# Residential Construction

***a. Source Category Description***

Emissions from residential construction activity are a function of the acreage disturbed and volume of soil excavated for residential construction. Residential construction activity is developed from data obtained from the U.S. Department of Commerce (DOC)’s Bureau of the Census.

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Source Classification Code** | **SCC Level One** | **SCC Level Two** | **SCC Level Three** | **SCC Level Four** |
| 2311010000 | Industrial Processes | Construction: SIC 15 - 17 | General Building Construction | Total |

## b. Activity Data

There are two activity calculations performed for this SCC, acres of surface soil disturbed and volume of soil removed for basements.

### *b.1. Surface soil disturbed*

The US Census Bureau has 2014 data for *New Privately Owned Housing Units Started by Purpose and Design1* which provides regional level housing starts based on the groupings of 1 unit, 2-4 units, 5 or more units. A consultation with the Census Bureau in 2002 gave a breakdown of approximately 1/3 of the housing starts being for 2 unit structures, and 2/3 being for 3 and 4 unit structures. The 2-4 unit category was then divided into 2-units, and 3-4 units based on this ratio.

*New Privately Owned Housing Units Authorized Unadjusted Units*2 gives a conversion factor to determine the ratio of structures to units in the 5 or more unit category. For example if a county has one 40 unit apartment building, the ratio would be 40/1. If there are 5 different 8 unit buildings in the same project, the ratio would be 40/5. Structures started by category are then calculated at a regional level.

Annual county building permit data were purchased from the US Census Bureau for 2014.3 The 2014 County Level Residential Building Permit dataset has 2014 data to allocate regional housing starts to the county level. This results in county level housing starts by number of units. The following surface areas were assumed disturbed for each unit type:

### ****Table 1: Surface Soil removed per unit type****

|  |  |
| --- | --- |
| 1-Unit | 1/4 acre/structure |
| 2-Unit | 1/3 acre/structure |
| Apartment | 1/2 acre/structure |

The 3-4 unit category was considered to be an apartment. Multiplication of housing starts to soil removed results in number of acres disturbed for each unit category.

### *b.2. Basement soil removal*

To calculate basement soil removal, the 2014 *Characteristics of New Single-Family Houses Completed, Foundation table4* is used to estimate the percentage of 1 unit structures that have a basement (on the regional level). The county level estimate of number of 1 unit starts is multiplied by the percent of 1 unit houses in the region that have a basement to get the number of basements in a county. Basement volume is calculated by assuming a 2000 square foot house has a basement dug to a depth of 8 feet (making 16,000 ft3 per basement). An additional 10% is added for peripheral dirt bringing the total to 17,600 ft3 (651.85yd3) per basement.

## c. Emission Factors

Initial PM10 emissions from construction of single family, two family, and apartments structures are calculated using the emission factors given in Table 2. The duration of construction activity for houses is assumed to be 6 months and the duration of construction for apartments is assumed to be 12 months.

**Table 2. Emission Factors for Residential Construction5**

|  |  |  |
| --- | --- | --- |
| **Type of Structure** | **Emission Factor** | **Duration of Construction** |
| Apartments | 0.11 tons PM10/acre-month | 12 months |
| 2-Unit Structures | 0.032 tons PM10/acre-month | 6 months |
| 1-unit Structures with Basements | 0.011 tons PM10/acre-month | 6 months |
| 0.059 tons PM10/1000 cubic yards |
| 1-Unit Structures w/o Basements | 0.032 tons PM10/acre-month | 6 months |

Regional variances in construction emissions are corrected using soil moisture level and silt content. These correction parameters are applied to initial PM10 emissions from residential construction to develop the final emissions inventory.

To account for the soil moisture level, the 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 were estimated based on PE values for specific climatic divisions within a State.

To account for the silt content, the PM10 emissions are weighted using average silt content for each county. EPA used the National Cooperative Soil Survey Microsoft Access Soil Characterization Database to develop county-level, average silt content values for surface soil.6 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 equation for PM10 emissions corrected for soil moisture and silt content is:

where: Corrected EPM10 = PM10 emissions corrected for soil moisture and silt content,

PE = precipitation-evaporation value for each State,

S = % dry silt content in soil for area being inventoried.

Once PM10 adjustments have been made, PM2.5-FIL emissions are estimated by applying a particle size multiplier of 0.10 to PM10-FIL emissions.7 Primary PM emissions are equal to filterable emissions since there are no condensible emissions from residential construction.

## d. Example Calculation

PM10 Emissions = ∑( Aunit x Tconstruction x EFunit ) x AdjPM

Where Aunit = HSUnit x SMUnit

HSUnit = Regional Housing Starts x (county building permits/Regional building permits)

SMUnit = Area or volume of soil moved for the given unit type

TConstruction = Construction time (in months) for given unit type

EFUnit = Unadjusted emission factor for PM10 for the givenunit type

AdjPM = PM Adjustment factor

As an example, in Beaufort County, North Carolina, 2010 acres disturbed and PM10 emissions from 1-unit housing starts without a basement are calculated as follows:

Aunit  = 345,000 x (142/343,036) x 0.921(Fraction without basement) \* 0.25 acres/unit

= 131.53 units \* 0.25 acres/unit = 32.9 acres

AdjPM = (24/110.1) \* (39.58/9) = 0.958

PM10 Emissions = (32.9 acres x 6 months x 0.032 tons PM10/acre-month) x 0.958 = 6.05 tons

## e. Updates to 2011 Methodology

## The housing starts and soil removed were updated using the latest data from the U.S. Census Bureau. The county-level silt values were updated and are now based on soil sampling data contained in the National Cooperative Soil Survey Microsoft Access Soil Characterization Database.

***f. Puerto Rico and US Virgin Islands Emissions Calculations***

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”.

## g. References

1. U.S. Census Bureau, New Privately Owned Housing Units Started by Purpose and Design in 2014, from <http://www.census.gov/construction/nrc/pdf/quarterly_starts_completions.pdf> (accessed September 2015).
2. U.S. Census Bureau, New Privately Owned Housing Units Authorized - Unadjusted Units for Regions, Divisions, and States, Annual 2010, Table 2au. From <https://www.census.gov/construction/bps/txt/tb2u2014.txt> (accessed September 2015).
3. U.S. Census Bureau, Annual Housing Units Authorized by Building Permits CO2014A, purchased September 2015.
4. U.S. Census Bureau, Type of Foundation in New One-Family Houses Completed, from <http://www.census.gov/construction/chars/completed.html> (accessed September 2015).
5. Midwest Research Institute. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District. March 29, 1996.
6. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database, from <http://ncsslabdatamart.sc.egov.usda.gov/> (accessed September 2015).
7. "Proposed Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors," C. Cowherd, J. Donaldson and R. Hegarty, Midwest Research Institute; D. Ono, Great Basin UAPCD. From <http://www.epa.gov/ttn/chief/conference/ei15/session14/cowherd.pdf> (accessed September 2015).