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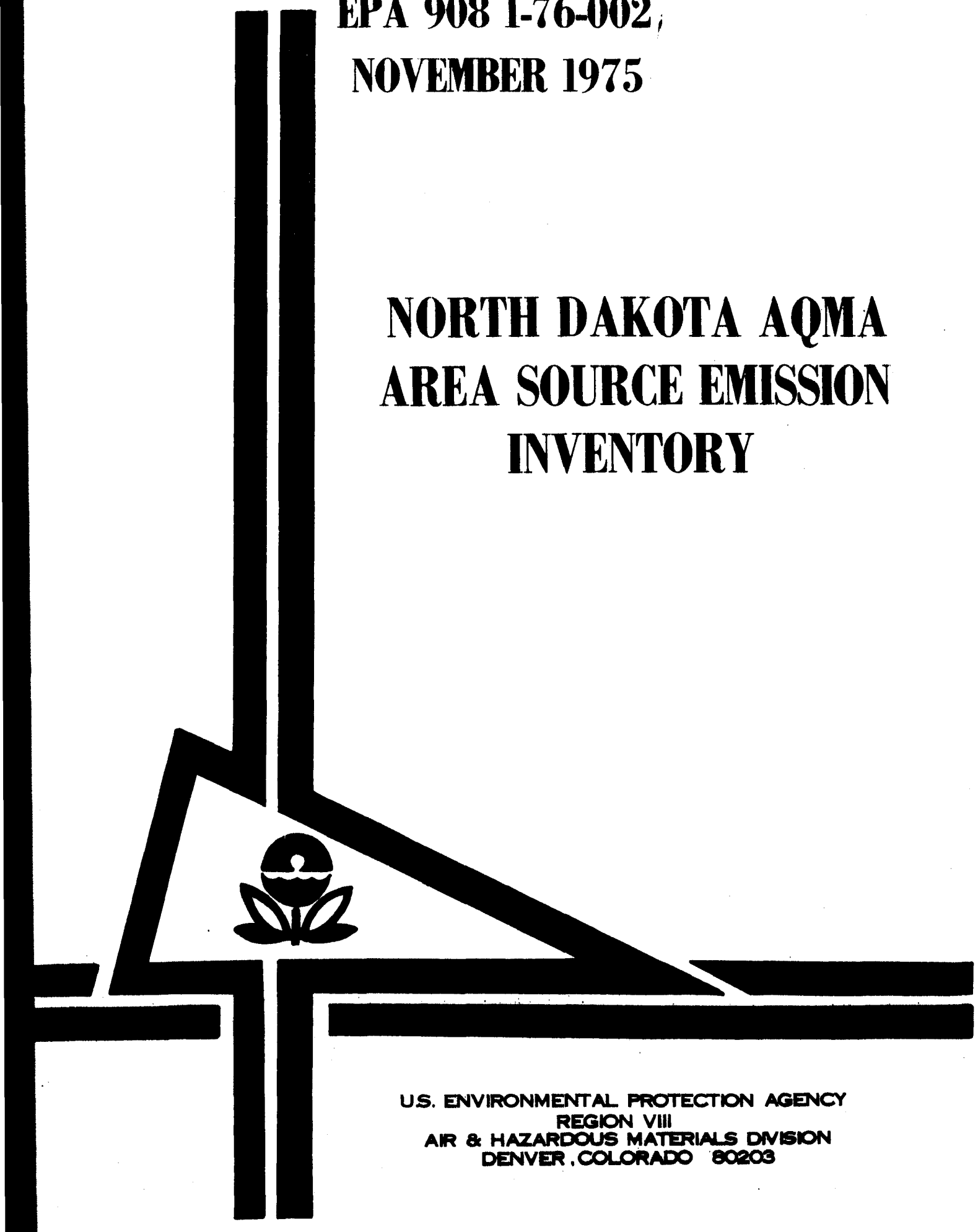
NORTH DAKOTA AQMA AREA SOURCE EMISSION INVENTORY



U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
AIR & HAZARDOUS MATERIALS DIVISION
DENVER, COLORADO 80203

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NORTH DAKOTA AQMA AREA SOURCE EMISSION INVENTORY

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Material included in this report was not originally intended for publication, but to document the data sources and assumptions made in preparing the area source emission inventory. Therefore, the text may be sketchy and the report more useful as a resource document than a general procedures manual for emission inventories. It should also be pointed out that the area source emission inventory is subject to frequent updating so that data presented herein may soon become obsolete.

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CONTENTS

TABLES

SUMMARY

This report presents a 1974 air pollutant emissions inventory of area sources in the two North Dakota Air Quality Maintenance Areas (AQMA's), plus projections of emissions in these areas for 1975, 1980, and 1985. The Fargo AQMA includes only Cass County and is designated only for particulates. The Natural Resource Development Area presently encompasses three counties--McLean, Mercer, and Oliver--and is designated for particulates, sulfur dioxide, nitrogen oxides, and oxidants. After the AQMA boundaries were originally set, plans to build coal gasification plants in Dunn County were announced, so this county has been added to the study area for the emissions inventory.

Designation of an AQMA by the North Dakota Department of Health and the U.S. Environmental Protection Agency indicates that there is a possibility that future growth in the area may cause the national ambient air quality standards to be exceeded despite enforcement of source control regulations. This area source inventory is to be used in a detailed analysis of each AQMA to better determine the impact of future growth on air quality.

A base year of 1974 was specified for the inventory in order that it be consistent with the time frame of the point source emission inventory also being prepared. At the time that the inventory was done, 1974 was the most recent year for which data could be obtained.

The area source categories included in the inventory are shown in Table 1 of this summary. The inventory includes

Table 1. AREA SOURCE PARTICULATE EMISSIONS FOR CASS COUNTY

Source category	Particulate emissions, ton/yr 1974	1975	1980	1985
Fuel combustion:				
1. Lignite coal	neg	neg	neg	neg
2. Distillate oil	109	110	114	119
3. Residual oil	92	92	113	131
4. Natural gas	11	11	12	14
5. LPG	3	3	3	3
6. Wood	2	2	2	2
Burning:				
7. Open burning	4	4	4	4
8. Incinerators	4	4	4	4
9. Agricultural burning	0	0	0	0
Mobile sources:				
10. Highway mobile sources	351	328	287	175
11. Off-highway vehicles	119	119	119	119
12. Aircraft	6	6	7	7
13. Railroads	34	40	61	82
Processes:				
14. Industrial processes	0	0	0	0
15. Evaporative losses	0	0	0	0
Fugitive dust:				
16. Unpaved roads	57,300	57,300	57,300	57,300
17. Agriculture	14,745	14,745	14,745	14,745
18. Construction	518	518	585	689
19. Mining	0	0	0	0
20. Paved roads	1,856	1,876	2,068	2,241
Total	75,154	75,158	75,424	75,635

all conventional source categories described in APTD-1135, Guide for Compiling a Comprehensive Emission Inventory, plus some additional categories of fugitive dust sources. For the source category of mining, no directly applicable emission factors were available so an estimate was developed based on data from a site visit to one of the surface mines.

The estimated annual particulate emissions in Cass County for each study year are summarized in Table 1. Particulate emissions for the base year and projection years in the four NRDA counties are presented in Table 2, and emissions of the other three pollutants (SO_2, nitrogen oxides, and hydrocarbons) in the NRDA counties are shown in Table 3. For source categories omitted in summary Tables 2 and 3, emissions are negligible in all the NRDA counties.

The survey data and methodology used to estimate emissions for each source category are documented in detail in the body of this report. Each category is discussed in a separate section and the procedures for estimating base year emissions are described separately from the procedures for projecting emission rates to future years.

The particulate area source categories with the greatest emissions are all fugitive dust sources. In every county, fugitive dust accounts for at least 99 percent of the inventoried area source emissions. Unpaved roads are by far the most significant source, with agriculture being the only other important source.

For the gaseous pollutants, motor vehicles, off-highway vehicles, and lignite coal combustion are generally the greatest contributors. However, area source emissions of SO_2, NO_x, and hydrocarbons are all quite small in the NRDA counties.

The emission projections do not show any trends or substantial changes in county-wide emissions associated with future growth and development in the AQMA's. For particulates, the stability in total emissions is due to the

Table 2. AREA SOURCE PARTICULATE EMISSIONS FOR NRDA COUNTIES

Source category	Particulate emissions, ton/yr															
	McLean County				Mercer County				Oliver County				Dunn County			
	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985
Fuel combustion:																
1. Lignite coal	63	62	56	51	130	127	115	104	53	52	47	42	64	63	57	51
2. Distillate oil	9	10	16	11	5	5	9	6	2	2	3	2	3	3	5	4
3. Residual oil	7	7	8	9	4	4	5	5	1	1	1	1	3	3	3	4
4. Natural gas	3	3	5	4	0	0	0	0	0	0	0	0	0	0	0	0
5. LPG	1	1	2	1	2	2	3	2	neg	neg	neg	neg	1	1	2	1
Burning:																
7. Open burning	5	5	5	5	neg	neg	neg	neg	5	5	5	5	11	11	11	11
Mobile sources:																
10. Highway vehicles	72	72	102	65	27	27	38	24	14	14	20	13	27	27	38	24
11. Off-highway	67	67	67	67	33	33	33	33	23	23	23	23	34	34	34	34
13. Railroads	4	5	7	10	1	1	2	2	1	1	2	2	1	1	2	2
Fugitive dust:																
16. Unpaved roads	39,610	39,610	39,610	39,610	16,180	16,180	16,180	16,180	10,240	10,240	10,240	10,240	19,770	19,770	19,770	19,770
17. Agriculture	4,679	4,679	4,679	4,679	3,439	3,439	3,439	3,439	2,551	2,551	2,551	2,551	4,221	4,221	4,221	4,221
18. Construction	39	171	0	0	96	0	835	96	96	160	0	0	0	0	643	0
19. Mining	0	0	0	1,725	1,587	1,587	4,904	5,635	437	437	1,256	1,256	0	0	0	2,300
20. Paved roads	267	284	597	406	96	102	220	149	45	49	110	73	86	92	180	139
Total	44,826	44,976	45,154	46,643	21,600	21,507	25,783	25,675	13,468	13,535	14,258	14,208	24,221	24,226	24,966	26,561

Table 3. AREA SOURCE EMISSIONS OF SO_2, HYDROCARBONS, AND OXIDES OF NITROGEN FOR AQMA COUNTIES

	Pollutant emissions, ton/yr											
	SO_2				HC				NO_x			
County/Source category	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985
McLean County:												
Lignite coal	39	38	34	31	3	3	3	2	16	16	14	13
Distillate oil	6	6	10	7	2	2	3	2	17	18	30	21
Residual oil	25	25	29	32	1	1	1	1	19	19	22	25
Natural gas	neg	neg	neg	neg	2	2	3	2	25	27	44	31
LPG	1	1	2	1	1	1	2	1	8	9	14	10
Open burning	neg	neg	neg	neg	9	9	9	9	2	2	2	2
Highway vehicles	32	33	59	43	1095	979	1312	563	736	770	1098	737
Off-highway vehicles	44	44	44	44	308	308	308	308	564	564	564	564
Railroads	10	12	18	24	17	20	31	41	66	78	119	160
Evaporative	0	0	0	0	96	101	162	105	0	0	0	0
Total	157	159	196	182	1534	1426	1834	1034	1453	1503	1907	1563
Mercer County:												
Lignite coal	81	79	71	65	5	5	5	4	32	31	28	25
Distillate oil	3	3	5	4	1	1	2	1	12	13	21	15
Residual oil	14	14	16	18	1	1	1	1	11	11	13	14
LPG	1	1	2	1	1	1	2	1	11	12	19	14
Open burning	neg	neg	neg	neg	1	1	1	1	neg	neg	neg	neg
Highway vehicles	12	13	22	16	413	369	495	212	277	290	413	277
Off-highway vehicles	22	22	22	22	153	153	153	153	281	281	281	281
Railroads	2	2	4	5	3	4	5	7	14	17	25	34
Evaporative	0	0	0	0	41	43	69	46	0	0	0	0
Total	135	134	142	131	619	578	733	426	638	655	800	660
Oliver County:												
Lignite coal	33	32	29	26	2	2	2	2	13	13	12	11
Distillate oil	1	1	2	1	neg	neg	neg	neg	8	9	14	10
Residual oil	5	5	6	6	neg	neg	neg	neg	3	3	3	4
LPG	neg	neg	neg	neg	neg	neg	neg	neg	3	3	5	4
Open burning	neg	neg	neg	neg	10	10	10	10	2	2	2	2
Highway vehicles	6	6	11	8	218	195	261	112	147	154	219	147
Off-highway vehicles	15	15	15	15	108	108	108	108	196	196	196	196
Railroads	2	2	4	5	3	4	5	7	11	13	20	27
Evaporative	0	0	0	0	19	20	33	22	0	0	0	0
Total	62	61	67	61	360	339	419	261	383	393	471	401
Dunn County:												
Lignite coal	40	39	35	32	3	3	3	2	16	16	14	13
Distillate oil	2	2	3	2	1	1	1	1	3	3	5	4
Residual oil	9	9	10	12	neg	neg	neg	neg	7	7	8	9
LPG	1	1	2	1	1	1	2	1	9	10	16	11
Open burning	1	1	1	1	20	20	20	20	4	4	4	4
Highway vehicles	12	13	22	16	417	373	500	214	216	226	322	216
Off-highway vehicles	23	23	23	23	160	160	160	160	290	290	290	290
Railroads	1	1	2	2	2	2	4	5	9	11	16	22
Evaporative	0	0	0	0	36	38	57	40	0	0	0	0
Total	89	89	98	89	640	598	647	443	554	567	675	569

prediction that neither of the major source categories, unpaved roads and agriculture, will change significantly during the next ten years. For the other pollutants, emissions due to increased development are projected to be offset by emission reductions from the Federal Motor Vehicle Emission Control Program.

1. LIGNITE COAL

BASE YEAR EMISSIONS

Consumption of coal by area sources in the five counties was estimated from contacts with all known retail coal distributors in these counties. Several small mines previously sold lignite to individuals in the Mercer-McLean-Oliver-Dunn area, but most of these had closed by 1974. Only two remaining retail distributors were located in these counties:[1,2]

North American Coal, Lignite Div., Zap - 15,000 tons locally

Consolidation Coal, Western Div., Stanton - 10,760 tons

The only retail distributor listed in the Fargo area had quit handling coal about a year ago and was not aware of any remaining coal-heated homes in Cass County.[3]

Consolidation Coal estimated that about 6000 tons were consumed in Mercer and Oliver Counties, and the remainder went to McLean County. North American Coal could not provide such a breakdown, but indicated that customers came from as far as Killdeer (Dunn) and Garrison (McLean). Therefore, the lignite sales from the two dealers were distributed to the four counties on the basis of number of homes heating with coal, obtained from the 1970 Census of Housing.[4] Since most of the sales were residential, emission factors for residential hand-fired units were applied to estimate emissions.[5]

Pollutant	Emission factor, lb/ton of lignite
Particulate	3A, or 24 with 8% ash
SO_2	30S, or 15 with 0.5% sulfur
HC	1
NO_x	6

County	1970 coal-heated homes	Coal consumption	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	196	neg	--	--	--	--
McLean	377	5,240	63	39	3	16
Mercer	779	10,820	130	81	5	32
Oliver	315	4,380	53	33	2	13
Dunn	383	5,320	64	40	3	16
Total, NRDA	1854	25,760				

The degree-day method of estimating space heating coal consumption could not be used to check the above data because no average values of lignite consumed per dwelling unit-degree day are available.

PROJECTIONS

Residential coal usage had been steadily declining in the NRDA area until 1973. The past two winters, total retail usage has remained almost constant. This is apparently due to increased costs and reduced availability of competitive fuels, and will probably continue through 1975. Longer term, no new homes will be heating with coal but few of the older homes will be converting to other fuels. A two percent annual attrition rate has been assumed.

2. DISTILLATE OIL

BASE YEAR EMISSIONS

Distillate oil consumption in AQMA counties was estimated by apportioning 1974 state totals obtained from Mineral Industry Surveys, Sales of Fuel Oil and Kerosene.[6] Although fuel oil sales by company were available from the State Laboratories Commission,[7] it was not possible to determine sales by county from this data because the major oil companies did not report sales by individual distributor.

Residential distillate oil usage (a portion of total heating oil usage) was first calculated based on degree-day heating requirements.[8] The average number of gallons of oil burned per dwelling unit per degree-day is 0.18.[8] The dwelling units in each county heating with oil, the average number of rooms per dwelling unit (compared to the national average of 5.0), the 1974 heating degree-days, and the estimated residential fuel oil consumption are shown below:

County	Oil heated homes	Av. rooms per dwelling	1974 heating degree-days	Residential fuel oil, 1000 gal
Cass	12,426	4.8	9,392	20,167
McLean	789	5.0	9,194	1,306
Mercer	353	4.9	9,194	573
Oliver	120	5.2	9,194	207
Dunn	342	5.0	9,194	566

Total distillate heating oil consumption (residential, commercial, and institutional) was obtained by apportioning the 1974 statewide total of 86,940,000 gal to each county in

proportion to its share of state population (1973 population data was considered to be sufficiently accurate for this purpose). Commercial-institutional distillate oil usage was then estimated as the difference between each county's total distillate heating oil consumption and its residential usage. These calculations are summarized below. This methodology indicated more fuel oil used for residential heating in Cass County than the county's proportion of total distillate heating oil, so no additional oil for commercial-institutional heating was assumed.

County	1973 population	1974 distillate heating oil, 1000 gal	1974 commercial-institutional distillate oil, 1000 gal
Cass	79,500	10,800	neg
McLean	11,700	1,590	284
Mercer	6,200	842	269
Oliver	2,400	326	119
Dunn	4,600	625	59
State	640,000	86,940	

Industrial usage of distillate oil was estimated by apportioning statewide industrial distillate oil usage of 4,872,000 gallons to the counties according to number of manufacturing employees.

County	1973 manufacturing employees	1974 industrial distillate oil, 1000 gal
Cass	2,421	1,150
McLean	40	19
Mercer	36	17
Oliver	0	0
Dunn	2	1
State	10,262	4,872

No point sources of distillate oil combustion were identified in the AQMA counties for subtraction from the

county totals. Therefore, the values shown represent area source fuel usage by category.

Emission factors for distillate oil combustion are presented below:[5]

Pollutant	Emission factor, lb/1000 gal
Particulate	
Residential	10
All other	15
SO_2 (0.05% av. S content)[7]	7
HC	3
NO_x	
Residential	12
All other	60

The resulting emissions from distillate oil combustion are summarized in the following table:

County	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	109	a	a	a
McLean	9	6	2	17
Mercer	5	3	1	12
Oliver	2	1	neg	8
Dunn	3	2	1	3

[a] not determined

PROJECTIONS

Most of the present distillate oil usage is associated with residential heating. Large price increases and questionable future availability for this fuel have reduced the desirability of oil heating. However, similar problems exist with alternative fuels, and natural gas is not even available in three of the five counties. Therefore, it is

assumed that fuel oil will continue to maintain its market share for new housing and fuel conversions, and that fuel oil usage will increase approximately in proportion to population in the AQMA counties.[9,10,11]

County	Growth factor 1975	1980	1985
Cass	1.01	1.05	1.09
McLean, Mercer Oliver, and Dunn	1.07	1.74	1.24

3. RESIDUAL OIL

BASE YEAR EMISSIONS

Residual oil consumption in AQMA counties was estimated by the same methodology as that used for distillate oil, except that there was no residential usage of residual oil. Thus, statewide residual heating oil for commercial-institutional use (30,954,000 gal) was apportioned to counties according to population and statewide residual oil for industrial use (17,682,000 gal) was apportioned to counties according to manufacturing employees. The county apportioning factors for the population and employment were presented in the previous section.

County	Residual heating oil, 1000 gal	Industrial residual oil, 1000 gal
Cass	3,845	4,172
McLean	566	69
Mercer	300	62
Oliver	116	0
Dunn	222	3

No point sources of residual oil combustion were identified in the AQMA counties for subtraction from the county totals. Therefore, area source residual oil usage is simply the sum of the heating oil and industrial oil gallonage in each county.

Emission factors for commercial or industrial residual oil combustion are summarized below.[5] The resulting emissions are also presented.

Pollutant	Emission factor, lb/1000 gal
Particulate	23
SO_2 (assume 0.5% av. S content)	78
HC	3
NO_x	60

County	Residual oil, 1000 gal	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	8,017	92	a	a	a
McLean	635	7	25	1	19
Mercer	362	4	14	1	11
Oliver	116	1	5	neg	3
Dunn	225	3	9	neg	7

[a] not determined

PROJECTIONS

Growth factors for residual oil consumption were derived from OBERS Projections of Regional Economic Activity in the U.S.[12] by assuming that future consumption would be proportional to projected activity in the manufacturing, wholesale and retail trade, services, and government sectors. The growth factors are summarized below.

County	Growth factor 1975	1980	1985
Cass	a	1.23	1.42
McLean, Mercer Oliver, and Dunn	a	1.16	1.30

[a] could not determine from available data, assume 1.0.

4. NATURAL GAS

BASE YEAR EMISSIONS

Consumption of natural gas by county for 1974 was obtained from records of the State Public Service Commission.[13,14] The data had been submitted to this agency by the two natural gas utilities operating in the AQMA's, Montana-Dakota Utilities (McLean) and Northern States Power (Cass). The natural gas sales were provided by community for three classes of customers--residential, commercial, and industrial.

There is no natural gas service in Mercer, Oliver, or Dunn Counties. Also, the sales data showed that there are no industrial rate customers in Cass or McLean Counties. Therefore, all natural gas combustion in the AQMA's falls within the category of domestic and commercial heating for emission calculation purposes, and has the following emission factors:[5]

Pollutant	Emission factor, lb/mmcf
Particulate	10.0
SO_2	0.6
HC	8.0
NO_x	100.0

Natural gas usage by point sources was subtracted from the county totals before calculating area source emissions from this category.

County	1974 nat. gas, mmcf	Pt. source totals, mmcf	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	3544	1370	11	a	a	a
McLean	501	0	3	neg	2	25
Mercer	0	0	0	0	0	0
Oliver	0	0	0	0	0	0
Dunn	0	0	0	0	0	0

[a] not determined

PROJECTIONS

Natural gas supplies appear to be adequate to provide for new customers in existing service areas,[15] but it is unlikely that distribution systems for residential/commercial customers will be expanded into the three remaining counties in the NRDA prior to 1985. Population projections are an adequate indicator of expected increases in natural gas demand. Growth factors based on county populations are summarized below:[9,10,11]

County	Growth factor 1975	1980	1985
Cass	1.01	1.05	1.09
McLean	1.07	1.74	1.24

5. LIQUEFIED PETROLEUM GAS

BASE YEAR EMISSIONS

The 1974 statewide consumption of liquefied petroleum gas (LPG) was 66,486,000 gal, of which 57,892,000 gal were for either residential or commercial use and 5,351,000 gal were used by industry.[16] Residential-commercial consumption by county was estimated from the ratio of dwelling units using LPG in the county to the state total.[4] It was assumed that the dwelling unit ratio for 1974 was the same as for 1970. Industrial consumption was estimated by the ratio of total county mining, contract construction, and manufacturing employees to the state total.[17]

The following emission factors were used to estimate emissions:[5]

Particulate	=	1.9 lb/1000 gal
SO_2	=	0.9 lb/1000 gal
HC	=	0.8 lb/1000 gal
NO_x	=	12.0 lb/1000 gal

County	1974 LPG consumption, 10^3 gal		Estimated 1974 emissions, ton/yr			
	Residential-commercial	Industrial	Partic	SO_2	HC	NO_x
Cass	2,147	1,285	3	a	a	a
McLean	1,283	22	1	1	1	8
Mercer	1,748	69	2	1	1	11
Oliver	471	6	neg	neg	neg	3
Dunn	1,488	4	1	1	1	9

[a] not determined

PROJECTIONS

Population projections[9,10,11] provide an adequate indicator of expected increase in LPG demands. Growth factors based on county populations are summarized below:

County	Growth factor 1975	1980	1985
Cass	1.01	1.03	1.09
McLean, Mercer, Oliver and Dunn	1.07	1.74	1.24

6. WOOD

BASE YEAR EMISSIONS

According to 1970 Census of Housing data,[4] there were 22 homes in Cass County heated by wood, but none in McLean, Mercer, Oliver, or Dunn Counties. It is assumed that approximately the same number of homes used wood for fuel in 1974. There were no data available to indicate that wood was consumed by commercial-institutional or industrial area sources in AQMA counties, so both were considered to be negligible.

The amount of wood burned in Cass County homes was estimated by the degree-day heating method.[8] The number of heating degree-days for 1974 in Fargo was 9392, the factor for average wood burned (tons) per dwelling unit per degree-day is 0.0017,[8] and the average number of rooms per dwelling unit in Cass County is 4.8.[4]

$$\text{Wood burned (ton/yr)} = \frac{4.8}{5.0} (22)(9392)(.0017)$$

$$= 337$$

The particulate emission factor for wood combustion in boilers is 10 lb per ton of wood. Using this factor, particulate emissions from home heating by wood in Cass County are estimated to be 2 tons per year.

PROJECTIONS

It is unlikely that wood will become a significant home heating fuel in the future or that any new homes will be heated with wood. On the other hand, there is no information to indicate the removal or conversion of existing units. Therefore, emissions from this category are projected to remain at 2 tons per year for all three projection years.

7. OPEN BURNING

BASE YEAR EMISSIONS

Open burning is prohibited in Cass County. However, 12 variances for specified burning were issued in 1974. From information on the variance request forms, the total amount of material burned was estimated to be 417 tons. With a particulate emission factor of 17 lb/ton for wood refuse, the 1974 emissions in Cass County were calculated to be 4 tons.

In the NRDA counties, open burning dumps and backyard burning both exist. The type of solid waste disposal in each town was determined from State Department of Health personnel.[18] For towns with open burning dumps and/or backyard burning (no sanitary landfill or private trash collection service), a factor of 3 lb/capita/day was used to estimate the amount of refuse generated and burned. The survey of towns did not account for all the population, so the assumption was made that in each county the same percentage of rural residents burned refuse as did persons living in the towns.

The estimated tons of refuse burned annually in each county is summarized below. Emission factors for open burning of municipal refuse were applied to calculate emissions.[5]

County	Refuse burned, ton/yr	Estimated emissions, ton/yr			
		Partic	SO_2	HC	NO_x
McLean	576	5	neg	9	2
Mercer	53	neg	neg	1	neg
Oliver	655	5	neg	10	2
Dunn	1343	11	1	20	4

PROJECTIONS

The State regulations permit open burning of refuse under specified conditions in areas with no municipal collection service. Therefore, some open burning should continue in low population density areas in the future. The trend toward improved disposal sites (with no burning) in small towns will probably be offset by population increases and higher per capita refuse generation rates so that total refuse burning will remain about constant through 1985.

Due to the nature of the variances for burning in Cass County, primarily for disposal of bulky demolition wastes and tree trimmings, it is likely that these periodic activities will also continue at about their 1974 level in future years.

8. INCINERATORS

BASE YEAR EMISSIONS

All companies which have requested a permit to operate an incinerator or have been issued a notice of violation have a source file in the State agency's office. The incinerator source files for the AQMA counties were reviewed and pertinent data extracted. Missing data were supplemented by estimates provided by agency staff.

There are 43 files for incinerators in Cass County. However, only 19 of these were still in operation during 1974, and all were multiple chamber. The amount of material charged annually into each of the 19 incinerators was estimated, and one of three emission factors was used to calculate particulate emissions:[5]

Type of incinerator	Emission factor, lb/ton
2 chamber with burner in one chamber	7
2 chamber, burners in both chambers or an afterburner	5
pathological waste incinerator	8

Total estimated emissions for the 19 incinerators were 4 ton/yr.

No incinerators were identified in McLean, Mercer, Oliver, or Dunn Counties.

PROJECTIONS

The recent trend in Cass County has been to shut down on-site incinerators and use dumpsters for solid waste disposal. However, this trend is expected to moderate because all of the remaining incinerators are in compliance with air pollution control regulations and will not require additional upgrading. Most incinerator operators probably will not change their method of disposal unless the economics of an alternate disposal method change or the facility moves or is renovated. Also, the possibility of new on-site incinerators exists. Therefore, it has been assumed that solid waste disposal in on-site incinerators will remain almost constant over the next ten years at the estimated 1974 level.

9. AGRICULTURAL BURNING

BASE YEAR EMISSIONS

County agricultural extension agents in each of the five counties were contacted to obtain estimates of the number of acres of stubble burned each year. None of the agents had seen any field burning within the past two years and all estimated that the numbers of acres burned within their counties were negligible. Therefore, pollutant emissions from this source category are also estimated to be negligible.

PROJECTIONS

A recent bulletin published by the North Dakota extension service[19] recommends that fields not be burned. This statement of progressive farming practices plus current lack of agricultural burning indicate that emissions from this category will continue to be negligible in future years.

10. HIGHWAY MOBILE SOURCES

BASE YEAR EMISSIONS

Information on motor vehicle travel was obtained from a State Highway Department publication, North Dakota Traffic Report, 1973.[20] This report is updated annually, but the 1974 edition was not yet available when the present emission inventory was prepared. It was assumed that the 1973 data are representative of 1974 because the general upward trend in annual vehicle-miles of travel (VMT) was moderated by the substantially higher costs of travel in 1974 compared to 1973.

Emissions were estimated by the procedure described in EPA's Compilation of Air Pollutant Emission Factors, Supplement 5.[21] Particulate and SO_2 emissions are each calculated as the product of annual VMT for the county and average emission factors per VMT (obtained from the above publication). For hydrocarbon and NO_x, the emission rates are a function of average vehicle operating speeds as well. Speeds were estimated by highway system (i.e., Interstate, Federal Aid Primary, State, County, other rural, and city streets). Therefore, VMT data were needed by highway system by county.

Emission factors vary for different vehicle types, so it was also necessary to determine the percent of total VMT traveled by each of four classes of vehicles--light duty vehicles (LDV), light duty trucks (LDT), heavy duty gasoline-powered vehicles (HDV), and heavy duty diesel (HDD).

Total annual VMT by county were obtained from the summary on page 59 of the North Dakota Traffic Report, 1973. The VMT by specific road system were compiled by adding values for city and rural travel as found on pages 57 and 60, respectively, and allocating any remaining unaccounted VMT among Federal Aid Primary, County FAS, and unincorporated city street systems in the ratio of 1:1:2.

The percentages of LDV, LDT, HDV, and HDD by road system for each county were assumed to be the same as statewide percentages derived from data on pages 53 through 56 of the report cited above. The following definitions for vehicle types were used:

LDV = passenger cars
LDT = panel and pickup trucks
HDV = 2-axle, 6 tire and 3-axle
HDD = semitrailers, full trailer combinations, buses

The VMT by county, road system, and vehicle type are summarized in Table 10.1.

Average speeds for each road system were estimated based on posted speed limits and speed measurements made by the State Highway Department:

Interstate	= 55 mph
FAP	= 55 mph
State, County FAS	= 55 mph
Other rural	= 35 mph
City streets	= 25 mph

The emission factors were calculated from test data presented in Compilation of Emission Factors, Supplement 5, and the following additional data:

Table 10.1. 1974 VEHICLE MILES OF TRAVEL IN AQMA COUNTIES

County	Vehicle type	Annual VMT x 10^3 by road type					
		Inter-state	FAP	State, FAS, County FAS	Other rural	City streets	Total
Cass	LDV	98,032	67,368	27,041	3,771	103,396	309,608
	LDT	37,564	19,468	19,316	8,353	19,421	104,122
	HDV	15,152	7,288	6,967	3,090	2,508	35,005
	HDD	17,632	4,421	1,254	801	94	24,202
	Total	168,380	98,545	54,578	26,015	125,419	472,937
McLean	LDV	-	22,180	14,007	8,690	3,743	48,620
	LDT	-	10,161	7,805	8,047	1,336	27,349
	HDV	-	4,643	3,122	3,018	267	11,050
	HDD	-	3,620	1,082	362	-	5,064
	Total	-	40,604	26,016	20,117	5,346	92,083
Mercer	LDV	-	7,798	5,679	3,090	1,618	18,185
	LDT	-	3,727	3,300	2,688	714	10,229
	HDV	-	1,722	1,280	1,008	123	4,133
	HDD	-	1,353	406	135	-	1,894
	Total	-	14,600	10,665	6,721	2,455	34,441
Oliver	LDV	-	2,244	4,814	2,433	205	9,696
	LDT	-	1,027	2,412	1,942	73	5,454
	HDV	-	453	933	803	15	2,204
	HDD	-	384	450	176	-	1,010
	Total	-	4,108	8,609	5,354	293	18,364
Dunn	LDV	-	8,367	4,455	4,787	863	18,472
	LDT	-	3,798	2,517	3,773	312	10,390
	HDV	-	1,651	1,007	1,500	40	4,198
	HDD	-	1,375	412	137	-	1,924
	Total	-	15,191	8,391	10,197	1,205	34,984

- Altitude = 1700 ft in NRDA (low altitude)
- Percent cold start = 20%

  Cold start correction = 1.0
- Distribution by model year[22] =

Age of vehicle	Passenger cars, %	Trucks, %
1	10.3	8.3
2	10.1	6.3
3	8.8	5.0
4	8.3	4.6
5	8.6	5.8
6	7.9	4.9
7	7.0	4.5
8	7.6	5.0
9	6.9	4.4
10 & older	24.5	51.2

- Mean temperature by season -

  Winter = 17

  Spring = 52

  Summer = 63

  Fall = 31
- Temperature correction factor by season -

	HC	NO_x
Winter =	1.62	1.28
Spring =	1.22	1.12
Summer =	1.10	1.07
Fall =	1.46	1.22

- Speed correction factors by road type -

	HC	NO_x
Interstate =	.56	1.23
FAP =	.56	1.23
State, County FAS =	.56	1.23
Other rural =	.65	1.14
City streets =	.83	1.05

The resulting emission factors are summarized in Table 10.2.

The annual emissions calculated with the VMT data and emission factors presented above are shown in Table 10.3.

Table 10.2. EMISSION FACTORS FOR NORTH DAKOTA

Vehicle type	Emission factor, gm/VMT			
	Partic	SO_2	HC	NO_x
LDV	0.56	0.13	7.68V[b] + 2.36[c]	4.47V
LDT	0.56	0.18	13.96V + 5.40	5.35V
HDV[a]	1.31	0.36	25.16V + 8.27	9.51V
HDD[a]	1.70	2.80	4.60	20.90

[a] assumes average of 8 tires per vehicle

[b] V = speed correction factor, specific for each highway system

[c] crankcase and evaporative emissions

Table 10.3. 1974 EMISSIONS FROM HIGHWAY MOBILE SOURCES

County	1974 VMT x 10^3	Estimated 1974 emissions, ton/yr			
		Partic	SO_2	HC	NO_x
Cass	472,937	351	a	a	a
McLean	92,083	72	32	1095	736
Mercer	34,441	27	12	413	277
Oliver	18,364	14	6	218	147
Dunn	34,984	27	12	417	216

[a] values not determined

PROJECTIONS

The VMT projections for the entire state were published in the North Dakota Traffic Report, 1973. These data indicated that VMT would increase at a faster rate than population during the next ten years, so that annual VMT per capita (statewide) would move from 6,558 in 1975 to 7,071 in 1980 and to 7,326 in 1985.

As shown in Table 10.4, there is considerable variation from the statewide average travel in different counties. Therefore, the base year values for VMT per capita in each county were modified by the projected percentage changes in statewide travel in future years. These modified values were multiplied by population projections to obtain projected annual VMT for each year. One additional assumption was made--that the predicted population growth in the NRDA counties would be evenly distributed among the four counties. The resulting VMT values are summarized in Table 10.4.

Emission factors for the projection years were derived by the same procedures as those used to determine the 1974 emission factors. The factors for future years are summarized in Table 10.5. In order to derive these values, the assumption was made that vehicle age distribution, temperature correction, etc. would remain the same as in the base year. Also, in calculating motor vehicle emissions, it was assumed that the percent of travel by vehicle type and average highway speeds would remain constant.

The annual emissions for each projection year were then calculated as the product of VMT and the appropriate emission factor. The emissions by county, projection year, and pollutant are shown in Table 10.6.

Table 10.4. PROJECTED VEHICLE MILES OF TRAVEL IN AQMA COUNTIES

Area	Year	Population	VMT x 10^6	VMT/capita
State	1975	645,000	4,230	6,558
	1980	659,000	4,660	7,071
	1985	692,000	5,070	7,326
State	1973-74	640,000	4,300	6,719
Cass	1973-74	79,500	472.9	5,948
McLean	1973-74	11,700	92.1	7,872
Mercer	1973-74	6,200	34.4	5,548
Oliver	1973-74	2,400	18.3	7,625
Dunn	1973-74	4,600	35.0	7,609
Cass	1975	80,300	466.0	5,805
	1980	83,400	522.0	6,260
	1985	86,700	562.3	6,485
McLean	1975	12,500	96.0	7,683
	1980	20,400	169.0	8,284
	1985	14,500	124.5	8,583
Mercer	1975	6,600	35.7	5,415
	1980	10,800	63.1	5,839
	1985	7,700	46.6	6,049
Oliver	1975	2,600	19.3	7,442
	1980	4,200	33.7	8,024
	1985	3,000	24.9	8,314
Dunn	1975	4,900	36.4	7,427
	1980	8,000	56.7	8,008
	1985	5,700	47.2	8,296

Table 10.5. EMISSION FACTORS FOR FUTURE YEARS

Vehicle type	Year	Emission factor, gm/VMT				
		Partic	SO_2	HC		NO_x
LDV[a]	1975	0.52	0.13	6.99V[c]	+ 2.24[d]	4.43V
	1980	0.36	0.13	3.98V	+ 1.69	2.40V
	1985	0.27	0.13	1.88V	+ 0.92	1.39V
LDT[a]	1975	0.52	0.18	13.15V	+ 4.33	5.38V
	1980	0.36	0.18	8.47V	+ 3.35	5.02V
	1985	0.27	0.18	5.15V	+ 1.78	4.59V
HDV[b]	1975	1.31	0.36	23.92V	+ 7.80	9.84V
	1980	1.31	0.36	18.72V	+ 6.80	10.26V
	1985	1.31	0.36	8.90V	+ 5.80	12.18V
HDD[b]	1975	1.70	2.80	4.6		20.90
	1980	1.70	2.80	4.6		20.20
	1985	1.70	2.80	4.6		20.20

[a] 1975 and later model year LDV and LDT are assumed to use unleaded fuel

[b] assumes average of 8 tires per vehicle

[c] V = speed correction factor, approximately the same as for 1974

[d] crankcase and evaporative emissions

Table 10.6. PROJECTED EMISSIONS FROM MOTOR VEHICLES

County	Year	Estimated emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	1975	328	a	a	a
	1980	287	a	a	a
	1985	175	a	a	a
McLean	1975	72	33	979	770
	1980	102	59	1312	1098
	1985	65	43	563	737
Mercer	1975	27	13	369	290
	1980	38	22	495	413
	1985	24	16	212	277
Oliver	1975	14	6	195	154
	1980	20	11	261	219
	1985	13	8	112	147
Dunn	1975	27	13	373	226
	1980	38	22	500	322
	1985	24	16	214	216

11. OFF-HIGHWAY VEHICLES

BASE YEAR EMISSIONS

This category includes gasoline- and diesel-powered equipment such as farm tractors, lawnmowers, construction equipment, snowmobiles, self-powered farm equipment, and electric generator units. The emissions were estimated based on fuel consumption and published emission factors per gallon of fuel used in specific off-highway equipment.

Data on statewide off-highway gasoline and diesel sales were available[22] because the tax on this fuel is either refunded or charged at a lower rate than for fuel used on-highway. In 1974, tax was refunded for 101,861,000 gal of gasoline sold for off-highway use. Tax was refunded on 7,807,000 gal of diesel fuel; this was assumed to be for construction equipment.

A total of 310,584,000 gal of diesel and fuel oil were subject to a $.02/gal nonhighway tax rate in 1974. This total included agricultural diesel fuel use, heating oil, industrial fuel oil, and railroad fuel. The statewide gallonages for heating, industrial, and railroad fuels were subtracted (236,208,000 gal according to Mineral Industry Survey report),[6] leaving 74,376,000 gal of diesel fuel sold for agricultural purposes.

The state fuel usage totals were allocated to the AQMA counties by two parameters--percent of tractors in the state (for agricultural fuel) and percent of heavy construction workers in the state (for construction fuel). In North Dakota, agriculture is the major off-highway fuel use.

According to a rough procedure for estimating fuel usage in areas where fuel sales data cannot be obtained,[8,a] agricultural uses would account for about 89 percent of the state's off-highway gasoline consumption and 88 percent of the off-highway diesel consumption.

Emission factors for off-highway sources were obtained from EPA's Compilation of Air Pollutant Emission Factors, Supplement 4.[5] Factors for agricultural fuels were derived by averaging the published factors for farm tractors and other farm equipment. Similarly, factors for construction equipment were developed by averaging the published emission factors for several different construction vehicles. The average emission factors are shown below:

Equipment	Emission factor, lb/1000 gal Partic	SO_2	HC	NO_x
Gasoline farm tractor	8.0	5.3	150	151
Other farm equipment, gasoline	6.9	5.3	162	99
Av. agricultural off-highway, gasoline-powered	7.4	5.3	156	125
Diesel farm tractor	45.7	31.2	61	335
Other farm equipment, diesel	51.3	31.1	57	307
Av. agricultural off-highway, diesel-powered	48.5	31.2	59	321
Ten diesel construction vehicles, range	14.8-46.5	31.1-31.2	13-51	240-524
Ten diesel construction vehicles, average	26.1	31.2	29	407

The estimated off-highway fuel use by county and resulting emissions are summarized in Table 11.1.

[a] 1000 gal/tractor, 13 gal/capita, 5000 gal/heavy construction employee; 60 percent of farm tractors gasoline-powered, 40 percent diesel-powered

Table 11.1. 1974 EMISSIONS FROM OFF-HIGHWAY VEHICLES

County	Off-highway gas., 1000 gal	Farm diesel, 1000 gal	Const. diesel, 1000 gal	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	4,162	3,039	2,270	119	a	a	a
McLean	3,087	2,254	46	67	44	308	564
Mercer	1,531	1,118	30	33	22	153	281
Oliver	1,078	787	14	23	15	108	196
Dunn	1,605	1,172	7	34	23	160	290

[a] not determined

PROJECTIONS

Since most of the off-highway fuel is used for agriculture-related purposes, fuel consumption will probably change approximately in proportion to farming activity. Projections for farming activity, developed in Section 17 of this report, are for relatively constant farm acreage over the next ten years in the AQMA counties.

The recent trend in statewide off-highway fuel sales has been a slight decrease, as shown below.[22]

Year	Off-highway gasoline, 1000 gal	Tax refunded diesel, 1000 gal
1965	115,110	5,930
1966	116,383	7,445
1967	109,990	7,408
1968	108,560	8,554
1969	112,542	11,684
1970	105,650	17,521
1971	104,922	10,194
1972	110,033	14,141
1973	105,442	11,947
1974	101,861	7,807

However, further declines in fuel sales are not anticipated, so emissions from off-highway vehicles in all projection years should be the same as in the base year.

12. AIRCRAFT

BASE YEAR EMISSIONS

The Hector Airport, Cass County, is the only commercial airport in the AQMA counties. There are no other airports of significance or any military airfields in these counties.

The number of landing and takeoff (LTO) cycles at Hector Airport by type of craft were obtained by direct contact with the airport manager.[23] The air carrier LTO cycles were divided into aircraft classifications by estimating 71 percent to be medium range jet and 29 percent turboprop.[24] General aviation was equally divided between single and twin engine aircraft.[23]

The 1974 particulate emissions from aircraft in Cass County are as follows:

Aircraft (engines)	Emission factor,[5] lb/engine-LTO	1974 LTO cycles[23]	Estimated 1974 emissions, ton/yr
Air carrier			
medium range jet (3)	0.41	3,224	2
turboprop (2)	1.10	1,317	1
Air taxi, piston (2)	0.02	1,327	neg
Military, jet (2)	0.31	5,924	2
General aviation			
piston (1)	0.02	19,276	neg
piston (2)	0.02	19,276	1
Total			6

PROJECTIONS

A master plan has been prepared for this airport projecting 65,500 LTO's in 1975 and 93,000 LTO's in 1980.[25] It should be pointed out that these appear to be optimistic projections. The airport manager reports LTO's to date in 1975 have declined slightly from 1974 when the total was 50,344.[23] In addition, the projected 1975 to 1980 increase in population for the city of Fargo is 4.6 percent,[9] while the master plan projects a 42 percent increase in LTO's over the same period. The 1980 master plan projections appear high, but they are the best available data.

The master plan did not make projections for 1985. The 1975 to 1985 population increase in the city of Fargo is estimated at 9.3 percent.[9] Since this is still well below the 1975 to 1980 projected increase in LTO's, it is estimated that the 1980 LTO's from the master plan are also valid for 1985. Air carrier and general aviation categories were separated into aircraft classifications by the same method as used for the 1974 data. The same emission factors were also used. The projected 1980 and 1985 emissions are as follows:

Aircraft (engines)	1980 and 1985 LTO cycles[25]	Estimated 1980 and 1985 emissions, ton/yr
Air carrier		
medium range jet (3)	4,438	3
turboprop (2)	1,812	2
Air taxi, piston (2)	1,850	neg
Military, jet (2)	4,300	1
General aviation		
piston (1)	40,300	neg
piston (2)	40,300	1
Total		7

The total 1980 and 1985 projected particulate emissions from aircraft in Cass County are therefore 7 ton/yr.

13. RAILROADS

BASE YEAR EMISSIONS

Emission estimates were based on fuel consumption by diesel locomotives in each county. The fuel consumption was estimated by a combination of methods, including use of data obtained from the railroad companies and the State Public Service Commission and allocation of statewide locomotive fuel sales as published in the Mineral Industry Surveys.[6]

For the three counties served only by a single Burlington Northern line from Mandan to Killdeer, the following information was obtained from the company:

- one train per day on this track (not one each direction)
- two locomotives per train
- average fuel consumption rate of 2 gal/mile/locomotive

Track mileages on this line in Oliver, Mercer, and Dunn Counties were scaled from the official state railroad map published by the Public Service Commission: 39, 51, and 35 miles, respectively.

Calculated fuel consumption is shown in the table below. These values are approximately 20 percent as high as estimates for the same counties obtained by allocating total statewide railroad fuel sales according to miles of track per county. This discrepancy is expected because of the extremely light traffic on this line; the values presented

in the table should be much more accurate than allocations of statewide totals.

County	1974 diesel fuel usage, 1000 gal	Estimated 1974 emissions, ton/yr Partic	SO_2	HC	NO_x
Cass	2693	34	a	a	a
McLean	356	4	10	17	66
Mercer	74	1	2	3	14
Oliver	57	1	2	3	11
Dunn	51	1	1	2	9

[a] not determined

McLean County is served primarily by Soo Line Railroad, with an east-west route and a north-south route through the county. Data submitted by Soo Line to the Public Service Commission indicated 1,904,600 locomotive unit-miles of travel in North Dakota in 1974. Soo Line has 1321 miles of track in North Dakota, 113 of which are in McLean County. If it is assumed that the track in this county receives an average amount of traffic, there would be 170,130 locomotive unit-miles in McLean County. With a fuel consumption rate of 2.0 gal/mile/locomotive, Soo Line's fuel usage is calculated to be 340,260 gal/year.

Burlington Northern has a line in McLean County that deadends at Turtle Lake. It has approximately the same operating conditions as the Mandan-Killdeer line, and runs for 11 miles in McLean County. Estimated diesel fuel usage is 16,060 gal/year.

In Cass County, Burlington Northern has a complex network of lines and switching yards with approximately 323 miles of track. Also, Chicago, Milwaukee, St. Paul and Pacific Railroad has 18 miles of track in the county. Because many of the lines in Cass County are more heavily traveled trunk lines, estimates of number of trains per day

could not be obtained. Therefore, the statewide fuel totals were used to estimate Cass County consumption based on the percentage of track mileage (341 miles out of 5192; 41 million gallons of locomotive fuel in North Dakota).

Emission factors per thousand gallons of fuel were from AP-42.[5] Area-wide emissions are summarized in the preceding table.

PROJECTIONS

While rail traffic in most parts of the country has shown a slight decrease or no change over the past few years, activity in North Dakota has greatly increased:[6]

Year	Fuel use in N.D. by railroads, 1000 bbl
1970	617
1971	413
1972	695
1973	976
1974	869

This is attributed to increased demand for and production of grain, the state's primary shipping commodity.

It is doubtful that further increases in grain shipping will sustain the recent rate of growth in rail use, but shipment of mechanical equipment and construction products into the energy development areas may provide an alternate source of growth in rail traffic, especially in the two AQMA's. Therefore, the 1970 through 1974 rate of increase in railroad fuel usage has been extrapolated to 1985 to obtain growth factors for railroad activity in the AQMA's:

Year	Projected fuel usage, 1000 bbl	Growth factor
1975	1034	1.19
1980	1568	1.80
1985	2101	2.42

14. INDUSTRIAL PROCESSES

All known industrial process sources in the AQMA counties with emissions of one ton/yr or more have been inventoried by the State Air Pollution Control Program. Pertinent emission data and stack parameters have been tabulated for each source. Because of the relatively few point sources in these counties, even the small sources can be considered individually in AQMA analyses rather than grouping them into an area source category. Therefore, emissions from the industrial processes area source category are negligible.

15. EVAPORATIVE LOSSES

BASE YEAR EMISSIONS

Evaporative hydrocarbon losses are attributed to gasoline handling, dry cleaning, surface coating, and degreasing operations.

The quantity of gasoline sold in the state for highway use in 1974 was 305,316,000 gal.[22] This was apportioned to county totals using the percent of travel by county.[20] To calculate emissions, the following emission factors were used:[5]

Filling underground storage tank = 7.30 lb/1000 gal
Filling motor vehicle, vapor loss = 11.00 lb/1000 gal
Filling motor vehicle, liquid spillage = 0.67 lb/1000 gal

The total emission factor used was therefore 19 lb/1000 gal.

County	1974 highway gasoline usage, 1000 gal	Estimated 1974 HC emissions from gas handling, ton/yr
McLean	6,534	62
Mercer	2,443	23
Oliver	1,313	12
Dunn	2,473	23

Dry cleaning solvent losses have been estimated at 2.7 lb/person/yr in colder climates.[8] Solvent usage for surface coatings and degreasing has been estimated at 3 lb/person/yr

in counties with a population less than 100,000. Census estimates for 1973 were projected to 1974 assuming the same rate of change as from 1970 to 1973.[4]

County	1973 population	Growth factor	Estimated 1974 population	Estimated 1974 solvent emissions, ton/yr
McLean	11,700	1.01	11,800	34
Mercer	6,200	1.00	6,200	18
Oliver	2,400	1.01	2,400	7
Dunn	4,600	0.98	4,500	13

PROJECTIONS

Gasoline usage in future years is expected to increase due to greater VMT, but also to decrease somewhat per VMT because of more efficient automotive engines in new vehicles. The VMT projections from Section 10 of this report were used in estimating growth factors. However, no data on average gasoline mileage rates for future vehicle fleets were discovered, so the assumption was made that gasoline consumption per VMT will decrease 10 percent by 1980 and 25 percent by 1985. The gasoline usage by county calculated with these data are shown below.

The emission factor of 19 lb/1000 gal was used to estimate projected gasoline handling emissions.

County	Highway gasoline usage, 1000 gal			Estimated HC emissions from gas handling, ton/yr		
	1975	1980	1985	1975	1980	1985
McLean	6,811	10,791	6,624	65	103	63
Mercer	2,535	4,033	2,482	24	38	24
Oliver	1,385	2,176	1,340	13	21	13
Dunn	2,572	3,606	2,501	24	34	24

Emissions from dry cleaning solvent losses, surface coating operations, and degreasing in the base year were

estimated on a per capita basis. Therefore, it is reasonable to project that these emissions will increase in proportion to population. The NRDA population growth factors of 1.07 for 1975, 1.74 for 1980, and 1.24 for 1985 were applied to the 1974 emission estimates for each county to calculate the projected emissions.

16. UNPAVED ROADS

BASE YEAR EMISSIONS

Information on travel on unpaved roads was obtained primarily from two State Highway Department publications, North Dakota Highway Statistics[22] and North Dakota Traffic Report.[20] The number of miles of unpaved road surfaces by county was reported on pages 9 and 10 of the former document, and is summarized for the AQMA counties in Table 16.1.

In order to estimate traffic volumes on the unpaved roads, county VMT totals for the road systems generally consisting of unpaved roads (i.e., county FAS, other rural roads, unincorporated village streets) were obtained from the North Dakota Traffic Report. These data are also presented in Table 16.1.

The VMT on paved roads in these systems were subtracted by first assuming that the VMT on unpaved roads averaged only half that of paved roads in the same system. For example, 93 percent of the county FAS road mileage in Mercer County is unpaved (see Table 16.1). Therefore, it was assumed that $\frac{.93}{.93+(2)(.07)}$, or 87, percent of the total VMT on county FAS roads in Mercer County occurs on unpaved roads.

The emissions per vehicle-mile were estimated by the method described in Compilation of Air Pollutant Emission Factors, Supplement 5:[21]

Table 16.1 TRAVEL ON UNPAVED ROADS

	County				
	Cass	McLean	Mercer	Oliver	Dunn
Road mileage, mi					
County FAS					
unpaved	320	299	191	113	258
total	568	355	206	113	258
% unpaved	56	84	93	100	100
Other rural roads					
unpaved	2,452	1,412	584	430	848
total	2,507	1,426	589	436	849
% unpaved	98	99	99	99	100
Village streets					
unpaved	12	10	3	1	3
total	20	12	3	1	3
% unpaved	60	83	100	100	100
VMT, 10^3/yr					
County FAS					
total	43,778	13,080	6,364	2,468	4,671
unpaved	17,025	9,472	5,531	2,468	4,671
Other rural roads					
total	26,015	20,117	6,721	5,354	10,197
unpaved	24,995	19,719	6,588	5,248	10,197
Village streets					
total	263	991	92	11	53
unpaved	113	703	92	11	53
Total VMT on all unpaved roads	42,133	29,894	12,211	7,727	14,921

$$EF = (0.6)(0.81)(s)(S/30)(1-W/365) \qquad \text{(eq.1)}$$

where EF = emission factor, lb/VMT

0.6 = average fraction of emitted particulate in the suspended particulate size range (less than 30 μ diameter)

s = silt content, percent

S = average vehicle speed, mph

W = days with 0.01 inch or more of precipitation or reported snow cover

The percent silt on gravel road surfaces was estimated to be 12 percent based on analytical data presented in the EPA publication, Development of Emission Factors for Fugitive Dust Sources.[26] For graded and drained road surfaces, no aggregate material is applied to the roadbed so it is composed of compacted native soil. The fine material originally on the surface is probably rapidly removed by turbulance from passing vehicles or by wind and water erosion forces. The remaining stable surface is composed of sand- and pebble-sized particles, with dust being generated primarily by the continuing mechanical breakdown of these particles as a result of traffic. It is assumed that the percent of silt-sized particles on a seasoned dirt road surface is approximately the same as that for gravel, or 12 percent.

No measurements were available for average speeds of vehicles on unpaved roads in North Dakota. Based on conversations with State Highway Department staff, a value of 30 mph has been used for unpaved roads in all road systems.

The number of days with 0.01 inch or more of precipitation and the days with snow cover were estimated from the National Weather Service 1974 Climatological Summary for the nearest NWS station. The resulting values for W and emission factors by county are presented below.

Total emissions from unpaved roads in each county were calculated by simply multiplying estimated VMT on unpaved roads by the emission factor for that county. The emissions from unpaved roads are also summarized below.

County	Days with rain or snow cover	EF, lb/VMT	1974 partic emissions, ton/yr
Cass	195	2.72	57,300
McLean	199	2.65	39,610
Mercer	199	2.65	16,180
Oliver	199	2.65	10,240
Dunn	199	2.65	19,770

PROJECTIONS

Current State Highway Department projections of statewide VMT on all roads show the same upward trend as that observed during the past ten to fifteen years.[22] Therefore, VMT on unpaved roads have been projected by extrapolating the past rate of increase.

Energy-related development in the Mercer-McLean-Oliver AQMA should not increase VMT on rural local roads substantially, as most of the travel generated during construction and operation should be on state highways. Also, higher vehicle operating costs should have a minimal impact in reducing VMT on local rural roads because most of the trips on these roads are essential, short-distance trips.

The VMT on local rural roads and unincorporated village streets statewide have increased approximately linearly an average of 17.6×10^6 VMT/yr since 1959. With this constant rate of increase, percentage increases from the 1974 base year would be 1.5 percent by 1975, 8.9 percent by 1980, and 16.3 percent by 1985. Projections by county could not be made with available data.

The planned paving of some of the local roads would offset the effect on emissions from unpaved roads resulting

from increased VMT. The total mileage of local roads in the state has remained almost constant over the past ten years, as shown on page 13 of the 1974 North Dakota Highway Statistics.[22] However, about 190 miles of local roads in the state have been paved each year during this period. While this is an annual rate of 0.25 percent of the local road miles (much less than the annual rate of increase in VMT on local roads), the VMT carried on the roads that are paved would be a higher percentage because heavily travelled roads are selected for paving first. Therefore, within the accuracy of the projection data, net VMT on unpaved roads statewide are not expected to change in the next ten years. Growth factors would be 1.0 for 1975, 1980, and 1985.

17. AGRICULTURE

BASE YEAR EMISSIONS

Wind erosion and tilling operations both cause dust emissions on active agricultural land. On an annual basis, emissions due to wind erosion are much greater than those from tilling. Therefore, only the emissions from wind erosion are considered for this source category.

The number of acres subject to wind erosion was determined from published North Dakota crop statistics.[27] The number of acres of each crop type planted in each county is summarized below:

	1974 acres planted				
Crop	Cass	McLean	Mercer	Oliver	Dunn
Corn	16,800	5,700	15,500	13,200	18,200
Wheat	423,200	337,100	106,500	49,300	119,100
Oats	19,000	52,800	32,800	26,400	49,800
Barley	129,100	21,800	9,000	6,400	11,700
Rye	2,900	2,600	300	200	300
Soybeans	89,300	-	-	-	-
Sugar beets	18,400	-	-	-	-

An adaptation of the U.S. Department of Agriculture's wind erosion equation was used to calculate an emission factor in tons per acre per year for wind erosion losses. The modified equation for estimating suspended particulate emissions is:[26]

$$E = a\ I\ K\ C\ L'\ V' \qquad \text{(eq.2)}$$

where E = emission factor, ton/acre/yr

a = portion of total wind erosion losses that would be measured as suspended particulate, estimated at 0.025

I = soil erodibility, ton/acre/yr

K = surface roughness factor

C = climatic factor

L' = unsheltered field width factor

V' = vegetative cover factor

In this equation, K, C, L', and V' are all dimensionless. The K, L', and V' are functions of the crop being grown, and the climatic factors (C) for Cass County and the NRDA are 0.3 and 0.5, respectively. In both areas, the predominant soil types as shown on U.S. Geological Survey soil maps have an erodibility (I) of 47 ton/acre/yr.

The calculated emission factors for each crop are summarized below:

	Emission factor, ton/acre/yr	
Crop	Cass	NRDA counties
Corn	0.050	0.120
Wheat	0.003	0.008
Oats	0.007	0.018
Barley	0.005	0.015
Rye	0.003	0.008
Soybeans	0.110	a
Sugar beets	0.110	a

[a] no crop acreage, so value not determined

The emission factors were multiplied by corresponding crop acreages in each county to arrive at total annual emissions from agriculture:

County	Estimated 1974 partic emissions, ton/yr
Cass	14,745
McLean	4,679
Mercer	3,439
Oliver	2,551
Dunn	4,221

PROJECTIONS

The number of acres statewide in farmland has not changed significantly during the past 15 years--42.1 million in 1960, 41.8 million in 1970, and 41.6 million in 1975.[27] County extension agents indicated that neither urbanization in Cass County nor mining development in the NRDA counties has reduced total crop acreage in these counties.

This trend of constant acreage is expected to continue over the next 10 years, especially given the strong demand for grain and shrinking reserves during the past few years. Any losses in cropland resulting from land development would probably be offset by more intensive agricultural use of the remaining land in that area, as evidenced by the recent downward trend in number of farm acres (statewide) allowed to remain fallow in the summer:[27]

1972 - 9.5 million
1973 - 7.8 million
1974 - 7.5 million

Emissions from agriculture in all projection years are assumed to be the same as in the base year.

18. CONSTRUCTION

BASE YEAR EMISSIONS

In Cass County, data on building permits issued[28] were used to estimate the number of acres of building construction in 1974. The number of permits issued for each category, the assumed average area with regrading, and the assumed duration of construction are summarized below:

Type construction	No. of permits	Av. area, acres	Av. duration, months	Acre-months of construction
One & two family residential	309	0.17	3	155
Apartments	28	0.50	4	56
Commercial & institutional	51	1.00	8	408
Industrial	13	2.00	8	208

In the NRDA counties, building permits are not required. However, with the exception of the two power plants under construction in 1974 (the Basin unit at Stanton and the Minnkota unit at Center), building construction was probably negligible. The estimated active construction area at each of these plants was 20 acres, and duration was about eight months.

Information on highway construction during 1974 was provided by the State Highway Department, Construction Section:[29]

County	Miles of road construction with grading[a] 1974	1975
Cass	1.5	2.7
McLean	9.0	17.3
Mercer	0	4.1
Oliver	0	0
Dunn	0	0

[a] all two lane roads except 10% of mileage in McLean County, which is four lane divided

With average regrading width of 50 feet (150 feet for four lane divided) and active construction period of four months, the miles of highway construction were converted to acre-months of construction.

A particulate emission factor of 1.2 ton/acre-month of construction[21] was used to estimate fugitive dust emissions for this category. Also, a 50 percent reduction for watering[21] has been used because this control method is commonly employed on large construction projects. The estimates are summarized below:

County	Acre-months of heavy construction	Estimated 1974 particulate emissions, ton/yr
Cass	863	518
McLean	65	39
Mercer	160	96
Oliver	160	96
Dunn	0	0

PROJECTIONS

For Cass County, future construction activity was projected based on OBERS economic projections[12] of contract construction earnings for 1980 and 1985 in the Fargo Standard Metropolitan Statistical Area compared to earnings for 1975. The resulting growth factors for this source category were 1.13 for 1980 and 1.33 for 1985.

For the NRDA counties, construction projections were made from available information on proposed major construction projects. As with the base year emission estimates, the assumption was made that residential and commercial construction would be inconsequential in comparison with the large industrial construction projects. Also, highway construction activity will probably be very small in comparison with industrial construction in the NRDA counties.[30]

The environmental impact report for Michigan Wisconsin Pipe Line's coal gasification plant indicated that 535 acres would be required for construction during the years 1977 to 1980. If one-fourth of the total area is under construction in each of the four years and the construction season is eight months, then 134 x 8 = 1072 acre-months of construction would occur during any of these years. The same level of construction activity has been assumed for the Natural Gas Pipeline coal gasification plant, but for the years 1978 to 1981.

Several power plant units are scheduled for construction during the projection years. For each of these units, 20 acres of active construction have been assumed for eight months of the years in which the plant is to be under construction. The Minnkota plant at Center will be completed in 1977; the United Power plant at Underwood will be under construction from 1975 to 1979; the MDU plant at Beulah will have two units built consecutively from 1977 through 1985; and Basin Electric will construct a new plant in Mercer County from 1978 to 1981.

Emission estimates for construction activities in 1975, 1980, and 1985 are summarized below:

County	Estimated particulate emissions, ton/yr 1975	1980	1985
Cass	518	585	689
McLean	171	0	0
Mercer	0	835	96
Oliver	160	0	0
Dunn	0	643	0

19. MINING

BASE YEAR EMISSIONS

Fugitive dust emissions from mining occur at the lignite strip mines in the NRDA counties. Information on the tons of coal and acres mined was obtained from the State Planning Division's Coal Impact Project Report,[31] contacts with the mining companies, and the Northern Great Plains Resource Program reports.[32] Data from different references were in good agreement; all assumed the addition of two coal gasification plants and approximately 4000 megawatts of coal-fired power plant capacity as major new coal consumers in the NRDA prior to 1985. Estimated annual production by mine for 1974, 1980, and 1985 is summarized below:

		Coal production, 10^6 ton/yr			Acres/yr mined		
Mine	County	1974	1980	1985	1974	1980	1985
Knife River	Mercer	0.8	3.1	5.6	54	212	371
North American, Beulah	Mercer	0.9	0.9	0.9	54	54	54
North American, Fallkirk	McLean	-	-	5.5	-	-	375
Consolidation	Mercer	3.0	3.8	3.8	237	300	300
Baukol-Noonan	Oliver	1.5	4.3	4.3	95	273	273
Mich-Wis Coal gasification	Mercer	-	12.0	12.0	-	500	500
Nat Gas Pipeline gasification	Dunn	-	-	13.0	-	-	500

Emission estimates were based on a factor developed from a survey[33] of one of the mines--Consolidation Coal in Stanton. At this strip mine, the major dust sources identified were:

Scrapers for topsoil removal	-	59 ton/yr
Dragline operation	-	800
Haul road traffic	-	204
Haul road repair and construction (graders)	-	22
Shovels and front-end loaders	-	38
Vehicle exhaust	-	15
Truck dump	-	38
Wind erosion	-	192
Total	-	1,368 ton/yr

Since most of the estimated emissions were associated with overburden removal (scrapers, dragline) and surface wind erosion rather than coal removal, it was determined that the most representative general emission factor would be in terms of acres mined rather than tons of coal mined. The mine surveyed was being mined at a rate of 300 acres/yr at the time of the visit, for a particulate emission factor of 4.6 ton/acre.

Battelle Memorial Institute has also studied air pollution emissions from strip mining[34] and found overburden removal to be the major source. Their study proposed an emission factor of 0.1 lb/ton of overburden. For an average overburden depth of 60 ft and a soil density of 100 lb/ft^3, this is equivalent to 6.5 ton/acre, which is in good agreement with the value derived above.

Using the emission factor of 4.6 ton/acre for the other mines, the 1974 particulate emissions by county are:

County	Estimated 1974 particulate emissions, ton/yr
McLean	-
Mercer	1,587
Oliver	437
Dunn	-

PROJECTIONS

By using the projected mining rates for 1980 and 1985 presented above and the same emission factor, estimated emissions can be calculated directly. These are summarized below:

	Estimated particulate emissions, ton/yr	
County	1980	1985
McLean	-	1,725
Mercer	4,904	5,635
Oliver	1,256	1,256
Dunn	-	2,300

20. DUST FROM PAVED ROADS

BASE YEAR EMISSIONS

Very little information exists on emission rates or procedures for estimating dust emissions from paved streets and highways. The American Public Works Association, Midwest Research Institute, and other groups are currently conducting studies to obtain data on the air pollution impact of reintrained dust from roads.

Until more definitive data become available, it is assumed that these emissions are directly proportional to the amount of traffic (VMT) on the streets.

The VMT data for the AQMA counties have already been generated to estimate exhaust emissions. The VMT on unpaved roads (also already estimated) were subtracted from the VMT totals to obtain VMT on paved roads. These data are summarized below:

County	1974 Annual traffic on paved roads, 1000 VMT
Cass	430,804
McLean	62,189
Mercer	22,230
Oliver	10,637
Dunn	20,063

In North Dakota, the normal amount of loose material on road surfaces is increased substantially by the periodic sanding of roads during the winter for snow and ice control. All roads maintained by the State Highway Department and

major streets in most municipalities are sanded. Since none of the sand is removed by street cleaners until spring, any day during the winter when the road surfaces are dry would be subject to higher emission rates due to sand on the paved roads. Review of 1974 weather records for Fargo and Bismarck and discussions with local street department personnel indicate about 15 such days in December through April.

An emission factor of 1.75 gm/VMT on days with no precipitation or snow cover has been used in a previous emission inventory.[35] It was based on a single test of a clean paved road in the Seattle area.[36] Data from a different test site in the same Seattle study indicated an emission rate of 77 gm/VMT for streets with sand and dirt on them.

If the emission factor of 77 gm/VMT is applied to the VMT for 15 days and the factor of 1.75 gm/VMT to the remaining days of the year with no precipitation or snow cover (155 in Cass County, 151 in NRDA counties), particulate emissions from paved roads are calculated to be:

	Estimated 1974 particulate emissions, ton/yr		
County	Dry winter days	Remainder of yr	Total
Cass	1,503	353	1,856
McLean	217	50	267
Mercer	78	18	96
Oliver	37	8	45
Dunn	70	16	86

It should be emphasized that the calculations in this section do not have the same accuracy as those in other sections of this report, and that the resulting emissions estimates are only order-of-magnitude values.

PROJECTIONS

The VMT projections from Sections 10 and 16 provide the necessary input data for projecting emissions from this source category. The emission factors should remain the same in the projection years.

County	Annual traffic on paved roads, million VMT			Estimated partic emissions, ton/yr		
	1975	1980	1985	1975	1980	1985
Cass	435.5	479.9	520.2	1876	2068	2241
McLean	66.1	139.1	94.6	284	597	406
Mercer	23.5	50.9	34.4	102	220	149
Oliver	11.6	26.0	17.2	49	110	73
Dunn	21.5	41.8	32.3	92	180	139

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16. ABSTRACT

This report contains emission estimates for non point sources of air pollution in AQMA counties of the State of North Dakota. Estimates for particulates, sulfur oxides, hydrocarbons and oxides of nitrogen emissions are made for the base year (present), 1980 and 1985. Methodologies and data sources are presented.

17. KEY WORDS AND DOCUMENT ANALYSIS

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