCAL ROAD | 0.86 | 32.80 | 42.87 | 0.18 | 9.46 | 6.08 | 0.00 | 0.68 | 2.27 | 2.27 | 0.18 | 0.06 | 2.27 |
| URBAN P.A. INTERSTATE | 0.01 | 31.24 | 26.03 | 0.39 | 4.34 | 0.61 | 0.01 | 1.97 | 26.87 | 3.75 | 1.35 | 0.28 | 3.16 |
| URBAN PRINCIPAL ARTERIAL | 2.77 | 52.41 | 36.20 | 0.23 | 4.33 | 1.01 | 0.23 | 1.02 | 0.78 | 0.51 | 0.11 | 0.17 | 0.24 |
| URBAN MINOR ARTERIAL | 0.57 | 56.93 | 36.15 | 0.44 | 3.52 | 0.36 | 0.17 | 0.68 | 0.39 | 0.22 | 0.11 | 0.26 | 0.21 |
| URBAN COLLECTOR | 0.90 | 53.06 | 38.47 | 0.49 | 4.77 | 0.50 | 0.05 | 0.59 | 0.67 | 0.26 | 0.10 | 0.04 | 0.11 |
| LOCAL SYSTEM | 1.11 | 52.61 | 39.70 | 0.00 | 5.94 | 0.00 | 0.00 | 0.40 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 |
| ALL | 1.42 | 47.41 | 37.40 | 0.43 | 5.15 | 0.90 | 0.10 | 1.37 | 3.65 | 1.20 | 0.12 | 0.14 | 0.71 |

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# Appendix B. Procedure for Revising MVEBs for PVNAA to Reflect MOVES and Paved Road Dust Model Changes

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# Procedure for Revising MVEBs for PVNAA to Reflect MOVES and Paved Road Dust Model Changes

## Introduction

The 2004 State Implementation Plan (SIP) for the Portneuf Valley Nonattainment Area (PVNAA) established motor vehicle emission budgets (MVEB) for 2005, 2010, and 2020 (DEQ 2004). The existing MVEBs were developed consistent with the emission inventory and attainment demonstration that showed future compliance with the National Ambient Air Quality Standards (NAAQS) for particulate matter with a diameter less than 10 microns ($PM_{10}$). The existing MVEBs established in the 2003 PVNAA SIP are shown in Table 1.

**Table 1. Existing MVEB established in 2004 PVNAA SIP.**

| Year | $PM_{10}$ (TPY) | $NO_x$ (TPY) | VOC (TPY) |
|---|---|---|---|
| 2005 | 897 | 1,575 | 983 |
| 2010 | 1,120 | 1,085 | 716 |
| 2020 | 1,364 | 514 | 585 |

*Notes*: motor vehicle emission budget (MVEB); Portneuf Valley Nonattainment Area (PVNAA); State Implementation Plan (SIP); particulate matter with a diameter less than 10 microns ($PM_{10}$); tons per year (TPY); nitrogen oxides ($NO_x$); volatile organic compound (VOC)

The existing budgets include on-road mobile emissions computed using MOBILE5, paved road dust emissions computed using the 1995 version of the AP-42 paved road dust emission factor methodology (EPA 1995), and a small amount of unpaved road dust emissions from the few remaining unpaved roads in the area. The United States Environmental Protection Agency (EPA) required the use of Motor Vehicle Emission Simulator (MOVES) (EPA 2009, 2011a) by March 2013 and a revised AP-42 paved road dust methodology (EPA 2011b) by February 2013 for all SIP documents and conformity tests. As a result, the Bannock Transportation Planning Organization (BTPO) is required to conduct their conformity tests using the new methods. To ensure that a model-only change does not cause BTPO to fail the conformity test, the Idaho Department of Environmental Quality (DEQ) is revising the existing SIP MVEBs (DEQ 2004) to reflect changes in the future year emission estimates that result strictly from the changes caused by the model/method used. The revised on-road motor vehicle emissions were developed by DEQ in 2013 using BTPO's latest Travel Demand Model (TDM) and planning assumptions for 2011 and 2020 (DEQ 2013). The purpose of this analysis is to compute revised MVEBs for the period from 2010 to 2020, and for 2020 and beyond to replace the 2004 MVEBs shown in Table 1 and to demonstrate that the revised MVEBs are equivalent to the existing MVEBs in terms of the net $PM_{10}$ projected to be contributed to the airshed, including $PM_{10}$ formed by the reaction of precursor gases, which produce secondary inorganic aerosol and contribute to the total $PM_{10}$ in the airshed. As long as the new MVEBs do not result in greater total $PM_{10}$ contribution to the PVNAA airshed than the existing MVEBs, and the growth factors and control strategy assumptions used in the original SIP future year

projections remain valid, such that the overall conclusions of the SIP attainment demonstration still hold, the other (nonmobile) categories of the emission inventory and demonstration do not need to be revisited (EPA 2012a).

## Development of Revised MOVES and Paved Road Dust Emission Inventory

The on-road mobile emission inventory for the PVNAA was updated for 2011 and 2020 as described by DEQ (2013). Emissions estimates for 2010 were not made, however, because newer information was available for 2011 as a result of the 2011 National Emission Inventory (NEI) project. DEQ used SIP-quality, county-level MOVES inputs (EPA 2012b) for the 2011 NEI so that it would be adequate for SIP documentation purposes. Then in early 2013, DEQ updated the 2011 NEI inputs to reflect activity data from the PVNAA TDM developed by BTPO. As a result, the more recent 2011 emissions will be used to replace the existing 2010 MVEBs because 2010 is no longer of interest, and the more recent model year is more relevant and timely. Nevertheless, the combined growth rate for the two cities in the PVNAA, Chubbuck and Pocatello, from 2010 to 2011 is estimated to be 0.6% (US Census 2013) so the 2010 and 2011 estimates are virtually equivalent in time and population and may be considered interchangeable. The SIP-level MOVES inputs developed for the 2011 NEI include source population data from the Idaho Department of Motor Vehicles, traffic temporal information from permanent automatic traffic recorders and bus and refuse truck local survey information (DEQ 2013). The MOVES modeling results are shown in Table 2 for the milestone years 2011 and 2020. In addition, road dust emissions are shown in Table 3 for the same two years, estimated using the 2011 AP-42 paved road dust emission factor method (EPA 2011b). The 2011 AP-42 method replaced the 1995 AP-42 paved road dust method in January 2011, and EPA required its use for any work after February 2013, so DEQ revised the paved road dust emissions to be consistent with any future conformity test that BTPO conducts. The few remaining unpaved roads that were modeled in the 2004 emission inventory have been paved since 2004 and no unpaved road emissions remain in the PVNAA, so unpaved road emissions are set to zero. MOVES and AP-42 paved road dust $PM_{10}$ emissions are shown in Table 3 along with the total direct $PM_{10}$ emissions from both sources.

**Table 2. On-road mobile source (MOVES) emissions for 2011 and 2020 (DEQ 2013).**

| Year | $NO_x$ | $SO_2$ | VOC | CO | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
|---|---|---|---|---|---|---|---|
| | (tons per year) | | | | | | |
| 2011 | 1,323 | 4.4 | 876 | 9,529 | 64.8 | 51.4 | 17.9 |
| 2020 | 651 | 4 | 495 | 6,643 | 41 | 27.6 | 12.7 |

*Notes:* Motor Vehicle Emission Simulator (MOVES); nitrogen oxides ($NO_x$); sulfur dioxide ($SO_2$); volatile organic compound (VOC); carbon monoxide (CO); particulate matter with a diameter less than 10 microns ($PM_{10}$); particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$); ammonia ($NH_3$)

**Table 3. Paved road dust $PM_{10}$ emissions, MOVES emissions, and total direct $PM_{10}$ emissions for model years 2011 and 2020 (DEQ 2013).**

| Year | Paved Road Dust $PM_{10}$ (TPY) | MOVES $PM_{10}$ (TPY) | Total Direct $PM_{10}$ Emissions |
|---|---|---|---|
| | (tons per year) | (tons per year) | (tons per year) |
| 2011 | 316.9 | 64.8 | 382 |
| 2020 | 337.5 | 41 | 378 |

A direct comparison of the updated MOVES and paved road emissions (DEQ, 2013) with the existing MVEB established in the 2004 SIP is shown in Table 4. The 2011 $PM_{10}$ emission estimates in Table 4 include the direct $PM_{10}$ emissions from MOVES (consisting of exhaust particulate, brake wear and tire wear) combined with $PM_{10}$ from revised paved road dust computations (DEQ, 2013). Only those pollutants that can significantly contribute directly to particulate matter levels in the atmosphere, or indirectly, through photochemical reactions are included in the motor vehicle budgets: Direct $PM_{10}$, nitrogen oxides ($NO_x$) and Volatile Organic Carbon compounds (VOCs). The $NO_x$ and VOCs form ammonium nitrate ($NH_4NO_3$) "*secondary aerosol*" by photochemical reaction in the atmosphere. Ammonia ($NH_3$), another precursor to ammonium nitrate is not included in the motor vehicle emission budget because vehicles exhaust extremely small amounts, and it is so plentiful in the western U.S. atmosphere that it is generally considered always available for reaction and relatively invariant in the atmosphere. In addition, sulfur dioxide ($SO_2$) may contribute to formation of the secondary aerosol ammonium sulfate $(NH_4)_2SO_4$), however motor vehicles produced very little $SO_2$ in 2004 (<1% of the total sulfur dioxide inventory) so it was not included in the 2004 MVEBs. Lower fuel sulfur standards have resulted in even less motor vehicle $SO_2$ since 2004. Carbon monoxide is a gas and plays no significant role in the photochemical production of secondary $PM_{10}$ so it too is not considered further.

In the Table 4 summary, the second column shows the emission estimates revised in 2013 in comparison to the existing MVEB in the third column. The final column shows the difference for each pollutant. Both $NO_x$ and VOC emissions are higher in the 2011 results than the existing MVEBs due to the change in model, while in 2020, only the $NO_x$ emissions are higher; the VOC emissions are slightly lower. In both cases, the total $PM_{10}$ emissions are well below the existing SIP MVEB levels. This large difference results primarily from using the more recent paved road dust estimation method and the newer silt loadings recommended by EPA in the new AP-42 method (EPA, 2011), rather than the 1995 AP-42 method and locally measured silt loadings (Light, 1998) based on measurements made in 1996/1997. Significant changes in road sanding operations occurred beginning in 1995 when road sanding agreements with the local city and county road departments established a much higher level of road dust controls including salt addition to replace portions of the sand, and street sweeping trucks to remove residual road dust after winter storms. DEQ believes those changes in road sanding practices from 1996 to 2011 made the Pocatello area silt loadings comparable to other cities across the nation, a significant benefit of the SIP process. As a result, DEQ believes the recommended nationwide silt loadings in the 2011 AP-42 paved road dust methodology are more representative of the PVNAA roadways than the 1996/1997 silt loading measured by Light (1998) prior to any significant road sanding control measures. These revised silt loadings are more realistic because they

account for the typically higher nationwide road silt associated with normal wintertime road sanding conditions but with silt levels that vary with the amount of traffic (e.g., restricted access interstates have much less silt and local roads have more).

The 2013 revised emissions show some reductions in direct $PM_{10}$ emissions and secondary aerosol precursors (including VOC in 2020) and some increases in secondary aerosol precursors (VOC in 2010 and $NO_x$ in 2010 and 2020). As a result, it was not immediately obvious what the net effect will be on the final airshed concentrations of $PM_{10}$. The following section discusses a conservative approach for reconciling the new emission estimates with the net effect the emissions will have on the airshed, thereby putting the new estimates on a common basis with the existing MVEBs from the 2004 SIP.

**Table 4. Direct comparison of 2013 on-road emission totals with existing SIP MVEB in tons per year (DEQ 2004).**

| | Existing SIP MVEB | 2013 Estimates Based on BTPOs 2011 TDM | Difference, Existing SIP MVEB—2013 Estimates |
|---|---|---|---|
| **Year** | **2010** | **2011[a]** | **2010/2011** |
| $NO_x$ | 1,085 | 1,323 | -238 |
| VOC | 716 | 876 | -160 |
| $PM_{10}$ | 1,120 | 382 | 738 |
| Total | 2,921 | 2,581 | — |
| **Year** | **2020** | **2020** | **2020** |
| $NO_x$ | 514 | 651 | -137 |
| VOC | 585 | 495 | 90 |
| $PM_{10}$ | 1364 | 379 | 986 |
| Total | 2,463 | 1,525 | — |

a. The 2011 year estimates are more up-to-date and therefore are used to replace 2010.
*Notes*: State Implementation Plan (SIP); motor vehicle emission budget (MVEB); Bannock Transportation Planning Organization (BTPO); Travel Demand Model (TDM); nitrogen oxides ($NO_x$); volatile organic compound (VOC); particulate matter with a diameter less than 10 microns ($PM_{10}$);

## Calculation of Net $PM_{10}$

To determine the effect of emission reductions on the $PM_{10}$ concentrations in the PVNAA airshed, the method used to demonstrate attainment in the 2004 SIP must be considered. CALPUFF dispersion modeling with chemical reaction and Speciated Linear Rollback Modeling were used to demonstrate attainment in the 2004 SIP, both based on the assumption that any change in emissions for any single species, either a primary or secondary pollutant, has a directly linear effect on the concentrations of $PM_{10}$ in the airshed. For direct $PM_{10}$ emissions, the effect on $PM_{10}$ concentrations above the regional background level is directly proportional to the relative change in emissions. For the $NO_x$ emissions, the actual effect is uncertain because it depends on the rate of photochemical transformation of $NO_x$ into $NH_4NO_3$, a solid particle less than 10 micrometers in size at wintertime temperatures. However, we can say unequivocally that the *maximum* amount of $PM_{10}$ that can be formed in the atmosphere from each ton of $NO_x$ emissions can be determined based

on stoichiometric calculations reflecting the overall transformation process. A simplified representation of the photochemical process is shown in Equation 1. In this process, it should be noted that (a) only one $NH_4NO_3$ molecule can be formed for each $NO_x$ molecule, (b) ammonia plays a role in forming $NH_4NO_3$ but is not considered further since the atmosphere is rich in $NH_3$ and thus has little effect on the extent or rate of $NH_4NO_3$ formation; and (c) VOCs participate in the chemistry and are essential in determining the overall rate and extent of this transformation; however, carbon does not appear on the right-hand side of the reaction as a part of the $NH_4NO_3$ particulate formed in the atmosphere, and motor vehicle VOCs produce no significant $PM_{10}$ in the atmosphere on their own accord.

$$NO_x + VOCs + NH_3 + \text{solar UV light} \rightarrow NH_4NO_3$$

**Equation 1. Ammonium nitrate formation.**

Since one molecule of $NO_x$ (NO or $NO_2$) forms one molecule of $NH_4NO_3$, the maximum amount of $PM_{10}$ as $NH_4NO_3$ that can be formed from 1 ton of $NO_x$, under any circumstances is therefore determined stoichiometrically by Equation 2:

$$\begin{aligned} \text{Tons of } PM_{10} \text{ as } NH_4NO_3 &= \text{tons } NO_x \times (80/31.6) \\ &= \text{tons } NO_x \times 2.53 \end{aligned}$$

**Equation 2. 100% $NO_x$ to $PM_{10}$ formula.**

Where the ratio (80/31.6) reflects the ratio of molecular weights of $NH_4NO_3$ (80) and $NO_x$ (31.6), assuming the $NO_x$ consists of 90% nitric oxide (NO) and 10% nitrogen dioxide ($NO_2$), the composition of $NO_x$ emissions in the MOVES model, reflecting tail-pipe measurements used by EPA in the formulation of the MOVES model (EPA 2010). Thus, although 100% $NO_x$ conversion to $NH_4NO_3$ does not occur in practice, we can say with absolute certainty that it is not possible for greater than 100% conversion and therefore, adopting it is a conservative assumption. It should be noted that there is also a night-time mechanism for forming nitrate aerosol from $NO_x$ emissions; however, the same rule applies: one $NO_x$ molecule can only produce one $NH_4NO_3$ molecule, and the conversion described in Equation 2 describes the maximum amount of $PM_{10}$ formed as $NH_4NO_3$ regardless of the chemical mechanism involved.

EPA (2008) and others (Boylan and Kim 2012) have estimated the likely atmospheric conversion rates of $NO_x$ to $NH_4NO_3$, since it is of regulatory interest when considering interpollutant trading in nonattainment areas. EPA's initial $PM_{2.5}$ implementation guidance early in the program (EPA 2008) suggested that a 100:1 interpollutant trading ratio (IPTR) (100 tons $NO_x$ to 1 ton $PM_{2.5}$) was appropriate for the western United States; however, EPA withdrew their 2008 suggested IPTRs in 2011 and required that IPTRs must be locally determined using photochemical models (McCarthy 2011). A recent Federal Register notice (FR 41349, July 13, 2011) indicates that EPA proposes to approve a western United States location-specific $NO_x$ to $PM_{2.5}$ IPTR of 9:1 for the San Joaquin Valley of California. This is less than one-third of the $PM_{10}$ formation rate that corresponds to DEQ's 100% conversion assumption (which is effectively equivalent to a 2.53:1 IPTR, in tons $NO_x$:ton $PM_{2.5}$, $PM_{10}$ being equivalent to $PM_{2.5}$ for the purposes of this discussion.) In view of the more realistic conversion rate such as 9:1, DEQ's *100% conversion* bounding assumption is very conservative. Should it become necessary, DEQ would pursue development of a local IPTR for the PVNAA; however, since MVEB equivalency is confirmed assuming 100% conversion, such a significant effort does not currently appear necessary.

The quantity of VOC emissions can affect the actual conversion rate of $NO_x$ to $NH_4NO_3$, as discussed above, however, once we assume that 100% of the $NO_x$ converts instantaneously in the atmosphere to $NH_4NO_3$, then no amount of VOC can have any additional effect in increasing the conversion rate or extent of conversion of $NO_x$ into $NH_4NO_3$ or $PM_{10}$. As a result, the quantity of VOC emissions drops out of the computation for determining the net $PM_{10}$ production. Thus the VOC emission budget will be the MOVES VOC estimate for the appropriate year with the same safety factors applied to the $NO_x$ and $PM_{10}$ budgets.

Based on the above discussion of net $PM_{10}$, the Table 4 comparison of the 2013 emission estimates with the existing MVEB from the 2004 SIP can be rearranged to show the net effects on $PM_{10}$. The rearranged table reflecting net $PM_{10}$ emissions due to both direct $PM_{10}$ emissions and $NO_x$ precursor emissions is shown in Table 5. In Table 5, VOC is not shown and the $NO_x$ emissions have been translated (using Equation 2) into *secondary $PM_{10}$*. Now it is clear, from the *total $PM_{10}$* values, that for both 2011 and 2020 model years, the 2013 $PM_{10}$ estimates are lower than the total $PM_{10}$ associated with the MVEB established by the 2004 PVNAA SIP. Therefore, the model changes implemented in 2013 resulted in lower net $PM_{10}$ in the airshed and are thus approvable as a SIP revision without consideration of the overall emission inventory and without revisiting the attainment demonstration.

**Table 5. Comparison of 2013 on-road emissions with 2004 MVEBs in terms of net $PM_{10}$, including primary and secondary particulate, assuming 100% $NO_x$ conversion.**

| | 2013 Estimates with 100% $NO_x$ Conversion Rate | Existing SIP MVEB with 100% $NO_x$ Conversion Rate | Difference, Existing SIP MVEB—2013 Estimates |
|---|---|---|---|
| **Year** | **2011** | **2010** | **2010/2011** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 3,347 | 2,745 | -602 |
| Primary $PM_{10}$ | 382 | 1,120 | 738 |
| Total $PM_{10}$ | 3,729 | 3,865 | 136 |
| **Year** | **2020** | **2020** | **2020** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 1,647 | 1,300 | -347 |
| Primary $PM_{10}$ | 379 | 1,364 | 986 |
| Total $PM_{10}$ | 2,026 | 2,664 | 639 |

*Notes:* motor vehicle emission budget (MVEB); particulate matter with a diameter less than 10 microns ($PM_{10}$); nitrogen oxides ($NO_x$); volatile organic compound (VOC)

# Safety Factor

The preceding section demonstrates that the revised MVEBs resulting from EPA-mandated changes in the on-road and paved road dust emission models results in lower net $PM_{10}$ in the airshed. However, if the updated emissions estimates were used directly as MVEBs, then any minor model input differences in future conformity tests could potentially cause the Transportation Improvement Program (TIP) emissions estimates to exceed the updated budgets without any actual increase in activity or emissions. To avoid this potential

problem, *safety factors* are typically built into the MVEBs to the extent that can be tolerated while still demonstrating future year NAAQS compliance in the attainment demonstration, or in this case, without exceeding the existing MVEB. Since the existing SIP MVEB is consistent with an overall emission inventory and approved attainment demonstration model showing future year compliance with the NAAQS (DEQ 2004), the revised *model change* MVEBs will remain consistent with the attainment demonstration as long as it does not exceed the effective $PM_{10}$ contributed to the airshed attributed to the existing MVEB. Thus, the small differences shown in Table 5 between the *Existing SIP MVEB* total $PM_{10}$ and the *2013 Estimates* total $PM_{10}$ (136 TPY in 2010 and 639 TPY in 2020) represent *extra* $PM_{10}$ reductions and, therefore, may be used to provide some minimal safety factor in the new MVEBs. The procedure for determining an allowable safety factor that does not cause the new MVEB to exceed the existing MVEB in terms of its net contribution to $PM_{10}$ in the airshed is represented in Table 6 through Table 8. Again it is important to note that the *extra* reductions *converted* to safety factor come only from the lower motor vehicle emission estimates, not from other emission categories, so a reassessment of the nonmotor vehicle emission inventory and the attainment demonstration is not required.

To ensure that the MVEB is protective for any TIP that must be evaluated during the period from 2010 to 2019, it is critical to conservatively select the highest component for each pollutant that occurs in the period (i.e., from either 2010 or 2020). For VOC and $NO_x$, that means that the emissions for 2011 must be used because these two pollutants are highest in 2011 and lowest in 2020. For $PM_{10}$, the selection is not as clear because the MOVES $PM_{10}$ emissions are higher in 2011 (65 TPY) than they are in 2020 (41 TPY), while the road dust emissions are higher in 2020 (338 TPY) than they are in 2011 (317 TPY), as shown in Table 2 and Table 3, respectively. Thus to ensure that the highest projected direct $PM_{10}$ emissions are used in the MVEBs to conservatively represent any year in between the two milestone years, the 2011 MOVES $PM_{10}$ (65 TPY) is added to the 2020 paved road dust $PM_{10}$ (338 TPY) resulting in a hypothetical maximum total direct $PM_{10}$ emission estimate of 403 TPY as shown highlighted in Table 6.

To reexamine the net effect on airshed $PM_{10}$ contributions after identifying the maximum emission levels for the period 2011–2020 (shaded grey in Table 6), we must again assume that 100% of the $NO_x$ may convert to $PM_{10}$ in the form of $NH_4NO_3$ as shown in Table 7. The 2011 *Maximum 2013 Estimates* shown in Table 7, representing the total net $PM_{10}$ emission estimates are again lower than the existing MVEBs, now by 115 tpy, or 3.1% in 2011 and by 639 tpy or 31.5% in 2020. These differences in net $PM_{10}$ emissions may then be translated into "*safety factor*" additions to the estimated emissions without causing the 2013 total $PM_{10}$ estimates to exceed the existing (2004 SIP) MVEB total $PM_{10}$. Thus, the motor vehicle emission projections may be increased by 3.1% in 2011 and 31.5% in 2020. The 2011 safety factor of 3.1% is not normally adequate, but since the first TIP submittal that must demonstrate conformity will be the 2015 TIP, the effective safety factor for that modeling year, by interpolation between 3% and 31.5%, would be approximately 13%, a somewhat more reasonable, yet still narrow margin of safety. Nevertheless, due to other conservative features of this analysis, DEQ is confident that these safety factors will be adequate.

**Table 6. Maximum emissions for the 2011–2020 period.**

| | Maximum 2013 Estimates | Existing SIP MVEB | Difference |
|---|---|---|---|
| **Year** | **2011** | **2010** | **2010/2011** |
| $NO_x$ | 1,323 | 1,085 | -238 |
| VOC | 876 | 716 | -160 |
| $PM_{10}$ | 403 | 1,120 | 717 |
| **Year** | **2020** | **2020** | **2020** |
| $NO_x$ | 651 | 514 | -137 |
| VOC | 495 | 585 | 90 |
| $PM_{10}$ | 379 | 1364 | 986 |

**Table 7. Maximum Net $PM_{10}$ emissions for the 2011–2020 period assuming 100% $NO_x$ conversion.**

| | Maximum 2013 Estimates with 100% Conversion Rate (TPY) | Existing SIP MVEB with 100% Conversion Rate (TPY) | Difference (TPY) |
|---|---|---|---|
| **Year** | **2011** | **2010** | **2010** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 3,347 | 2,745 | -602 |
| Primary $PM_{10}$ | 403 | 1,120 | 717 |
| Total $PM_{10}$ | 3,750 | 3,865 | 115 |
| % Available as Safety Factor | = 115 TPY/3,750 TPY | | = 3.1% |
| **Year** | **2020** | **2020** | **2020** |
| Secondary $PM_{10}$ produced from $NO_x$ and VOC | 1,647 | 1,300 | -347 |
| Primary $PM_{10}$ | 379 | 1,364 | 986 |
| Total $PM_{10}$ | 2,026 | 2,664 | 639 |
| % Available as Safety Factor | = 639 TPY/2,026 TPY | | = 31.5% |

*Notes*: particulate matter with a diameter less than 10 microns ($PM_{10}$); nitrogen oxides ($NO_x$); tons per year (TPY); State Implementation Plan (SIP); motor vehicle emission budget (MVEB); volatile organic compound (VOC)

Finally, the explicit safety factors of 3.1% in 2011 and 31.5% in 2020 are applied to the 2013 emission estimates of Table 6 to provide a *New SIP MVEB* highlighted in Table 8. In this table, the *Maximum 2013 Estimates* in Table 6 were increased, by 3% for 2011 and by 31.5% in 2020, then entered in Table 8 as the *New SIP MVEB*.

**Table 8. New SIP MVEBs including safety factor compared to existing MVEBs.**

| | Existing SIP MVEB | New SIP MVEB | Difference, New MVEB—Existing MVEB |
|---|---|---|---|
| **Year** | **2010** | **2011** | **2010/2011** |
| $NO_x$ | 1,085 | 1,364 | 279 |
| VOC | 716 | 903 | 187 |
| $PM_{10}$ | 1,120 | 415 | -705 |
| **Year** | **2020** | **2020** | **2020** |
| $NO_x$ | 514 | 856 | 342 |
| VOC | 585 | 651 | 66 |
| $PM_{10}$ | 1,364 | 498 | -866 |

*Notes:* State Implementation Plan (SIP); motor vehicle emission budget (MVEB); nitrogen oxides ($NO_x$); volatile organic compound (VOC); particulate matter with a diameter less than 10 microns ($PM_{10}$)

As a final step in the process of setting new MVEBs, the new values are tested to demonstrate that the net effect on the PVNAA airshed $PM_{10}$ levels, after applying the safety factors, will be equivalent to the existing MVEB established in the 2004 SIP. The net $PM_{10}$ is once more computed, assuming 100% conversion of $NO_x$ to $PM_{10}$ as shown in Table 9. Table 9 demonstrates that the total $PM_{10}$ in the *New SIP MVEB* budget for PVNAA is equivalent to the *Existing SIP MVEB* established in the 2004 SIP, as the difference between the two is zero in both 2010/2011 and 2020.

**Table 9. New versus existing SIP MVEBs equivalence check in terms of net $PM_{10}$ contribution to PVNAA.**

| | Existing SIP MVEB | New SIP MVEB | Difference, New MVEB—Existing MVEB |
|---|---|---|---|
| **Year** | **2010** | **2011** | **2010/2011** |
| Secondary $PM_{10}$ produced from $NO_x$ | 2,745 | 3,450 | 705 |
| Primary $PM_{10}$ | 1,120 | 415 | -705 |
| Total $PM_{10}$ | 3,865 | 3,865 | 0 |
| **Year** | **2020** | **2020** | **2020** |
| Secondary $PM_{10}$ produced from $NO_x$ | 1,300 | 2,167 | 866 |
| Primary $PM_{10}$ | 1,364 | 498 | -866 |
| Total $PM_{10}$ | 2,664 | 2,664 | 0 |

*Notes*: State Implementation Plan (SIP); motor vehicle emission budget (MVEB); particulate matter with a diameter less than 10 microns ($PM_{10}$); Portneuf Valley Nonattainment Area (PVNAA); nitrogen oxides ($NO_x$)

## New Motor Vehicle Emission Budget for the Period 2011–2020 and Beyond 2020

The analysis above demonstrates that model changes resulting from the use of the MOVES2010b model and the 2011 paved road dust method results in new MVEBs that are equivalent to the existing MVEBs in terms of $PM_{10}$ contributions to the PVNAA airshed. The resulting MVEB for this period is shown in Table 10. Conformity tests for any TIPs conducted from 2015 through 2019 will be required to meet the budget shown for 2011 (Recall that the 2011 $PM_{10}$ includes the maximum [2011] MOVES emissions plus the maximum (2020) paved road dust emissions). Any TIP conducted in 2020 and beyond will be required to meet the budget shown for 2020.

**Table 10. New motor vehicle emission budgets for the PVNAA.**

| Year | $PM_{10}$ (TPY) | $NO_x$ (TPY) | VOC (TPY) |
|---|---|---|---|
| 2005 | N/A | N/A | N/A |
| 2011 | 415 | 1,364 | 903 |
| 2020 | 498 | 856 | 651 |

*Notes*: Portneuf Valley Nonattainment Area (PVNAA); particulate matter with a diameter less than 10 microns ($PM_{10}$); tons per year (TPY); nitrogen oxides ($NO_x$); volatile organic compound (VOC); not applicable (N/A)

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# Appendix C. 2004 SIP Emission Inventory with Updated On-road Mobile Emissions

**Table 1. SIP 2004 emission Inventory with updated on-road mobile emissions (shaded).**

| Source Category | Original Emissions (DEQ 2004)[a] | | | Updated Emissions (DEQ 2013)[b] | | |
|---|---|---|---|---|---|---|
| | MOBILE5 & 1995 Paved Road Dust | | | MOVES & 2011 Paved Road Dust | | |
| **2000 EI** | **$PM_{10}$** | **VOC** | **$NO_x$** | **$PM_{10}$** | **VOC** | **$NO_x$** |
| Point | 640.8 | 230.3 | 924.9 | Not updated | | |
| Area | 980.3 | 1,610.1 | 181.9 | | | |
| Non-road | 41.4 | 255.4 | 823.0 | | | |
| On-Road Mobile | 768.6 | 1,186.7 | 1,677.8 | | | |
| **Total** | **2,431.0** | **3,282.4** | **3,607.4** | | | |
| **2005 EI** | **MOBILE5 & 1995 Paved Road Dust** | | | | | |
| Point | 622.2 | 106.4 | 538.3 | Not updated | | |
| Area | 1,006.2 | 1,683.2 | 191.8 | | | |
| Non-road | 41.1 | 217.5 | 680.7 | | | |
| On-Road Mobile | 904.4 | 890.0 | 1,380.2 | | | |
| **Total** | **2,573.8** | **2,897.0** | **2,791.0** | | | |
| **2010 EI** | **MOBILE5 & 1995 Paved Road Dust** | | | **MOVES & 2011 Paved Road Dust** | | |
| Point | 622.3 | 106.4 | 538.3 | 622.3 | 106.4 | 538.3 |
| Area | 1032.0 | 1756.3 | 201.7 | 1,032.0 | 1,756.3 | 201.7 |
| Non-road | 40.4 | 183.0 | 596.4 | 40.4 | 183.0 | 596.4 |
| On-Road Mobile | 1019.0 | 629.9 | 964.5 | 381.7 | 876.0 | 1,323.0 |
| **Total** | **2713.7** | **2675.5** | **2300.8** | **2,076.4** | **2,921.6** | **2,659.4** |
| **2015 EI** | **MOBILE5 & 1995 Paved Road Dust** | | | | | |
| Point | 622.2 | 106.4 | 538.3 | Not updated | | |
| Area | 1,057.9 | 1,829.4 | 211.6 | | | |
| Non-road | 42.2 | 184.5 | 578.5 | | | |
| On-Road Mobile | 1,138.5 | 480.8 | 618.6 | | | |
| **Total** | **2,860.8** | **2,601.1** | **1,947.0** | | | |
| **2020 EI** | **MOBILE5 & 1995 Paved Road Dust** | | | **MOVES & 2011 Paved Road Dust** | | |
| Point | 622.2 | 106.4 | 538.3 | 622.2 | 106.4 | 538.3 |
| Area | 1,089.8 | 1,902.5 | 221.5 | 1,089.8 | 1,902.5 | 221.5 |
| Non-road | 44.5 | 195.7 | 579.4 | 44.5 | 195.7 | 579.4 |
| On-Road Mobile | 1,258.8 | 415.3 | 452.7 | 378.5 | 495.0 | 651.0 |
| **Total** | **3,015.4** | **2,619.9** | **1,792.0** | **2,135.0** | **2,699.6** | **1,990.2** |

*Notes*:
State Implementation Plan (SIP); Motor Vehicle Emission Simulator (MOVES); emission inventory (EI); particulate matter with a diameter less than 10 microns ($PM_{10}$); volatile organic compound (VOC); nitrogen oxides ($NO_x$)
a. DEQ (Idaho Department of Environmental Quality). 2004. *Portneuf Valley $PM_{10}$ Nonattainment Area State Implementation Plan, Maintenance Plan and Redesignation Request.* Pocatello, ID: DEQ.
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