EPA-450/3-74-085

EMISSIONS INVENTORY OF AGRICULTURAL TILLING, UNPAVED ROADS AND AIRSTRIPS, AND CONSTRUCTION SITES

by

Chatten C. Cowherd, Jr.,
Christine M. Guenther, and Dennis D. Wallace

Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

Contract No. 68-02-1437

EPA Project Officer: Charles O. Mann

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, N. C. 27711

November 1974

This report is issued by the Environmental Protection Agency to report technical data of interest to a limited number of readers. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - as supplies permit - from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

This report was furnished to the Environmental Protection Agency by Midwest Research Institute, Kansas City, Missouri 64110, in fulfillment of Contract No. 68-02-1437. The contents of this report are reproduced herein as received from Midwest Research Institute. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency.

Publication No. EPA-450/3-74-085

ACKNOWLEDGEMENTS

This report was prepared for the Environmental Protection Agency's Office of Air Quality Planning and Standards under EPA Contract No. 68-02-1437. Mr. Charles O. Mann served as EPA Project Officer.

The program was conducted in MRI's Physical Sciences Division under the supervision of Dr. Larry J. Shannon, Head, Environmental Systems Section. Dr. Chatten Cowherd, Jr., was the Principal Investigator for MRI. Dr. Cowherd was assisted by Ms. Christine Guenther and Mr. Dennis Wallace.

Approved for:

MIDWEST RESEARCH INSTITUTE

H. M. Hubbard, Director
Physical Sciences Division

8 January 1975

CONTENTS

	Page
List of Figures	vii
List of Tables	viii
Introduction	1
Unpaved Road Emissions	5
Source Extent	5
Correction Factors	7
Silt Content	7
Dry Days Per Year	9
Emission Factor	9
Heavy Construction Emissions	11
Source Extent	11
Emission Factor	11
Agricultural Tilling Emissions	17
Source Extent	17
Correction Factors	17
Silt Content	17
Precipitation-Evaporation Index	22
Emission Factor	24
Unpaved Airstrip Emissions	27
Source Extent	27
Correction Factors	29
Emission Factor	29

CONTENTS (Concluded)

	Page
Data Tabulations and Accuracies	31
References.	39

LIST OF FIGURES

No.		Page
1	Annual vehicle miles on unpaved roads	6
2	Unpaved roads silt content (percent).	8
3	Emission factors for unpaved roads (lb/vehicle mile). . .	10
4	Annual acres of construction.	12
5	Emission factors for construction (tons/acre)	14
6	Annual acres of land tilled	18
7	Agricultural silt content (percent)	20
8	Precipitation-Evaporation Index	23
9	Emission factors for agricultural tilling (lb/acre) . . .	25
10	Annual LTO cycles on dirt airstrips	28
11	Emission factors for dirt airstrips (lb/LTO cycle). . . .	30

LIST OF TABLES

No.		Page
1	Fugitive dust source parameters	2
2	Construction dollars-to-acres conversion factors.	13
3	Estimated annual tillings by crop	19
4	Coded NEDS area source data for Alabama	32
5	Correction factors and corrected emission factors for Alabama	34
6	Smallest geographical areas assigned single values. . . .	36
7	Estimated error ranges for tabulated data	37

INTRODUCTION

Area dust emission sources contribute substantially to the atmospheric particulate burden in many parts of the country. The Environmental Protection Agency has identified several fugitive source categories for inclusion in the National Emissions Data System (NEDS) area source file. Among them are the following categories of fugitive dust sources:

1. Unpaved Roads (dirt and gravel),

2. Heavy Construction Sites (such as road and building construction),

3. Agricultural Land Tilling,

4. Unpaved Airstrips.

To determine the impact of these sources, it is necessary to develop a national emissions inventory of these sources on a county-by-county basis. Calculation of county emission totals for each source category requires, in addition to the basic emission factor, (1) an appropriate measure of the extent of the source type within the county and (2) correction factors which adjust the emissions estimates for local climatic conditions and properties of the emitting surface.

The basic emission factors with associated correction terms were developed by MRI[1/] under EPA Contract No. 68-02-0619. Table 1 lists the measures of source extent and the correction parameters which are required for the calculation of corrected emission estimates.

The objective of the program reported herein was (1) the calculation of source extent and emission factor correction terms on a county-by-county basis for the source categories designated above, and (2) the documentation of the methodology used in these calculations, including procedures used to estimate missing data.

Table 1. FUGITIVE DUST SOURCE PARAMETERS

Source category	Measure of extent	Correction parameters
Unpaved roads	Vehicle-miles traveled	• Surface texture (silt content)
		• Surface moisture (dry days per year)
Heavy construction	Acres of active construction	• Duration of construction activity
Agricultural land tilling	Acres of crops tilled	• Surface texture (silt content)
		• Surface moisture (Precipitation-Evaporation Index)
Dirt air strips	Landing/take-off (LTO) cycles	• Surface texture (silt content)
		• Surface moisture (dry days per year)

The following sections of this report present, for each source category, a comprehensive description of the calculation methodology. The final data tabulations including the coded NEDS area source data forms, have been submitted as a separately bound attachment to this report.

UNPAVED ROAD EMISSIONS

SOURCE EXTENT

The basic equation for the calculation of annual traffic flow on unpaved roads in a specified county is given by:

$$v = 365\ (ADT)\ m \tag{1}$$

where v is the vehicle miles traveled per year; ADT is average daily traffic on unpaved roads in the county; and m is mileage of unpaved roads in the county. The procedure used to determine ADT and m for each county is depicted in Figure 1.

Regression analysis of statewide traffic counts for unpaved roads in Kansas yielded the following equation:

$$ADT = 15 + 2.8 \left(\frac{p}{a} \right) \tag{2}$$

where p is the county rural population[2/] and a is the county area (sq mile).[2/] Kansas was the only state which was found to have actual ADT data for unpaved roads. For this reason and because Kansas is thought to be fairly representative of areas of the country with substantial mileage of unpaved roads, the above ADT correlation was applied to all of the other states.

Tabulations of the mileage of unpaved roads (surface types A through E) in each state are prepared annually by the Department of Transportation.[3/] However, the county statistics must be obtained individually from each state.

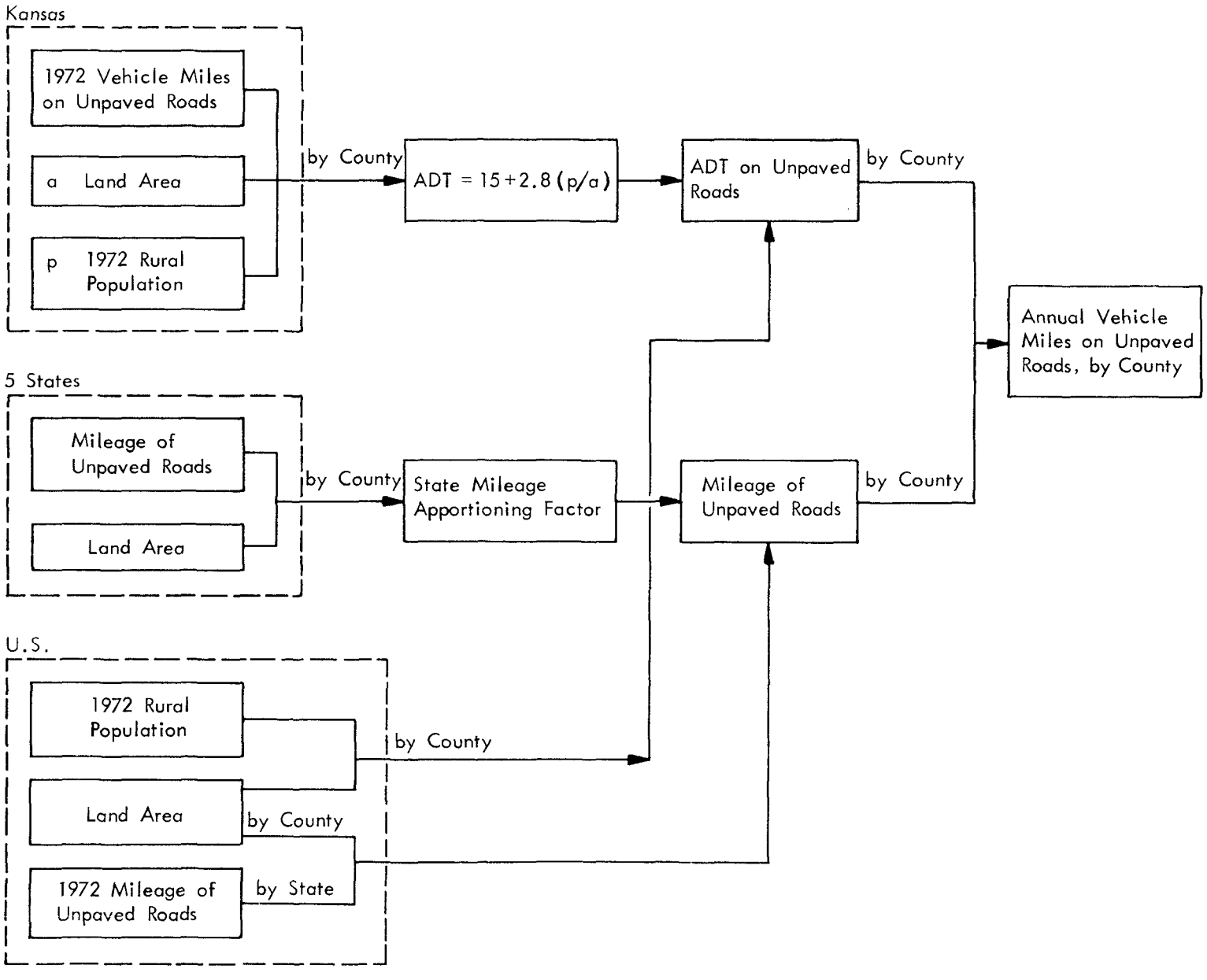

Figure 1. Annual vehicle-miles on unpaved roads.

Unpaved road mileage data by county for five states (Kansas,[4] Nebraska,[5] Arkansas,[6] North Dakota,[7] and South Dakota[7]) were analyzed by plotting mileage density (m/a) versus rural population density (p/a) for each state. It was observed that for $p/a > 8$ persons per square mile, the mileage density becomes essentially independent of rural population density. For the counties with $p/a < 8$, further analysis leads to the conclusion that the dependence of mileage density on population density was too small to justify development of complex correlations to be applied to the relatively few sparsely populated counties. Therefore, for all states (other than the five mentioned above) the state unpaved road mileage totals were apportioned among the respective counties on the basis of county area.

CORRECTION FACTORS

The emission factor for dust emissions from unpaved roads[1] contains three correction factors: (1) average vehicle speed; (2) surface silt content; and (3) rainfree days per year.

Based on previous field testing experience,[1] the average vehicle speed on unpaved roads was taken to be 40 mph.

Silt Content

The average surface silt content of unpaved roads for each state was calculated using the following equation (see Figure 2):

$$s_r = \frac{3\,(DE)(15) + (NS)\bar{s}}{3(DE) + NS} \qquad (3)$$

where s_r is the weighted surface silt content; DE are miles of roads with surface types D (soil-surfaced) and E (slag, gravel, or stone-surfaced); NS are the miles of nonsurfaced* roads in the state; and $\bar{s}$ is the average soil silt content for the state. The value for $\bar{s}$, which represents the silt content for vehicles traveling on dirt roads, was determined by averaging the county soil silt contents determined for calculation of agricultural tilling emissions (see Agricultural Tilling Correction Factors). The constant 15 represents the percent silt for D- and E-surfaced roads.[1] The factor 3 is an estimate of the ratio of vehicle miles traveled on D- and E-surfaced roads compared to that on nonsurfaced roads.

---

* Nonsurfaced roads include primitive (type A), unimproved (type B), and graded and drained (type C) roads.

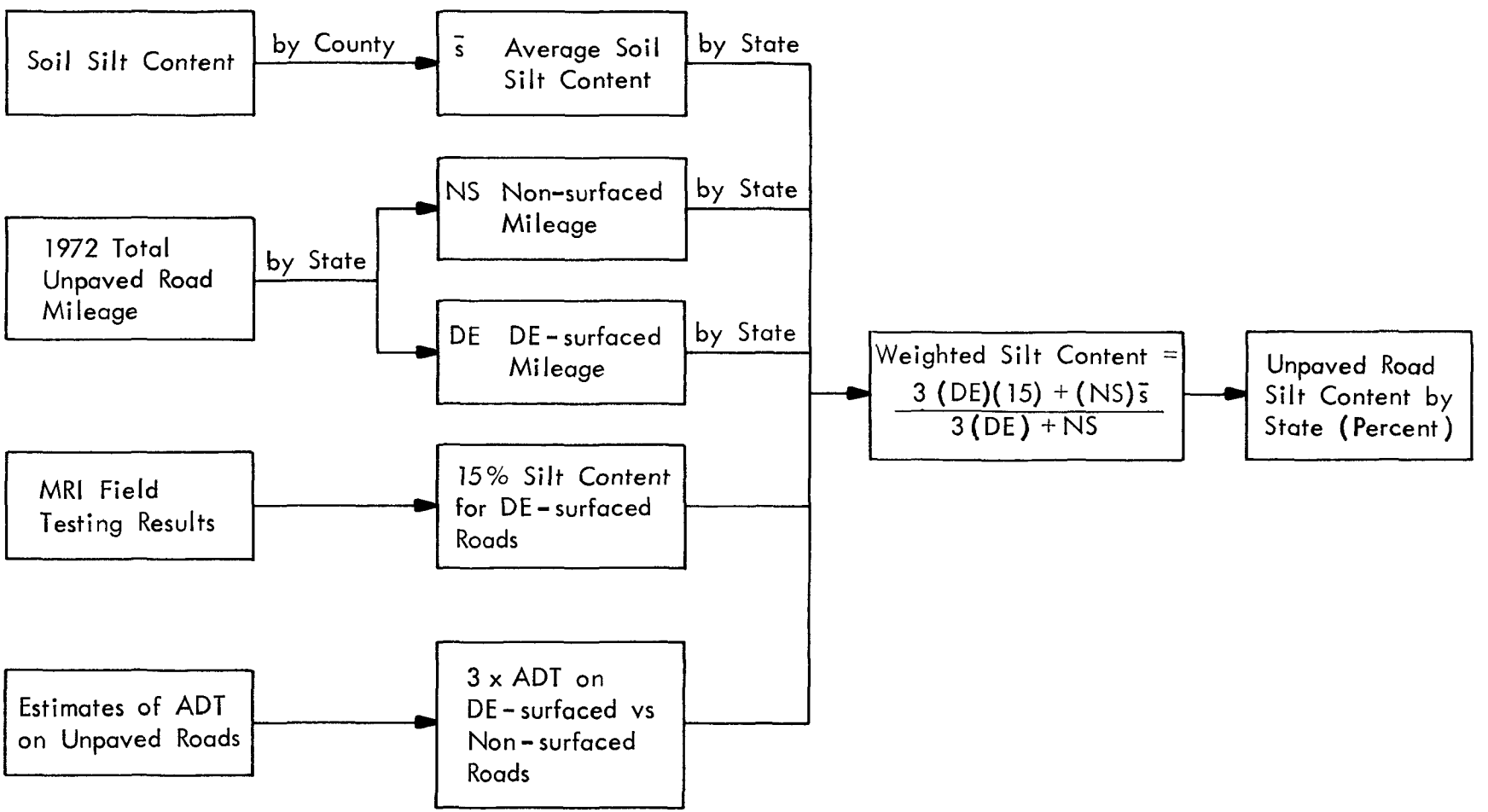

Figure 2. Unpaved roads silt content (percent).

Dry Days per Year

The starting point for the determination of the number of dry days per year for each county was a national map of average annual frequency of measurable precipitation.[8] If the number of dry days in a given state varied by less than 20, an average was taken for the state; otherwise, the state was divided into regions for which the difference was less than 20, and an average for each region was estimated. Finally, the dry days for each county were taken to be the average value for the region or the state in which that county is located.

EMISSION FACTOR

The emission factor for dust emissions from unpaved roads[1] is given by (see Figure 3):

$$EF_r = 0.49(s_r)\left(\frac{40}{30}\right)\left(\frac{d}{365}\right) \qquad (4)$$

The factor gives the pounds of dust particles smaller than 30 μm in diameter* (based on a particle density of 2 to 2.5 g/cm^3) emitted by a vehicle traveling at a speed of 40 mph over a distance of 1 mile.

* The approximate effective cutoff diameter of a standard high-volume particulate sampler.[1]

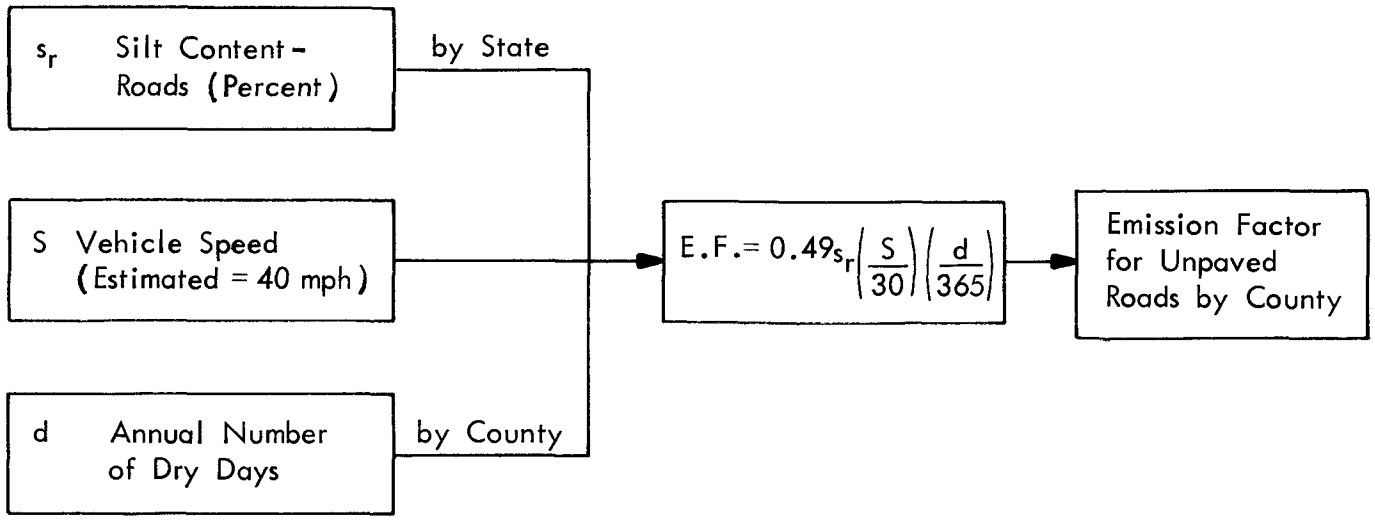

Figure 3. Emissic

800/2
EP 450/3 74-037
* EP 450/3 74-085
8-340-0762
Tekin Derkowski

HEAVY CONSTRUCTION EMISSIONS

SOURCE EXTENT

The most comprehensive available data on the extent of heavy construction* in the United States are state construction receipts as derived from the 1972 Census of Construction.[9] Values are broken down by SIC subcategory. Figure 4 diagrams the procedure which was used to go from state construction receipts to acres of construction by county.

After consultation with construction statistics experts, it was decided that the most reasonable technique for estimation of county acres would consist of:

(1) conversion of state construction receipts to equivalent acres of construction,

(2) apportionment of state construction acreage to counties on the basis of the fraction of the state construction employment assigned to each county.[2]

The conversion factors for step 1, as presented in Table 2, were developed by MRI for each SIC subcategory. These were applied separately to the state construction dollars in each SIC code to determine the acreage of active construction during the base year (1972). It should be noted that construction dollars for certain SIC categories were missing for a few states, and therefore were not included in the computation of total construction acreage.

EMISSION FACTOR

To determine a state-wide emission factor for dust emissions from construction activities, it was necessary to multiply the previously

---

* Although heavy construction normally is defined as nonbuilding construction, both building (SIC Code 15) and nonbuilding (SIC Code 16) construction were included in this section.

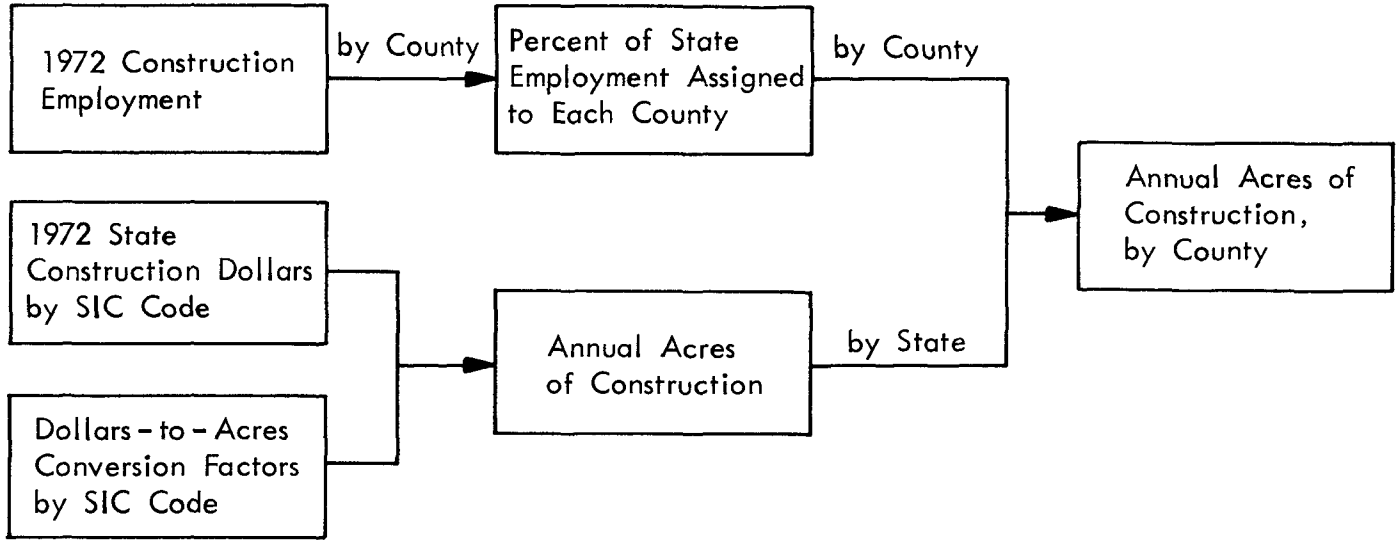

Figure 4. Annual acres of construction.

Table 2. CONSTRUCTION DOLLARS-TO-ACRES CONVERSION FACTORS

SIC code	Factor (acres/$\$10^6$)
1521	5
1522	5
1531	5
1541	5
1542	5
1611	25
1622	25
1623	5
1629	150

determined emission rate factor (1 ton/acre/month)[1/] by an average duration of construction projects within each state. As indicated in Figure 5, the average duration was determined from the relative proportions of acreage differentiated by project type and the average duration of construction for each project type. MRI economists estimated the average duration of construction to be:

- 6 months for residential buildings,
- 11 months for nonresidential buildings,
- 18 months for nonbuilding construction.

Therefore, the emission factor for heavy construction can be written as follows:

$$EF_c = D \text{ ton/acre} \tag{5}$$

where D is the weighted average duration of construction within a given state. Note that this factor describes emissions of particles

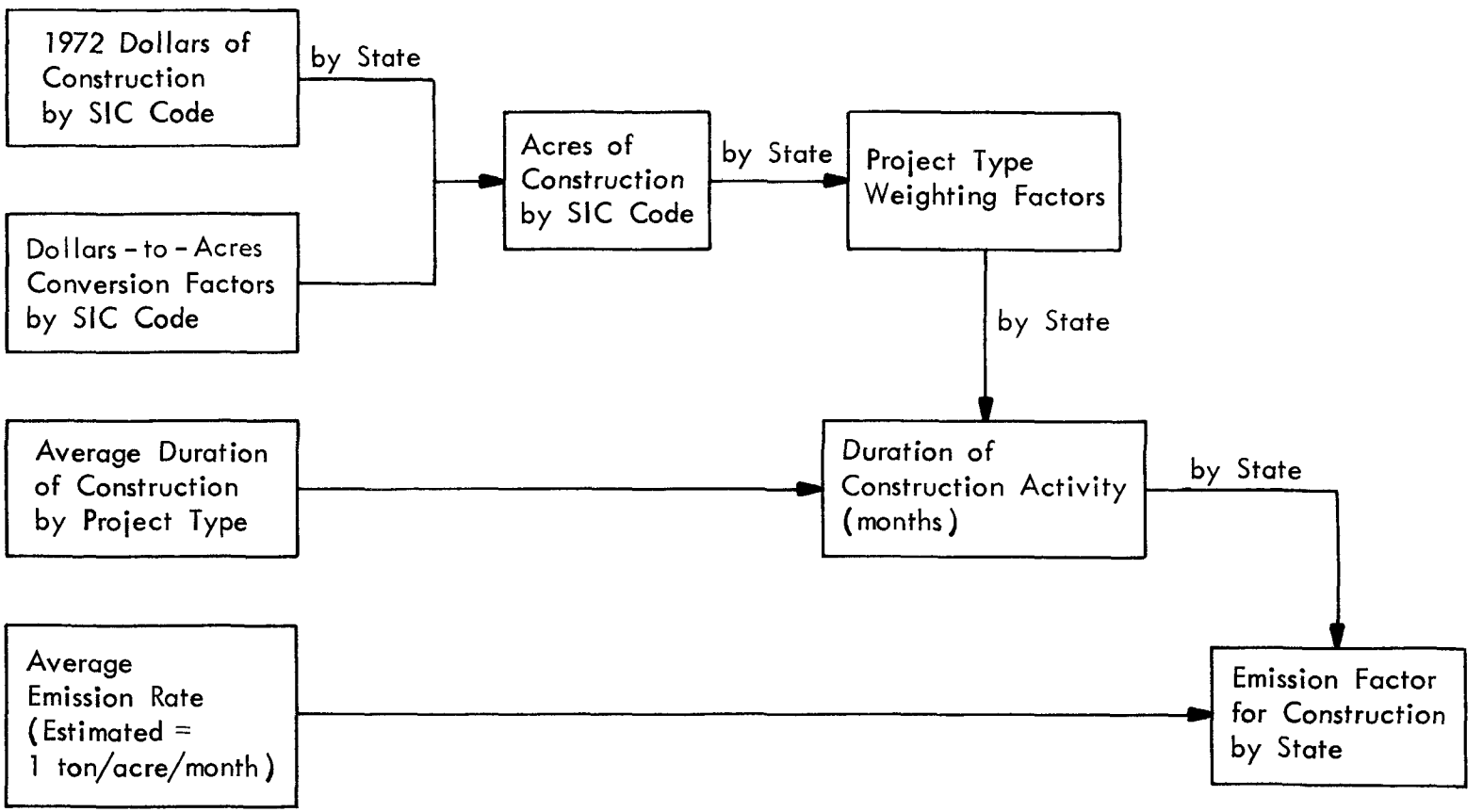

Figure 5. Emission factors for construction (tons/acre).

smaller than 30 μm in diameter* (based on a particle density of 2 to 2.5 g/cm^3).

* The approximate effective cutoff diameter for a standard high-volume particulate sampler.[1/]

AGRICULTURAL TILLING EMISSIONS

SOURCE EXTENT

The annual acres of land tilled is the designated measure of source extent for fugitive emissions from agricultural tilling. Data used for this determination were (see Figure 6):

(1) harvested cropland by county, in acres; and

(2) an estimation of the number of annual tillings, by crop.

The acres of harvested cropland for all farms on a county basis was obtained from the 1969 Census of Agriculture.[10/] The number of annual tillings for major crops was estimated by knowledgeable MRI personnel (see Table 3). An overall value of three tillings per year was determined to be representative for all cropland. Therefore, the acres of land tilled in each county was calculated to be three times the annual harvested cropland.

CORRECTION FACTORS

Two correction factors were calculated for agricultural tilling: (1) agricultural soil silt content; and (2) Precipitation-Evaporation Index (a measure of average surface soil moisture content).

Silt Content

Three soils maps were used in determining agricultural silt content by county. Figure 7 shows the procedure for this calculation.

A map of the soils of the North Central United States[11/] was used as the main source of data for the agricultural belt. This map classifies soils according to their soil series (the most specific soil classification unit). Map numbers indicate a predominant soil series and one or two secondary soil series for each respective geographical area.

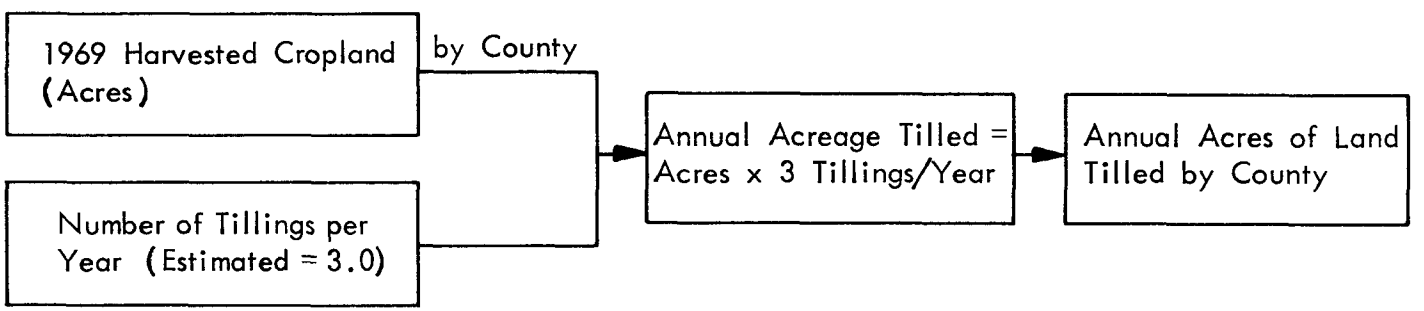

Figure 6. Annual acres of land tilled.

Table 3. ESTIMATED ANNUAL TILLINGS BY CROP

Crop	Number of tillings per year
Barley	3
Corn	3
Cotton	4, 3 (East, West)
Oats	3
Sorghum	2, 3 (East, West)
Soybeans	3
Wheat	3, 2 (East, West)

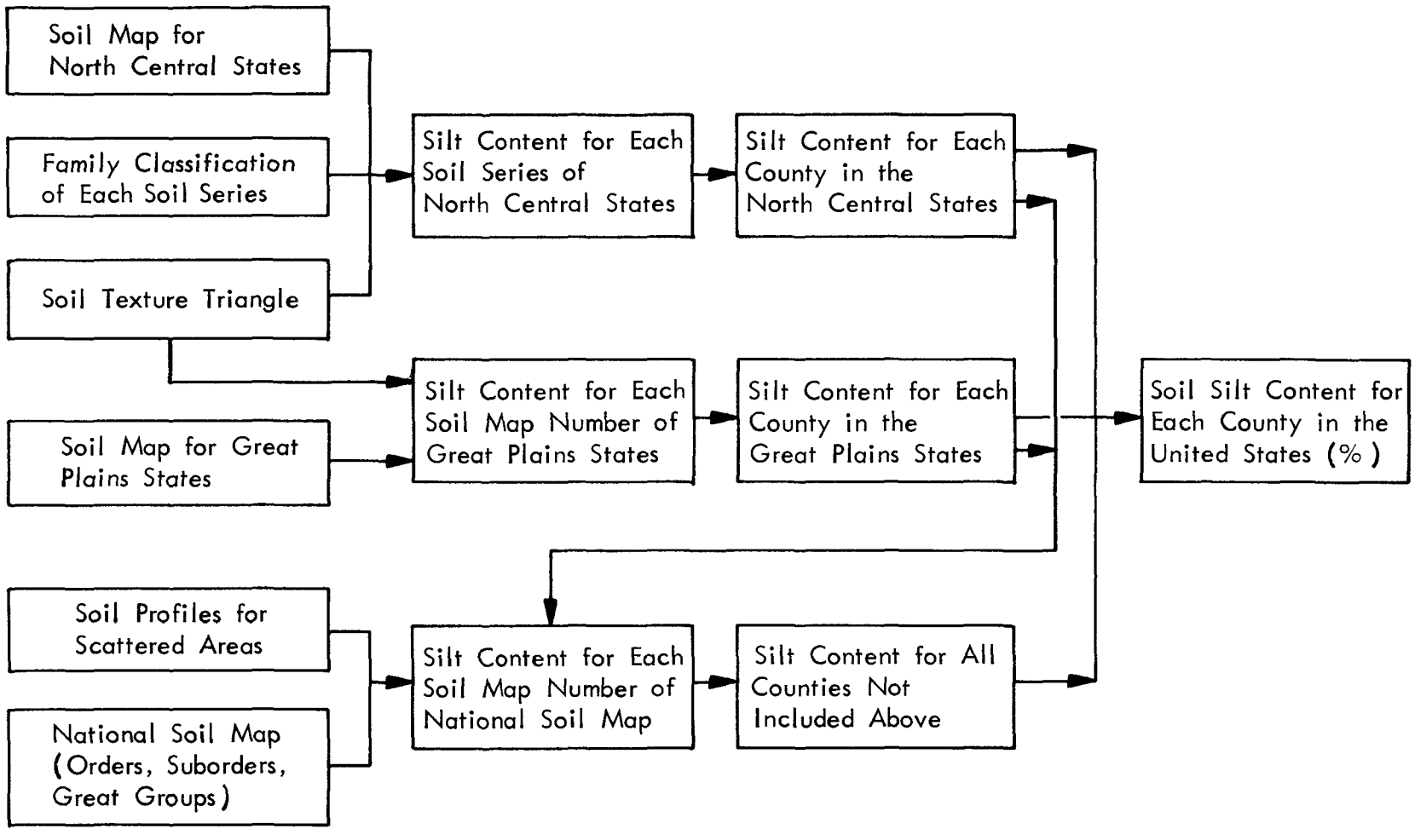

Figure 7. Agricultural silt content (percent).

The following steps were taken to convert soil series information to silt content values:

(1) The soil series were redefined into soil families[12/] (the second most specific classification of soils, indicating the texture of the soil);

(2) The soil texture triangle[13/] was used to estimate silt content for each family classification;

(3) A representative value of percent silt content was determined for each map number by weighting the silt content of each of the one to three soil series silt content values.

The silt content for each county in the 12-state North Central region was then determined by the following procedure:

(1) The one or two soil map numbers covering the largest areas within the county were identified and the fraction of the county that each covered was estimated.

(2) If the map numbers identified in step 1 covered more than two-thirds of the area, step 3 was skipped.

(3) The soil map number covering the third largest area within the county was identified and the fraction of the county that it covered was estimated.

(4) From the fractions of county area determined above, and the silt content for each soil map number, a weighted value for soil silt content was calculated.

The second map encompassed the Great Plains region of the United States[14/] and contained several states not included in the first map. In this case, map numbers specified the soil family classification. This information was used along with the soil texture triangle [13/] to assign an estimated silt content to each map number. The silt content for each county was then determined in the manner described above for the North Central states.

The third map was a soils map of the entire United States.[15/] This map indicated only broad soil classifications: orders, suborders, and great groups. No general procedure was available to determine family (or texture) classifications from either suborders or great groups; for this reason, it was not possible to use the soil texture

triangle to estimate silt content. The methods detailed in the paragraphs below were used to estimate silt content for each great group (where possible) or suborder indicated on the national soils map.

First, for each soils area outside the states covered by the first two maps, an attempt was made to locate the designated great group (or suborder) in one of the previously defined soils areas. If the desired great group (or suborder) was located, the soils area in question was assigned the corresponding silt content.

If it was not possible to locate a similar soil for which the silt content had been previously estimated, a set of scattered soil texture profiles[16/] was searched. Each of these measured profiles characterizes a soil suborder, i.e., the dominant soil suborder at the location where that soil sample was obtained. If a profile for the corresponding suborder was located, the soil in question was assigned the silt content from the profile.

Finally, if neither of these procedures was possible, an estimate of the silt content was made for the suborder based upon the silt content of the surrounding area and the silt content of other suborders within the same order.

After each of the suborders was assigned a silt content, the silt content for each county was determined using the method described previously for the North Central states.

It should be noted that the method for estimation of silt content from the national soils map is less accurate than the methods which utilized the first two maps. Thus, the confidence level of estimates of silt content for areas not covered by the North Central states map and Great Plains map is lower. However, agricultural tilling in areas outside those maps is also less significant.

Precipitation-Evaporation Index

Thornthwaite's Precipitation-Evaporation index[17/] is used to correct emissions for geographical differences in soil mixture. A map of PE-index by state climatic division was generated from an earlier MRI study.[1/] A value of the PE-index for each county was determined by assigning all counties in each state climatic division the value assigned to that state climatic division. Weighted values of the PE-index were determined for those counties which were part of more than one state climatic division. State maps [18/] indicating both the state climatic division and the counties were used for assigning values and weighting functions. This procedure is outlined in Figure 8.

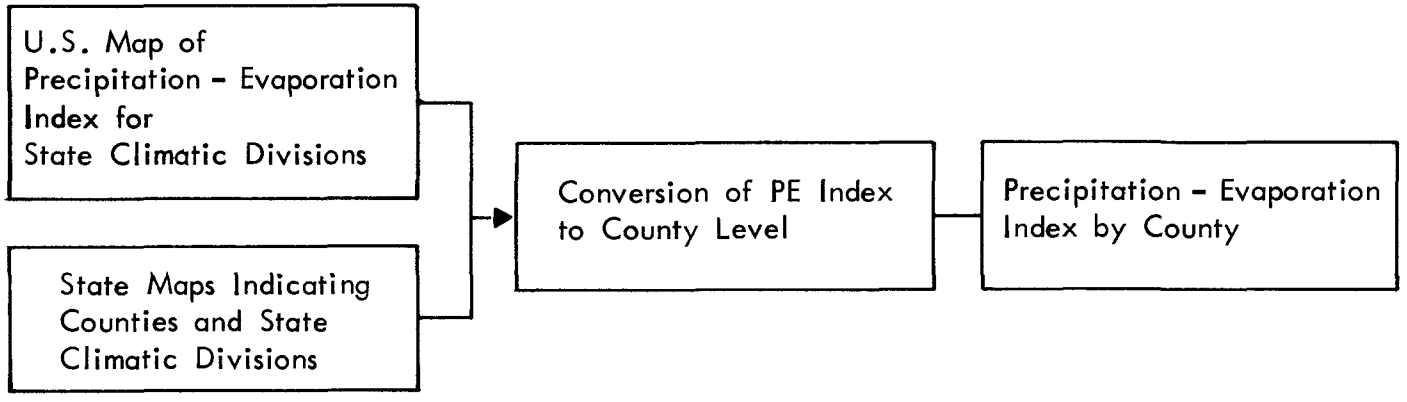

Figure 8. Precipitation-Evaporation Index.

EMISSION FACTOR

The emission factor for dust emissions from agricultural tilling is given by the following equation:

$$EF_t = \frac{1.1s}{(PE/50)^2} \tag{6}$$

where the symbols are defined in Figure 9 and a value of 5.5 mph has been substituted for average implement speed.

Equation (6) estimates the total emissions of dust particles smaller than 30 μm in diameter* (based on a particle density of 2 to 2.5 g/cm^3).

---

* The approximate effective cutoff value for a standard high-volume particulate sampler.

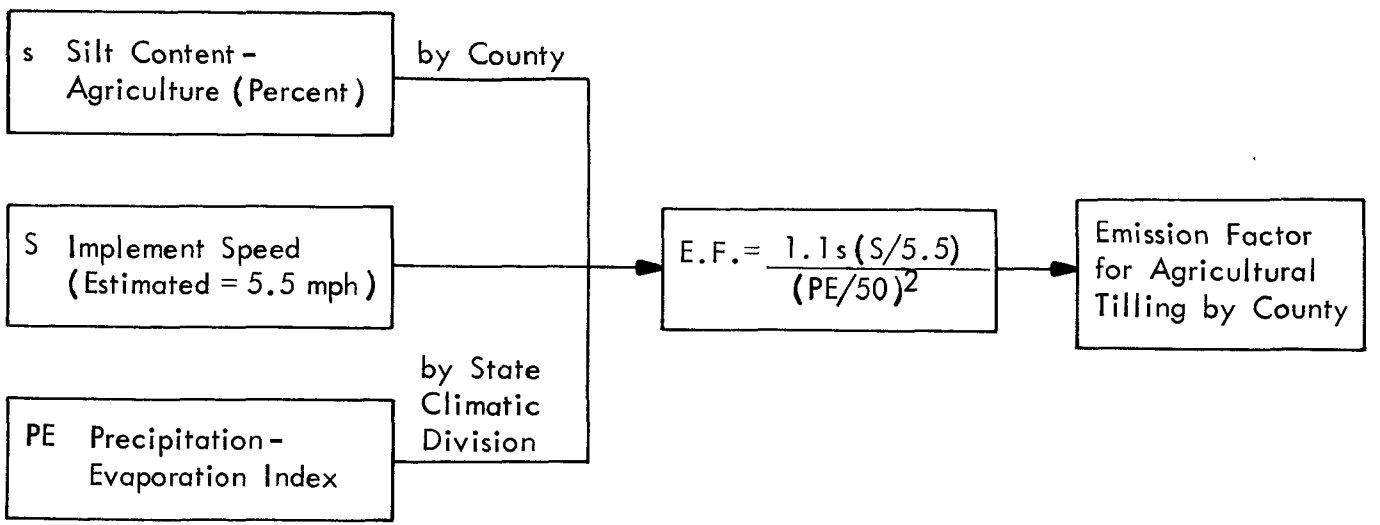

Figure 9. Emission factors for agricultural tilling (lb/acre).

UNPAVED AIRSTRIP EMISSIONS

SOURCE EXTENT

The measure of source extent for fugitive emissions from unpaved* airstrips is annual LTO (landing/take-off) cycles. Figure 10 illustrates the procedure used to determine LTO cycles on unpaved airstrips by county.

Contacts were made with the Federal Aviation Administration to determine availability and accessibility of data on:

(1) the number of LTO cycles at small airport facilities, in relation to the number of based aircraft: and

(2) the number of aircraft based at unpaved airstrips in the United States, by county.

A computer tape with data on each airport[19/] was obtained from the Washington offices of FAA. Data on this tape included the following information for each airport in the United States: site number, city, state, airport name, county code, latitude, longitude, airport type, number of total based aircraft, number of multi-engine based aircraft, runway pavement, runway length, population served, ownership type and usage type.

The computer tape was processed and punched cards were generated containing the pertinent information for those airports listed as pavement type 5. (This pavement type includes dirt, water, sand, and gravel pavement.) The punched cards were then sorted to eliminate airports with no based aircraft, airports no longer in operation, and heliport or seaplane bases. Data for over 1,000 airports remained, and these cards were sorted by county and state codes. It was necessary to convert the state and county codes from the FAA system to the SAROAD coding system. This was manually accomplished by code comparison using an IBM manual[20/] and the SAROAD Station Coding Manual.[21/]

---

* Excluding grass (turf) airstrips.

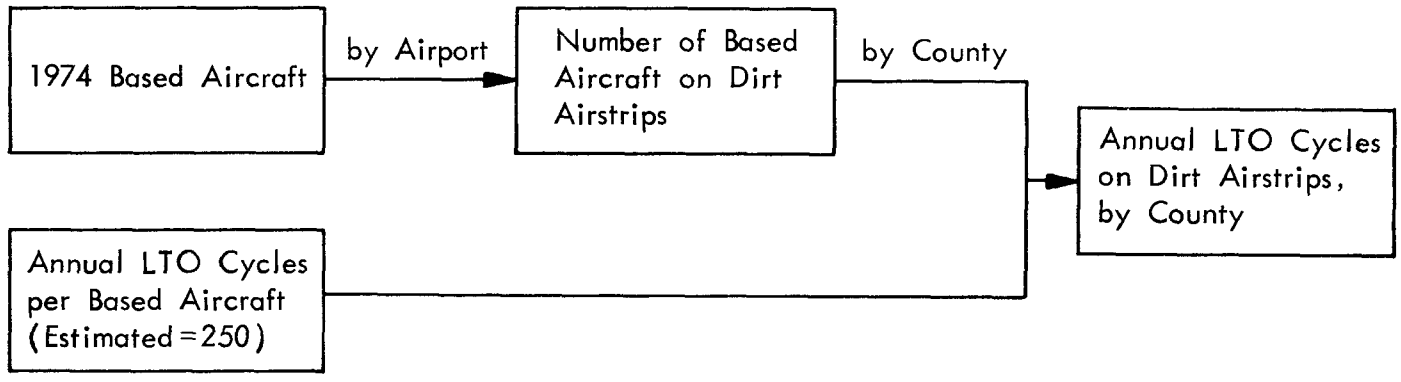

Figure 10. Annual LTO cycles on dirt airstrips.

Local FAA officials estimated the number of operations per based aircraft at small airport facilities to be in the range of 400 to 800 operations per year with a typical value being 500, i.e., 250 LTO cycles. Thus, the total number of LTO cycles on unpaved airstrips in each county was calculated by multiplying the total number of aircraft based at unpaved airstrips by 250.

CORRECTION FACTORS

The emission factor for dust emissions from unpaved airstrips contains five correction parameters (see Figure 11):

(1) the surface texture, measured as percent silt content;

(2) the average LTO speed, estimated to be 40 mph;

(3) the surface soil moisture as determined by annual number of dry days;

(4) the length of runway used for one complete LTO cycle, estimated to 1 mile; and

(5) a wind-erosion multiplier, estimated to be equal to 2.

The silt content on a state basis and the annual number of dry days on a county basis were assumed to be the same as those developed as correction factors for unpaved roads. The estimates for average LTO speed and length of runway used* in one LTO cycle were derived from conversations with local FAA officials. The wind-erosion multiplier is an estimated value which accounts for the emissions generated by the propeller wash.

EMISSION FACTOR

The emission factor for unpaved airstrips (lb/LTO cycle) was derived by analogy to the equation for unpaved roads. The equation for unpaved airstrips is given by:

$$EF_a = 2\left[0.49\ s_a\left(\frac{40}{30}\right)\left(\frac{d}{365}\right)(1)\right] \qquad (7)$$

* Predominate use of unpaved airstrips is limited to single-engine aircraft.

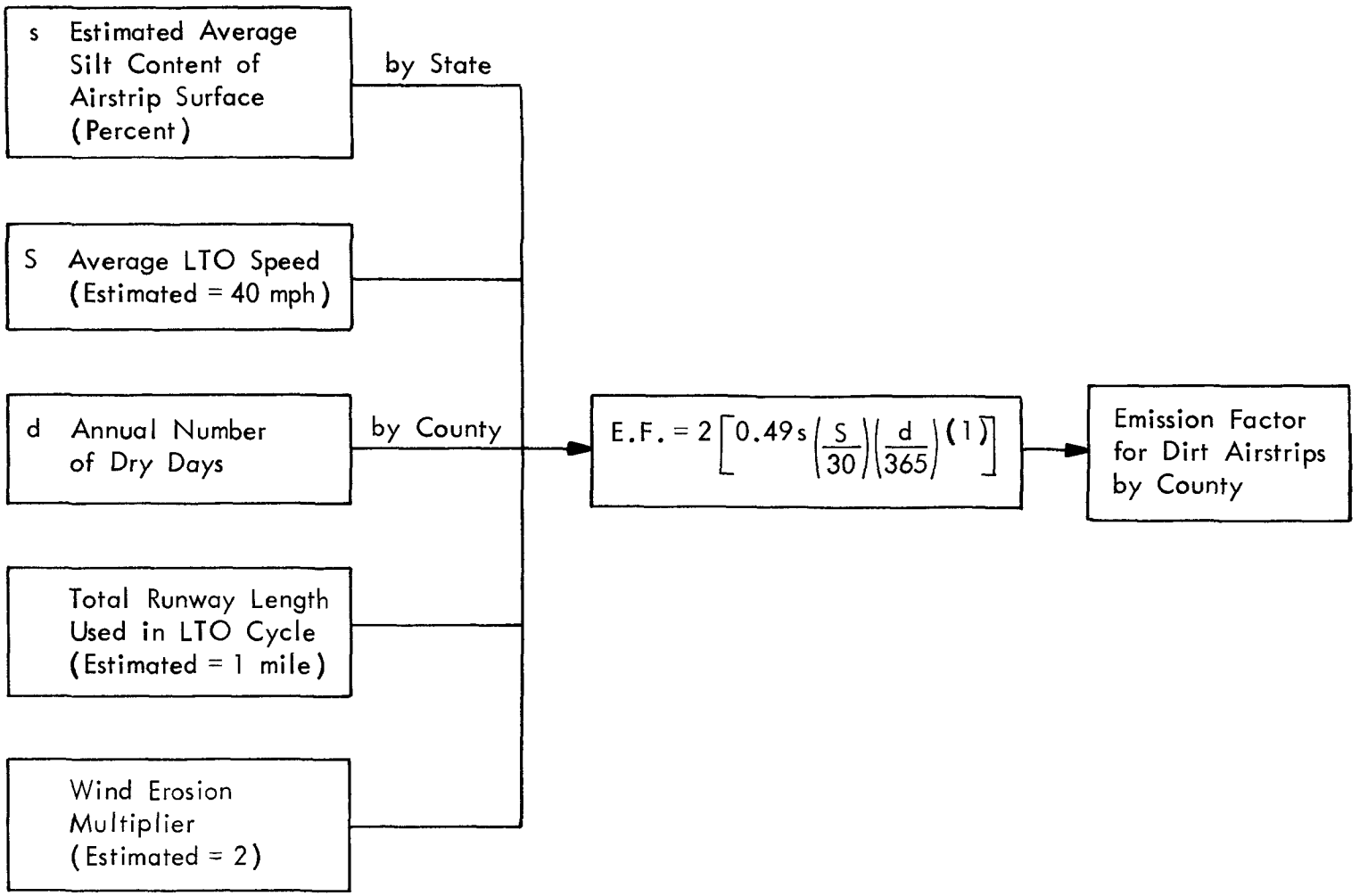

Figure 11. Emission factors for dirt airstrips (lb/LTO cycle).

DATA TABULATIONS AND ACCURACIES

Two types of data tabulations were prepared as part of this study:

(1) coded NEDS area source data forms, listing source extent for each designated source category, on a county-by-county basis.

(2) tabulations of the correction factors and the corrected emission factors for each source category, on a county-by-county basis. Example completed forms (for Alabama) are shown in Tables 4 and 5.

A listing of data specificity of the submitted tabulation is presented in Table 6. As indicated, for some correction factors, single values were assigned to multi-county regions or to states as a whole rather than to individual counties.

The annual number of dry days and silt content for unpaved roads and airstrips (mostly D- and E-surfaced) do not vary sharply enough to justify calculation of separate values for each state. In the case of duration of construction activity, county construction data were not available.

Table 7 presents estimates for possible error in the calculated data. These values correspond to a 90% confidence level. They were determined by a progressive analysis of the errors associated with each calculation step. Separate values are presented for the source extent and the corrected emission factor for each source category.

Table 4. CODED NEDS AREA SOURCE DATA FOR ALABAMA

State Alabama

County		State (1–2)	County (3–6)	AQCR (7–9)	Unpaved Roads (10^3 Veh. Miles) (10–16)	Dirt Air Strips (LTO Cycles) (17–21)	Construction (Acres) (22–27)	(28–32)	Land Tilling (10^3 Acres) (33–37)
Autauga	1	01	0240	002	9470	0	163		104
Baldwin	2		0260	005	3380	0	350		470
Barbour	3		0280	006	1190	0	108		140
Bibb	4		0360	004	1120	0	52		24
Blount	5		0400	004	1680	0	198		107
Bullock	6		0520	002	705	0	61		68
Butler	7		0540	002	1180	0	115		72
Calhoun	8		0560	003	2590	0	404		65
Chambers	9		0580	003	1530	0	167		30
Cherokee	10		0600	003	121	0	106		132
Chilton	11		0660	004	1500	0	260		69
Choctaw	12		0680	001	1400	0	65		32
Clarke	13		0720	001	1520	0	145		32
Clay	14		0740	003	1030	0	48		17
Cleburne	15		0760	003	719	0	48		10
Coffee	16		0780	006	1190	0	172		174
Colbert	17		0800	007	1560	0	243		153
Conecuh	18		0820	001	1060	0	76		84
Coosa	19		0840	003	920	0	50		6
Covington	20		0880	006	1300	0	200		182
Crenshaw	21		0900	002	1070	0	59		102
Cullman	22		0940	007	2200	0	371		153
Dale	23		0980	006	1500	0	160		112
Dallas	24		1000	001	2160	0	221		217
De Kalb	25		1020	007	2450	0	304		221
Elmore	26		1140	002	1930	0	239		115
Escambia	27		1180	005	1630	0	165		172
Etowah	28		1200	003	1910	0	421		83
Fayette	29		1360	004	968	0	93		60
Franklin	30		1460	007	1270	0	107		90
Geneva	31		1540	006	1160	0	117		235
Greene	32		1600	004	730	0	54		100
Hale	33		1700	001	1050	0	78		177
Henry	34		1780	006	686	0	105		184
Houston	35	01	1820	006	1490	0	421		314

Page 1

Table 4 (concluded)

State Alabama (Concluded)

County		State (1–2)	County (3–6)	AQCR (7–9)	Unpaved Roads (10^3 Veh. Miles) (10–16)	Dirt Air Strips (LTO Cycles) (17–21)	Construction (Acres) (22–27)	(28–32)	Land Tilling (10^3 Acres) (33–37)
Jackson	1	01	1920	007	21300	0	273		254
Jefferson	2		1980	004	52500	0	2894		26
Lamar	3		2020	004	11400	0	122		63
Lauderdale	4		2080	007	24400	0	425		165
Lawrence	5		2100	007	20100	0	275		226
Lee	6		2120	002	14800	0	254		59
Limestone	7		2160	007	19700	0	297		314
Lowndes	8		2220	002	10900	0	126		99
Macon	9		2240	002	11100	0	126		98
Madison	10		2260	007	28800	0	714		409
Marengo	11		2280	001	12200	0	91		147
Marion	12		2320	007	14000	0	111		66
Marshall	13		2340	007	20100	0	338		143
Mobile	14		2400	005	41500	0	1840		152
Monroe	15		2420	001	14000	0	137		136
Montgomery	16		2480	002	21400	0	1000		173
Morgan	17		2520	007	22700	15000	549		163
Perry	18		2720	001	9780	0	83		173
Pickens	19		2760	004	14500	0	91		135
Pike	20		2800	002	10100	0	211		135
Randolph	21		2880	003	10500	0	124		25
Russell	22		2920	002	15300	0	275		61
St. Clair	23		2960	004	16700	0	193		38
Shelby	24		3060	004	23400	0	297		51
Sumter	25		3080	004	12300	0	72		108
Talladega	26		3140	003	22400	0	321		96
Tallapoosa	27		3160	003	13600	0	178		25
Tuscaloosa	28		3300	004	24300	0	568		81
Walker	29		3380	004	30600	0	280		39
Washington	30		3400	001	14300	0	78		28
Wilcox	31		3460	001	13700	0	72		95
Winston	32	01	3500	007	10300	0	115		28
	33								
	34								
	35								

Page 2

Table 5. CORRECTION FACTORS AND CORRECTED EMISSION FACTORS FOR ALABAMA

State Alabama

County		CORRECTION FACTORS				EMISSION FACTORS		
		Silt Content -Agriculture (%)	Silt Content -Roads (%)	Precipitation -Evaporation Index	Dry Days Per Year	Unpaved Roads (lb./veh. mi.)	Agricultural Tilling (lb./acre)	Dirt Air Strips (lb /LTO cycle)
Autauga	1	17	16	119	260	7.39	3.36	14.8
Baldwin	2	42		130			6.96	
Barbour	3	17		116			3.54	
Bibb	4	69		119			13.6	
Blount	5	17		122			3.20	
Bullock	6	17		107			4.16	
Butler	7	17		116			3.54	
Calhoun	8	17		112			3.79	
Chambers	9	17		112			3.79	
Cherokee	10	17		112			3.79	
Chilton	11	52		119			10.3	
Choctaw	12	47		116			9.78	
Clarke	13	57		116			11.9	
Clay	14	17		112			3.79	
Cleburne	15	17		112			3.79	
Coffee	16	17		116			3.54	
Colbert	17	17		117			3.47	
Conecuh	18	17		116			3.54	
Coosa	19	34		112			7.59	
Covington	20	17		116			3.54	
Crenshaw	21	17		116			3.54	
Cullman	22	17		122			3.20	
Dale	23	17		116			3.54	
Dallas	24	17		107			4.57	
De Kalb	25	17		122			3.20	
Elmore	26	17		112			3.79	
Escambia	27	17		116			3.54	
Etowah	28	17		112			3.79	
Fayette	29	34		119			6.72	
Franklin	30	17		117			3.48	
Geneva	31	17		116			3.54	
Greene	32	17		107			4.16	
Hale	33	17		107			4.16	
Henry	34	17		116			3.54	
Houston	35	17	✓	116	✓	✓	3.54	✓

Page 1

Table 5 (concluded)

State Alabama (Concluded)

County		CORRECTION FACTORS				EMISSION FACTORS		
		Silt Content -Agriculture (%)	Silt Content -Roads (%)	Precipitation -Evaporation Index	Dry Days Per Year	Unpaved Roads (lb./veh. mi.)	Agricultural Tilling (lb./acre)	Dirt Air Strips (lb /LTO cycle)
Jackson	1	17	16	122	260	7.39	3.20	14.8
Jefferson	2	17		122			3.20	
Lamar	3	17		119			3.36	
Lauderdale	4	17		117			3.48	
Lawrence	5	17		117			3.48	
Lee	6	17		112			3.79	
Limestone	7	17		117			3.48	
Lowndes	8	31		107			7.58	
Macon	9	17		107			4.16	
Madison	10	17		117			3.48	
Marengo	11	57		107			13.9	
Marion	12	17		119			3.36	
Marshall	13	17		122			3.20	
Mobile	14	42		130			6.96	
Monroe	15	17		116			3.54	
Montgomery	16	17		107			4.16	
Morgan	17	17		117			3.48	
Perry	18	17		107			4.16	
Pickens	19	17		119			3.36	
Pike	20	17		116			3.54	
Randolph	21	17		112			3.79	
Russell	22	17		116			3.54	
St. Clair	23	17		112			3.79	
Shelby	24	42		112			9.37	
Sumter	25	42		107			10.3	
Talladega	26	52		112			11.6	
Tallapoosa	27	17		112			3.79	
Tuscaloosa	28	52		119			12.3	
Walker	29	34		119			6.72	
Washington	30	42		116			8.74	
Wilcox	31	57		116			11.9	
Winston	32	52	↓	119	↓	↓	10.3	↓
	33							
	34							
	35							

Page 2

Table 6. SMALLEST GEOGRAPHICAL AREAS ASSIGNED SINGLE VALUES

Source category	Data specificity by County	State region	State
Unpaved roads	Vehicle-miles	Number of dry days per year	Silt content
Heavy construction	Acres of active construction		Duration of construction activity
Agricultural tilling	Acres of crops tilled		
	Silt content		
	Precipitation-Evaporation Index		
Dirt airstrips	LTO cycles	Number of dry days	Silt content

Table 7. ESTIMATED ERROR RANGES FOR TABULATED DATA

Source category	Estimated relative error	
	Extent of source	Corrected emission factor
Unpaved roads	± 50%	± 20%
Heavy construction	± 40%	± 50%
Agricultural tilling	± 15%	± 30%
Dirt airstrips	± 25%	± 30%

REFERENCES

1. Cowherd, C., Jr., K. Axetell, Jr., C. M. Guenther, and G. A. Jutze, Development of Emission Factors for Fugitive Dust Sources, prepared for the U.S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Contract No. 68-02-0619, Publication No. EPA-450/3-74-037, June 1974.

2. County and City Data Book 1972, a Statistical Abstract Supplement, U.S. Department of Commerce, Bureau of the Census, U.S. Government Printing Office, Washington, D.C. (1973).

3. Highway Statistics 1972, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., Table M-3, October 1973.

4. "Number of Miles and Annual Average Daily Vehicle Miles of Travel on Local Rural Roads in Kansas by County for the Year Ending December 31, 1972," State Highway Commission of Kansas Planning and Development Department, August 10, 1973.

5. Nebraska Highway Statistics State and Local Construction Mileage for 1972, Nebraska Department of Roads, Office of Engineering Services, Planning Division, Highway Statistics Unit, September 1973.

6. Arkansas Road and Street Mileages, Arkansas State Highway Department, Division of Planning and Research, in cooperation with the Federal Highway Administration, U.S. Department of Transportation, January 1, 1973.

7. "Miles of Unpaved Roads by County," estimated for North Dakota and South Dakota, personal communication from Charles Mann, U.S. Environmental Protection Agency, National Air Data Branch, July 23, 1974.

8. Climatic Atlas of the United States, U.S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service, U.S. Government Printing Office, Washington, D.C., June 1968.

9. 1972 Census of Construction Industries, Preliminary Report, U.S. Department of Commerce, Bureau of the Census.

10. 1969 Census of Agriculture, County Summary, Table 2, U.S. Department of Commerce, U.S. Government Printing Office, Washington, D.C.

11. "Major Soils of the North Central Region, U.S.A.," a map from Soils of the North Central Region of the United States, North Central Regional Publication No. 76, Bulletin 544, published by the Agricultural Experimental Station, University of Wisconsin, in cooperation with the U.S. Department of Agriculture, June 1960.

12. Soil Series of the United States, Puerto Rico, and Virgin Islands: Their Taxonomic Classification, Soil Conservation Service, U.S. Department of Agriculture, pp. 1-1 through 1-228, April 1972.

13. "Guide for Textural Classification in Soil Families," supplement to Soil Classification: A Comprehensive System, Seventh Approximation, Soil Survey Staff, Soil Conservation Service, U.S. Department of Agriculture, p. 40, March 1967.

14. "Soils of the Great Plains," soil map, copyright A.R. Aandahl, 1972, P. O. Box 81242, Lincoln, Nebraska.

15. "Distribution of Principal Kinds of Soils: Orders, Suborders, and Great Groups," a map from the National Atlas, Sheet No. 85/86, U. S. Geological Survey, Soil Conservation Service, Washington, D.C. (1967).

16. Soil Classification: A Comprehensive System, Seventh Approximation, Soil Conservation Service, U. S. Department of Agriculture, August 1960.

17. Thornthwaite, C. W., "Climates of North America According to a New Classification," Geograph. Rev., 21:633-655 (1931).

18. State maps, National Climatic Center, Asheville, North Carolina.

19. "Airport Services Tape," Federal Aviation Administration, Public Information Center, AIS 230, Washington, D.C. 20591.

20. Numerical Code for States, Counties, and Cities of the United States, IBM Manual C20-8073-0.

21. Fair, Don H., SAROAD Station Coding Manual for Aerometric Sampling Networks, U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, Publication No. APTD-0907, February 1972.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-74-085	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Emissions Inventory of Agricultural Tilling, Unpaved Roads and Airstrips, and Construction Sites		5. REPORT DATE November 1974
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Chatten C. Cowherd, Jr., Christine M. Guenther, and Dennis D. Wallace		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Midwest Research Institute 425 Volker Boulevard Kansas City, Missouri 64110		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-1437
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

To determine the air pollution impact of selected fugitive dust sources, a national emission inventory on a county-by-county basis was developed. Source categories included were unpaved roads, unpaved airstrips, heavy construction sites (road and building construction), and agricultural land tilling. Emission factors, which include correction factors to adjust for local climatic conditions and properties of emitting surfaces were calculated for each county based on the results from EPA Contract No. 68-02-0619. Measures of the extent of activity for each category were derived from available data. The methodology including procedures used to estimate missing data, is documented in the report. The source data were coded on National Emission Data System (NEDS) area source forms.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Emission Factors Correction Factors NEDS		

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 41
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (9-73)