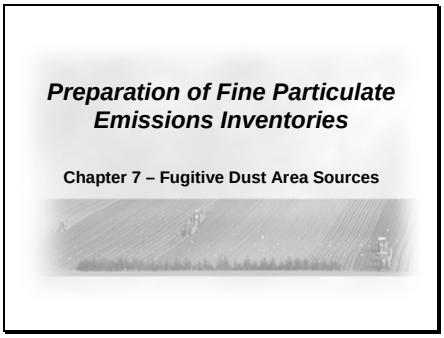
Chapter 7 – Fugitive Dust Area Sources

7 - 1



After this lesson, participants will be able to identify fugitive dust emissions from the following area sources:

- agricultural tilling,
- paved roads,
- unpaved roads, and
- residential, commercial, and road construction activities.

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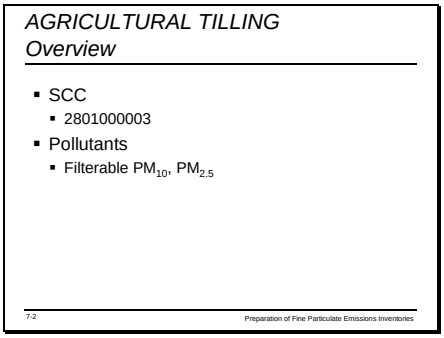

The SCC that is contained in the National Emissions Inventory for agricultural tilling emissions is 2801000003.

For this category the NEI contains estimates of filterable PM_{10} and $PM_{2.5}$. There are no condensibles associated with this category.

7 - 3

AGRICULTURAL TILLING
NEI Method

- Activity Data (no. of acres of land tilled)
  - 1998 County-Level Activity Data
    - Acres of crops tilled in each county by crop type and by tilling method obtained from CTIC
    - Five tilling methods include:
      - no till
      - mulch till
      - ridge till
      - 0 to 15 percent residue
      - 15 to 30 percent residue

7-3 Preparation of Fine Particulate Emissions Inventories

The activity data for the NEI was obtained from the Conservation Technology Information Center, which publishes a national crop residue management survey every two years that contains county level activity data.

The NEI used 1988 survey data. This database provides acres of crops tilled in each county by crop type and by tilling method.

The five tilling methods included in the database are listed here.

7 - 4

AGRICULTURAL TILLING
NEI Method (cont.)

- Emission Factor (mass of TSP per acre tilled)
  - Emission factor comprises:
    - Constant of 4.8 lbs/acre pass
    - Silt content of the surface soil
    - Number of tillings per year (conservation and conventional use)
    - Particle size multiplier for PM_{10} and $PM_{2.5}$

7-4 Preparation of Fine Particulate Emissions Inventories

The emission factor in the NEI is expressed as the mass of the total suspended particulate per acre tilled.

The emission factor comprises:

- a constant of 4.8 pounds per acre pass of PM
- the silt content of the surface soil
- the number of tillings per year (separated into conservation and conventional use)
- the particle size multiplier to calculate the PM_{10} or the $PM_{2.5}$ from the PM emissions

7 - 5

AGRICULTURAL TILLING
NEI Method (cont.)

- Emission Factor (cont.)
  - Silt content

Soil Type	Silt Content (%)
Silt Loam	52
Sandy Loam	33
Sand	12
Loamy Sand	12
Clay	29
Clay Loam	29
Organic Material	10-82
Loam	40

  - Soil types assigned to counties by comparing USDA surface soil and county maps

7-5 Preparation of Fine Particulate Emissions Inventories

The silt content values that are used for various soil types in the NEI are listed here.

These soil types are assigned to counties by using the USDA surface soil and county level maps to match the soil types to counties.

7 - 6

AGRICULTURAL TILLING
NEI Method (cont.)

- Emission Factor (cont.)
  - Number of Tillings

Crop	Conservation Use	Conventional Use
Corn	2	6
Spring Wheat	1	4
Rice	5	5
Fall-Seeded Small Grain	3	5
Soybeans	1	6
Cotton	5	8
Sorghum	1	6
Forage	3	3
Permanent Pasture	1	1
Other Crops	3	3
Fallow	1	1

7-6 Preparation of Fine Particulate Emissions Inventories

This chart shows the number of tillings that are assumed by crop type for both conservation and conventional use.

The no till, mulch till, and ridge till methods come from the county level inventory from the CTIC and are grouped into the conservation use category.

The acres reported for the zero to 15 percent residue and the 15 to 30 residue are grouped into the conventional use category.

As the data demonstrate, the conventional use category has more tilling passes per acre than the conservation use.

7 - 7

AGRICULTURAL TILLING
NEI Method (cont.)

- Emission Calculation

$$E = c * k * s^{0.6} * p * a$$

where: E = PM emissions, lbs per year
c = constant 4.8 lbs/acre-pass
k = dimensionless particle size multiplier (PM_{10}= 0.21; $PM_{2.5}$ = 0.042)
s = silt content of surface soil, defined as the mass fraction of particles smaller than 75 µm diameter found in soil to a depth of 10 cm (%)
p = number of passes or tillings in a year
a = acres of land tilled

7-7 Preparation of Fine Particulate Emissions Inventories

This equation is used in the NEI for calculating total PM emissions from agricultural tilling operations.

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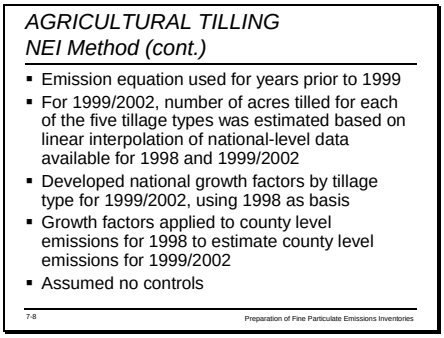


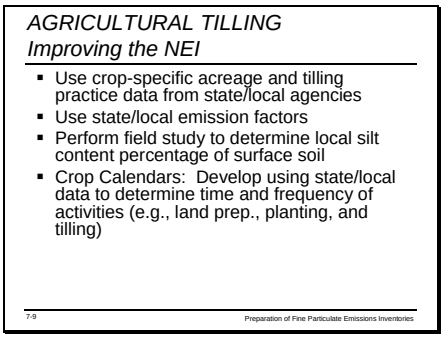
The equation in the previous slide has been used to estimate PM emissions from agricultural operations in the NEI prior to 1999.

Since 1999 the number of acres tilled for each of the five tillage types has been estimated based on a linear interpolation of national level data available for 1998, 1999 and 2002.

Using 1998 as the basis, national growth factors were developed by tillage type for 1998, 1999 and 2002. These growth factors were applied to county level emissions for 1998 to estimate county level emissions for 1999 and 2002.

Note that the NEI emission calculation assumed no controls.

7 - 9



One way to improve upon the NEI method is to use crop-specific acreage and tilling practice data from the state or local agency or tribal authority. In addition, if state or local emission factors exist, they should be used.

Another improvement is to perform a field study to determine the local silt content percentage of the surface soil.

Silt values used in the NEI are based on limited data and represent averages for the entire country

Local or state conditions may exist that warrant improving NEI values

Finally, the development of crop calendars to determine the time and frequency of the activities will be an improvement over the NEI data.

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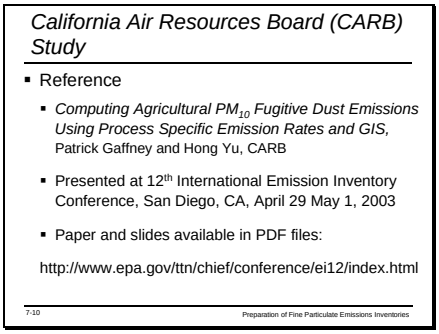

This discussion is based on the report "Computing Agricultural PM_{10} Fugitive Dust Emissions Using Process Specific Rates and GIS" by Patrick Gaffney and Hong Yu. The study was presented at the National Emissions Inventory Conference in San Diego during April 2003.

The paper and slides can be download from the CHIEF web site.

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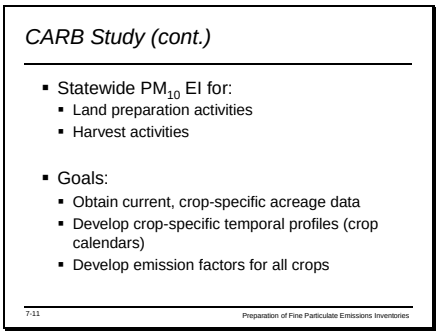
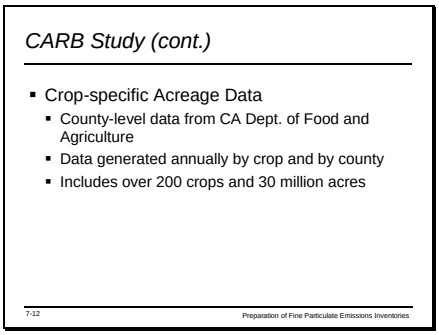


The California Air Resources Board prepared a statewide PM_{10} inventory for land preparation activities and harvest activities at the county level.

The goals were to:

- obtain current crop-specific acreage data
- develop crop-specific temporal profiles or crop calendars, and
- develop emission factors for all crops

7 - 12



In developing the inventory CARB obtained county level crop-specific acreage data from the California Department of Food and Agriculture.

This department generates the crop data every year by county, and it includes over 200 crops and 30 million acres.

7 - 13

CARB Study (cont.)

- Crop Calendars
  - Developed for 20 most important crop types
    - Importance based on acreage and potential emissions
  - Define temporal periods of farming operation activities by crop type

7-13 Preparation of Fine Particulate Emissions Inventories

CARB also developed crop calendars for the 20 most important crop types with importance based on the acreage and the potential emissions associated with each crop type.

The crop calendars were used to define the temporal periods of farming operation activities for each of the crop types.

7 - 14

Example Crop Calendar for Corn

Farming Operations	Crop Cycles Per Year	Passes Per Crop Cycle	Fraction of Acreage Per Cycle	Passes During Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Land Preparation															
Stubble Disc	1	1	1.0											1	1
Finish Disc	1	1	1.0	1											
Lay & Fertilize	1	1	1.0			1									
Mulch Beds	1	1	1.0			1									
Planting	1	1	1.0			1	1								
Cultivation	1	2	1.0				1	1							
Harvesting	1	1	1.0									1	1		

(Reference: *Computing Agricultural PM_{10} Fugitive Dust Emissions Using Process Specific Emission Rates and GIS*, prepared by Patrick Gaffney and Hong Yu from California Air Resources Board for U.S. EPA 2003 Annual Emission Inventory Conference.)

7-14 Preparation of Fine Particulate Emissions Inventories

This is an example of a crop calendar for corn. These types of calendars are very informative in terms of identifying when specific activities occur.

As an example, stubble disking for corn occurred in November and December with one pass across the field. In contrast, the NEI assumes these emissions are annual and does not apply any temporal adjustments.

7 - 15

CARB Study (cont.)

- Emission Factors (EFs)
  - Previous EIs:
    - Land Preparation: AP-42 Tilling factor (4.0 (lbs PM_{10}/acre-pass) applied to all operations
    - Harvesting: Estimated for only 3 crop types for which EFs were available
  - Improvements:
    - Conducted field testing to develop EFs for more operations
    - Crop & operation specific (for crop calendars)

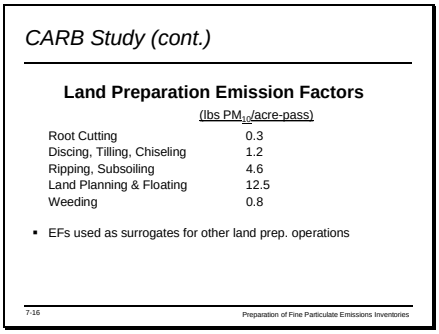
7-15 Preparation of Fine Particulate Emissions Inventories

Prior to preparing the statewide PM_{10} inventory for land preparation activities and harvest activities, CARB used the AP-42 tilling emission factor of 4.0 lbs PM_{10}/acre-pass for all land preparation activities.

For harvesting, CARB only estimated emissions for three crop types for which emission factors were available.

In order to improve this approach, CARB conducted field testing over a seven-year period to develop emission factors for different activities that are crop specific and operation specific. These new data allowed CARB to develop the crop calendars.

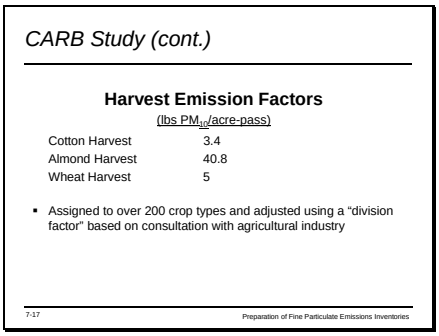
7 - 16



These are the land preparation emission factors that CARB developed for five different types of activities.

These emission factors were used as surrogates for other land preparation activities, such as wheat cutting, where specific factors were not available.

7 - 17

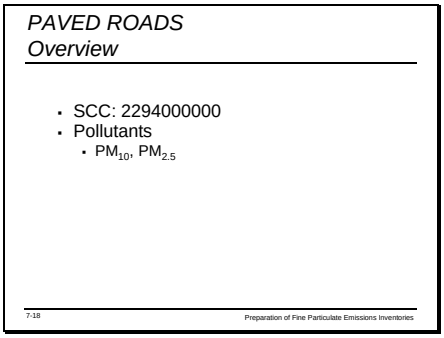


The harvest emission factors that CARB developed for three types of crops are shown here.

These factors were assigned to over 200 crop types and adjusted using a division factor developed in consultation with the state agricultural industry.

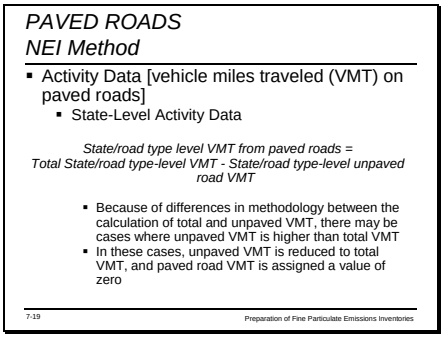
For example, wheat harvesting was assigned to another crop type, and then adjusted with a division factor. The adjusted factors were considered as the upper limit of emission factors for other crop types.

7 - 18



The SCC that is contained in the National Emissions Inventory for paved road emissions is 2294000000. For this category the NEI contains emission estimates for PM_{10} and $PM_{2.5}$.

7 - 19



Vehicle miles traveled on paved roads are used as activity data for the NEI.

To estimate paved road VMT, subtract the state and road type-level unpaved road VMT from the total state road type-level VMT.

Because the Federal Highway Administration uses different methodologies to calculate unpaved road VMT and total road VMT, there are times (principally in western states) where the unpaved road VMT is higher than the total VMT.

When this occurs, the unpaved VMT is reduced to equal the total VMT, and the paved roads are assumed to be zero.

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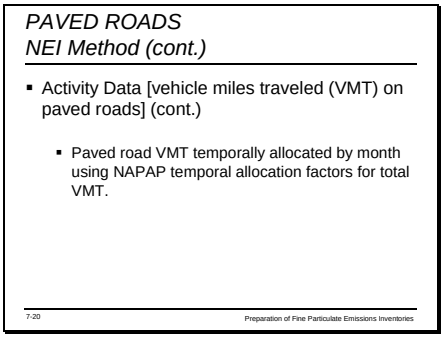


The NEI estimates monthly paved road VMT by applying temporal allocation factors to the annual paved road VMT estimate.

These factors were developed for the 1985 NAPAP study.

7 - 21

PAVED ROADS
NEI Method (cont.)

- Emission Factor
  - Empirical emission factor equation from AP-42

$$PAVED = PSDPVD * (PVSILT/2)^{0.65} * (WEIGHT/3)^{1.5} - C$$

where:

PAVED	=	paved road dust emission factor for all vehicle classes combined (grams per mile)
PSDPVD	=	constant for particles of less than 10 microns in diameter (7.3 g/mi for PM_{10})
PVSILT	=	road surface silt loading (g/m^2)
WEIGHT	=	average weight of all vehicle types combined (tons)
C	=	emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear

7-21 Preparation of Fine Particulate Emissions Inventories

The December 2003 version of the emission factor equation in AP-42 only estimates PM emissions from resuspended road surface material.

PM emissions from vehicle exhaust, brake wear, and tire wear are estimated using EPA's MOBILE6 model and are subtracted from the emission factor equation.

The formula shown here is used to calculate the paved road emission factor for all vehicle classes. The NEI used the pre-December 2003 version of the emission factor equation for estimating paved road emissions.

7 - 22

PAVED ROADS
NEI Method (cont.)

- Emission Factor (cont.)
  - Paved road silt loadings assigned to each of the twelve functional roadway classifications
    - Road types with average daily traffic volume (ADTV) < 5,000 vehicles per day = 0.20 g/m^2
    - Freeways = 0.015 g/m^2
  - See AP-42, Section 13.2.1 for more information
  - AP-42 emission factors for paved roads only apply to reentrained dust
  - Use MOBILE model for estimating PM from tailpipe exhaust, brake wear, and tire wear.

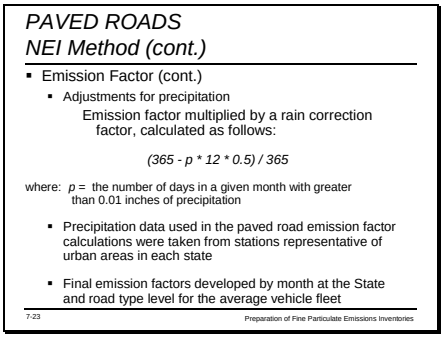
7-22 Preparation of Fine Particulate Emissions Inventories

The road surface silt loading varies according to the 12 functional roadway classifications contained in the NEI.

- For example, for road types with an average daily traffic volume of less than 5,000 vehicles per day the silt loading is 0.2 grams per square meter.
- For freeways, the silt loading is 0.015 grams per square meter.

See Ap-42, Chapter 13.2.1 for more information on determining appropriate silt loading factors.
Note that the AP-42 emission factors for paved roads now only apply to reentrained dust. EPA's MOBILE model should be used to calculate PM emissions from tailpipe exhaust, brake wear, and tire wear.

7 - 23



Since the amount of fugitive dust emissions is related to the amount of rain, the NEI makes an adjustment for precipitation.

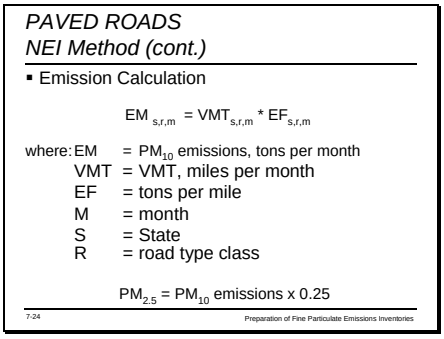
To adjust for precipitation:

- use the formula shown here to derive a rain correction factor
- multiply the emission factor by the rain correction factor

The precipitation data for the NEI was taken from one meteorological station representative of an urban area for each state.

By this method, the NEI developed emission factors on a monthly basis at the state and the road type level for the average vehicle fleet.

7 - 24



The formula used in the NEI to calculate PM_{10} emissions from paved roads from resuspended road surface material is shown.

PM emissions from vehicle exhaust, brake wear, and tire wear are estimated using EPA's MOBILE6 model.

$PM_{2.5}$ emissions are estimated by multiplying the PM_{10} emissions by a particle size multiplier of 0.25.

7 - 25

PAVED ROADS
NEI Method (cont.)

- Allocation of State Emissions to County Level
  - Paved road emissions are allocated to the county level according to the fraction of total State VMT in each county for the specific road type

$$PVDEMIS_{X,Y} = PVDEMIS_{ST,Y} * VMT_{X,Y}/VMT_{ST,Y}$$

where:
- $PVDEMIS_{X,Y}$ = paved road PM emissions (tons) for county x and road type y
- $PVDEMIS_{ST,Y}$ = paved road PM emissions (tons) for the entire State for road type y
- $VMT_{X,Y}$ = total VMT (million miles) in county x and road type y
- $VMT_{ST,Y}$ = total VMT (million miles) in entire State for road type y

7-25 Preparation of Fine Particulate Emissions Inventories

The equation for allocating the monthly paved road emissions at the state level to the county level is shown.

7 - 26

PAVED ROADS
NEI Method (cont.)

- Controls
  - Control efficiency of 79 percent applied to:
    - Urban and rural roads in serious PM NAAs; and
    - Urban roads in moderate PM NAAs
      - Corresponds to vacuum sweeping on paved roads twice per month
  - Rule penetration varies by road type and NAA classification (serious or moderate)

7-26 Preparation of Fine Particulate Emissions Inventories

The NEI methodology assumes that controls are only in place for urban and rural roads in serious PM non-attainment areas and for urban roads in moderate PM non-attainment areas.

A control efficiency of 79% is applied in these areas. This value corresponds to vacuum sweeping on paved roads twice per month. There is also an accounting of rule penetration that varies by road type and the non-attainment area classification.

7 - 27

PAVED ROADS
Improvements to NEI Method

- VMT on paved roads for local area

  (Source: State Dept. of Transportation, Mobile Source Section of Environmental Dept)

- Local registration data representing the average weight of vehicles (since this variable is weighted most heavily)

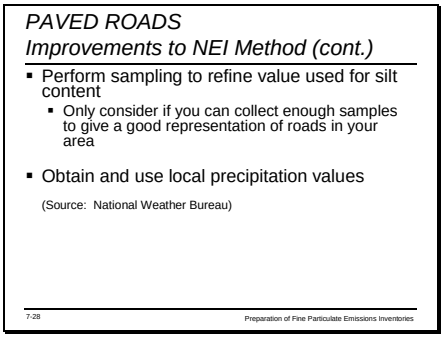
  (Source: State Dept. of Motor Vehicles, Mobile Source Section of Environmental Dept)

7-27 Preparation of Fine Particulate Emissions Inventories

One method to improve the NEI is to obtain VMT data for both paved and unpaved roads. This is preferable to the NEI approach of subtracting the unpaved road VMT from the total VMT.

Also, local registration data may be available that represents the average weight of the vehicles. This is preferable to the use of the NEI default value, particularly since this variable is weighted most heavily.

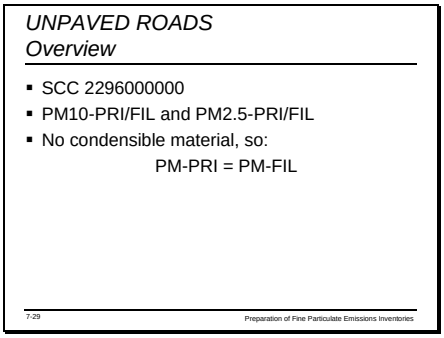
7 - 28



Also, you can perform sampling to refine the value used for silt content. However, this can be resource intensive and should only be used if enough samples can be collected to give a good representation of the roads in the inventory area.

Finally, using local precipitation data is an improvement over the NEI method.

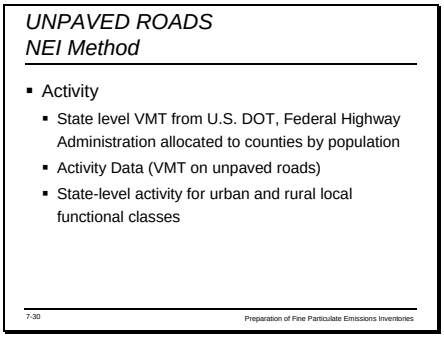
7 - 29



The SCC in the National Emissions Inventory for unpaved road emissions is 2296000000. For this category the NEI contains emission estimates for PM_{10} and $PM_{2.5}$.

There is no condensable material so the PM filterable is equivalent to PM primary.

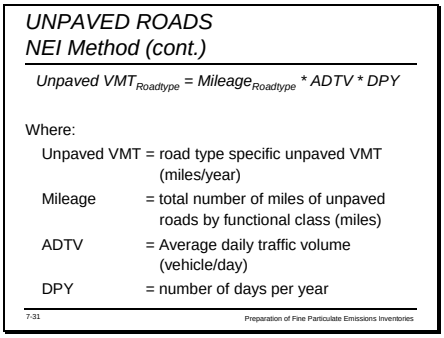
7 - 30



The activity data used by the NEI for unpaved roads is state level unpaved road VMT data that is available from the Federal Highway Administration. This data is allocated to counties by population.

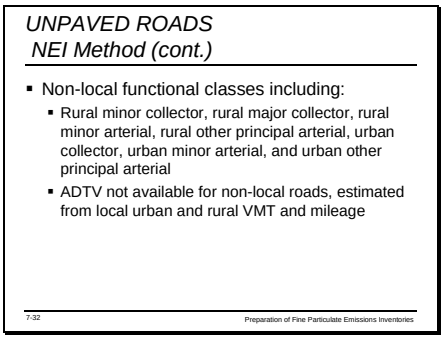
Because specific activity for the local classes is available, this calculation is done differently for urban and rural local functional classes (i.e., county maintained road types) than for the state and federally maintained roads.

7 - 31



The equation for calculating the vehicle mile traveled by road type is shown.

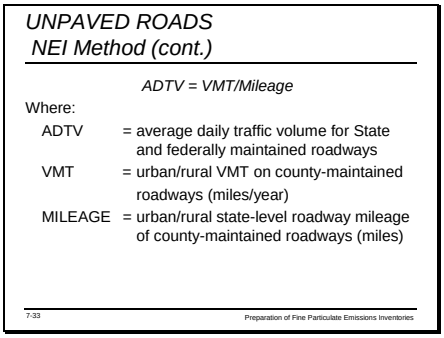
7 - 32



The non-local functional classes of roads tracked by the Federal Highway Administration include:

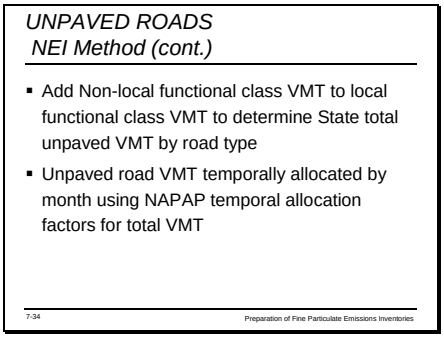
- rural minor collector
- rural major collector
- rural minor arterial
- rural other principal arterial
- urban collector
- urban minor arterial
- urban other principal arterial

7 - 33



Because there are no estimates of average daily traffic volume for the non-local roads, it is estimated from local urban and rural VMT and mileage data for the local roads using the equation shown.

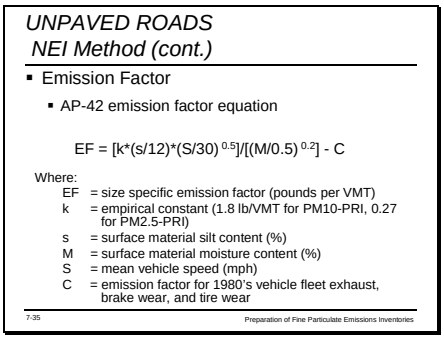
7 - 34



Calculate total state unpaved VMT by road type by adding the non-local functional class VMT to local functional class VMT.

The total state unpaved VMT is temporally allocated by month using NAPAP temporal allocation factors.

7 - 35



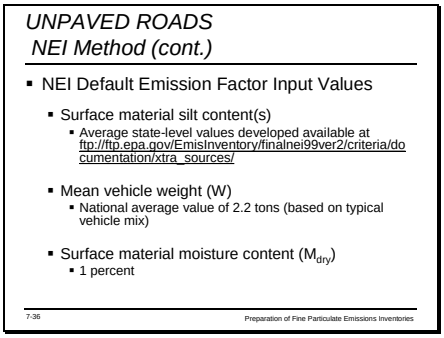
The unpaved road emission factor equation only estimates PM emissions from resuspended road surface material. This is similar to the AP-42 emission factor equation for paved roads.

PM emissions from vehicle exhaust, brake wear, and tire wear are estimated separately, using EPA's MOBILE6, and are subtracted out of the emission factor equation.

Note that the vehicle exhaust, brake wear, and tire wear component is relatively much less for unpaved roads than for paved roads.

The AP-42 empirical equation that is used to calculate the unpaved road emission factor is shown. It has some of the same variables as the paved road equation, but they are weighted differently. For example, there is more weight given to surface material silt content.

7 - 36

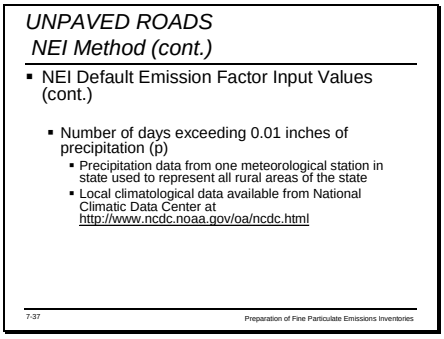


This slide summarizes the NEI default emission factor input values and the source of the values.

The web address for the surface materials silt content values links to a database for unpaved roads that provides the supporting documentation used. This includes a database of state level silt content.

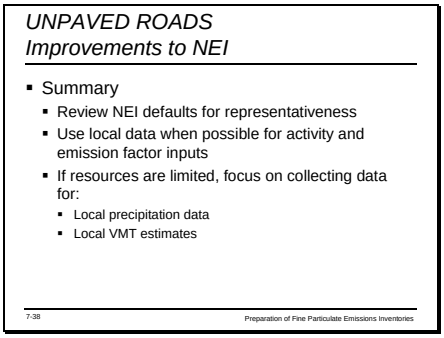
The calculation of unpaved road emissions in the NEI used the pre-December 2003 AP-42 emission factor equation. This equation considers mean vehicle weight.

7 - 37



Because unpaved road activity is expected to occur in rural areas, the precipitation data is obtained from one meteorological station that represents rural areas.

7 - 38

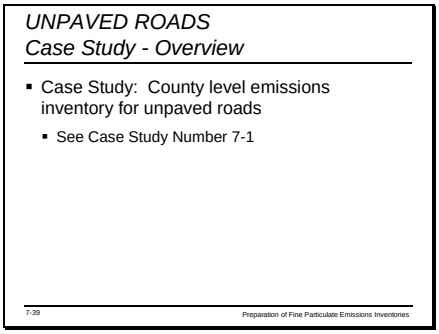


Short of developing independent estimates, the NEI defaults should be reviewed for representativeness.

Also, local data should be used when possible for the activity and emission factor.

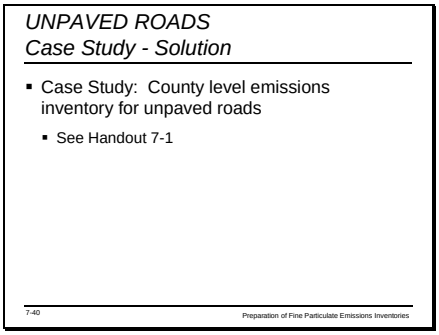
If resources are limited, the focus should be on collecting data that represents local precipitation as well as actual local VMT estimates.

7-39



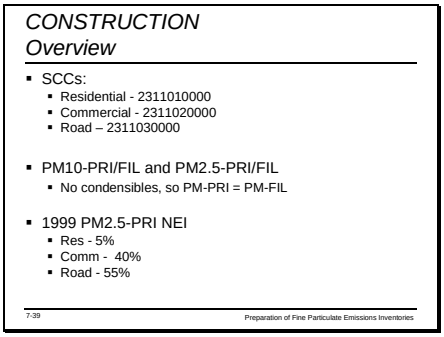
This hypothetical case study involves developing a local inventory using available county level inventory data and filling the data gaps with the NEI default data. Direct student to Case Study Number 7-1 and discuss it with the students.

7-40



Distribute the solutions (Handout 7-1) to the case study. Review each question with the students. Encourage discussion among the class. Ask each group to report on the questions that were assigned to them. Ask the other groups to critique their responses.

7 – 41

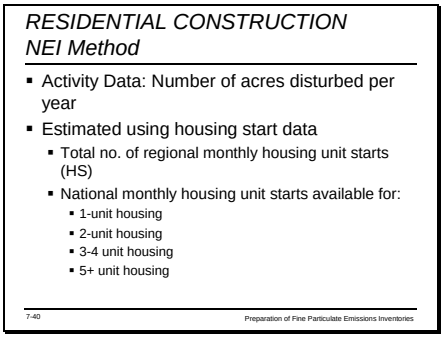


The SCCs contained in the National Emissions Inventory for the construction category are shown.

The NEI contains emission estimates for PM_{10} and $PM_{2.5}$ and there are no condensibles, so PM-PRI is equal to PM-FIL.

The relative contribution to the 1999 NEI of three different types of construction is also listed on this slide.

7 – 42

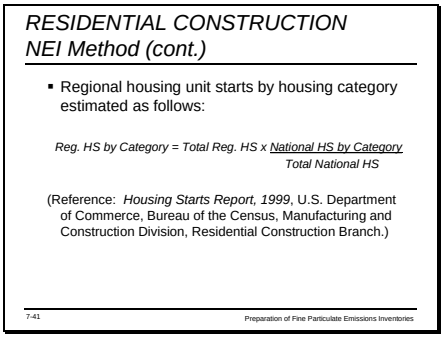


The NEI uses the number of acres disturbed per year as the activity data for residential construction.

Since direct estimates are generally unavailable, the value for this activity is estimated through the use of housing start data that is available from the Bureau of the Census. These data are available as regional monthly housing unit start values.

Data for housing unit starts for various housing classifications are also available at a national level. These classifications include 1-unit houses, 2-unit houses, 3-4 unit houses, and 5+ unit housing.

7 – 43



Housing classifications are important because there are different numbers of acres disturbed for each type of housing.

The regional housing unit starts for each of these categories is estimated using the fraction available at a national level, as shown in the equation.

7 - 44

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- Monthly regional housing starts by housing category summed to obtain an annual total
- County Activity
  - Annual no. of building permits in each county for:
    - Housing structures with 1-unit
    - Housing structures with 2-units
    - Housing structures with 3-4 housing units
    - Housing structures with 5+ units

(Reference: *Building Permits Survey, 1999*, U.S. Department of Commerce, Bureau of the Census, Manufacturing and Construction Division, Residential Construction Branch.)

7-42 Preparation of Fine Particulate Emissions Inventories

Regional housing starts are provided on a monthly basis, so they are summed to obtain an annual total.

The next step is to allocate these regional housing starts data to the county level. This is done by using data on the annual number of building permits in each county for each housing unit classification.

Note that the building permit data should not be used to estimate housing starts but only to allocate housing starts to the county. At times, a building permit is issued but the dwelling is never constructed. Consequently, the housing start data is a more accurate estimate of what is really being constructed.

7 - 45

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- Regional no. of residential *structure* starts based on the reported no. of housing unit starts:
  - No. of 1-unit housing units = no. of 1-unit housing structures
  - No. of 2 unit housing units divided by 2 units per structure
  - No. of 3-4 unit housing units divided by 3.5 units per structure
  - No. of 5+ unit housing units divided by region-specific units per structure as calculated from building permits data

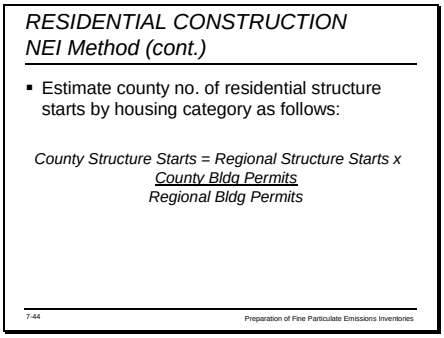
7-43 Preparation of Fine Particulate Emissions Inventories

The regional housing start data actually represents the number of units that were started. However, the number of structures is a better activity indicator of the number of acres that are disturbed.

For example, the activity data for an apartment building with multiple units should reflect the structure as a whole (i.e., the number of acres disturbed in the building of the structure and not for each unit).

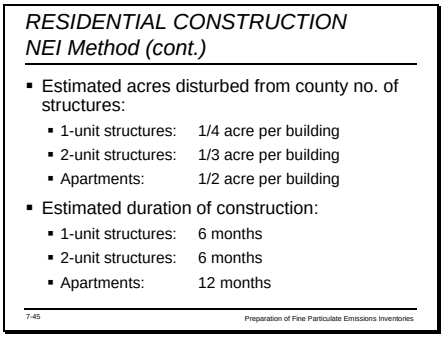
The information here shows the correlation between residential structure starts and housing unit starts.

7 - 46



The equation shown is used to estimate the number of county residential housing structure starts based on the regional number of structure starts.

7 - 47

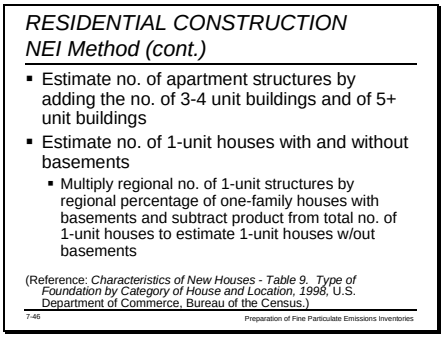


The number of acres disturbed and the duration of the construction activity vary depending on the size and type of the structure.

The assumed values for both acres disturbed and duration are listed here.

The basis for these assumptions can be found in *Estimating Particulate Emissions from Construction Operation*, 1999.

7 - 48



The number of apartment structures is estimated by adding the number of 3-4 unit buildings and the number of 5+ unit buildings.

Also, the number of 1-unit houses should be estimated separately for houses with a basement and those without a basement. This is because building a house with a basement requires the removal of additional dirt. This must be taken into account in the emission factor equation.

The number of 1-unit houses without basements is estimated by multiplying the regional number of 1-unit structures by the regional percentage of one-family houses with basements and subtracting the product from the total number of 1-unit houses.

7 - 49

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- For 1-Unit Housing with Basements
  - Estimate cubic yards of dirt moved per house
    - Multiply assumed 2,000 square feet per structure by assumed average basement depth of 8 feet
    - Add-in 10 percent of above cubic yard estimate to account for footings and other backfilled areas adjacent to basement

7-47 Preparation of Fine Particulate Emissions Inventories

Estimate the amount of dirt moved for 1-unit houses with basements by multiplying the assumed average basement depth of 8 feet by the assumed value of 2,000 square feet of dirt moved per structure.

Add 10 percent to this value to account for footings and other back-filled areas adjacent to the basement.

7 - 50

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- 1-Unit Housing with Basements
  - PM10-PRI: 0.011 tons/acre/month plus 0.059 tons/1000 cubic yards of on-site cut/fill
- 1-Unit Housing without Basements and all 2-Unit Housing
  - PM10-PRI: 0.032 tons/acre/month
- Apartments
  - PM10-PRI: 0.11 tons/acre/month
- PM2.5-PRI = 0.2 * PM10-PRI

7-48 Preparation of Fine Particulate Emissions Inventories

The emission factor data that the NEI uses to estimate the emissions on an acre-per-month basis is shown. Also, $PM_{2.5}$ is assumed to be 20% of PM_{10}.

7 - 51

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- 1-Unit Structures with Basements

Emissions = (0.011 tons PM_{10}/acre/month) x B x f x m) +
0.059 tons PM_{10}/1000 yards^3 of cut/fill)

where: *B* = no. of housing starts with basements;
f = buildings-to-acres conversion factor (1/4 acre per building);
m = duration of construction activity in months.

7-49 Preparation of Fine Particulate Emissions Inventories

The equation that NEI uses to estimate PM_{10} emissions from 1-unit residential structures with basements is shown.

7 - 52

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- 1-Unit Structures without Basements, All 2 Structures, and Apartments

Emissions = (0.032 tons PM_{10}/acre/month) x B x f x m)

where: *B* = no. of housing starts without basements;
f = buildings-to-acres conversion factor; and
m = duration of construction activity in months

7-50 Preparation of Fine Particulate Emissions Inventories

Use this equation for one-unit structures without basements, as well as all two-unit structures.

The same equation is used for apartments with the exception that the emission factor of 0.11 tons/acre/month is used instead of the 0.032 tons/acre/month value.

7 - 53

RESIDENTIAL CONSTRUCTION
NEI Method (cont.)

- Apply a control efficiency of 50 percent for both PM10-PRI and PM25-PRI emissions for PM-10 NAAs; all other areas 0 percent
- Control efficiency represents Best Available Control Method (BACM) controls on fugitive dust construction activities in these counties

7-51 Preparation of Fine Particulate Emissions Inventories

Controls in PM_{10} non-attainment areas are taken into account by applying a control efficiency of 50% for both PM_{10} and $PM_{2.5}$ emissions for all PM_{10} nonattainment areas. There is no adjustment made for attainment areas.

The 50% value represents best available control methods on fugitive dust construction activities in the nonattainment counties.

7 - 54

RESIDENTIAL CONSTRUCTION
NEI Correction Parameters

- Applied to final emissions for all 3 construction categories
- Soil Moisture Level

Moisture Level Corrected Emissions = Base Emissions x (24/PE)

where: PE = Precipitation-Evaporation value for county

- Compiled statewide average Precipitation-Evaporation (PE) values according to Thornthwaite's PE Index

7-52 Preparation of Fine Particulate Emissions Inventories

Additional adjustments for soil moisture content and silt content are applied to the emission estimates for all three construction categories.

Emissions are adjusted for soil moisture content by using average Precipitation Evaporation values according to Thornthwaite's Precipitation Evaporation Index.

The formula used to make this adjustment is shown. It accounts for precipitation and humidity in a certain area. As shown in the equation, the higher the PE the smaller the adjustment.

7 - 55

RESIDENTIAL CONSTRUCTION
NEI Correction Parameters

- Silt Content

Silt Content Corrected Emissions = Base Emissions x (s/9%)

where: s = % dry silt content in soil for area being inventoried

- County-specific dry silt values are applied to PM10-PRI emissions for each county

7-53 Preparation of Fine Particulate Emissions Inventories

Emissions are adjusted for the dry silt content in the soil of the area being inventoried by using the formula shown here.

7 - 56

RESIDENTIAL CONSTRUCTION
Improvements to NEI

- Obtain local data for new construction housing starts, permits for additions/modifications to existing homes

Source: State Housing Agency or Real Estate Association

- Develop a building to acres conversion factor for acres disturbed per construction unit
- Obtain information on seasonality of residential construction practices
- Obtain local information on soil moisture content, silt content, and control efficiency

7-54 Preparation of Fine Particulate Emissions Inventories

Obtaining local data for new housing starts, or permits for additions or modifications to existing homes would be an improvement over the use of the NEI defaults.

Another improvement is to develop a buildings-to-acres conversion factor for acres disturbed per construction unit. Obtaining data on the seasonality of residential construction practices is a third alternative.

Finally, obtaining local information on soil moisture content, silt content, and control efficiencies would improve the NEI default values.

7 - 57

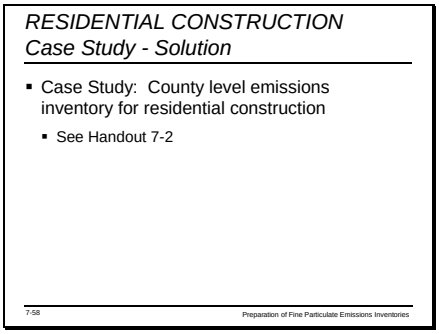
RESIDENTIAL CONSTRUCTION
Case Study - Overview

- Case Study: County level emissions inventory for residential construction
  - See Case Study Number 7-2

7-57 Preparation of Fine Particulate Emissions Inventories

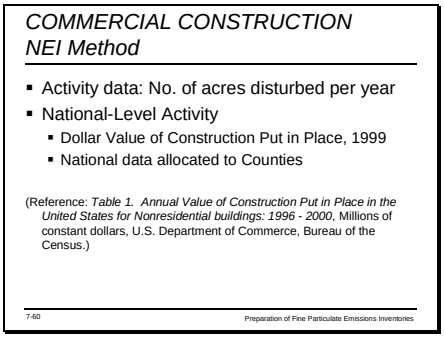
This case study demonstrates the approach for developing an inventory for residential construction at the county level in a PM nonattainment area.
Direct student to Case Study Number 7-2 and discuss it with the students.

7 - 58



Distribute the solutions (Handout 7-2) to the case study. Review each question with the students. Encourage discussion among the class. Ask each group to report on the questions that were assigned to them. Ask the other groups to critique their responses.

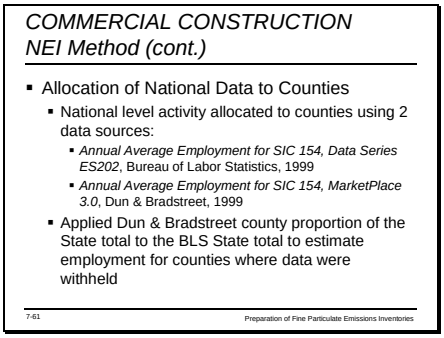
7 - 59



Similar to the residential construction category, the NEI uses the number of acres disturbed each year to represent fugitive dust emissions from commercial construction.

The NEI developed a top-down inventory by using national level activity data on the dollar value of commercial construction. These data were then allocated to the county level.

7 – 60

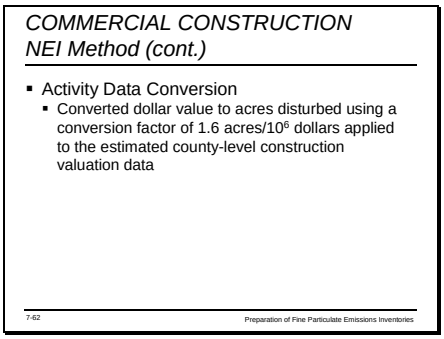


The allocation of the national level expenditure data was performed by using the two data sources shown here.

The Dunn & Bradstreet database was used to fill in the gaps for data missing from the first database.

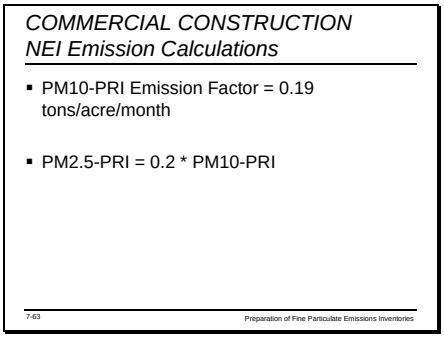
Specifically, the county proportion of the state total from the Dunn & Bradstreet database was applied to the state total from the BLS database to estimate employment for counties where data were missing.

7 - 61



The dollar value activity data were converted to acres disturbed using a conversion factor of 1.6 acres/10^6 dollars. This conversion factor was applied to the estimated county-level construction valuation data.

7 - 62



The PM10-PRI emission factor for commercial construction is 0.19 tons per acre month. The $PM_{2.5}$ is assumed to be 20% of the PM_{10}.

7 – 63

COMMERCIAL CONSTRUCTION
NEI Emission Calculations (cont.)

- Emission formula for calculating the emissions is:

Emissions = (0.19 *tons/acre/month) x $ x f x m*

where: $ = dollars spent on nonresidential construction in millions
f = dollars-to-acres conversion factor
m = duration of construction activity in months (assumed 11 months)

7-64 Preparation of Fine Particulate Emissions Inventories

The emission formula used in the NEI to calculate the PM emissions from commercial construction is shown.

The calculated emissions are adjusted to reflect control measures that are in place in PM_{10} non-attainment areas.

In addition to accounting for the control measures, adjustments are applied for soil moisture content and silt content.

7 - 64

COMMERCIAL CONSTRUCTION
Improvements to NEI

- Obtain local information on number of acres disturbed per construction event or per construction dollars spent

Source: Construction Industry Association

- Obtain information on location, average duration, and seasonality of commercial construction practices
- Obtain local information on soil moisture content, silt content, and control efficiency

7-65 Preparation of Fine Particulate Emissions Inventories

The NEI results can be improved by obtaining local information on the number of acres disturbed per construction event or per construction dollar spent.

Also information on location, average duration, and seasonality of commercial construction practices would be an improvement over the NEI default values.

Finally, local information on soil moisture content, silt content, and control efficiency would result in improved emission estimates.

7 – 65

ROAD CONSTRUCTION
NEI Method

- Activity data: Number of acres disturbed
- State-Level Activity
  - Obtained State expenditure data for capital outlay for six classifications
    - Interstate, urban
    - Interstate, rural
    - Other arterial, urban
    - Other arterial, rural
    - Collectors, urban
    - Collectors, rural

(Reference: Highway Statistics, Section IV - Finance, Table SF-12A, "State Highway Agency Capital Outlay - 1999." Federal Highway Administration.)

7-66 Preparation of Fine Particulate Emissions Inventories

The NEI uses the number of acres disturbed as the activity data indicator for road construction.

State level expenditure data for capital outlay for the six road construction classifications listed are available.

7 – 66

ROAD CONSTRUCTION
NEI Method (cont.)

- State-Level Activity (Continued)
  - Expenditures include all improvement types except for:
    - Minor widening
    - Resurfacing
    - Bridge rehabilitation
    - Safety
    - Traffic operation and control
    - Environmental enhancement and other

7-67 Preparation of Fine Particulate Emissions Inventories

Because some of the activities included in the total state level expenditure data do not contribute to PM emissions, the expenditures for these activities have been removed.

These activities include minor widening, resurfacing, bridge rehabilitation, safety, traffic operation and control, and environmental enhancement and other.

7 - 67

ROAD CONSTRUCTION
NEI Method (cont.)

- Estimate miles of new road constructed
  - $4 million/mile for interstate roads
  - $1.9 million/mile for other arterial and collector roads

(Reference: Personal Communication with North Carolina Department of Transportation)

7-68 Preparation of Fine Particulate Emissions Inventories

To obtain the activity data in terms of acres disturbed, it was necessary to first convert the expenditure data to mileage and then to acreage.

The NEI estimated the miles of new road constructed by applying conversion factors of $4 million dollars per mile of interstate, and $1.9 million dollars per mile for other arterial and collector roads.

These conversion factors were based on information obtained from the North Carolina Department of Transportation.

7 – 68

ROAD CONSTRUCTION
NEI Method (cont.)

- Estimate acres for each road type using estimates of acres disturbed per mile:
  - Interstate, urban and rural; Other arterial, urban - 15.2 acres/mile
  - Other arterial, rural - 12.7 acres/mile
  - Collectors, urban - 9.8 acres/mile
  - Collectors, rural - 7.9 acres/mile

(Reference: *Estimating Particulate Matter Emissions from Construction Operations*, prepared by Midwest Research Institute for U.S. Environmental Protection Agency, 1999.)

7-69 Preparation of Fine Particulate Emissions Inventories

The NEI then applied the conversion factors listed on this slide to convert to acres disturbed per mile of road activity level.

7 - 69

ROAD CONSTRUCTION
NEI Method (cont.)

- Sum across road types to yield state total of acres disturbed
- Activity Data Allocation to Counties
  - Distributed state-level estimates of acres disturbed to counties according to housing starts
    - see residential construction for description of development of county-level housing start data

7-70 Preparation of Fine Particulate Emissions Inventories

The estimated acres disturbed are summed across all road types to estimate the total acres disturbed.

The NEI allocates these state-level estimates to the county-level by using housing start data. These are the same data that were developed for the residential construction category. The assumption is that new road development is directly proportional to new housing starts.

7 - 70

ROAD CONSTRUCTION
NEI Emission Calculations

- PM10-PRI Emission Factor = 0.42 tons/acre/month
- PM2.5-PRI = 0.2 * PM10-PRI

7-71 Preparation of Fine Particulate Emissions Inventories

The PM10-PRI emission factor for road construction is 0.42 tons per acre month. The $PM_{2.5}$ is assumed to be 20% of the PM_{10}.

7 - 71

ROAD CONSTRUCTION
NEI Emission Calculations (cont.)

- The formula for calculating emissions is:

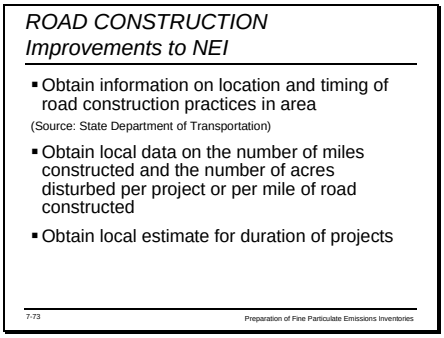
Emissions = (0.42 tons PM10/acre/month) x $ x f1 x f2 x d

where: $ = State expenditures for capital outlay on road construction
f1 = $-to-miles conversion factor
f2 = miles-to-acres conversion factor
d = duration of roadway construction activity in months (assumed 12 months)

7-72 Preparation of Fine Particulate Emissions Inventories

The NEI uses the emission formula shown to calculate the PM emissions from road construction.

7 - 72

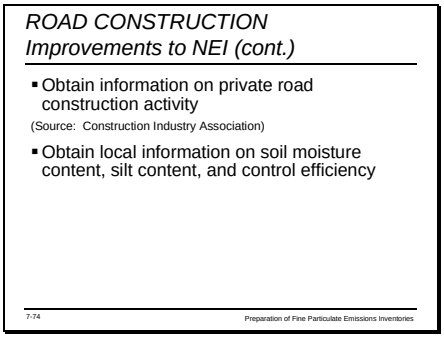


Obtaining information on location and timing of road construction practices in the area is one way to improve NEI results.

Also, obtaining local data on the number of miles constructed and the number of acres disturbed per project or mile of road constructed is better than using the NEI default values based on expenditure data.

Using local data on the duration of the projects would also improve the NEI.

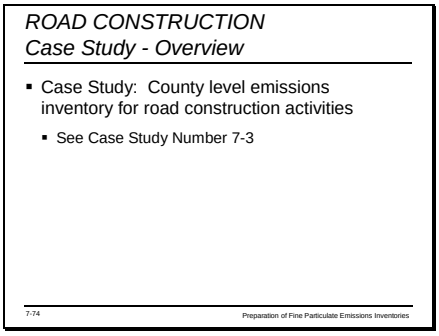
7 - 73



Information on private road construction activity (not included in the NEI) would also serve to improve the NEI.

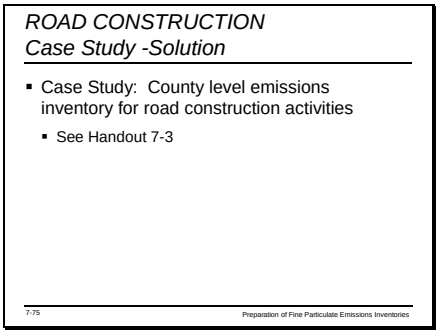
Obtaining information for making adjustments for soil moisture content, silt content, and control efficiency also improve NEI default values.

7 - 74



This hypothetical case study involves developing a local inventory using available county level inventory data and filling the data gaps with the NEI default data. Direct student to Case Study Number 7-3 and discuss it with the students.

7 - 75



Distribute the solutions (Handout 7-3) to the case study. Review each question with the students. Encourage discussion among the class. Ask each group to report on the questions that were assigned to them. Ask the other groups to critique their responses.

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