2020 National Emissions Inventory Technical Support Document: Dust – Construction -Road

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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC

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22.1 Sector Descriptions and Overview

Construction dust refers to residential and non-residential construction activity, which are functions of acreage disturbed for construction. This sector will be divided below when describing the calculation of EPA's emissions. Table 22-1 lists the nonpoint SCCs associated with this sector in the 2020 NEI. The SCC level 1 and 2 descriptions is "Industrial Processes; Construction: SIC 15 - 17" for all SCCs.

Table 22-1: SCCs in the Construction Dust sector

SCC	SCC Level Three	SCC Level Four
2311010000	Residential	Total
2311020000	Industrial/Commercial/Institutional	Total
2311030000	Road Construction	Total

22.2 EPA-developed estimates

The calculations for estimating the emissions from road construction involve first estimating the acres disturbed from new road constructed in each county. The amount of state-level road construction spending by road type is available from the Federal Highway Administration (FHWA) and is converted to acreage disturbed using conversion factors from the Florida Department of Transportation (FLDOT). The state-level acreage disturbed by road type is summed together and distributed to the counties based on the proportion of building starts in each county. Emissions factors for PM10 and PM25 are calculated based on precipitation-evaporation values and dry silt content in each county. The total amount of acres disturbed is multiplied by these emissions factors to estimate emissions of PM from road construction.

22.2.1 Activity data

The activity data for this source category is the acreage disturbed from new road construction, which is estimated using data from FHWA's *Highway Statistics, State Highway Agency Capital Outlay, Table SF-12A* [ref 1] and FLDOT's *Generic Cost per Mile Models* [ref 2]. From the FHWA table, the following construction types are used: New Construction, Relocation, Added Capacity, Major Widening, and Minor Widening. Each of the following road types have spending broken out for each construction type:

1. Interstate, urban
2. Interstate, rural
3. Other arterial, urban
4. Other arterial, rural
5. Collectors, urban
6. Collectors, rural

Construction spending for each road type is summed across all construction types to determine the total annual highway spending for each road type.

$$HS_{s,r} = \sum_{ct} S_{s,r} \quad (1)$$

Where:

$HS_{s,r}$ = Annual highway spending for road type *r* in state *s*, in dollars
ct = Construction type
$S_{s,r}$ = Annual spending per construction type in state *s* for road type *r*, in dollars

State expenditure data are converted to miles of new road and acres disturbed per mile of new road by applying conversions based on data obtained from FLDOT. The conversions are shown in Table 22-2, and the acres disturbed per mile conversions are calculated by multiplying the FLDOT's total affected roadway width (including all lanes, shoulders, and areas affected beyond the road width) in feet by the number of feet in a mile and converting the resulting land area from ft^2 to acres [ref 2]. Total affected roadway with is the sum of the numbers of lanes (assumed at 12 feet each), number of shoulders, and area affected beyond the road width (25 feet). There are 5,280 feet in a mile, and 43,560 ft^2 in an acre.

$$RC_{m,s,r} = \frac{HS_{s,r}}{TDM} \quad (2)$$

$$RC_{a,s,r} = RC_{m,s,r} \times ADM \quad (3)$$

Where:

$RC_{m,s,r}$ = Miles of FHWA road type *r* constructed in state *s*
$RC_{a,s,r}$ = Acres of land disturbed for construction of FHWA road type *r* in state *s*
$HS_{s,r}$ = Annual highway spending for road type *r* in state *s*
TDM = Conversion of dollars spent to road miles constructed, in thousand dollars per mile
ADM = Conversion of road miles constructed to acres disturbed, in acres per mile

Table 22-2: Spending per mile and acres disturbed per mile by highway type

Road Type	Thousand Dollars per mile	Total Affected Roadway Width (ft)*	Acres Disturbed per mile
Urban Areas, Interstate	9,636	94	11.4
Rural Areas, Interstate	4,796	89	10.8
Urban Areas, Other Arterials	4,829	63	7.6
Rural Areas, Other Arterials	2,643	55	6.6
Urban Areas, Collectors	4,829	63	7.6
Rural Areas, Collectors	2,643	55	6.6

The acres of land disturbed by road type can then be summed across all road types in a state to calculate the total state-level acreage disturbed due to new road construction.

$$A_s = \sum_{r} RC_{a,s} \quad (4)$$

Where:

A_s = Acres of land disturbed for all road construction in state *s*
$RC_{a,s}$ = Acres of land disturbed for construction of FHWA road type *r* in state *s*

The process used to distribute the state-level amount of acreage disturbed to the counties is discussed in the next section.

22.2.2 Allocation procedure

Building permits data, used as a surrogate for road construction activity, from the U.S. Census Bureau are used to allocate the state-level acres disturbed by road construction to the county-level [ref 3]. Specifically, the ratio of the county-to state-level number of building starts is calculated and multiplied by the state-level acreage disturbed (from equation 4) to estimate the county-level acreage disturbed by road construction.

$$BFrac_c = \frac{Build_c}{Build_s} \quad (5)$$

$$A_c = A_s \times BFrac_c \quad (6)$$

Where:

$BFrac_c$ = The fraction of building starts in county*c*
$Build_c$ = The number of building starts in county *c*
$Build_s$ = The number of building starts in state *s*
A_c = Acres of land disturbed for road construction in county *c*
A_s = Acres of land disturbed for all road construction in state *s*

22.2.3 Emission factors

Due to regional variances in soil moisture and silt content, uncontrolled emissions factors for PM10 and PM25 are adjusted for each county. The initial uncontrolled PM10 emissions factor from construction of roads is 0.42 tons/acre-month [ref 4]. This emission factor represents the large amount of dirt moved during the construction of roadways, reflecting the high level of cut and fill activity that occurs at road construction sites.

To account for the soil moisture level, the uncontrolled PM10 emissions are weighted using the 30-year average precipitation-evaporation (PE) values from Thornthwaite's PE Index. Average precipitation evaporation values for each state are estimated based on PE values for specific climatic divisions within a state [ref 4]. The average PE value for the test sites from which the PM10 emissions factor was developed is 24. Equation 7 adjusts the county-level uncontrolled emissions factor based on this PE value.

To account for the silt content, the uncontrolled PM10 emissions are weighted using average silt content for each county. EPA uses the National Cooperative Soil Survey Microsoft Access Soil Characterization Database to develop county-level, average silt content values for surface soil [ref 5]. The U.S. Department of Agriculture and the National Cooperative Soil Survey define silt content of surface soil as the percentage of particles (mass basis) of diameter smaller than 50 micrometers (µm) found in the surface soil. Note that this definition is different than the U.S. Environmental Protection Agency's definition that includes all particles (mass basis) of diameter smaller than 75 micrometers. This

database contains the most commonly requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities. The average silt content for the test sites from which the PM10 emissions factor was developed is 9%. Equation 7 adjusts the county-level uncontrolled emissions factor based on this silt content value.

$$UEF_{PM10,c} = EF_{PM10} \times \frac{24}{PE_s} \times \frac{S_c}{9\%} \quad (7)$$

Where:

$UEF_{PM10,c}$ = Uncontrolled PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month
EF_{PM10} = Initial PM_{10} emissions for road construction, 0.42 tons/acre-month
PE_s = Precipitation-evaporation value for state *s*
S_c = Percent dry silt content in soil for county *c*

Once uncontrolled PM_{10} adjustments have been made, uncontrolled $PM_{2.5}$ emissions are set to 10% of PM_{10}.

$$UEF_{PM25,c} = 0.10 \times UEF_{PM10,c} \quad (8)$$

Where:

U$EF_{PM10,c}$ = Uncontrolled PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month
$UEF_{PM25,c}$ = Uncontrolled $PM_{2.5}$ emission factor corrected for soil moisture and silt content in county *c,* in tons/acre-month

Primary PM emissions are equal to filterable emissions as there are no condensible dust emissions from road construction. Emission factors for these sources are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site.

22.2.4 Controls

Dust emissions from road construction are generally controlled by watering the construction site. The Midwest Research Institute recommends using a control efficiency of 50% for PM10 and PM25 emissions from road construction [ref 4].

$$EF_{P,c} = 0.50 \times UEF_{p,c} \quad (9)$$

Where:

$EF_{p,c}$ = Controlled emissions factor of pollutant *p* in county *c*
$UEF_{p,c}$ = Uncontrolled emissions factor of pollutant *p* in county *c*

22.2.5 Emissions

The total annual dust emissions from road construction in each county are multiplied by the emissions factors calculated in equation 9. The duration of construction activity for road construction is assumed to be 12 months.

$$E_{p,c} = A_c \times EF_{p,c} \times M \quad (10)$$

Where:

$E_{p,c}$ = Annual emissions of pollutant *p* in county *c*
A_c = Acres of land disturbed for road construction in county *c*
$EF_{PM10,c}$ = Controlled PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month
$EF_{PM25,c}$ = Controlled $PM_{2.5}$ emission factor corrected for soil moisture and silt content in county *c,* in tons/acre-month
M = Duration of construction activity in months

22.2.6 Sample calculations

Table 22-3 lists sample calculations to determine the dust emissions from road construction. The values in these equations are demonstrating program logic and are not representative of any specific NEI year or county.

Table 22-3: Sample calculations for urban interstate, urban other arterial, and urban collector road construction

Eq. #	Equation	Values	Result
1	$HS_{s,r} = \sum_{ct} S_{s,r}$	$\$1{,}000 + \$9{,}155{,}000$	\$9,156,000 spent on urban interstate construction
		$\$1{,}276{,}000 + \$2{,}471{,}000$	\$3,747,000 spent on urban other arterial construction
		$\$2{,}583{,}000$	\$2,583,000 spent on urban collector construction
2	$RC_{m,s,r} = \frac{HS_{s,r}}{TDM}$	$\frac{\$9{,}156{,}000}{6{,}895{,}000\ \$\ per\ mile}$	1.328 miles of urban interstate constructed
		$\frac{\$3{,}747{,}000}{4{,}112{,}000\ \$\ per\ mile}$	0.911 miles of urban other arterial constructed
		$\frac{\$2{,}683{,}000}{4{,}112{,}000\ \$\ per\ mile}$	0.628 miles of urban collector constructed
3	$RC_{a,s,r} = RC_{m,s,r} \times ADM$	$1.328\ miles \times 11.4\ acres\ per\ mile =$	15.1 acres disturbed from urban interstate construction

Eq. #	Equation	Values	Result
		$0.911\ miles \times 7.6\ acres\ per\ mile$	6.9 acres disturbed from urban other arterial construction
		$0.628\ miles \times 7.6\ acres\ per\ mile$	4.8 acres disturbed from urban collector construction
4	$A_s = \sum_r RC_{a,s}$	$15.1\ acres + 6.9\ acres + 4.8\ acres$	26.78 acres disturbed from urban road construction
5	$BFrac_c = \frac{Build_c}{Build_s}$	$\frac{185\ building\ starts\ in\ county}{952\ building\ starts\ in\ state}$	0.194 fraction of building starts
6	$A_c = A_s \times BFrac_c$	$26.78\ acres \times 0.194$	5.20 acres disturbed from urban road construction
7	$UEF_{PM10,c} = EF_{PM10} \times \frac{24}{PE_s} \times \frac{S_c}{9\%}$	$0.42\ tons/acre - month \times \frac{24}{132} \times \frac{41{,}45\%}{9\%}$	0.3517 tons per acre-month uncontrolled PM10 emissions from road construction
8	$UEF_{PM25,c} = 0.10 \times UEF_{PM10,c}$	$0.10 \times 0.3517\ tons/acre - month$	0.0352 tons per acre-month PM25 emissions from road construction
9	$EF_{P,c} = 0.50 \times UEF_{p,c}$	$0.50 \times 0.3514\ tons\ per\ acre - month$	0.1758 tons per care-month controlled PM10 emissions from new road construction
		$0.50 \times 0.0352\ tons\ per\ acre - month$	0.0176 tons per care-month controlled PM25 emissions from new road construction
10	$E_{p,c} = A_c \times EF_{p,c} \times M$	$5.2\ acres \times 0.1758\ tons/acre - month \times 12$	10.98 tons PM10 from urban road construction
		$5.2\ acres \times 0.0176\ tons/acre - month \times 12$	1.98 tons PM25 from urban road construction

22.2.7 Improvements/Changes in the 2020 NEI

No changes were made to methods for the 2020 NEI. Activity data was updated to reflect best available data for the NEI cycle.

22.2.8 Puerto Rico and Virgin Islands

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

22.3 References

1. Federal Highway Administration. Table SF-12A, State Highway Agency Capital Outlay -2020.
2. Florida Department of Transportation. Generic Cost per Mile Models for 2020
3. U.S. Census Bureau. 2015. Annual Housing Units Authorized by Building Permits. ASCII files by State, MSA, County or Place, co2020a.
4. Midwest Research Institute. 1996. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District.
5. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database.
6. Midwest Research Institute. 1999. Estimating Particulate Matter Emissions from Construction Operations, Final Report, Section 5.7.1. prepared for the Emission Factor and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency.

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