REGIONAL COPPER-NICKEL STUDY

COPPER-NICKEL STUDY REGION POINT SOURCE EMISSIONS INVENTORY FOR PARTICULATE AND SULFUR DIOXIDE EMISSIONS

Minnesota Environmental Quality Board

Level 1-2 Report

Ingrid Ritchie

July, 1978

TABLE OF CONTENTS

	Page
Point Source Inventory	1
Sulfur Dioxide	2
Particulates	4
Stack Parameters	5
Geographic Comparisons of Sulfur Dioxide and Particulate Point Source Emissions	7
Sulfur Dioxide	7
Particulates	9
References	11

LIST OF TABLES

Table 1. Regional emission inventory for sources emitting greater than 100 metric tons per year of SO_2 or particulates.

Table 2. Point source regional emission inventory summary for particulates and sulfur dioxide (MTPY).

Table 3. Sulfur dioxide regional emissions inventory for point sources emitting more than 100 MTPY.

Table 4. Particulate regional emissions inventory for point sources emitting more than 100 MTPY.

Table 5. Representative slack data for regional emissions inventory point sources.

Table 6. 1976 point source SO_2 emission inventory summary by source category for the Copper-Nickel Study Region and the seven-county Metropolitan Area (metric tons per year).

Table 7. 1976 point source particulates emission inventory summary by source category for the Copper-Nickel Study Region and the seven-county Metropolitan Area (metric tons per year).

LIST OF FIGURES

Figure 1. Regional emissions inventory locations.

Figure 2. Source category contributions to sulfur dioxide emissions by location.

Figure 3. Regional SO_2 point source emissions inventory, baseline (1975-76) and projected (1985).

Figure 4. Source category contributions to particulate emissions by location.

Figure 5. Regional particulate point source emissions inventory, baseline (1975-76) and projected (1985).

POINT SOURCE INVENTORY

The emissions inventory includes point sources emitting more than 100 MTPY sulfur dioxide (SO_2) or total suspended particulates (TSP) within a 100 kilometer radius of the copper-nickel resource area (Figure 1) for the base period 1975-76 and the projected period 1985. Point sources in northeastern Minnesota, northwestern Wisconsin and southern Ontario are included in the inventory. Area sources such as fugitive emissions from tailings basins, unpaved roads, and space heating requirements and line sources such as traffic are not included and will be discussed in another section.

The base year period 1975-76 was selected because it is the most recent year that the state inventory was both complete and available in computerized form, and it corresponds closely to the baseline ambient air quality data which were collected during 1976-77. 1985 was the latest year for which emissions projections could be based on expansion plans for industrialization in the region or on possible enforcement actions by the Minnesota Pollution Control Agency. 1985 is also the earliest anticipated date that a smelter complex might be operational.

The baseline ambient air quality data, baseline emissions inventory and projected emissions inventory are used in the air quality modeling to determine the effect of regional emissions both with and without smelter emissions on the atmospheric concentration and deposition of SO_2, sulfate, and particulate. The comparison of these results will demonstrate potential atmospheric impacts of a copper-nickel smelter.

Table 1 is a listing of sources which were included in the point source inventory. Baseline emissions were estimated directly from stack tests when the data were available. Emissions data were also taken directly from inventories of emissions data which are compiled by Minnesota and Wisconsin from questionnaires sent to major emitters of air pollutants.

Projected emissions are based on proposed source changes in the Study Area including expansions in the power generation and taconite industries, additions to pollution control systems, fuel conversions such as the change from gas to coal in the taconite industry and the shut-down of some sources.

Sources for baseline and projected emissions data include the Minnesota Pollution Control Agency, Minnesota Energy Agency, Wisconsin Department of Natural Resources, and the Ontario Ministry of the Environment.

Sulfur dioxide

Table 2 provides an overall comparison between baseline and projected sulfur dioxide emissions. Table 3 and Figure 2 give a breakdown of emissions by source categories (power generation, taconite processing, grain elevators, refineries and commercial-industrial) and by geographic area (Minnesota, Wisconsin and Canada).

Point source sulfur dioxide emissions (Table 2) are expected to increase 132% over the next ten years. This dramatic rise can be traced directly to proposed growth in the power generation and taconite industries (Table 3 and Figure 2). The taconite companies are planning on a steady expansion which would result in an additional taconite pellet processing capacity of 36.3 million metric tons per year increase over the 1976-77 capacity of 56.6 million metric tons per year, requiring 1300 megawatts of additional

electrical power availability in northeastern Minnesota. In addition, taconite companies are converting their operations from natural gas to coal or synthetic gas made from coal. (Coal can emit 2000 times more SO_2 than natural gas to supply an equivalent amount of energy.)

If the planned taconite expansions and fuel conversions are implemented in Minnesota, sulfur dioxide emissions from these sources could increase by 111900 MTPY by 1985 (from 84820 MTPY to 196700 MTPY, a 132% increase). This increase is partially offset, however, by the planned closing of two taconite mines near Atikokan, Ontario, which will result in a sulfur dioxide emissions decrease of about 13620 MTPY. On a regional basis sulfur dioxide emissions from the taconite industry are projected to increase 35% by 1985 (Table 3).

The 99760 MTPY increase (242%) in SO_2 emissions from the power generation industry will be due primarily to 53060 MTPY (53%) from the proposed Atikokan generating station, 28180 MTPY (18%) from the proposed generating station at Floodwood, Minnesota and an increase of 17320 MTPY (17%) at the MP&L Clay Boswell plant, Cohasset, Minnesota. Development plans for the proposed Atikokan plant which will contribute about 27% of the total projected regional SO_2 emissions are being closely monitored because the plant will be located on the edge of the Quetico Provincial Park, a Canadian Wilderness area adjacent to the Boundary Waters Canoe Area.

Grain elevators, refineries and commercial-industrial sources have substantially smaller impacts on regional SO_2 emissions. These categories contribute less than 13% of total baseline SO_2 and less than 6% of total projected emissions (Figure 2).

The SO_2 point source emissions inventory does not include area sources such as space heating requirements or line sources such as automobile traffic which would increase regional emissions. These data are being compiled by the Minnesota Pollution Control Agency through a contract with Midwest Research Institute, Kansas City, Missouri. The final report due in September, 1985 will include a detailed air quality analysis for the Iron Range region.

Figure 3 provides a comparison between present and projected emissions.

Particulates

Table 2 provides an overall comparison between baseline and projected emissions of particulates from point sources. Table 4 and Figure 4 give a breakdown of emissions in terms of source categories (power generation, taconite processing, grain elevators, refineries and commercial-industrial) and geographic area (Minnesota, Wisconsin and Canada).

The 38% decrease (Table 2) in regional particulate emissions between the present and 1985 is primarily due to abatement efforts. These efforts will result in a 68% decrease for point sources in Duluth, a 48% decrease in Carlton County and nearly a 97% decrease in particulate emissions at the Reserve Mining Company operations at Silver Bay, Minnesota. Particulate emissions in Atikokan, Ontario, are expected to decrease by 85% due to the closing of the Steep Rock Iron Mines Limited and the Caland Ore Company Limited, two major taconite mining companies.

These decreases, however, are partially offset by projected growth in both the taconite processing industry and the power generation industry. Proposed generating stations near Floodwood, Minnesota, in Atikokan, Ontario and the

expansion of the MP&L Clay Boswell in Cohassett, Minnesota will increase regional particulate emissions by 2364 MTPY, 1900 MTPY, and 2145 MPTY, respectively.

By 1985 taconite processing in Minnesota will contribute an additional 6274 MTPY particulates over present emissions.

The taconite industry is the largest contributor to regional particulate emissions for both the baseline (81% of total baseline) and projected (66% of total projected) emissions (Figure 4 and Table 4).

Although particulate point source emissions are expected to decrease, the decline may have little overall effect in the Copper-Nickel Study Region where fugitive emissions from taconite mines and unpaved roads appear to be major sources of particulates. The extent of the fugitive emissions problem is currently being assessed by the Minnesota Pollution Control Agency through a contract with Midwest Research Institute, Kansas City, Missouri and a report is due in September, 1978.

Figure 5 provides a comparison between present and projected emissions.

Stack parameters

In order to estimate the air quality impact of a point source certain characteristics must be known. In addition to pollutant emission rates, the following information should be known: location of source, stack height, inside top diameter, exhaust gas temperature, flow rate and heat emissions. Sources emitting the same pollutant from several stacks that are within approximately 100 meters of each other may be analyzed by treating all emissions as coming from a single representative stack (USEPA, 1973).

The technique involves calculating an arbitrary parameter, k, which accounts for the relative influence of stack height, plume rise and emission rate on concentrations (Budney 1977).

$$k = \frac{hVT_S}{Q}$$

where

k = arbitrary parameter
h = stack height, m
V = stack gas flow rate, m^3/sec
T_S= stack gas exit temperature, ^oK
Q = stack pollutant emission rate, g/sec.

The k value was then used to select representative stack parameters for a facility with several stacks as follows:

1) a k value was calculated for each stack within the facility

2) the stack with the lowest k value was selected as the representative stack

3) if the difference between stack height or flow rate was greater than 25%, the sum of emissions from all stacks was then assumed to be emitted from the representative stack.

If the difference between stack height or flow rate was greater than about 20%, then the stack parameters of the largest emitter were used as representative parameters. The representative stack procedure may result in concentrations estimates which are high if the stacks are located more than 100 meters apart or if the stack heights or volume flow rates differ by more than about 20%.

The sources in each community or city were then combined using the largest emitter as the representative stack.

Facilities which are located along and below Lake Superior were uniformly assigned a stack height of 10 meters because of the elevated terrain and likely plume interception. Heat emissions were calculated according to the formula:

$$Q_H = \rho\, C_p\, V\, T_g$$

where Q_H = heat emission, cal/sec

T_g = exhaust gas temperature, ^oK

C_p = specific heat of air, cal g^{-1} $^oK^{-1}$

V = exhaust gas flow rate, m^3/sec

ρ = density of air, kg/m^3

In those instances where stack parameter data was not available for a particular facility, data from a similar facility were used. Specifically, stack data for the planned MP&L generating station at Floodwood were based on MP&L Clay Boswell unit No. 3 and stack data for the proposed operations of Jones and Laughlin at Gilbert and Pickands Mather at Biwabik were taken from Hanna Mining Company.

GEOGRAPHIC COMPARISONS OF SULFUR DIOXIDE AND PARTICULATE POINT SOURCE EMISSIONS

Sulfur dioxide

On a global scale natural sulfur emissions, expressed as SO_2, have been estimated to be 258 million metric tons per year (Williamson, 1973). Sulfate aerosols produced by sea spray and hydrogen sulfide (H_2S) from volcanic activity and organic decomposition are the primary sources of natural sulfur compounds. Anthropogenic sources have been estimated at 133 million metric tons per year, expressed as SO_2, and result primarily

from the combustion of fossil fuels (Williamson, 1973). About 70% of anthropogenic sulfur emissions are the result of coal combustion (Robinson and Robbins, 1970).

On a national scale sulfur oxide emissions decreased slightly from 1972 to 1975. Anthropogenic emissions in 1972 totaled 33.4 million metric tons per year compared to 29.9 million metric tons per year in 1975, a 12% decrease (USEPA, 1976). The National Air Quality and Emission Trend Report (1976) states that ambient sulfur dioxide levels in urban areas declined markedly probably due to a combination of more stringent pollution control efforts and a significant shift in the use of high sulfur fuels from urban to rural sources (USEPA, 1976).

In Minnesota sulfur dioxide point source emissions decreased slightly from 1970-71 to 1973-74. The 5% decrease (from 316900 metric tons per year compared to 302700 metric tons per year) is likely to be reversed in the future due to statwide growth in coal consumption.

In 1976 coal consumption by 71 facilities was 12.0 million metric tons per year; by 1985, it is projected that 75 facilities will consume 25.8 million metric tons per year, over a two-fold increase (Minnesota Energy Agency, 1978). Most of this increase will occur in the power generation industry.

In 1976 the three largest coal consumption development areas were the seven-county metropolitan area (36% of state total), northeastern Minnesota (30.3% of state total) and central Minnesota (19% of state total). By 1985, these three areas will still be the largest users but their ranking will be shifted: central Minnesota (36% of total), northeastern Minnesota

(35% of total), and metropolitan (17% of total) (Minnesota Energy Agency, 1978). The shift in coal usage from the Metropolitan area is due primarily to the growth in the taconite and power generation industries anticipated in central and northeastern Minnesota.

A summary of point source SO_2 emissions (sources emitting more than 100 metric tons per year) for both the Copper-Nickel Study Region and the seven-county metropolitan area is given in Table 6.

Particulates

The largest sources of atmospheric particulates are natural, contributing approximately 2273 million metric tons per year (Robinson and Robbins, 1971). Natural particulate matter is produced by wind erosion of land and sea, forest fires, volcanic eruption, vegetation and gas-to-particle reactions. Anthropogenic sources contribute approximately 295 million metric tons per year which arise from industrial processes, combustion of fossil fuels and agricultural activities (Robinson and Robbins, 1971). Nationally, there has been a 23% decrease in particulate point source emissions from 1972 to 1975 (21.3 million metric tons per year compared to 16.4 million metric tons per year). This has been attributed primarily to the installation of control equipment on industrial processes and utilities, a reduction in coal consumption by non-utility stationary sources and a decrease in the burning of solid wastes (USEPA 1976).

In Minnesota, particulates decreased by a substantial 43% from 1970-71 to 1973-74 (278200 metric tons per year compared to 157700 metric tons per year) primarily due to greater use of pollution control equipment.

A comparison of source category point source particulate emissions between the seven county metro area and the Copper-Nickel Study Region is given in Table 7 which clearly shows regional differences in industrial patterns.

REFERENCES

Budney, Laurence J. 1977. Guidelines for air quality maintenance planning and analysis. Volume 10 (revised): Procedures for evaluating air quality impact of new stationary sources. EPA-450/4-77-001, Research Triangle Park, North Carolina.

Minnesota Energy Agency. 1978. The Minnesota Coal Study. An interim report to the Legislature. St. Paul, Minnesota.

Minnesota Pollution Control Agency, 1978. Personal communication, Sue Wierman, Division of Air Quality.

Minnesota Pollution Control Agency, 1978. Emissions Inventory, 1975-76, Roseville, Minnesota.

Ontario Ministry of the Environment. 1977. Personal communication, I. Ramsay, November 8. Northwestern Region, Thunder Bay, Ontario.

Ontatio Ministry of the Environment. 1978. Personal Communication, I. Ramsay, January 9. Northwestern Region, Thunder Bay, Ontario.

Robinson, E. and Robbins, R.C. 1970. Gaseous sulfur pollutants from urban and natural sources. Journal of the Air Pollution Control Association. 20 (4): 233-235.

Robinson, E. and Robbins, R.C. 1971. Emission concentrations and fate of atmospheric pollutants. American Petroleum Institute Publication No. 4076.

U.S. Environmental Protection Agency. 1976. National air quality and emission trends report, 1975. Office of Air and Waste Management. EPA Publication Number 450/1-76-002. Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency. 1973. Guidelines for compiling a comprehensive emission inventory. Revised Publication No. APTD-1135. Research Triangle Park, North Carolina.

Williamson, Samuel J. 1973. Fundamentals of air pollution. Addison Wesley Publishing Company, Reading, Massachusetts.

Wisconsin Department of Natural Resources. 1977. Emissions Inventory. Madison, Wisconsin.

Table 1. Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Note: numbers in quotation marks are estimates by Copper-Nickel Study using available data.

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
MINNESOTA						
CARLTON COUNTY						
Cloquet						
Potlatch Northwest	1312	1522	1980: install an electrostatic precipitator, replace old boiler with a new one using coal & bark, close sulfite plant	691	5300	MPCA Emissions Inventory 5/78 MPCA memo 8/30/77
Conwed	444	104	1976: replace old boilers with a new one using oil and gas 1978: install cyclones	"227"	"90"	MPCA Emissions Inventory 5/78 Stipulation agreements with MPCA (5/30/74 and 6/22/76)
Wrenshall						
Continental Oil	92	1512	NA, use baseline data	92	1512	MPCA Emissions Inventory 5/78
COOK COUNTY						
Taconite Harbor						
Erie Mining Co.	813	15310	none planned	813	15310	J.H. Fatum, CoN Rehearing 10/5/76
ITASCA COUNTY						
Cohasset						
MP&L Clay Boswell	5504	28400	1980: completion of Unit 4 (504 megawatt capacity); improved emissions controls on units 1, 2, and 3	7649	45720	MPCA, Draft EIS, page V-137 (July, 1977)

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
ITASCA COUNTY						
Keewatin						
National Steel Pellet	1766	0	1978: 3.4 million TPY expansion and improvement of old plant.	1392	0	MPCA Permit Review (6/25/74)
			Late 70's: convert to coal	1804	1035	MPCA Permit Review (9/10/76) R.M. Martinson op. cit.
			1983-84: 1 million TPY expansion	2093	"1364"	ibid.; MPCA Permit Review (6/25/74)
			1988-1992: 4.1 million TPY expansion at Butler or National	"3000"	"2091"	R.M. Martinson op. cit.
Nashwauk						
Butler Taconite	1575	1	1977: test conversion to coal	1779	514	MPCA Memo (6/12/76); R.M. Martinson, CoN Re-hearing (10-5-76)
			1981-1984: 3 million TPY expansion	"3182"	"1545"	ibid.
			1988-1992: 4.1 million TPY expansion at Butler or National	"4091"	"2273"	ibid.
KOOCHICHING COUNTY						
International Falls						
Boise Cascade	2335	838	1980's: new boiler to burn coal, improved emissions controls	"546"	"818"	MPCA

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
LAKE COUNTY						
Silver Bay						
Reserve Mining	31140	3226	1979: possible completion of new emissions controls for pelletizers & ore treatment	"2727"	"3182"	T. Kosa, MPCA/DNR Permit Hearings (3/9/76);
			1980: new emissions controls for power plant	"1000"	"3182"	MPCA
ST. LOUIS COUNTY						
Aurora						
MP&L Generating Station	662	6095	NA, use baseline data	662	6095	MPCA Emissions Inventory 5/78
Babbitt						
Reserve Mining	none reported	111	none planned	0	111	D.E. Evanson CoN Re-hearing (10/5/76)
Duluth						
Arrowhead Blacktop	100	0	NA, use baseline data	100	0	MPCA Emissions Inventory 5/78
Cargill Elevator B	498	0	1977; second unit opens, doubling capacity	"509"	0	MPCA Emissions Inventory 5/78
			early 1980's: reduced emissions from ship loading	"91"	0	MPCA Emissions Inventory 5/78

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
Duluth						
Cargill Elevator C	205	0	early 1980's: one-sixth reduction in emissions from ship loadings	"36"	0	MPCA Emissions Inventory 5/78
Duluth Steam	150	418	late 1970's: will probably meet standards by replacing some coal with oil	"150"	"327"	MPCA Emissions Inventory 5/78
General Mills A	306	0	early 1980's: one-sixth reduction in emissions from ship loadings	"64"	0	MPCA Emissions Inventory 5/78
International Multifoods	496	0	early 1980's: one-sixth reduction in emissions from ship loadings	"236"	0	MPCA Emissions Inventory 5/78
MP&L - Hibbard Station	19	1555	1980's: Scheduled for closing in 1987, and could happen earlier.	none		MPCA Emissions Inventory 5/78 MP&L/UPA, Application for CoN (Oct., 1976);
Superwood Corp.	279	139	NA, use baseline data	279	139	MPCA Emissions Inventory 5/78
U.S. Steel-Duluth Coke	1053	3468	1980; plant closes	none		MPCA Emissions Inventory 5/78 Stipulation Agreement w/MPCA (8/24/76)
U.S. Steel-Shipping	193	326	1980: two new ore vessels replace 16 old ones 1980-83: modify remaining coal-fired vessels to meet standards	"46"	0	MPCA Emissions Inventory 5/78 draft Stipulation Agreement (not approved by all parties)

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
Eveleth						
Eveleth Taconite	857	0	1977: completion of Eveleth Expansion Co., 3.9 million TPY capacity	2300	1273	MPCA Emissions Inventory 5/78 MPCA Review (10/3/74)
			1977: conversion of original plant to fuel oil	2300	2073	MPCA Memo (12/17/76)
			late 1970's: 0.6 million TPY expansion	"2545"	"2273"	D.K. Campbell, CoN Re-hearing (10/5/76)
			1981-86: 3 million TPY expansion	"3909"	"3364"	ibid.
Floodwood or Brookston						
MP&L Generating Station	none		1984-85: proposed 800 Mw generating plant (certificate of need has not yet been issued)	"2364"	"28180"	MP&L/UPA Application for CoN (Oct., 1976)
Gilbert						
Jones and Laughlin	none		1984-85: planned start-up of 4.2 million TPY facility	"1909"	"1455"	R.E. Prittinen, CoN Re-hearing (10/5/76)
Hibbing						
Public Utility	52	1009	NA, use baseline data	52	1009	MPCA Emissions Inventory 5/78
Hibbing Taconite	0	0	1976-78: original construction, 5.4 million TPY capacity, fueled by oil.	1218	1382	MPCA Emissions Inventory 5/78 Scaled to emissions from 1978 expansion (below)
			1978-80: 2.7 million TPY expansion	1791	2073	Letter from Bethlehem Steel (4/6/76)

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
Hibbing						
Hanna Mining Co.	703	0	1985-87: new mine capacity 2.8 million TPY	1273	1000	MPCA Staff R.M. Martinson, CoN Re-hearing (10/5/76)
Hoyt Lakes						
Erie Mining Co.	7727	707	1980: start-up of coal-gasification unit at Hoyt Lakes, initial capacity of 500 tons of coal per day and final capacity of 1300 TPD (assuming success in initial units)	"10460"	"5000"	J.H. Fatum, CoN Re-hearing (10/5/76); ERDA staff; Pickands Mather staff
Mountain Iron						
Minntac	17440	238	1978: completion of Stage III, 6 million TPY capacity	19160	2036	MPCA Staff MPCA Review (10/13/76)
			late 70's: Stage I & II conversion to coal & improvements	"5273"	"5545"	MPCA staff estimate; C.W. Niemi CoN Re-hearing (10/5/76)
			1982-85: 6 million TPY expansion	"7000"	"7364"	ibid.
Virginia						
Public Utilities Dept.	612	1896	1976: install emission control equipment	"127"	"1818"	Stipulation Agreement w/MPCA (12/12/74); MPCA staff

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
Virginia						
Inland Steel	0	0	1978: original construction complete, 2.6 million TPY capacity	1227	636	MPCA Review (10/3/74); MPCA Staff
			1980's: able to double its capacity--no date planned	"2455"	"4272"	P.P. Ribotto, CoN Re-hearing (10/5/76)
Biwabik						
Pickands Mather	none		1985-87: construction of new mine, 5 million TPY capacity	"2273"	"1727"	J.H. Fatum, CoN Re-hearin (10/5/76)
WISCONSIN						
ASHLAND COUNTY						
Ashland						
Lake Superior Power District	648	1440	late 1970's: three-fold increase in output	"1909"	"4364"	WDNR Staff
Roffler's Construction	277	2	NA, use baseline data	277	2	WDNR Staff
DOUGLAS COUNTY						
Superior						
Murphy Oil Corp.	56	1824	NA, use baseline data	56	1824	WDNR Staff
Farmers' Union Grain	354	0	1977: improved emissions control	13	0	WDNR Staff
Globe Elevator	321	0	1977: improved emissions control	2	0	WDNR Staff

Table 1 (contd.). Regional emissions inventory for sources emitting more than 100 metric tons per year of SO_2 or Particulates (metric tons per year)

Location and Facility	Baseline Emissions 1975-76 Particulates	Baseline Emissions 1975-76 SO_2	Proposed Changes	Projected Emissions 1985 Particulates	Projected Emissions 1985 SO_2	Reference
Superior						
Superior WL&P	5	413	NA, use baseline data	5	413	WDNR Staff
Orba Corp.	none		1980: completion of a coal transhipment facility	318	0	WDNR Staff
Burlington Northern	none		1977: opening of a taconite transhipment facility	146	0	WDNR Staff
Univ. of Wisc.	76	105	NA, use baseline data	76	105	WDNR Staff
CLM Corp.	2	284	1977: install a new kiln which burns gas and high sulfur coal	8	918	WDNR Staff
CANADA, ONTARIO						
Atikokan						
Ontario Hydro	none		1983-85: proposed 800 Mw generating plant	1900	53060	Ontario Hydro, Environmental Analysis
Caland Ore Co.	1356	254	closing	none		I. Ramsay, Ont. Ministry of the Environment (Nov. 8, 1977)
Steep Rock Mines	11650	13360	closing	none		ibid.
Ft. Frances						
Minnesota Pulp & Paper	1405	257	NA, use baseline data	1405	257	MPCA staff

Emissions Inventory Errata
Projected (1985)

	particulates (MTPY)	sulfur dioxide (MTPY)
Potlach Northwest	900	
Conwed	300	
MP&L Clay Boswell	7638	45620
U.S. Steel Shipping	220	
Virginia Public Utilities	480	1900
Farmers' Union Grain	354	
Globe Elevator	321	
Atikokan	1990	

Table 2. Point source regional emissions inventory summary for particulates and sulfur dioxide (metric tons per year).

	Baseline 1975-76	Projected 1985	Percent* Change
Particulates	92540	57740	-38
Sulfur Dioxide	84820	196700	+132

*percent change is calculated by:

$$\frac{\text{Baseline} - \text{Projected}}{\text{Baseline}} \times 100$$

Table 3. Sulfur dioxide regional emissions inventory for point sources emitting more than 100 MTPY (emissions in MPTY)

	Power Generation			Taconite Processing			Grain Elevators			Refineries			Commercial and Industrial			County/Location Total		
	Baseline[a]	Projected[b]	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change
[illegible]	0	0	0	0	0	0	0	0	0	1512	1512	0	1626	5391	+232	3138	6903	+120
[illegible]	0	0	0	15310	15310	0	0	0	0	0	0	0	0	0	0	15310	15310	0
[illegible]	28400	45720	+61	1	2909	+290800	0	0	0	0	0	0	0	0	0	28400	48630	+71
[illegible]	0	0	0	3226	3182	-1	0	0	0	0	0	0	0	0	0	3226	3182	-1
[illegible]	10950	37430	+241	1056	23370	+2113	0	0	0	0	0	0	3933	139	-96	15960	60930	+282
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	838	818	-2	838	818	-2
	39350	83150	+111	19600	44770	+128	0	0	0	1512	1512	0	6397	6348	-1	66880	135800	+103
[illegible]																		
[illegible]	1440	4364	+203	0	0	0	0	0	0	0	0	0	2	2	0	1442	4366	+203
[illegible]	413	413	0	0	0	0	0	0	0	1824	1824	0	389	1023	+163	2626	3260	+24
	1853	4777	+158	0	0	0	0	0	0	1824	1824	0	391	1025	+162	4068	7626	+87
[illegible]																		
[illegible]	0	53060	--	13620	0	-100	0	0	0	0	0	0	0	0	0	13620	53060	+290
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	257	257	0	257	257	0
	0	53060	--	13620	0	-100	0	0	0	0	0	0	257	257	0	13880	53320	+284
[illegible] TOTAL	41220	141000	+242	33220	44770	+34.8	0	0	0	3336	3336	0	7045	7630	+8	84820	196700	+132

[a] Baseline year 1975-76

[b] Projected year 1985

[c] Totals are rounded

Table 4. Particulate regional emissions inventory for point sources emitting more than 100 MTPY (emissions in MTPY)

	Power Generation			Taconite Processing			Grain Elevators			Refineries			Commercial and Industrial			County/Location Total		
	Baseline[a]	Projected[b]	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change	Baseline	Projected	%Change
[illegible]	0	0	0	0	0	0	0	0	0	92	92	0	1756	918	-48	1848	1010	-45
[illegible]	0	0	0	813	813	0	0	0	0	0	0	0	0	0	0	813	813	0
[illegible]	3504	7649	+39	3341	5275	+58	0	0	0	0	0	0	0	0	0	8845	12929	+46
[illegible]	0	0	0	31140	1000	-97	0	0	0	0	0	0	0	0	0	31140	1000	-97
[illegible]	1484	3414	+129	26730	31070	+16	1505	427	-72	0	0	0	1625	425	-74	31350	35340	+13
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	2335	546	0	2335	546	-77
	5988	11063	+58	62020	38160	-38	1505	427	-72	92	92	0	5716	1889	-67	76340	53630	-30
[illegible]																		
[illegible]	648	1909	+195	0	0	0	0	0	0	0	0	0	277	277	0	925	2186	+136
[illegible]	5	5	0	0	0	0	675	15	-98	56	56	0	78	548	+603	814	624	-23
	653	1914	+193	0	0	0	675	15	-98	56	56	0	355	825	+132	1739	2810	+62
[illegible]																		
[illegible]	0	1900	---	13000	0	-100	0	0	0	0	0	0	0	0	0	13000	1900	-85
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	1405	1405	0	1405	1405	0
	0	1900	---	13000	0	-100	0	0	0	0	0	0	1405	1405	0	14410	3305	-77
[illegible]	7641	14880	+94	75020	38160	-49	2180	442	-80	148	148	0	7476	4119	-69	92480	57740	-38

[illegible] base year 1975-76

[illegible] projected year 1985

[illegible] as reported

Table 5. Representative[1] stack data for regional emissions inventory point sources.

	Coordinates		Stack dimension, meters		Exhaust Gas		
	longitude	latitude	height	diameter	Temp, °K	flowrate, m^3/sec	heat emission, x 10^6 cal/sec
MINNESOTA							
Cloquet	92.4399	46.7147	68.0	4.4	470	35.1	3.70
Wrenshall	92.3746	46.6077	41.0	0.8	923	5.1	1.05
Taconite Harbor	90.9765	47.5350	10.0	3.1	413	116.8	10.81
Cohasset	93.6587	47.2571	122	5.3	386	565.0	48.86
Keewatin	93.0656	47.4081	42.0	3.9	393	194.0	17.08
Nashwauk	93.8638	47.3515	38.0	3.7	797	177.1	31.63
Silver Bay	91.2449	47.3011	10.0	8.9	423	88.3	8.37
Aurora	92.1625	47.5260	91.0	3.2	331	233.7	17.33
Babbitt	91.8836	47.6708	10.0	0.4	260	4.7	0.27
Duluth	92.1488	46.7345	66.4	3.3	449	76.9	7.74
Eveleth	92.5735	47.3479	46.3	3.0	326	139.2	10.17
Floodwood	92.8648	46.8607	120	1.6	386	565.0	48.86
Gilbert	92.3998	47.5116	41.7	4.0	387	129.0	11.18
Hibbing	92.9417	47.4162	41.7	4.0	387	129.0	11.18
Hoyt Lakes	92.1359	47.5970	40.0	1.1	533	19.3	2.30
Mountain Iron	92.6468	47.5476	31.7	4.6	324	262.2	19.03
Virginia	92.5426	47.5188	40.0	2.2	453	38.7	3.93
Biwabik	92.3506	47.5350	41.7	4.0	387	129.0	11.18
International Falls/ Ft. Francis	93.4063	48.5962	30.0	2.5	433	35.4	3.43
WISCONSIN							
Ashland	90.8645	46.6023	43.0	2.1	423	28.0	2.65
Superior	92.1024	46.7210	10.0	2.0	923	23.6	4.88
CANADA	91.6198	48.8210	198	7.6	676	398.8	60.41
Atikokan							

[1] Since each city or community may have more than one stack, a representative stack has been selected for modeling purposes.

Table 6. 1976 point source SO_2 emissions inventory summary by source category for the Copper-Nickel Study Region and the seven-county Metropolitan area.

Region		Power Generation	Taconite	Grain	Refinery	Commercial-Industrial	Total [b]
Seven-county Metro [a]	MTPY	136800	0	177	22620	23420	183000
	percent of total	74.8	0	0.1	12.4	12.8	100
Copper-Nickel Study	MTPY	41230	33210	0	3336	7045	84820
	percent of total	48.6	39.2	0	3.9	8.3	100

a Minnesota Pollution Control Agency, 1978.

b Total is rounded off.

Table 7. 1976 point source particulate emissions inventory summary by source category for the Copper-Nickel Study Region and the seven-county Metropolitan area.

Region		Power Generation	Taconite	Grain	Refinery	Commercial-Industrial	Total [b]
Seven-county Metro [a]	MTPY	10230	0	6285	2882	21230	40630
	percent of total	25.2	0	15.5	7.1	52.2	100
Copper-Nickel Study	MTPY	7651	75020	2180	148	7476	92480
	percent of total	8.2	81.1	2.4	.2	8.1	100

a Minnesota Pollution Control Agency, 1978

b Total is rounded off.

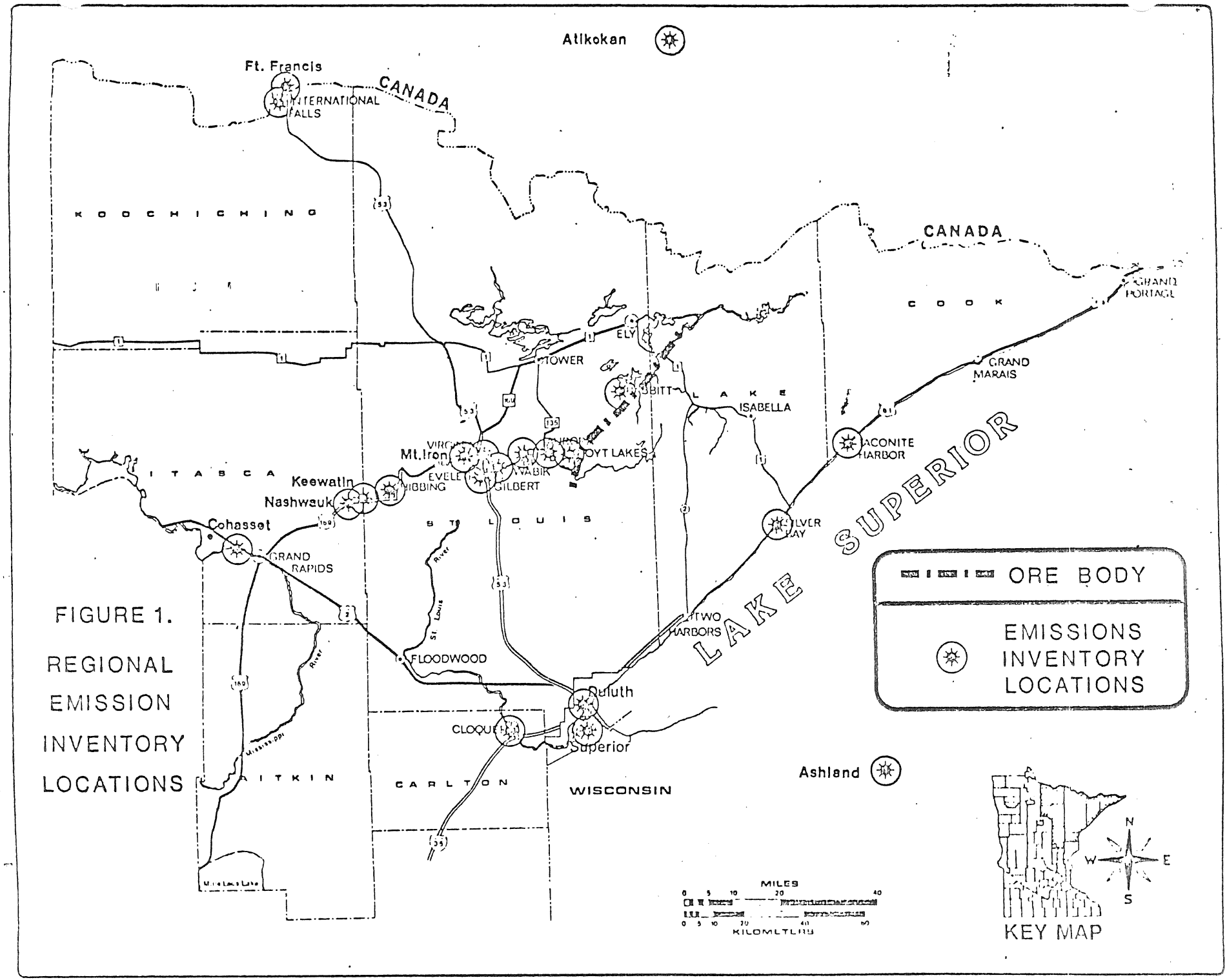
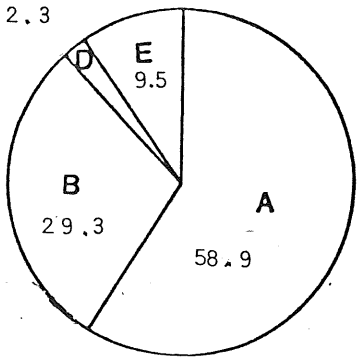


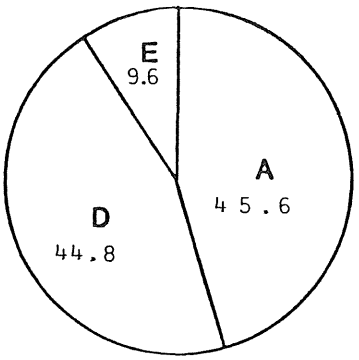
FIGURE 1.

REGIONAL EMISSION INVENTORY LOCATIONS

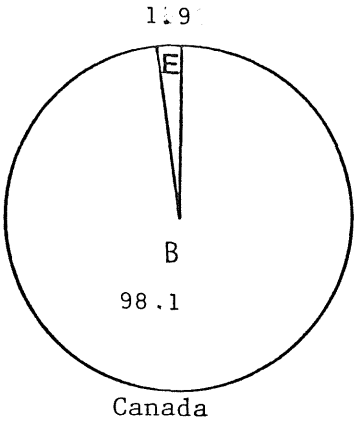
Figure 2. Source Category Contributions to Sulfur Dioxide Emissions By Location



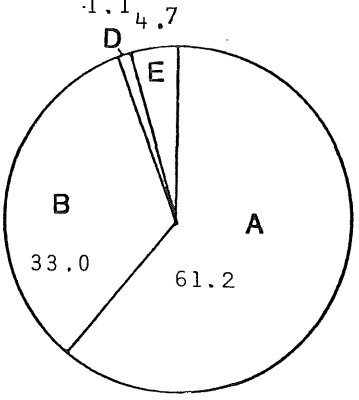
Minnesota
Baseline
Total: 68880 MTPY



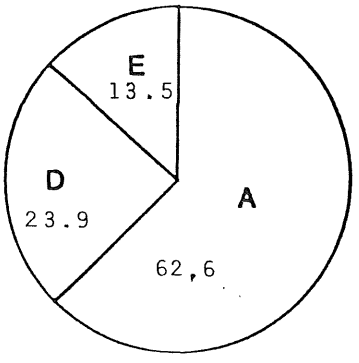
Wisconsin
Baseline
Total: 4068 MTPY



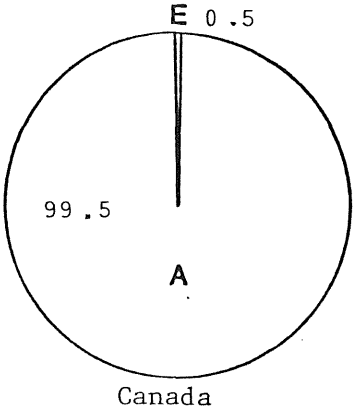
Canada
Baseline
Total:13880 MTPY



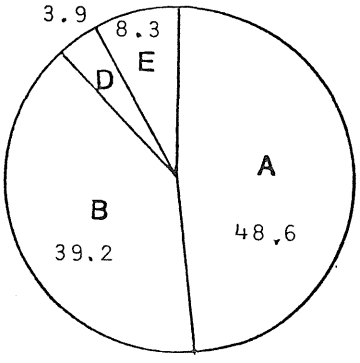
Minnesota
Projected
Total: 135800 MTPY



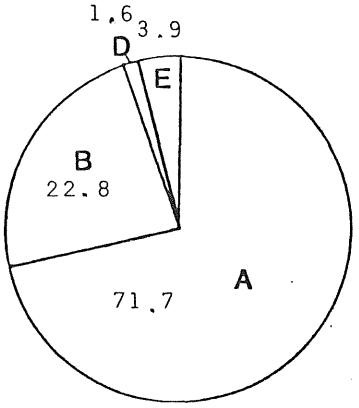
Wisconsin
Projected
Total: 7626 MTPY



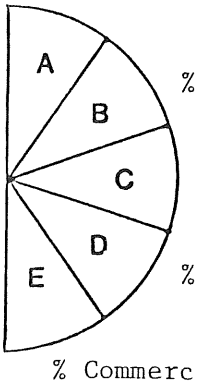
Canada
Projected
Total:53320 MTPY



Region
Baseline
Total: 84820 MTPY



Region
Projected
Total: 196700 MTPY



% Power Generation
% Taconite Processing
% Grain Elevators
% Refineries
% Commercial/Industrial

Fig e 3. Regional SO_2 point source emissions inventory, base line (1975-76) and projected (1985).

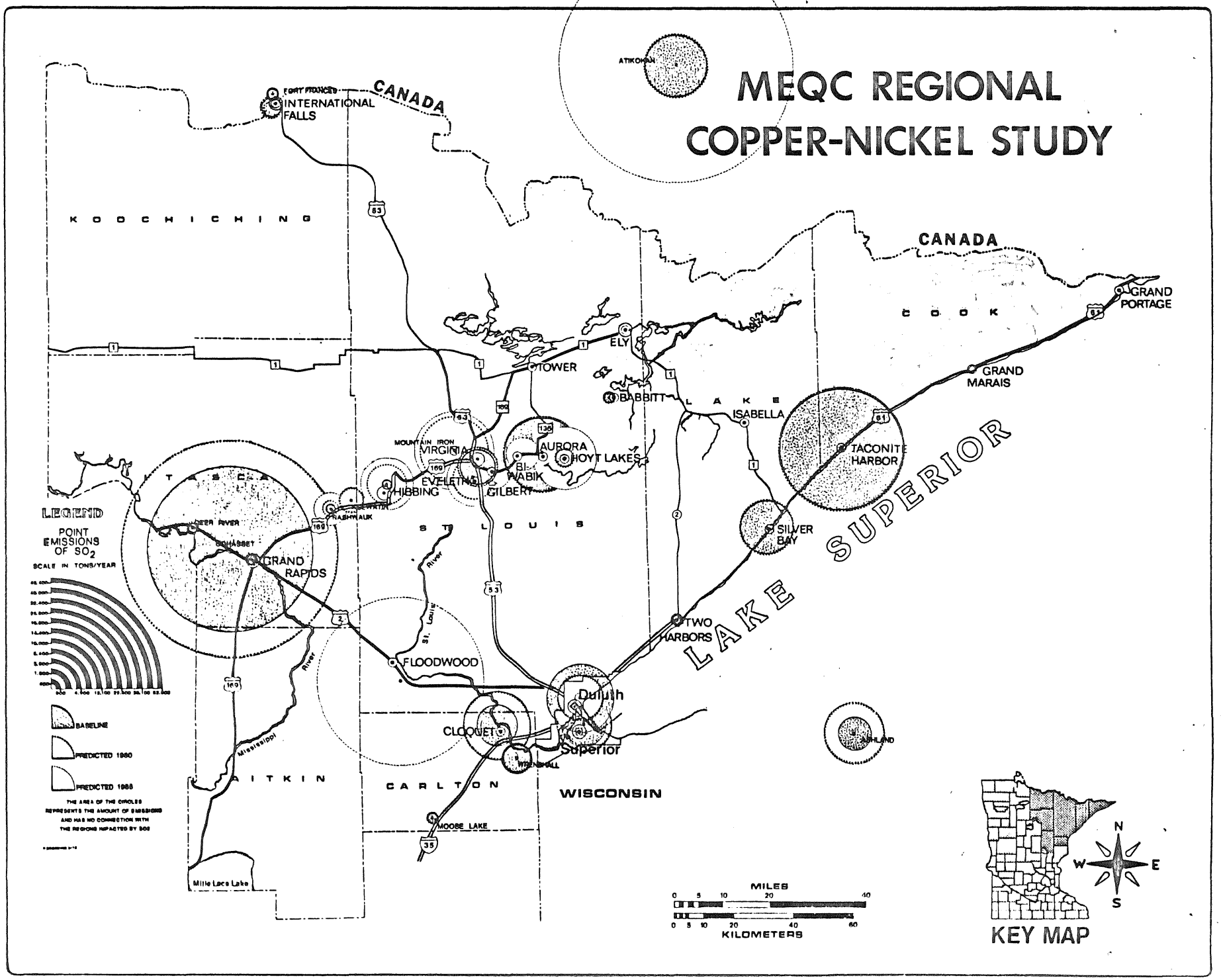
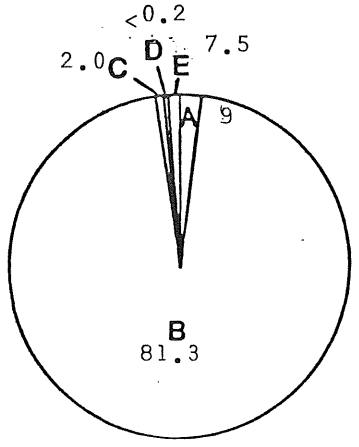
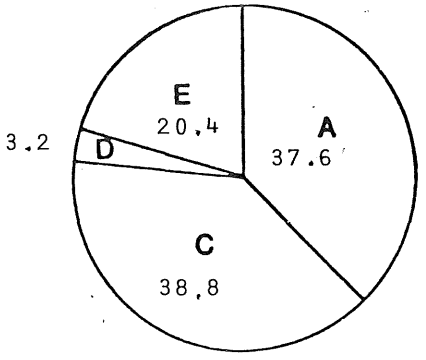


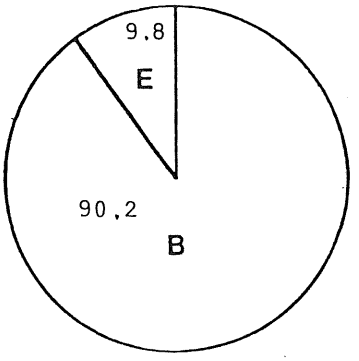
Figure 4. Source Category Contributions to Particulate Emissions



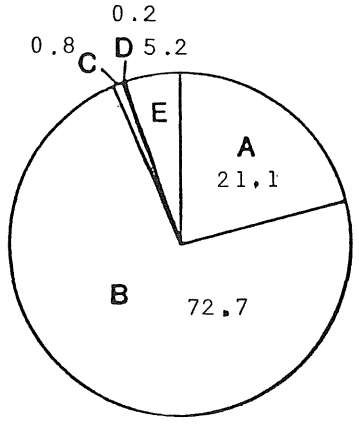
Minnesota Baseline
Total: 76340 MTPY



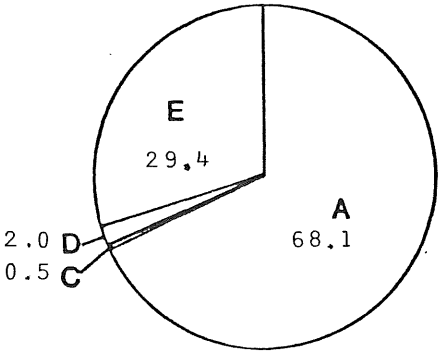
Wisconsin
Baseline
Total: 1739 MTPY



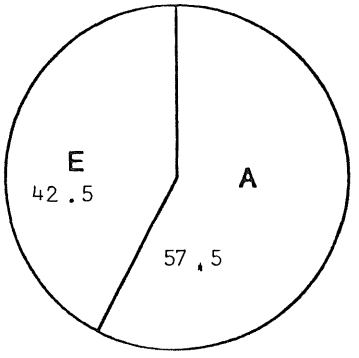
Canada
Baseline
Total:14410 MTPY



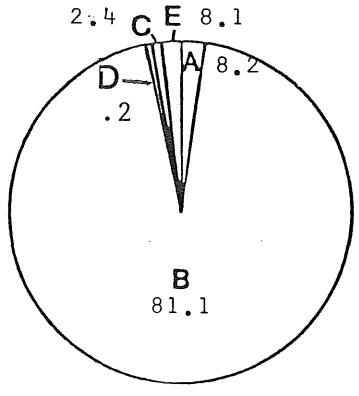
Minnesota Projected
Total: 51630 MTPY



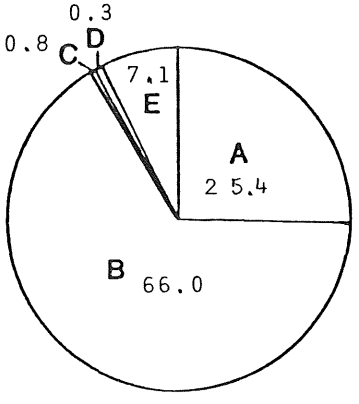
Wisconsin Projected
Total: 2810 MTPY



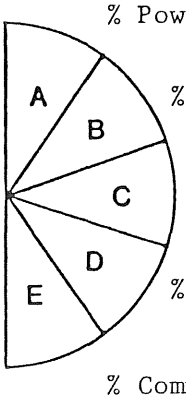
Canada
Projected
Total: 3305 MTPY



Region
Baseline
Total: 92480 MTPY

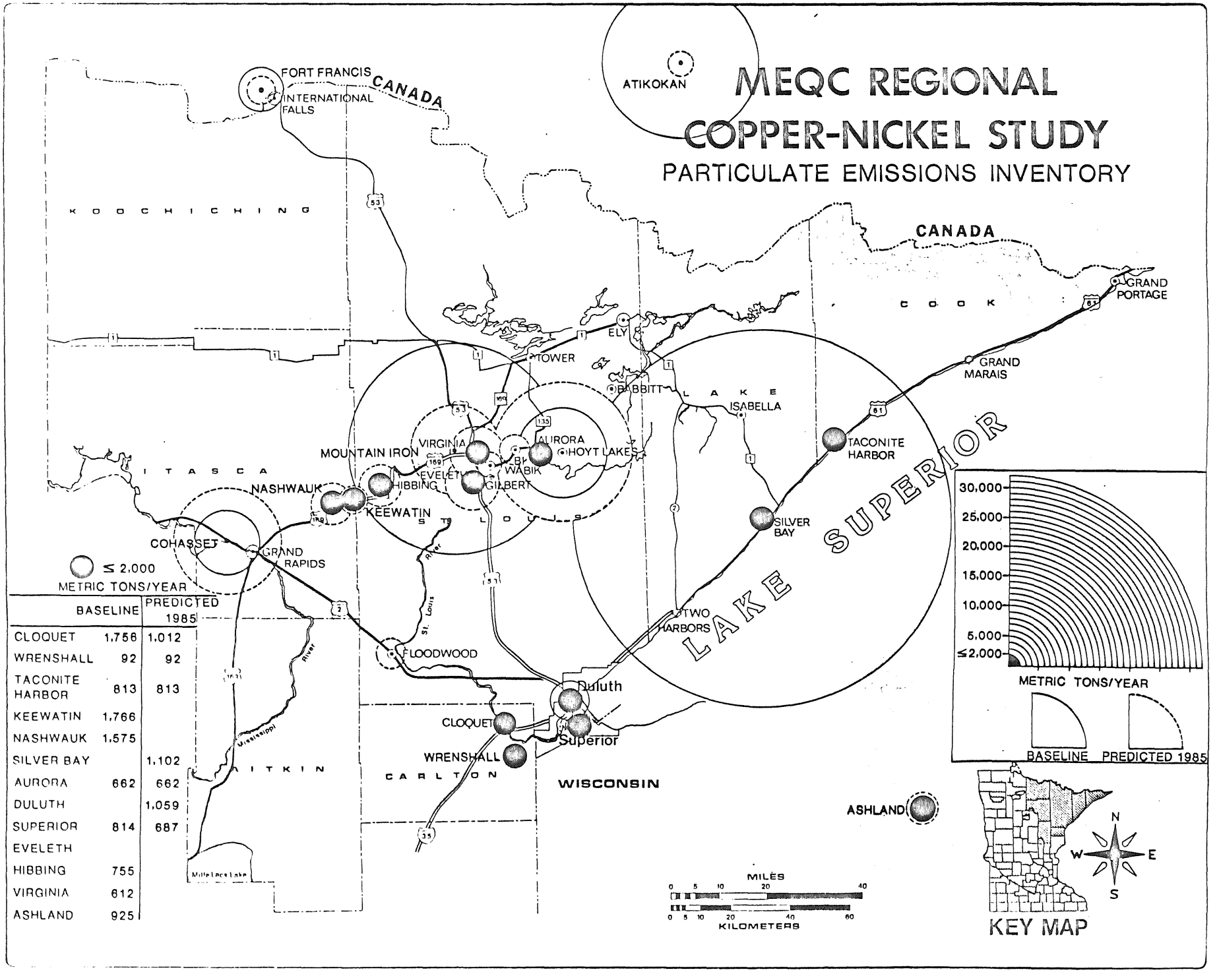


Region
Projected
Total: 57740 MTPY



% Power Generation
% Taconite Processin
% Grain Elevators
% Refineries
% Commercial/Industrial

Figure 5. Regional particulate point source emissions inventory, baseline (1975-76) and projected (1985).



	BASELINE	PREDICTED 1985
CLOQUET	1,756	1,012
WRENSHALL	92	92
TACONITE HARBOR	813	813
KEEWATIN	1,766	
NASHWAUK	1,575	
SILVER BAY		1,102
AURORA	662	662
DULUTH		1,059
SUPERIOR	814	687
EVELETH		
HIBBING	755	
VIRGINIA	612	
ASHLAND	925	