The Southwest Lake Michigan Pilot Study:

Developing an Inventory of Toxic Air Emissions from Area Sources in the Chicago, Milwaukee, and Gary Urban Areas, 1993

*** FINAL ***

December 1995

U.S. Environmental Protection Agency
Pilot Program for Emissions Inventory
Under the Clean Air Act
Sections 112(c), 112(k) and 112(m)

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Great Lakes Commission

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Acronyms and Abbreviations

ACFM	Actual Cubic Feet per Minute
AIRS	Aerometric Information Retrieval System
AMS	Area and Mobile Source
As	Arsenic
ASCII	American Standard Code for Information Interchange
BTU	British Thermal Unit
CAA	Clean Air Act
CAERS	Computerized Annual Emission Reporting System, Illinois
CARB	California Air Resources Board
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cu	Copper
EET	Emission Estimating Techniques
EIS	Emission Inventory System
ESP	Electrostatic Precipitator
FIRE	Factor Information Retrieval System (Version 3.0)
FESOP	Federally Enforceable State Operating Permit
GEMAP	Geocoded Emissions Modeling and Projections
GLC	Great Lakes Commission
GLEI	Great Lakes Emissions Inventory
GLIN	Great Lakes Information Network
GLNPO	Great Lakes National Program Office, U.S. Environmental Protection Agency
GLPF	Great Lakes Protection Fund
HAP	Hazardous Air Pollutant
Hg	Mercury
HP	Horsepower
IDEM	Indiana Department of Environmental Management
IEPA	Illinois Environmental Protection Agency
IJC	International Joint Commission
IMS	Information Management System
IPP	Inventory Preparation Plan
IRIS	Integrated Risk Information System, U.S. EPA
LAN	Local Area Network
MACT	Maximum Achievable Control Technology
Mn	Manganese
MSDS	Material Safety Data Sheet
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Ni	Nickel
NO_x	Nitrogen Oxides
ORCIS	Ozone Regional Computer Inventory System, Illinois

Acronyms and Abbreviations
(continued)

PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PC	Personal Computer
PCB	Polychlorinated Biphenyls
PCDD	Total Polychlorinated Dibenzodioxins
PCDF	Total Polychlorinated Dibenzofurans
PERC	Perchloroethylene
PM	Particulate Matter
POM	Polycyclic Organic Matter
POTW	Publicly Owned Treatment Works
QA/QC	Quality Assurance/Quality Control
RAPIDS	Regional Air Pollutant Inventory Development System
SCC	Source Classification Code
SIC	Standard Industrial Classification
SSD	Source Summary Database
STEPS	State Environmental Programs Systems
SWLM	Southwest Lake Michigan
TANKS	Storage Tank Emissions Software
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCDF	2,3,7,8-tetrachlorodibenzo-furan
TCE	Trichloroethylene
TPY	Tons per year
TRI	Toxic Release Inventory
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
VOM	Volatile Organic Material
WDNR	Wisconsin Department of Natural Resources

Preface

The Southwest Lake Michigan Pilot Study represents a unique milestone in the continuing effort to quantify and manage the toxic air emissions which impact the waters of the Great Lakes Basin. Three Great Lakes states, Illinois, Indiana, and Wisconsin, cooperated in compiling this emissions inventory as part of a program to quantify toxic air emissions from small sources in major urban areas. The pilot study provided the first practical test of processes, procedures, and systems which the states have been developing over the last several years to ensure that this, and subsequent, regionwide inventories, are accurate and consistent from one state to another.

The governors of the eight Great Lake states established the framework for reaching this milestone when they signed the Toxic Substances Control Agreement in 1986. This agreement recognized the need for coordinating regional action to quantify and control toxic pollutants entering the Great Lakes system. Since 1989, the Great Lakes states and the Province of Ontario, Canada have been working together through the Great Lakes Commission to develop a regional database of air toxic emissions data and estimates.

The U.S. EPA funded this pilot study to help meet the requirements of Sections 112(c)(6), 112(k), and 112(m) of the Clean Air Act, as amended in 1990. Section 112(k) requires U.S. EPA to identify "not less than 30 hazardous air pollutants which, as a result of emissions from area sources, present the greatest threat to public health in the largest number of urban areas." The categories of area sources that contribute 90 percent of the emissions of each of the 30 or more hazardous air pollutants must then be regulated by U.S. EPA by the year 2000. U.S. EPA must also establish a National Strategy which reduces the public health risks associated with such source categories by not less than 75 percent in the incidence of cancer attributable to emissions from such sources.

While we believe the air toxic emission estimates contained in the report for the Chicago, Gary, and Milwaukee urban areas represent the best single compilation of such estimates, the pilot study has also illustrated the limitations which still exist in making such estimates. The results should therefore be viewed as a first step for use by policy-makers and others involved in air quality management. These data can support regulatory decisions if used in conjunction with other sources of quality-assured data.

The Great Lakes states, along with the Great Lakes Commission, are now working to compile an eight-state air toxic inventory using the experience of the pilot study to improve their efforts. The full eight-state inventory, using calendar year 1993 data, is expected to be completed in late summer, 1996. Through this continuing effort, the mechanism has been established to compile and maintain an inventory which will continue to improve in quality until it will support sound regulatory decisions.

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Acknowledgments

The Southwest Lake Michigan Urban Areas Toxic Air Emissions Inventory Pilot Study has been a challenging endeavor for all involved. As a ground breaking effort to develop a regional inventory of toxic air emissions, a multitude of complex issues had to be resolved to ensure that the priorities of the states and federal government were adequately addressed.

This unique effort was developed under the leadership of Dave Kolaz, chair of the Steering Committee for the Great Lakes Regional Air Toxics Inventory Project, and Carol Ratza, project manager, Great Lakes Commission. Emission inventory specialists from the pilot study states, as well as staff from the other Great Lakes states, U.S. EPA and the province of Ontario worked together closely, making the study a team effort. The primary staff involved in developing the pilot study, and their roles, are listed below.

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This report was written, compiled and reviewed by all of the above project participants with additional editorial and regional report compilation support provided by Great Lakes Commission staff members Mike Conley, Matt Doss and Celeste Whiting.

Dedication

This report is dedicated to the memory of Tom Lahre. As the primary contact to the pilot study from the Urban Area Sources Program of the U.S. Environmental Protection Agency, Tom worked closely with the state subcommittee members and Great Lakes Commission staff up until his death in September 1995. He was a dedicated professional and a good friend to us all. We miss him and hope that we have lived up to the high professional standards that he set for himself and for those with whom he worked.

Executive Summary

The purpose of the Southwest Lake Michigan (SWLM) Pilot Study was to a) inventory small point and area sources of toxic air emissions from the combined urban areas of Chicago, Gary and Milwaukee (see Figure 1-1, page 1); b) test the *Air Toxics Emissions Inventory Protocol for the Great Lakes States;* and c) design and test an automated emissions estimation and data management system that could be used in later years in developing larger, multistate, Great Lakes regionwide inventories.

Importantly, emissions from "major sources," as defined by the Clean Air Act, were not inventoried and estimated and are therefore not documented in the regional summary. Consequently, the ratio of area to major source emissions in the study area is not available and the tables and charts provided herein should not be construed to represent an estimate of total emissions of the subject hazardous air pollutants released in the study area. Under the terms of the Clean Air Act (CAA), which defines major sources in terms of quantity, the sources inventoried in the SWLM study are accurately described as "area sources."

The SWLM study began in October 1993 with primary funding provided by the U.S. Environmental Protection Agency (U.S. EPA). The study built upon four previous years of effort by the Great Lakes states, funded by the states themselves through the Great Lakes Protection Fund.

This report is but one of six products of the SWLM study. The complete product package includes:

> This report, titled *The Southwest Lake Michigan Pilot Study: Developing an Inventory of Toxic Air Emissions from Area Sources in the Chicago, Milwaukee and Gary Urban Areas, 1993*;
>
> Regional Air Pollutant Inventory Development System (RAPIDS) client/server software;
>
> The Southwest Lake Michigan Urban Area Source Inventory;
>
> *Air Toxics Emissions Inventory Protocol for the Great Lakes States*;
>
> Improved Great Lakes state air emissions inventory systems for criteria and toxic air pollutants; and
>
> Demonstration of the cost effective and time efficient use of the Internet as an aid to solving regional environmental problems and, introduction of the concept and successful demonstration of the feasibility of states using client/server technology via the Internet to transmit and exchange environmental data with other states, federal agencies and industry.

The three states that conducted the SWLM study (Illinois, Indiana and Wisconsin) believe that the air toxic emission estimates contained in this report (and in the Southwest Lake Michigan Urban Area Source Inventory housed by the U.S. EPA Great Lakes National Program Office) for the Chicago, Gary and Milwaukee urban areas represent the best single compilation of such estimates. The scope of the project did not allow the states to undertake a massive discovery effort; instead, the states used available 1993 calendar year process data, emission factors and reported information. The SWLM study objective was to enhance current inventory capabilities, resolve procedures and protocol issues across several states, and develop and test an automated emission estimation and inventory system. In the process, the urban area source inventory for the SWLM study area was compiled.

In brief, the pilot study should be viewed as an initial effort to bridge the gap between the *science* of inventorying toxic air emissions and the public policy *debate* concerning how these emissions affect human health and the environment and how they should be addressed. Follow-up by U.S. EPA and the states is necessary to make further progress toward meeting the goals of Section 112 of the CAA. The SWLM pilot study states recommend that regulatory decisions not be based on this data unless more compelling research is completed or accessed to warrant such action.

The following are the specific sections of the CAA, as amended in 1990, addressed by the SWLM study:

Section 112(c)(6) Specific Pollutants: Each of the 112(c)(6) pollutants was targeted in the SWLM small point and area source emissions inventory. The objective of this study, in terms of Section 112(c)(6) of the CAA, was to locate small point and area sources of these toxic compounds in the 12-county area. The summary regional tables and charts (beginning on page 28) highlight these emissions and respective area sources. Section 5, *Results*, provides suggested refinements to the procedures listed in the *Air Toxics Emissions Inventory Protocol for the Great Lakes States* in order to more accurately estimate total emissions of Polycyclic Organic Matter (POM) and related pollutants.

Section 112(k) Area Source Program: The objective of the SWLM pilot study was to provide the mechanism, procedure and the first compilation of data on emissions from area sources of a targeted list of hazardous air pollutants, including those identified in Section 112(c)(6) of the CAA. The study sought to provide the best compilation of such data for calendar year 1993 emissions from small point and area sources. Section 5 of this report presents the best currently available estimates of area sources for the inventoried toxic air pollutants for calendar year 1993 for the Chicago, Milwaukee and Gary urban areas. This project begins a long-term state and federal effort to categorize emissions from various area sources (and major sources) in the Great Lakes region. The states believe this work will provide the strongest foundation upon which the U.S. EPA can build the national strategy to reduce urban area toxic air emissions as outlined in Section 112(k)(3) of the CAA.

The study focused on the identification of small point and area source categories that contribute the most to the total emissions of hazardous air pollutants listed in Table 2-1. The SWLM study concentrated on locating significant sources not currently regulated under the CAA. These sources include many traditionally unregulated sites with relatively small gas-fired, coal-fired, or oil-fired boilers; asphalt and concrete plants; industries dealing with primary metals (including zinc, aluminum and iron), or secondary metals (primarily used in the processing of refined metals); cultured marble companies; woodburning stoves and fireplaces; non-road engines; and generally, any facility with an incinerator. The focus was on finding many small sources within one county or urban area that collectively release large amounts of one or more toxic air pollutants of concern.

Section 112(m) Great Waters and the Great Lakes Toxic Substances Control Agreement: The Great Lakes states made significant progress toward meeting the goals of the governors' agreement and CAA Section 112(m) by developing the Regional Air Pollutant Inventory Development System (RAPIDS) and testing the *Air Toxics Emissions Inventory Protocol for the Great Lakes States*. The RAPIDS software, and the accompanying protocol will be used by all eight Great Lakes states in future years to jointly conduct point and area source inventories of the 49 target compounds identified in Table 2-1.

The *Air Toxics Emissions Inventory Protocol for the Great Lakes States*, finalized in June 1994, provides instructions for the states to follow to ensure the completeness, accuracy, consistency and quality of the regional toxic emissions inventory. Each state prepared its portion of the SWLM pilot inventory in the manner outlined in the protocol, and provided a quality assurance check on their state-specific emissions data and estimates to ensure the highest possible quality database.

Rather than comparing one state's emissions against another state's results, the focus of the pilot study was to prepare a reliable and technically accurate inventory for the southwest Lake Michigan region as a whole, and to outline areas where improvements are needed in overall methodology and implementation.

Development of RAPIDS has been the key to the effort to develop a comprehensive, accurate, and consistent urban area air toxic emissions inventory across three states.

As a multistate, regional effort, a high level of coordination and communication was necessary to ensure consistency among the three states in terms of data management, methodology, calculation methods, and other issues. To facilitate the necessary communication on these issues, a Southwest Lake Michigan Pilot Study Subcommittee was established by the Great Lakes Commission's Regional Emission Inventory of Toxic Air Contaminants Steering Committee. During the course of the SWLM study, the subcommittee communicated via daily e-mail exchanges, conference calls on a weekly or biweekly basis, and monthly or bimonthly in-person meetings to oversee contractor development of the inventory software, and to resolve outstanding issues and inconsistencies among the three states contributing to the pilot study.

During the course of this study, the Southwest Lake Michigan Subcommittee worked closely with the project software development contractor, Radian Corporation, to develop and test RAPIDS. The effort represents the first attempt to prepare software for estimating toxic pollutant emissions on a multistate basis. RAPIDS is a client/server system consisting of an ORACLE back-end database designed using ORACLE CASE tools, and a "suite" of front-end applications developed using various software tools (primarily PowerBuilder and SAS). The software takes full advantage of new Internet/Great Lakes Information Network (GLIN) connections between the states, Great Lakes Commission, and the U.S. EPA GLNPO office in Chicago.

Finally, a Quality Assurance/Quality Control (QA/QC) Committee was formed to review the pilot study report, establish QA/QC criteria for use by the three states, and ensure the report provides an accurate and useful summary of toxic air emissions at the regional level.

The tables and charts presented in Section 4, *Results*, provide the results of the regional inventory for the southwest Lake Michigan pilot study area. It is important to note that, as a pilot study, the subcommittee has refrained from interpreting the results or from drawing major conclusions that might have policy implications. In addition, the subcommittee finds that, beyond the actual results, the process of compiling the regional inventory has, itself, proven extremely valuable as a means of resolving the many technical, methodological, and policy-related issues that impact a multistate, regional toxic air emissions inventory. The U.S. EPA GLNPO office serves as the repository for the Southwest Lake Michigan Urban Area Source Inventory. Small point and area source toxic air emissions data collected by Illinois, Indiana and Wisconsin reside in the repository. Internet access to the inventory, using the RAPIDS client software, is available to select researchers.

One important outcome is that the SWLM pilot study illustrated the serious shortcomings that still exist in regional emissions estimates (see regional results page 28), and suggested necessary steps that must be made to ensure data quality for estimating various pollutant groupings (see Section 5, *Conclusions*). A significant contribution to the goals of CAA section 112(c)(6) relates to the identified need for better methodology for use in next year's full eight-state regional inventory.

The SWLM pilot study emissions inventory for small point and area sources in the Chicago, Milwaukee and Gary urban areas are summarized in the following tables and figures beginning on page 28:

Table 4-1: Regional Summary of Pollutant Emissions, by State and Region, for all Inventoried Sources in the Southwest Lake Michigan Pilot Project Study Area, 1993.

Table 4-2: Regional Toxic Air Emissions by Inventoried Source for the Southwest Lake Michigan Pilot Project Study Area, 1993.

Figures 4-6 through 4-35: Estimated Emissions from Small Point and Area Sources in the Southwest Lake Michigan Study Area, 1993.

Working together on this pilot project, the Great Lakes states, and particularly the lead states of Illinois, Indiana, Wisconsin and Michigan, have set a national example of cooperative emissions inventory development across states. The efforts the state air agencies are undertaking together in this project, supported by U.S. EPA, are unprecedented.

An important result from the SWLM pilot inventory is that the states have learned how to conduct a multistate inventory and are now poised to prepare a successful regionwide, eight-state effort.

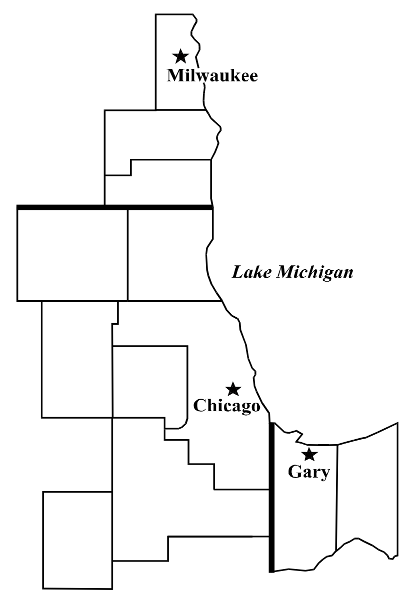
1. Introduction

SOUTHWEST LAKE MICHIGAN PILOT STUDY

The purpose of the Southwest Lake Michigan (SWLM) Pilot Study was to inventory small point and area sources of toxic air emissions from the combined urban areas of Chicago, Gary and Milwaukee (see Figure 1-1) and, in the process, to test the *Air Toxics Emissions Inventory Protocol for the Great Lakes States* and to design and test an automated emissions estimation and data management system that could be used in later years in developing larger, multistate Great Lakes regionwide inventories.

Importantly, this study did not inventory major sources of toxic air emissions in the urban study area. Emissions from "major sources," as defined by the Clean Air Act (CAA), were not estimated, and are not documented in the regional summary; consequently, the ratio of area to major source emissions in the study area is not available and the tables and charts provided herein should not be construed to represent an estimate of total emissions of the subject hazardous air pollutants released in the study area.

Figure 1-1: SWLM Pilot Study Area



The SWLM pilot study began in October 1993 with primary funding provided by the U.S. Environmental Protection Agency (U.S. EPA) and built upon four previous years of effort by the Great Lakes states, funded by the Great Lakes states themselves through the Great Lakes Protection Fund. In addition, the project benefited from substantial in-kind contributions of staff time by the lead states of Illinois, Indiana, Michigan and Wisconsin and federal collaborators at U.S. EPA. Project oversight was provided by the Great Lakes Commission Regional Emission Inventory of Toxic Air Contaminants Steering Committee (see Appendix F), working together under the auspices of the Great Lakes Commission. Project management was provided by Great Lakes Commission, an Ann Arbor, Michigan-based compact agency of the eight Great Lakes states (Illinois, Indiana, Michigan, Minnesota, Ohio, New York, Pennsylvania and Wisconsin).

PRODUCTS

This report is but one of six products of the SWLM study. The complete product package includes:

1. This report, *The Southwest Lake Michigan Pilot Study: Developing an Inventory of Toxic Air Emissions from Area Sources in the Chicago, Milwaukee and Gary Urban Areas, 1993.*

2. Regional Air Pollutant Inventory Development System (RAPIDS) client/server software for estimation of toxic air emissions from point and area sources. RAPIDS software and

documentation may be downloaded from the Internet at the site: ftp.great-lakes.net/pub/RAPIDS/production/.

3. The Southwest Lake Michigan Urban Area Source Inventory. The U.S. EPA Great Lakes National Program Office (GLNPO) serves as the inventory repository. Internet access to the inventory, using the RAPIDS client software, is available to approved state and federal employees.

4. *Air Toxics Emissions Inventory Protocol for the Great Lakes States.* The SWLM project tested the procedures outlined in this 1994 toxic air emission estimation protocol document. The full protocol and the Quality Control/Quality Assurance plan are available at http://www.great-lakes.net/partners/glc/projects/air/protocol/protohome.html. The protocol is a living document; additions and refinements to the protocol as a result of the SWLM project are in progress. The protocol will be used to guide the efforts of all eight Great Lakes states in 1995-96 as they prepare the first full statewide toxic air emissions point and area source inventories and populate the regional repository. Further additions and refinements may be expected after the first full eight-state inventory.

5. Improved state air emissions inventory systems for criteria and toxic air pollutants. At least two of the region’s states are now adapting part or all of the state-of-the-art RAPIDS client/server software developed during the SWLM study to serve as their in-state toxic and criteria pollutant emission estimation and inventory system for major sources and area sources. In addition, several other states are using various RAPIDS modules as an adjunct to existing or planned systems to house the state toxic air emissions inventory.

6. Finally, perhaps the most important product of this effort has been the jump start that the Great Lakes region's state, provincial, federal and regional project partners have gained in the understanding and use of client/server and Internet communications technology. The SWLM project successfully demonstrated the cost effective and time efficient use of the Internet as an aid to solving regional environmental problems. With the assistance of the U.S. EPA GLNPO office, the project introduced the concept and successfully demonstrated the feasibility of states using client/server technology via the Internet to transmit and exchange environmental data with other states, federal agencies and industry.

DEFINITIONS

Definitions of a major source and an area source as presented in CAA, Section 112 Hazardous Air Pollutants, are inserted here to assist the reader’s understanding of the effort undertaken by the states that conducted the SWLM study.

> “Section 112. (a) (1) Major source. - The term “major source” means any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants. The Administrator may establish a lesser quantity, or in the case of radio nuclides different criteria, for a major source than that specified in the previous sentence, on the basis of the potency of the air pollutant, persistence, potential for bioaccumulation, other characteristics of the air pollutant or other relevant factors.

> "Section 112. (a) (2) Area source. - The term "area source" means any stationary source of hazardous air pollutants that is not a major source. For purposes of this section, the term "area source" shall not include motor vehicles or non-road vehicles subject to regulation under title II.

Under the terms of the CCA, which defines major sources in terms of quantity, the sources inventoried in the SWLM study are accurately described as "area sources." However, emissions inventory specialists sometimes use the terms point and area source in a different way: A point source is one located at a discrete location where emissions estimates can be based on activity at that location. An area source is a *type* of source where inventory specialists assume a geographic area contains several or many similar sources, and emissions are estimated based on activity within the geographic area (usually a county), rather than at discrete points.

Generally, this report follows this convention, and refers to sources as either "small point" or "area sources" to provide a further level of refinement to aid in understanding the size and type of sources inventoried. Emission estimates generated for facilities were grouped by Standard Industrial Classification (SIC) codes and labeled as emissions from "small point sources." The protocol refers to such sources as "facility sources," regardless of size. Source categories, such as residential woodburning and non-road engines, are referred to as "area sources" by the states in the protocol and retain that classification in this report; these sources are referred to by name (i.e., woodburning for residential woodburning) in the attached regional tables and charts, or, when necessary, generically, as "area sources."

2. Objectives

The federal incentive for the project was to assist the U.S. EPA in meeting requirements of Section 112 of the Clean Air Act (CAA). This project report documents substantive progress toward meeting the urban area goals of the CAA Sections 112(c)(6) and 112(k) and the Great Lakes goals of Section 112(m).

URBAN AREA SOURCE EMISSIONS ESTIMATION GOAL UNDER THE CLEAN AIR ACT

Sections 112(c)(6) and 112(k) of the CAA require U.S. EPA, through its Urban Area Source Program, to identify "not less than 30 hazardous air pollutants which, as a result of emissions from area sources, present the greatest threat to public health in the largest number of urban areas." U.S. EPA also must list and regulate the categories and subcategories of area sources that contribute 90 percent of the emissions of each of the 30 or more hazardous air pollutants. Furthermore, U.S. EPA must develop a national strategy to reduce emissions of hazardous air pollutants emitted by area sources, as well as reduce by 75 percent the incidence of cancer attributable to such area sources.

The three states that conducted the SWLM study believe that the air toxic emission estimates contained in this report for the Chicago, Gary and Milwaukee urban areas represent the best single compilation of such estimates. The scope of the project did not allow the states to undertake a massive discovery effort; instead, the states used available calendar year 1993 process data, emission factors and reported information. It was the objective of the SWLM study to enhance current inventory capabilities, resolve procedures and protocol issues across several states and develop and test an automated emission estimation and inventory system, and, in the process, compile the urban area source inventory for the SWLM study area.

In short, the pilot study should be viewed as an initial effort to bridge the gap between the *science* of inventorying toxic air emissions and the public policy *debate* concerning how these emissions affect human health and the environment and how they should be addressed. Follow-up by U.S. EPA and the states themselves is necessary to make further progress toward meeting the goals of Section 112 of the CAA. The pilot study states recommend that regulatory decisions not be based on this data unless more compelling research exists to warrant such action.

No effort was made to develop a ratio of the total emissions from small point and area sources to total emissions from major sources. Emissions from "major sources" were not estimated and are not documented in the regional summary; consequently the ratio of area to major source emissions in the SWLM study area is not available, and the tables and charts provided herein should not be construed to represent an estimate of total emissions for hazardous air pollutants released in the study area.

Section 112(c)(6) Specific Pollutants

Section 112(c)(6) specified the need to list categories and subcategories of sources emitting the following pollutants: alkylated lead compounds, polycyclic organic matter (POM), hexachlorobenzene, mercury, polychlorinated biphenyls (PCBs), 2,3,7,8-tetrachlorodibenzofurans (TCDF) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

Each of the 112(c)(6) pollutants was targeted in the SWLM small point and area source emissions inventory. Importantly, this study did not inventory major sources of these toxic compounds or others in the urban study area. The objective of this study, in terms of the pollutants referenced in Section 112(c)(6), was to locate small point and area sources of these toxic compounds in the 12-county area. The *Results* section provides suggested refinements to the procedures listed in the *Air Toxics Emissions Inventory Protocol for the Great Lakes States* in order to more accurately estimate total emissions of POM and related pollutants.

Section 112(k) Area Source Program

Section 112(k) of the CAA authorizes the U.S. EPA to conduct, after consultation with state and local air pollution control officials, a program of research with respect to sources of hazardous air pollutants in urban areas that shall include analysis to characterize the sources of such pollution with a focus on area sources and the contribution that such sources make to public health risks from hazardous air pollutants. This work is seen as preliminary to the development of a national strategy to reduce emissions in urban areas from area sources of hazardous air pollutants and to gain an equivalent reduction in public health risks associated with such sources.

The objective of the SWLM pilot study was to provide the mechanism, procedure and the first compilation of data on emissions from area sources of a targeted list of hazardous air pollutants, including those identified in Section 112(c)(6) of the CAA. The study aimed to provide the best compilation of such data for calendar year 1993 emissions from small point and area sources. The *Results* section of this report presents the best currently available estimates of area sources for the inventoried toxic air pollutants for calendar year 1993 in the Chicago, Milwaukee and Gary urban areas. The project begins a long-term state and federal effort to categorize emissions from various area sources (and major sources) in the Great Lakes region. An objective for the states in the SWLM study is to work cooperatively with the U.S. EPA to enhance and stabilize the regional inventory software and protocol developed under this effort, and as a consequence, to make it possible for the U.S. EPA to use following years' eight-state emissions data for risk assessment purposes in the future.

The states believe that this work will provide the strongest foundation upon which the U.S. EPA can build the national strategy to reduce urban area toxic air emissions as outlined in Section 112(k)(3) of the CAA.

Further clarification of objectives and descriptions of inventoried sources and estimation procedures used to estimate CAA "area source" emissions by the three states are provided in the *Conclusions* section and in the state summaries provided in appendices A through C.

1986 GREAT LAKES GOVERNORS' TOXIC SUBSTANCES CONTROL AGREEMENT AND CAA SECTION 112(m)

The Great Lakes region had an additional incentive to undertake the SWLM project. The development of multistate client/server toxic air emission inventory software and procedures goes a long way toward meeting provisions of the Council of Great Lakes Governors' Toxic Substances Control Agreement (governors' agreement) of 1986, which called on the states to jointly identify sources of persistent toxic substances contaminating the Great Lakes. Similar Great Lakes-specific goals were promulgated under Section 112(m) of the CAA. The fact that the Great Lakes states and the U.S. federal government realized the convergent nature of these two initiatives and tied them together into a jointly funded project to meet the needs of both levels of government is in itself an achievement. The pilot study provided a unique opportunity to simultaneously support both regional and national air quality management efforts. This report documents substantive progress toward meeting both governors' agreement and Section 112(m) goals.

Great Lakes States' Goal: Cooperatively Quantifying Sources of Toxic Substances Entering the Great Lakes

In 1986 the governors of the eight Great Lakes states signed an agreement that stated, in part:

> "Toxic contaminants enter the Great Lakes Basin from a wide variety of sources including industrial discharges, nonpoint sources and atmospheric deposition. It is acknowledged that the atmosphere is a significant source of the total balance of pollutants entering the Great Lakes system. However, in many cases additional research is needed to quantify sources of toxic substances transported through the atmosphere.
>
> "Therefore:
>
> "1. The signatory States agree to cooperate in quantifying toxic substances loadings originating from all sources, with the purpose of developing the most environmentally and economically sound control programs.
>
> "2. The signatory States agree to consider the effects of airborne pollutants on human health and aquatic life when setting air emission standards and granting air emission permits, and to better integrate their respective air and water programs to address atmospheric deposition affecting the lakes.
>
> "3. The signatory States endorse the work of the atmospheric component of the Great Lakes international Surveillance Plan and its increased focus on monitoring toxic substances.

In 1988 this agreement was further ratified by the provinces of Ontario and Québec. Since that time, the Great Lakes states have worked cooperatively to develop a common method to quantify emissions of toxic air pollutants in the region. Ontario has participated fully in discussions, but is not yet prepared to undertake a province-wide air toxics inventory. Québec has not participated in the project to date.

Great Waters Goal: Identifying Sources of Atmospheric Deposition to the Great Lakes

The goal of Section 112(m) of the CAA, Atmospheric Deposition to Great Lakes and Coastal Waters, is to conduct a program to identify and assess the extent of atmospheric deposition of hazardous air pollutants (and at the discretion of the administrator, other air pollutants) to the Great Lakes, the Chesapeake Bay, Lake Champlain and coastal waters. As part of this program, the U.S. EPA is charged with investigating the source or sources of any pollution to the Great Lakes which is attributable to atmospheric deposition.

The Great Lakes states made significant progress toward meeting the goals of the governors' agreement and CAA Section 112(m) by developing the Regional Air Pollutant Inventory Development System (RAPIDS) and testing the *Air Toxics Emissions Inventory Protocol for the Great Lakes States*. The RAPIDS software, and the accompanying protocol will be used by all eight Great Lakes states in future years to conduct joint point and area source inventories of the 49 target compounds identified in Table 2-1. RAPIDS data will be made available to state and U.S. EPA researchers conducting analysis of the effects of atmospheric deposition of air pollutants on the Great Lakes. In addition, other (non-Great Lakes) states participating in the Great Waters Program will be offered copies of the RAPIDS software and protocol for their use in estimating toxic air emissions impacting the Chesapeake Bay, Lake Champlain and the coastal waters of the United States. In addition, the states of Texas and Louisiana have followed development of the project to date and have access to the software and protocol.

The *Results* section of this report briefly outlines the point and area source emission estimation and inventory capabilities of RAPIDS.

TARGET COMPOUNDS

The study focused on the identification of small point and area source categories that contribute the most to the total emissions of hazardous air pollutants listed in Table 2-1. The list of target compounds was developed over a period of five years, and is based on several criteria. The list includes pollutants identified in the Great Lakes Basin by the International Joint Commission on the basis of toxicity to aquatic life, carcinogenicity and toxic effects on human health and bioaccumulative potential. Table E-1 in Appendix E lists the carcinogenicity ratings for the target compounds based on U.S. EPA's Integrated Risk Information System Database. Pollutants have been added to the list based on the suggestions of individual Great Lakes states; the U.S. EPA Office of Air Quality Planning and Standards; Factor Inventory Retrieval (FIRE) system developers; U.S. EPA Great Waters/Section 112(m) and Urban Area Source 112(c)(6) program staff; and from the list of pollutants identified in Section 112(c)(6) of the CAA. The current list of 49 pollutants should not be considered final. There are procedures in the protocol for states, and others, to suggest the addition or deletion of compounds. Upon consensus approval of the full eight-state steering committee, the list may be amended. See the *Conclusions* section for suggested amendments to the list generated by the SWLM study.

Table 2-1: List of Target Compounds for the Regional Toxic Air Emissions Inventory

	Pollutant	Toxic List			CAS #
		[1]Great Waters	[2]Great Lakes Commission	[3]CAA 112(c)(6)	
1	Arsenic	Yes	Yes		7440-38-2
2	Atrazine	Yes			1912-24-9
3	Benz(a)anthracene (1,2-Benz(a)anthracene Benzo(a)anthracene)		Yes		56-55-3
4	Benzo(a)pyrene	Yes	Yes		50-32-8
5	Cadmium	Yes	Yes		7440-43-9
6	Carbon tetrachloride	Yes	Yes		56-23-5
7	Chlordane	Yes			57-74-9
8	Chromium	Yes	Yes		7440-47-3
9	Chrome VI		Yes		18540-29-9
10	Chrysene (Benz(a)phenanthrene)		Yes		218-01-9
11	Cobalt	Yes			7440-48-4
12	Coke oven emissions	Yes			8007-45-2
13	Copper	Yes			7440-50-8
14	1,2-Dichloroethane		Yes		107-06-2
15	Diethlyhexyl phthalate (Bis(2-ethylhexyl) Phthalate)		Yes		117-81-7
16	Di-n-butyl phthalate		Yes		84-74-2
17	Di-n-octyl phthalate		Yes		117-84-0
18	Dioxins	Yes			
19	Ethylbenzene	Yes			100-41-4
20	Fluoranthene (1,2-Benzacenapthene Benzo(jk)fluorene)		Yes		206-44-0
21	Heptachlor	Yes			76-44-8
22	Hexachlorobenzene	Yes	Yes	Yes	118-74-1
23	Hexachlorobutadiene		Yes		87-68-3
24	Hexachloroethane		Yes		67-72-1
25	Lead	Yes	Yes		7439-92-1
26	Alkylated lead compounds		Yes	Yes	7439-92-1
27	Manganese & compounds	Yes			
28	Mercury	Yes	Yes	Yes	7439-97-6
29	Methoxychlor Dimethoxy-DDT	Yes			72-43-5
30	Methylene Chloride Methane Dichloride Freon 30	Yes			75-09-2
31	Naphthalene		Yes		91-20-3
32	Nickel and compounds Ni carbonyl Ni cyanide NI subsulfide	Yes			 13463-39-3 557-19-7 12035-72-2
33	Parathion	Yes			56-38-2
34	Pentachloronitrobenzene (PCNB) (Quintobenzene)	Yes			82-68-8
35	Pentachlorophenol (PCP)	Yes			87-86-5
36	Phenol (Carbolic Acid)	Yes			108-95-2
37	Total polychlorinated biphenyls (PCBs)	Yes	Yes	Yes	1336-36-3

	Pollutant	Toxic List			CAS #
		[1]Great Waters	[2]Great Lakes Commission	[3]CAA 112(c)(6)	
38	Total polychlorinated dibenzodioxins (PCDDs)	Yes	Yes		
39	Total polychlorinated dibenzofurans (PCDFs)		Yes		
40	Total polycyclic aromatic hydrocarbons (PAHs)	Yes	Yes		
41	Polycyclic organic matter (POM)	Yes		Yes	
42	2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)		Yes	Yes	1746-01-6
43	2,3,7,8-tetrachlorodibenzofuran (TCDF)	Yes	Yes	Yes	51207-31-9
44	Tetrachloroethene (Tetrachloroethylene 1,1,2,2-Tetrachloroethylene Perchloroethylene PERC)		Yes		127-18-4
45	Trichloroethene (Trichloroethylene)		Yes		79-01-6
46	1,1,1-trichloroethane		Yes		71-55-6
47	2,4,5-trichlorophenol		Yes		95-95-4
48	2,4,6-trichlorophenol		Yes		88-06-2
49	Trifluralin (2,6-Dinitro-n,n-dipropyl-4-(trifluoro-methyl) benzenamine)	Yes			1582-09-8

1. Compounds listed (among others) on U.S. EPA Great Waters Program's list of targeted toxic chemicals.
2. Compounds originally targeted by the Great Lakes Commission. The full GLC list now includes all 49 compounds listed above.
3. Compounds identified (among others) in the U.S. Clean Air Act, as amended in 1990 (Section 112 (c)(6)).

3. Methodology

The SWLM study concentrated on locating significant sources not currently regulated under the CAA. These sources include many traditionally unregulated sites with relatively small gas-fired, coal-fired, or oil-fired boilers; asphalt and concrete plants; industries dealing with primary metals (including zinc, aluminum and iron), or secondary metals (primarily used in the processing of refined metals); cultured marble companies; woodburning stoves and fireplaces; non-road engines; and generally, any place with an incinerator. The focus was on finding many small sources within one county or urban area that collectively release large amounts of one or more toxic air pollutants of concern. For detailed discussions of methodology, see appendices A, B and C and the 1994 *Air Toxics Emissions Inventory Protocol* (under separate cover).

AIR TOXICS EMISSIONS INVENTORY PROTOCOL FOR THE GREAT LAKES STATES

The *Air Toxics Emissions Inventory Protocol for the Great Lakes States*, finalized in June 1994, provides instructions for the states to follow to ensure the completeness, accuracy, consistency and quality of the regional toxic emissions inventory. Each state prepared its portion of the SWLM pilot inventory in the manner outlined in the protocol, and provided a quality assurance check on their state-specific emissions data and estimates to ensure the highest possible quality database.

Inventory completeness, one of the most important objectives of the protocol, has been addressed by identifying all source categories that have the potential to emit one of the target toxic air pollutants within the Great Lake states region. The accuracy of the regional inventory is addressed by using the most recent information available to identify and locate emission sources and estimate emissions. The QA/QC Plan outlines procedures to maximize the quality and accuracy of the regional inventory's data and estimates.

The protocol does not contain specific, detailed information on estimating emissions for each type of device/process expected to be encountered in the Great Lakes region. Instead, acceptable generic emission estimating techniques (EETs) are identified for the emission sources that produce toxic emittants. A generic discussion of each EET and a list of technical references is provided for those who require more detailed information.

U.S. EPA required agencies to prepare Inventory Preparation Plans (IPPs) as part of the 1990 baseline criteria pollutant inventories required under the Clean Air Act, as amended in 1990. The protocol was prepared in partial fulfillment of this requirement. According to the U.S. EPA, the IPP should outline the agency's inventory development effort plan, and present and document the resulting emissions data and estimates. The U.S. EPA recommended that, at a minimum, the IPP include the following information:

definition of the inventory's structure, content and inventory area;

background and basis for the inventory;

identification of the parties responsible for the inventory;

identification of the quality assurance coordinator; and procedures used to collect data and determine emissions.

The protocol is not intended to replace the IPP, but does include most of the above information. By focusing on the procedures that the participating states must follow to compile their portion of the regional database, the protocol assigns responsibilities and procedures (joint, state, Great Lakes Commission, U.S. EPA GLNPO); outlines procedures to identify and locate emission sources of target compounds; guides selection of specific emission estimation techniques; instructs states on compiling and updating the regional repository at GLNPO; outlines quality assurance/quality control procedures for emission data and estimates; and identifies and explains the full suite of automated tools available for developing the regional inventory (RAPIDS, GLC-FIRE, Version 3.0, and others).

Since the participating states envision that the full eight-state regional database of air toxic emissions data and estimates will be updated periodically, the protocol also provides the procedures to update the regional inventory and an estimated schedule for such updates. Procedures to resolve differences of opinion among the participating states regarding various aspects of the regional inventory development effort are a significant component of the protocol.

Figure 3-1 on the following page outlines the major steps and checkpoints that the protocol stipulates the Great Lakes states follow in developing their portion of the regional inventory. These include the completion of: staff resource development; device/process identification in the study area; and data collection requirements analysis. The data collection, emission calculation and area source reconciliation also must be completed, as well as data entry and pre-upload QA/QC activities. Finally, a successful upload to the regional repository and the Aerometric Information Retrieval System (AIRS) must be accomplished.

Two important issues for the inventory development effort are the appropriate level of detail and the use of facility versus area approach for calculating emissions. For the Great Lakes states regional inventory, the protocol defines the following level of detail as being appropriate for meeting the goals of the project:

Emittants included: Include all target compounds listed in Table 2-1;

Spatial resolution: By county for area sources, and to the nearest 100 meters for facility sources and associated devices;

Temporal resolution: Annual emissions estimates and annual activity data; and

Source/device/process categorization: By the most detailed source/device/process, as identified in U.S. EPA's Source Classification Codes (SCC) and Area and Mobile Source (AMS) coding systems of process codes plus a further breakdown by Standard Industrial Classification (SIC), as appropriate, to better categorize a given source (required to prevent the problem of inconsistent aggregation of sources/devices/processes among the participating states).

Figure 3-1: Major Steps and Checkpoints in the Regional Inventory Development Effort as Stipulated in the *Air Toxics Emissions Inventory Protocol*

The protocol describes the two emission calculation approaches as follows:

- **Facility source approach:** Separately identify each device/process at each facility source and calculate its emissions (often referred to as a facility/point source approach); and

- **Area source approach:** Aggregate all similar or identical device/processes within a defined area and calculate their total emissions directly using the appropriate surrogate activity data (the source in this case is the area in which all of the devices are found, usually an entire county).

The area source approach is generally used for sources that are small and numerous, such as gasoline stations and dry cleaning establishments. These are not included as facility sources because the effort required to gather and estimate emissions for each individual facility is beyond the resources available for inventory development efforts. Some area sources, such as consumer products, have no analog as a facility source.

The protocol refers to certain software tools (e.g. the Regional Air Pollutant Inventory Development System, RAPIDS, discussed below) that can be used to prepare a state or province's portion of the regional inventory. However, the protocol procedures, if followed, will result in emissions data and estimates that are compatible and consistent, whether or not these software tools are used.

DEVELOPING AND TESTING CLIENT/SERVER EMISSION ESTIMATION AND INVENTORY SOFTWARE: RAPIDS

Development of the Regional Air Pollutant Inventory Development System (RAPIDS) has been the key to the effort to develop a comprehensive, accurate and consistent urban area air toxic emissions inventory across three states.

During the course of this study, the Southwest Lake Michigan Subcommittee worked closely with the project software development contractor, Radian Corporation, to develop and test RAPIDS. The effort represents the first attempt to prepare software for estimating toxic pollutant emissions on a multistate basis. RAPIDS is a client/server system consisting of an ORACLE back-end database designed using ORACLE CASE tools, and a "suite" of front-end applications developed using various software tools (primarily PowerBuilder and SAS). The software takes full advantage of new Internet/GLIN connections between the states, the Great Lakes Commission and the U.S. EPA GLNPO office in Chicago.

See section 4, *Results* for discussion on the use of RAPIDS in compiling the SWLM inventory.

COLLECTING AND COMPILING DATA FROM THREE STATES

Emission estimates were based on the best available state inventory data. The data presented represent different levels of emissions reporting requirements and data collection efforts by each of the participating states. If emissions from certain source categories are missing from one state's data, this may reflect varying reporting requirements among the states and not necessarily the absence of those sources within the state. Contact each individual state's quality assurance/quality control representative, listed in Table 3-1 below, for further information. The states promoted consistency among their respective inventories by following the *Air Toxics Emissions Inventory Protocol for the Great Lakes States* (developed to help the eight Great Lakes states prepare a comprehensive, regional air toxic emissions inventory) and by using emissions factors from FIRE Version 3.0.

Rather than comparing one state's emissions against another state's results, the focus of the pilot study was to prepare a reliable and technically accurate inventory for the southwest Lake Michigan region as a whole and to outline areas where improvements are needed in overall methodology and implementation.

Table 3-1: Personnel Responsible for Pilot Inventory Compilation and Quality Assurance/Quality Control

Role	Illinois	Indiana	Wisconsin
Inventory Development	Buzz Asselmeier Division of Air Pollution Control IL Environmental Protection Agency	Chris Hammack, Susan Bem Office of Air Management IN Dept. of Environmental Management	Orlando Cabrera-Rivera Bureau of Air Management WI Dept. of Natural Resources
Quality Assurance/ Quality Control	Buzz Asselmeier Division of Air Pollution Control IL Environmental Protection Agency	Susan Bem, Chris Hammack Office of Air Management IN Dept. of Environmental Management	John Shenot Bureau of Air Management WI Dept. of Natural Resources

COORDINATION METHODS

As a multistate, regional effort, a high level of coordination and communication was necessary to ensure consistency among the three states in terms of data management, methodology, calculation methods and other issues. To facilitate the necessary communication on these issues, a Southwest Lake Michigan Pilot Study Subcommittee was established by the Great Lakes Regional Emission Inventory of Toxic Air Contaminants Steering Committee. The subcommittee (see Appendix G) included members from the three lead states and Michigan and observers from Minnesota, U.S. EPA and Ontario. The Great Lakes Commission provided project management and secretariat services.

During the course of the SWLM study, the subcommittee communicated via daily e-mail exchanges, conference calls on a weekly or biweekly basis, and monthly or bimonthly in-person meetings to oversee contractor development of the inventory software, and to resolve outstanding issues and inconsistencies among the three states contributing to the pilot study. The project team developed an Internet group mailing service, airtoxics@great-lakes.net, which facilitated transmittal of thousands of messages among the subcommittee members, contractors, and with a larger group of steering committee members, peer reviewers, university and industry researchers, other Great Waters/Urban Area Source states (including Texas and Louisiana), and federal agency representatives. The Great Lakes Commission holds a complete archive of all airtoxics@great-lakes.net messages, including minutes for all conference calls and in-person meetings. The complete e-mail address list for the airtoxics@great-lakes.net mailing service is included in Appendix I.

Finally, a Quality Assurance/Quality Control (QA/QC) Committee was formed to review the pilot study report, establish QA/QC criteria for use by the three states and ensure the report provides an accurate and useful summary of toxic air emissions at the regional level. Members of the SWLM Regional QA/QC subcommittee are listed in Appendix H. Minutes of this committee's meetings and all e-mail transactions have been archived by the Great Lakes Commission.

4. Results

URBAN AREA SOURCE EMISSIONS ESTIMATION GOAL UNDER THE 1990 CAA

The results summarized below should be viewed as a first step for use by policy-makers and others involved in air quality management. These data can support regulatory decisions if used in conjunction with other sources of quality-assured data. With these results, and an enhanced understanding of current inventory capabilities, additional questions can be asked, issues can be more precisely framed, and the goals and objectives of future inventory efforts can be specified in greater detail. In short, the pilot study should be viewed as an initial effort to bridge the gap between the *science* of inventorying toxic air emissions and the public policy *debate* concerning how these emissions affect human health and the environment and how they should be addressed.

The tables and charts beginning on page 28 provide the results of the regional inventory for the southwest Lake Michigan pilot study area. It is important to note that, as a pilot study, the subcommittee has refrained from interpreting the results or from drawing major conclusions that might have policy implications. In addition, the subcommittee finds that, beyond the actual results, the *process* of compiling the regional inventory has, itself, proven extremely valuable as a means of resolving the many technical, methodological, and policy-related issues that impact a multi-state, regional toxic air emissions inventory. Important lessons have been learned, and while these may not be immediately apparent from the tables and charts below, they will nonetheless be put to use in compiling the full, eight-state inventory for the Great Lakes region.

Perhaps the most important outcome of the project is that the SWLM pilot study illustrated the serious shortcomings which still exist in the emissions inventory estimates (see regional results page 28), and suggested necessary steps that must be made to ensure data quality for estimating various pollutant groupings (see Section 5, *Conclusions*).

Southwest Lake Michigan Urban Area Source Inventory

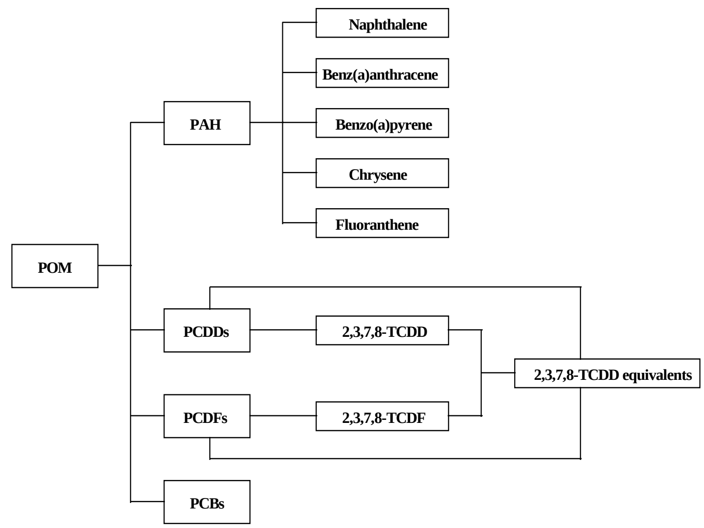
The U.S. EPA GLNPO office serves as the repository for the Southwest Lake Michigan Urban Area Source Inventory. Small point and area source toxic air emissions data collected by the states of Illinois, Indiana and Wisconsin reside in the repository. Internet access to the inventory, using the RAPIDS client software, is available to select researchers. Petitions for access should be directed to the Great Lakes Commission.

1990 CAA Section 112(c)(6): A Protocol for Inventorying Pollutant Subsets

Perhaps the most significant contribution to the goals of CAA Section 112(c)(6) relates to the identified need for better methodology for use in next year’s full eight-state regional inventory. With the assistance of a quality assurance/quality control subcommittee, the states drafted new methodology, titled *QA/QC for Pollutant Subsets*, to be added to the protocol.

PAH emission estimates should include total emissions for several pollutants (subsets), a number of which were separately inventoried in this study. Figure 4-1 shows the hierarchy of POM and PAH compounds. Similarly, total chrome should include emission totals for chrome VI, a separately inventoried pollutant. Total emissions for PAH should equal or exceed the sum of all PAH compounds; and total chrome emissions should exceed emission estimations for chrome VI. However, emission factors in FIRE Version 3.0 may exist in one of three combinations: 1) factors for PAH and factors for associated compounds; 2) factors just for PAH; or 3) factors just for some of the associated compounds. A similar situation occurs with chrome and chrome VI.

Figure 4-1:Hierarchy of POM Compounds in the Target Compounds List of the Regional Air Toxic Emissions Inventory



Source: Chun Yi Wu, State of Minnesota, Pollution Control Agency, Air Toxic Unit, 1995

The Quality Assurance/Quality Control Committee expected that emissions estimates for POM, PAH and the PAH subsets would relate to one another as follows:

POM PAH naphthalene + benz(a)anthracene + benzo(a)pyrene + chrysene + fluoranthene

In fact, due to the availability and use of selected emission factors, naphthalene emission estimates exceeded PAH emission estimates. A similar error occurred in the chromium and hexavalent chrome emission estimates. The SWLM pilot study subcommittee recognizes the discrepancies in these totals and has drafted methodology, presented in Section 5, *Conclusions*, to rectify this error. The next step for improving the pollutant subset estimation methodology in the protocol is review and refinement by the eight Great Lakes states, Ontario and U.S. EPA; upon consensus approval by the eight Great Lakes states the methodology will be added to the protocol.

CAA Section 112(k) Area Source Program: Toxic Emissions from Urban Area Sources

The SWLM pilot study emissions inventory for small point and area sources in the Chicago, Milwaukee and Gary urban areas are summarized in the following tables and figures:

Table 4-1: Regional Summary of Pollutant Emissions, by State and Region, for All Inventoried Sources in the Southwest Lake Michigan Pilot Project Study Area, 1993: This table, beginning on page 28, lists total emissions in pounds per year, from all inventoried sources, for each of the 49 target compounds inventoried in the pilot study. Totals are shown for each state's portion of the inventory, as well as for the 12-county region as a whole. This summary is intended to provide a general overview of toxic air pollutants in the 12-county study area. While the data can be broken down further, doing so would focus attention on a level of detail that may not be appropriate at this point in the study process.

Appendix E provides the carcinogenicity ratings for the pollutants inventoried in the SWLM project, based on U.S. EPA's Integrated Risk Information System (IRIS) Database. Ratings in the IRIS database are based on agency consensus positions on the potential adverse human health effects of approximately 500 substances, updated monthly. The carcinogenicity ratings provided in Appendix E are from September 1995.

Table 4-2: Regional Toxic Air Emissions by Inventoried Source for the Southwest Lake Michigan Pilot Project Study Area, 1993: This table, beginning on page 30, summarizes pollutant emissions for each SIC code and area source included in the pilot study. The information in the table is displayed in two parts. The page on the left shows the contribution from each SIC code to the total emissions of each pollutant, in pounds. The page on the right displays the percentage contribution from each SIC to the total emissions of each pollutant. Each set of facing pages show data for the same SICs. Appendix D provides a comprehensive listing of SIC codes available in the RAPIDS database.

Figures 4-6 through 4-35: Estimated Emissions from Small Point and Area Sources in the Southwest Lake Michigan Study Area, 1993: The pie charts beginning on page 73 show the percentage emission contributions from small point sources (by SIC code) and area sources (by type) to the total area source emissions for each of the inventoried pollutants.

1986 Great Lakes Governors' Toxic Substances Control Agreement and CAA Section 112(m)

Working together on this pilot project, the Great Lakes states, and particularly the lead states of Illinois, Indiana, Wisconsin and Michigan, have set a national example of cooperative emissions inventory development across states. The efforts the state air agencies are undertaking together in this project, supported by U.S. EPA, is unprecedented. The Great Lakes states have developed and are sharing with each other a core of expertise in toxic inventory development; in fact, in May 1995 the SWLM pilot states hosted a regional training seminar at the U.S. EPA GLNPO office in Chicago. Using the office's computer training facility, the states offered a hands-on RAPIDS training program to emission inventory specialists from the states of Minnesota, New York, Ohio, Pennsylvania, Ontario and U.S. EPA Region 5. Pilot inventory state personnel from Illinois, Indiana, Michigan and Wisconsin each developed and taught components of the two-day session.

An important result from the SWLM pilot inventory is that the states learned how to conduct a multistate inventory and are now poised for a successful regionwide, eight-state effort. The concrete implications in terms of the governors' agreement and CAA Section 112(m) will be seen in 1996 and thereafter. However, if the SWLM pilot study had not been conducted, the pilot study states expect that the quality of the results from the full, eight-state regional inventory would be greatly reduced.

The SWLM project began a unique process whereby multiple states collaborated to develop common client/server software, and populated and tested a core system while working on their own jurisdiction-specific enhancements and made these modifications available to others to use as needed. States have agreed to maintain the ability to populate the regional repository core system, while modifying their state-specific systems to meet their own evolving needs.

Michigan and Wisconsin have moved a step further with RAPIDS and both are building major RAPIDS components into their state emission inventory systems. The Michigan Department of Environmental Quality estimates that the use of RAPIDS has saved the state between $300,000 and $500,000, and perhaps more.

OVERVIEW OF THE RAPIDS SYSTEM

A copy of the RAPIDS software (Version 1.5) and user manual may be downloaded via anonymous ftp from the Great Lakes Information Network (ftp.great-lakes.net/pub/great-lakes/RAPIDS/ver1_5).

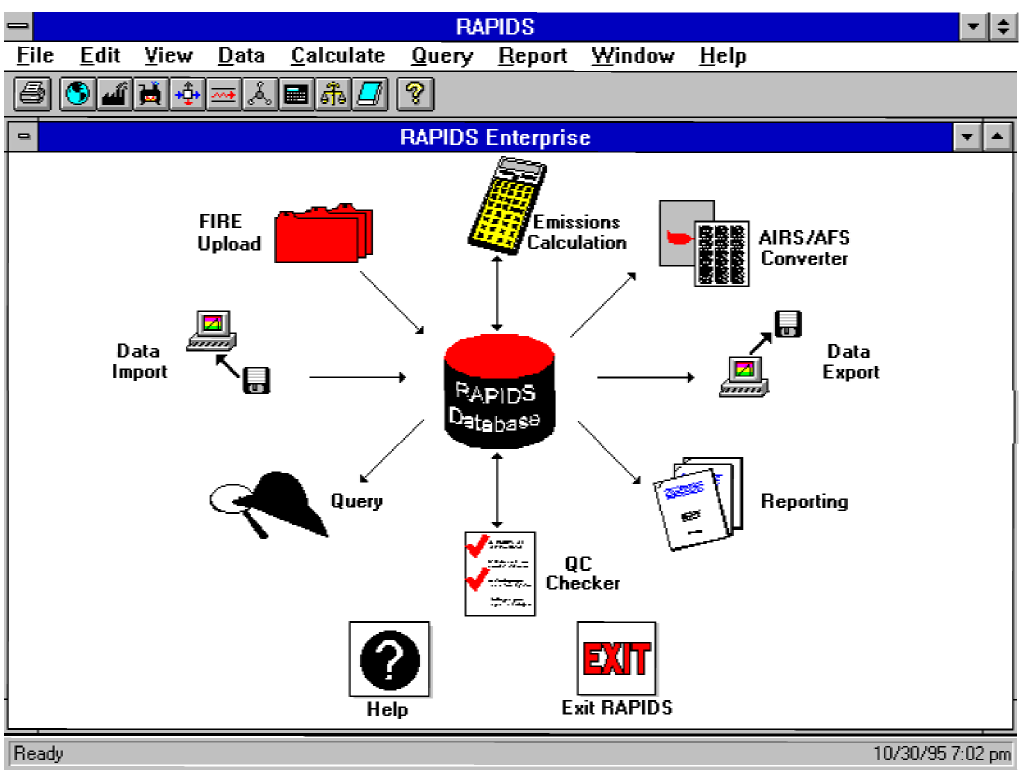
RAPIDS is a client/server system consisting of an ORACLE back-end database designed using ORACLE CASE tools, and a suite of front-end applications developed using various software tools (primarily PowerBuilder and SAS). The design of the RAPIDS system is depicted in Figure 4-2.

The RAPIDS system includes the following components:

An ORACLE back-end database consisting of various ORACLE data tables of emissions data and estimates located on a separate (i.e., separate from the front-end client applications) file server at each participating state.

A set of ORACLE data tables of emissions data and estimates located at the U.S. EPA GLNPO office containing emissions data and estimates obtained from each of the participating states (i.e., a regional database of emissions data and estimates). RAPIDS includes a client/application that uploads (*GLNPO Upload*) each state's set of ORACLE

Figure 4-2: Design of the RAPIDS System



tables to the regional repository located at GLNPO.

Data Import and *Data Export* client applications that facilitate the import of emissions data and estimates maintained by the states external to RAPIDS into the back-end database, and which facilitate the export of data from the back-end database into ASCII files (i.e., import file format).

A *FIRE Upload* client/application (this application is under development) that will upload the emission factors contained in FIRE (Factor Information Retrieval System) into a reference table used to calculate emissions. FIRE is an emission factor database repository developed by U.S. EPA. The emission factors contained in FIRE have been incorporated into RAPIDS and used within the system to compute emission estimates for certain source categories.

A set of *Data Entry* client/applications developed in PowerBuilder that consist of various forms/screens to enter different types of emissions data, and emission estimates derived external to RAPIDS.

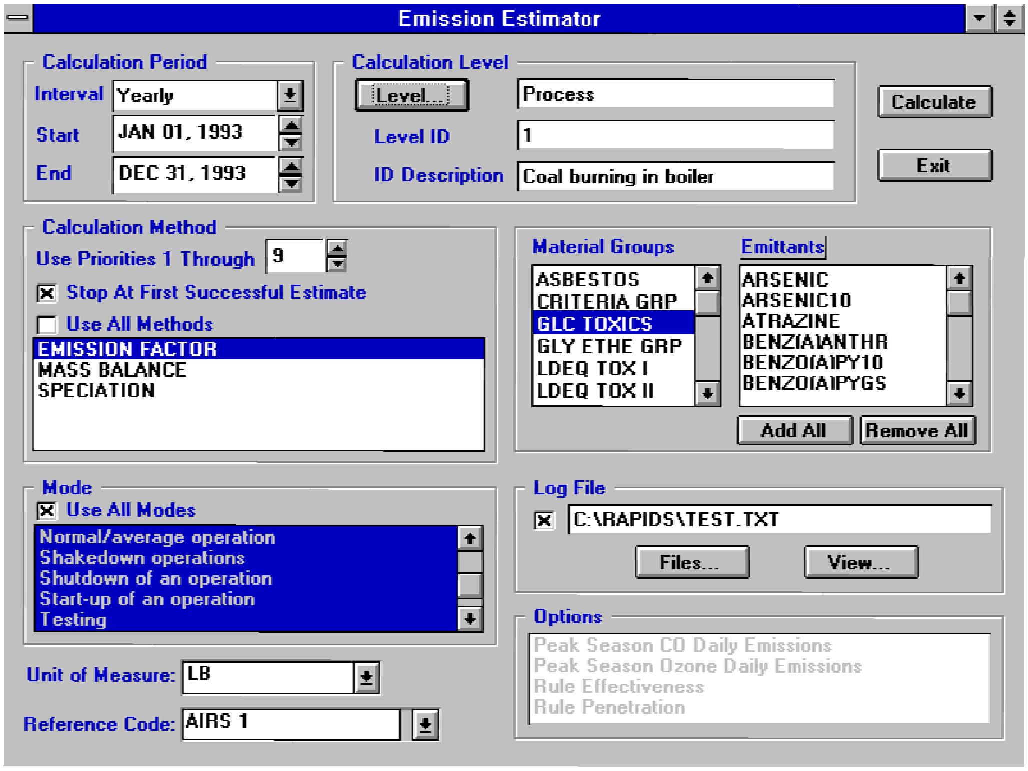
Emission Estimator client/application that allows the user to compute emission estimates using a variety of emission estimation techniques (e.g., product of activity data and an approved emission factor, speciation of either particulate matter or VOC emission estimates or user-defined algorithms) that match pre-established SCC/compound-specific methodologies listed in the protocol. (The protocol is a comprehensive document that describes the methodologies the participating states will use to compile the regional inventory, including the procedures to resolve differences of opinion.) A sample emission estimation screen is depicted in Figure 4-3 and shows the various options available to the user for estimating emissions.

A *QC Checker* client/application that performs various statistical checks on the emissions data and estimates contained in the ORACLE back-end database. Due to time constraints, the states did not test the automated QC Checker during the SWLM pilot project. Section 5, *Conclusions*, provides further discussion of the QC Checker. Figure 5-1 shows a sample QC Checker screen.

A *Report Generator* consisting of various client/applications that generate summary reports of the emissions data and estimates contained in the ORACLE back-end database.

A *Data Converter* client/application that converts the emissions data and estimates into the U.S. EPA AIRS Facility Subsystem (AFS) transaction records. Discussion of the RAPIDS-to-AIRS data converter is provided in Section 5, *Conclusions*, under *Implications for RAPIDS*.

Figure 4-3: Sample RAPIDS Emission Estimation Screen



Description of the RAPIDS Data Model

The RAPIDS data model is the cornerstone of the RAPIDS system. It consists of a core data model that includes entities that are common or shared by most mission critical applications, such as emission inventory, permitting and compliance. As more applications are added to the RAPIDS system, the core data model will be extended to include the additional entities/attributes needed to support these new applications. As such, the core data model is the foundation upon which the enterprise is built. The stronger the foundation, the more robust the enterprise.

The RAPIDS core data model can be viewed as consisting of the following Modules: Geographic, Legal, Source, Device, Process, Stream and Material. RAPIDS is geo-referenced and locations can be entered as either points, lines or polygons.

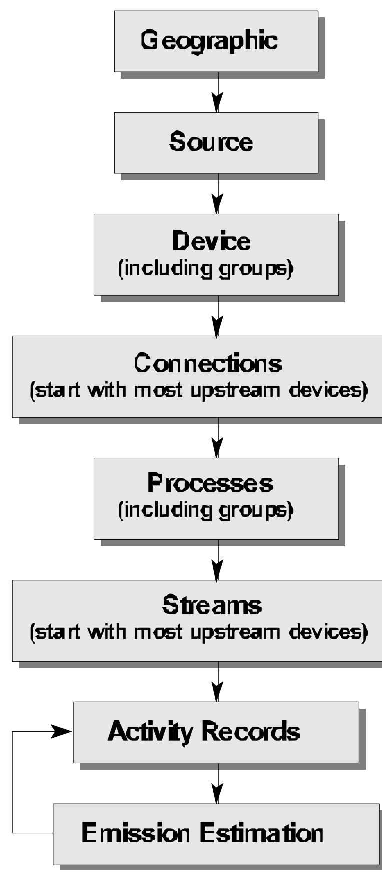
The data flow in RAPIDS is illustrated in Figure 4-4. RAPIDS follows a geographic-source-device-process-stream hierarchy. At the geographic-source-device levels, physical/locational information is stored and managed. Every source type has a process, every process is located at a device and every device is located at a source. Processes are associated with input and output streams that transfer energy and material into and out of the process. Output streams transport air pollutant emissions (gaseous streams), water contaminants (liquid streams), solid and hazardous waste materials (solid streams), and products (product streams) generated by a process. Input streams/materials feed device/process combinations and are transformed into output streams/materials.

Both physical connectivity between devices and logical connectivity for various device/process combinations are tracked. Logical connectivity allows the proper tracking of streams for different device/process combinations when the pathway is process-specific. For example, a boiler burning oil might have different controls than when the same unit is burning gas. In RAPIDS, that situation would be represented by two separate processes and the logical connectivity would allow the user to track the associated streams through different pieces of control equipment.

The features of the RAPIDS data model that provide the flexibility needed to handle multimedia environmental data management needs, as well as complexity of device and process connections, are itemized below.

There are a relatively small number of tables required to quantify and characterize sources of emissions. This is achieved by a design that is highly table-driven.

Figure 4-4: RAPIDS Data Flow



A full record, rather than a single

le field, is used to store information on a data item. This is a means of providing complete information on the data item of interest, including the context (when, where and subject material), confidentiality, and reference information (other documents, who and when the data were entered). This is referred to as a “flexible attribute” format, which contrasts with the fixed attributes used in most other data models (see discussion below on the activity record structure).

Only a single source table, a single device table and a single process table is needed to contain data on all types of sources, devices and processes, including both point and area sources.

Entities can be grouped as needed and activity records can be associated with such groups (e.g., a group of related processes in use during an operating scenario).

Activity Record Structure

The traditional data modeling approach for storing the value of a data item in a database is the use of a fixed attribute field for that data item. That field is included in a table along with other data items used to quantify or qualify the object of interest. For example, the value of temperature of a process would have a field called TEMPERATURE included in a table for the subject process; the units (Fahrenheit or Celsius) would not be coded but would be implied and listed in the data dictionary for the database.

The method used in RAPIDS for storing nearly all attribute information is an activity record. An activity record can contain any type of data (e.g., temperature, tank color, emissions), any form of data (i.e., numeric, character or logical), and information on any entity in the database: Geographic, Legal, Source, Device, Process, Stream and Material. This method of storing data is referred to as a "flexible attribute" method. Although the activity record method requires more data storage, it provides much greater flexibility.

Figure 4-5 shows how the flexible and fixed attribute methods compare. In this figure, a Floating Roof Tank Table has been designed as a fixed attribute table to use a single record to record all physical parameters. The units and time period associated with the data in these records are not explicitly stored in the database; the units are predefined in the data dictionary (and displayed in a hard coded table) and the year is understood or included in the name of the database. In the flexible approach, the physical parameters of floating roof tanks are included in a single Activity Table which contains all parameters, including physical parameters on devices. The Activity Table uses one record for each parameter stored; a metric is used to define the parameter (discussed further below). Values of the parameter can be character, numeric or logical. The Activity Table includes the start date/time and the end date/time for the period over which the value of that parameter was valid; a blank end date/time indicates that the value is currently valid. Use of start and end date/time provides the flexibility to code any time period, not just a fixed time period implicitly used for a given table. In addition, this approach makes possible the inclusion of previous values of the same parameter with the date/time that the value changed (as shown in column four of Figure 4-5 for the color of the tank). The units are explicitly coded; this allows for entry of any valid units (so that units do not need to be manually converted to the requirements of the database) and makes automation of unit conversion relatively easy.

A metric is a code that identifies a specific type of data that can be measured and recorded in an activity record. Metrics are defined for the data types of interest. Examples of metric codes are PRO TEMP, VOL RATE, DISCHARGE, and ID PT AFS for the temperature of a process, the rate that a volume of material can flow in a stream, the mass of material discharged into the environment and the AIRS identification number for a point of discharge, respectively.

The complete contents of a RAPIDS activity record are as follows:

The specific source, device, process or stream with which the value is associated;

Metric--a code describing the type of activity data (e.g., temperature, mass flow of emissions, color of a tank, ID number used in another system);

Start Date/Time--the date and time at the beginning of the period of the activity data recorded;

End Date/Time--the date and time at the end of the period of the activity data recorded (may be the same as the Start Date/Time for an event or blank if the value continues to be the current value);

Material--a name/code describing the type of material with which a

Figure 4-5: Comparison of Fixed and Flexible Attribute Approaches to Data Storage

Conventional Approach (Fixed Attribute)

Floating Roof Tank Table, Period=1993

Device ID	Height (ft)	Diameter (ft)	Color	Seals
1	57	200	White	Y
2	40	105	Blue	N
.	.	.	.	.
.	.	.	.	.

RAPIDS Approach (Flexible Attribute)

Device Table, Device ID=1, (Device Code=Floating Roof Tank)

Start Date/Time	End Date/Time	Metric	Value	Units
1-1-90		Height	57	ft
1-1-90		Diameter	200	ft
1-1-90	7-7-93	Color	Blue	
7-7-93		Color	White	
7-7-93		Seal	Y	

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stream or material activity data record is associated (e.g., an emittant, product, fuel, chemical or liquid waste);

Value Type--a code identifying the basis on which a production or emission rate value was developed (allowed, maximum, minimum, average, design capacity or potential this field is blank for actual data);

Value--the data quantifying or qualifying the activity data (including numeric and text information);

Units--a code for the units of the activity data value (if any);

Confidential--a flag for the confidential status of the data;

Method--a code for the method used to generate the activity data (e.g., emission factor);

Reference--the type and identification of other information associated with how this value was generated; and

Entry documentation--a code for who entered the data and the date when it was entered.

The power and flexibility of the activity record approach of structuring attribute data is evident by the fact that a new data item can be added to the database simply by defining a new metric. The time period of the data is completely flexible. Nothing in the activity record is implied; the time period, units of measure and material measured are entered explicitly. The original value with its units of measure can be reported as actually recorded rather than using converted units that do not correspond to the original documentation.

Conceptually, RAPIDS is a process-oriented system. The paradigm that RAPIDS follows is to perform a mass balance on all device/process combinations for any time period of interest at a given source (i.e., facility). It treats a source as a control volume. Inside that control volume are smaller control volumes (i.e., devices) where processes occur. A mass balance (i.e., a tracking of all input and output streams/materials) for each process at a device is tracked, and in this manner, a mass balance on the entire source can be performed, if desired. Streams that enter the environment are actually identified as a different variable (i.e., discharge as compared to mass/volume flow). In this manner all streams are tracked and characterized by their physical state (e.g., gaseous, liquid, solid, etc...) and associated materials, and not whether they are waste or product streams. RAPIDS, in its conceptual formulation, can be extended to include all media, including both waste and product streams, in one integrated database, and could function as a multimedia enterprise system.

New Source, Device and Process Codes

RAPIDS includes its own set of source, device and process codes (RAPIDS process codes are different from SCC and AMS codes; however, it is possible to map the latter codes to their RAPIDS equivalent). These RAPIDS codes are not specific to a particular categorization of emission sources, (e.g., point or area, as is common in most other inventory systems). Therefore, all sources, devices and processes in RAPIDS, or any grouping of these entities, can use the same RAPIDS codes. For example, the device code “DRY CLEANING EQUIPMENT” is used for all such equipment, whether it is an area source (i.e., a group of dry cleaning equipment associated with a group of dry cleaning facilities) or a point source (i.e., a specific piece of dry cleaning equipment at a specific dry cleaning facility).

Common Treatment of Point and Area Sources

One of the unique features of RAPIDS is its common treatment of point and area emission sources. In most systems/databases, point and area sources are treated differently, and the resulting emission estimates are typically stored in separate databases, one for point sources and another for areas sources.

RAPIDS treats all source types, whether they are point or area (or even mobile), in the same manner. The key to the common treatment of point and area sources is the ability of RAPIDS to accommodate groups of sources, devices and/or processes. A source can be an industrial facility, such as a large dry cleaning facility or a utility (examples of typical point sources), or using the grouping capability of RAPIDS, a group of small dry cleaners. A device can be a piece of stationary industrial equipment, such as the equipment used to dry clean clothes or a boiler, or, again, using the grouping capability, a group of dry cleaning equipment, a group of boilers at an industrial facility or a group of fuel burning equipment associated with a group of homes.

An example of how RAPIDS would treat dry cleaners as an area source is as follows. The user would create a source group that included all dry cleaners in a given county. Then a device group that included all dry cleaning equipment associated with the dry cleaning establishments that were members of the above mentioned source group would be created. Following this paradigm, a process group would be created for the above mentioned device group with input and output streams. The emissions associated with the group of dry cleaning establishments would be stored on the output stream of the process group.

This formulation allows the user the flexibility to treat large dry cleaning facilities as discrete point sources and the remaining smaller dry cleaning establishments in a county as a group of sources. Treating point and area source types the same, both in the structure of the database and the codes used for these types (see below), facilitates reconciliation between these two types of emission sources. Double counting of emissions can be easily avoided as the emissions associated with the large dry cleaning facility can be subtracted from the emissions associated with the source group. In this manner, all typical area source categories can be accommodated using the same source/device/process/stream paradigm used to characterize typical point sources. Instead of using point and area sources, the user simply decides when it is more convenient to store and manage information at the "member" (i.e., a discrete source/device/process) or the "group" (i.e., a group of source/device/processes) level. Different treatments can be used for different purposes. For the dry cleaning example, risk assessment studies may require treating even small dry cleaners as discrete sources; however, photochemical modeling studies might only need to characterize emissions from dry cleaners at the county level (i.e., a group of dry cleaning establishments located in a given county).

Overview of Emission Estimation in RAPIDS

The RAPIDS data model allows for very complex material flow relations among devices. The Emission Estimator was designed to track and record the amount of a material of interest (i.e., emittants) flowing into and out of each process as the material flows downstream. The terminology used to define various devices relative to their flow characteristics is as follows:

> An originating device is a device that creates a stream and has no inputs of that emittant (and is the device where the SCC-AMS code is stored);
>
> A stack device is a device that discharges a stream into the environment without altering the amounts of the emittant involved; and
>
> A control device is a device that alters the amount of the emittant in a stream as that stream passes through the device.

In general, these definitions are emittant-specific. A device could create one material stream and alter another material stream (e.g., a scrubber reduces SO_2 gas and creates a liquid waste containing sulfur compounds). The RAPIDS Emission Estimator assumes that all devices fit one of these categories regardless of the emittant.

The calculated emissions for a given execution of the Emission Estimator are stored in the Activity Table for a stream. Summary reports, such as the Source Detail Report and the Tier 1-2-3 Report, are generated by reading the Activity Table records containing this data.

The following Metric Codes are used to identify the amount of material in a stream Activity Table:

> MASS FLOW is the amount of material that travels through a connection to another device; and
>
> DISCHARGE is the amount of material that is discharged to the environment.

All streams have the amount of material flowing in a stream using one of these metric codes. The MASS FLOW and DISCHARGE of emissions from an originating device is the same as uncontrolled emissions.

Reporting of emissions requires that the emissions entering the atmosphere (i.e., controlled emissions) be associated with an SCC-AMS code which is stored with the originating device. RAPIDS identifies these emissions with the device that discharged the emissions, not the device from which the emissions originated. In order to facilitate reporting of controlled emissions, RAPIDS uses a third Metric Code to cover this case. The Metric Code DOWNSTRMDIS (for downstream discharge) is the amount of material that was created in an originating device and actually discharged to the environment. Downstream discharge is calculated by summing individual discharges of emissions created by the originating device (i.e., stack emissions and fugitive emissions). RAPIDS writes a DOWNSTRMDIS Activity Table record at the output stream of the originating device.

The methods that can be used to calculate emissions are:

> Mass Balance;
>
> Emission Factors (using generic and source-specific emission factors); and
>
> Speciation (using generic and source-specific speciation factors).

The method(s) applicable to any source, device, process and material are identified in the protocol document and then incorporated into RAPIDS. This helps ensure consistency among all users in calculating emission estimates for a given source category.

Pie charts were not created for the following 19 pollutants due to the lack of inventoried source data:

Atrazine
Chlordane
Coke oven
Diethylhexyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Dioxins; 2,3,7,8, equivalent
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachloroethane
Alkylated Pb compounds
Methoxychlor
Parathion
Pentachloronitrobenzene
Pentachlorophenol
2,4,5 Trichlorophenol
2,4,6 Trichlorophenol
Trifluralin

5. Conclusions

The three states that conducted the SWLM study believe that the toxic air emission estimates contained in Section 4, *Results*, of this report and available for U.S. EPA and Great Lakes state online review at the regional repository at the U.S. EPA Great Lakes National Program Office in Chicago, represent the best single compilation of such estimates.

The pilot study's conclusions focus on ways to improve the emission estimation protocol, enhance quality control of multistate toxic inventories of emissions from large and small sources, streamline automated procedures and outline next steps in reaching the goal of institutionalizing a full eight-state toxic air emissions inventory. The emission estimates provided herein must be viewed as a pilot effort; area source emission estimation techniques for urban areas in the Great Lakes region will improve over time as the lessons learned in this effort are incorporated by the states and as new emission factors are propagated for the toxics of interest.

During the next few years, the Great Lakes states will be working together to inventory the target list of toxics from all sources in the region. Once the eight-state, regionwide inventory is completed and quality assured, the compiled data can be used to support studies on the relative impacts of the inventoried emissions and regulatory decisions.

IMPLICATIONS FOR THE PROTOCOL

The pilot study provided a trial run for the *Great Lakes Air Toxics Emissions Inventory Protocol*. The three states that participated in the pilot study used the protocol in developing their portions of the pilot inventory. With this experience, the protocol can be refined to address issues that arose during the pilot study.

Pollutant Subsets

It will most likely be necessary to add a whole section to the protocol on pollutant categories and how to reconcile automated estimates with what is known about the "real world" emission of these pollutants, including how to interpret the data. The minimum goal of the SWLM pilot study was to use emission factors to estimate emissions of hazardous air pollutants. Going to the next level would involve rectifying the group/group members relationships. The following is draft methodology, prepared by the SWLM states, that will be considered by the Great Lakes Commission Regional Emissions Inventory of Toxic Air Contaminants Steering Committee.

Draft Methodology for Quality Assurance/Quality Control of Pollutant Subsets for the Air Toxics Emissions Inventory Protocol for the Great Lakes States

Methodology:

1. Identify pollutants that have subsets. For example, see Figure 4-1. Other examples include:
   - chrome VI and total chrome
   - any others
   - should organic material be fully inventoried (i.e. reactive, non-reactive, chain, ring, POM, etc.)?

2. Do subsets include pollutants not being inventoried? For example, PAH also includes pyrene.
   - identify these cases
   - should these pollutants be inventoried?
   - what emission factors are available?

3. Identify cases in state's data where group members' emissions are greater than group emissions. Make a special note of group members' emissions that do not have a group emission. Correct the report.

4. Identify emission factors (in FIRE, RAPIDS or any other reference used) having group member emission factors greater than group emission factors (or group emission factors not present).
   - research these factors to see how they came about and apply to each other
   - select proper factor
   - change protocol (RAPIDS) to update factors
   - suggest updates/corrections to FIRE
   - recalculate emissions

Clarifying the List of Pollutants

Metals

Metals are inconsistently listed in the list of target compounds (Table 2-1). The states agreed to clarify their intent to **inventory both elemental and compound releases** by making the following changes:

Existing Target Compounds	Proposed Change
Cobalt	Cobalt and compounds
Chromium	Chromium and compounds
Mercury	Mercury and compounds
Copper	Copper and compounds
Lead	Lead and compounds
Nickel	Nickel and compounds

These changes will be reflected in the protocol document.

PAHs/POMs

With regard to the issue of PAHs and POMs, the subcommittee recommended that discussion among the eight states center on the proposal to add all 16 PAHs to the inventory while leaving PAH in as a group category. If accepted, this proposal would require that the protocol be modified. A decision also is required concerning whether 2,3,7,8-TCDD equivalents should be kept on the target compound list. This question also may require modification of the protocol. The SWLM subcommittee will raise this issue at an early 1996 meeting of the full committee.

Quality Assurance/Quality Control

A comprehensive Quality Assurance/Quality Control (QA/QC) Plan is included as Appendix A of the protocol. Chapters 4 and 5 of the QA/QC Plan include a variety of statistical checks on the quality of the numerical inventory results and stipulate that the RAPIDS software may be used as the tool for making these checks.

The automated QA/QC checks built into the RAPIDS software were not fully developed and tested at the time the states prepared their pilot inventories. Other QA/QC checks in RAPIDS (e.g. SIC validation checks) were implemented and proved to be valuable. Therefore, many of the specific statistical checks prescribed in the protocol were not performed as part of the pilot inventory effort. However, each state made significant efforts to manually check the quality of their data before including it in this report. Furthermore, each state adhered to those portions of the QA/QC Plan which did not require the use of automated statistical checks. Finally, the states have formed a committee to direct additional analysis of the data (see Appendix H). The QA/QC committee will further define the manual checks necessary to ensure an accurate regional inventory.

The efficacy of the RAPIDS automated QA/QC checks cannot be evaluated at this time; thus, the pilot states are currently unable to completely evaluate the effectiveness and usefulness of the QA/QC portion of the protocol. This should be a higher priority during Phase Three of the regional inventory effort.

Consistency Across Source Categories Inventoried by the States

The protocol indicates that in order for a state's inventory to be considered complete, the inventory must be comprehensive; that is, it must include emission estimates from every source/source category believed to emit one or more of the target pollutants.

The states compiling this pilot inventory faced time and resource constraints that made it impossible for any of them to develop comprehensive inventories that fully satisfy the protocol. Each state did the most comprehensive inventory it could, given these constraints. Consequently, the specific categories inventoried by each state varied, for at least two reasons. First, some states had access to readily available data (e.g., gasoline service station sales) that other states did not have. And second, some states already had in-state initiatives (e.g., toxic emission reporting rules), which overlapped with the goals of this inventory and allowed them to provide more extensive data.

One implication of this finding is that the states participating in the regional inventory in Phase Three should consider dropping the comprehensiveness *requirement* from the protocol in favor of *minimum criteria for acceptance*. In other words, the states should reach agreement every time an inventory is prepared on what the minimum criteria are for completeness, then encourage each other to exceed the stated minimums. This approach was adopted in the pilot effort and each state was able to exceed the minimum criteria for acceptance.

IMPLICATIONS FOR RAPIDS

As with the protocol, the pilot study provided an opportunity to utilize the RAPIDS software in a multistate emissions inventory effort. The three states used the system in compiling their portion of the pilot inventory. During the course of the SWLM project, the states took the RAPIDS software all the way from data model design through software development to testing and implementation. Considering the tight time line of the project and the large software design, development and testing task, some components of the RAPIDS software were not tested to the extent the states would have preferred. Those components requiring further development and testing include: QC Checker, RAPIDS-to-AIRS Facility Subsystem (AFS) upload and automated FIRE upload.

The Great Lakes states have agreed to optimize the speed of the Emission Estimation module designed under the SWLM project. Work is already underway to optimize the speed of the import/export module. This work should be completed in late 1995 or early 1996.

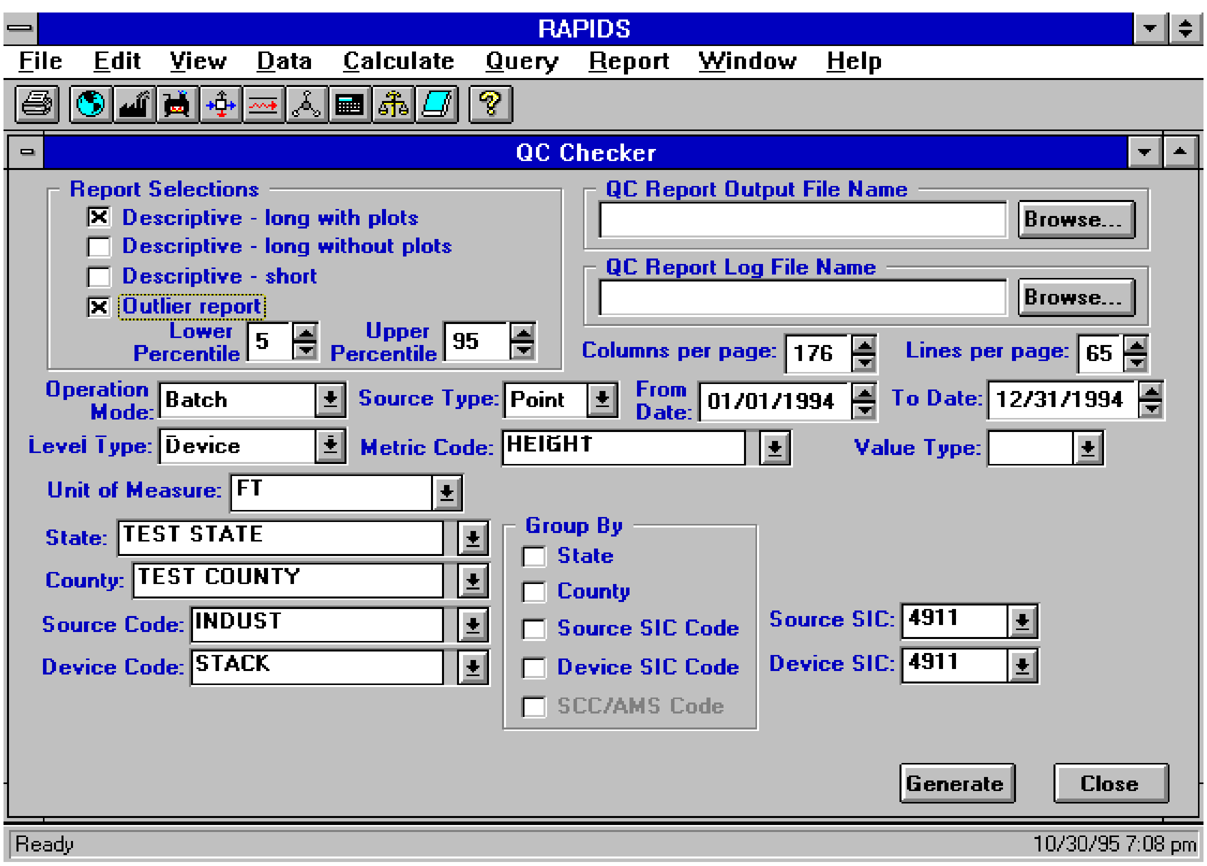
Minnesota has taken the lead in developing an AFS-to-RAPIDS converter. This module should prove useful for a number of jurisdictions interested in exporting AIRS data to the RAPIDS system and then working from there to estimate toxic emissions.

As of this writing, each of the eight Great Lakes states is expected to run a copy of the RAPIDS software in their air quality management agency. The software will be used to calculate toxic air emissions and provide internal quality assurance checks on the state data generated externally. Each state will use the RAPIDS-to-GLNPO upload mechanism to transmit point and area source data to the regional repository at the U.S. EPA GLNPO office.

QC Checker

The QC Checker screen depicted in Figure 5-1 shows the various options available to the user for performing these statistical checks. The efficacy of the RAPIDS automated QA/QC checks cannot be evaluated at this time; this should be a high priority during Phase Three of the regional inventory effort. It also is likely that additional statistical checks will be added to the QC Checker application over time.

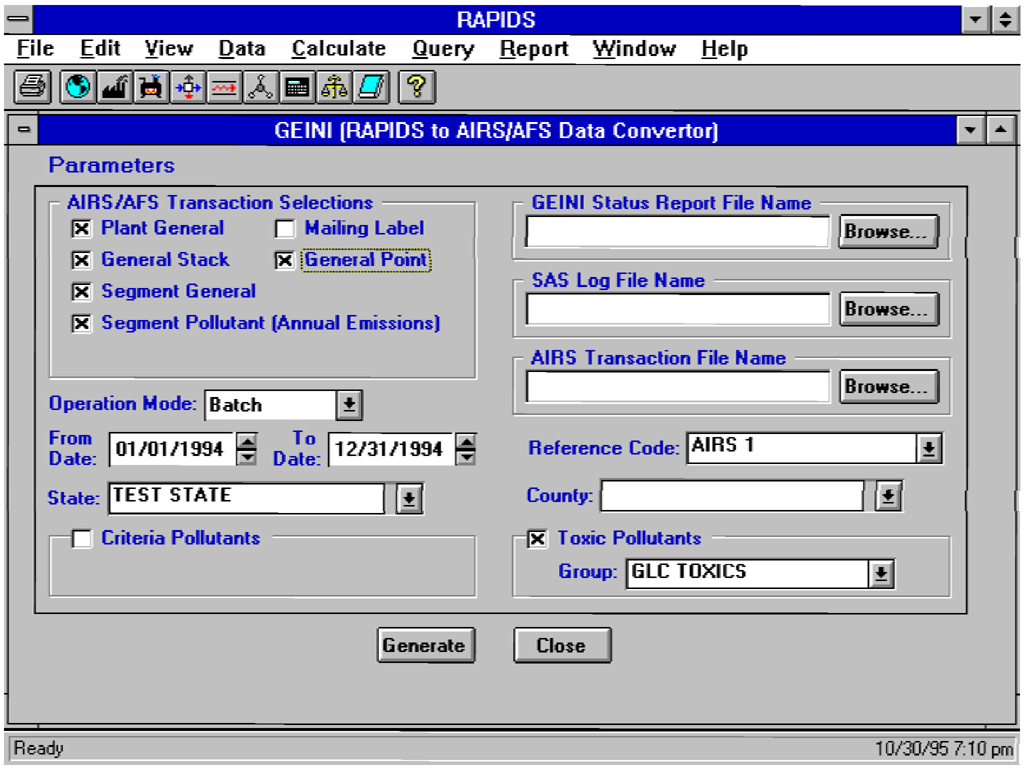
Figure 5-1: Sample RAPIDS QC Checker Screen



FS Data Converter

A Data Converter is the client/application that converts the emissions data and estimates into the U.S. EPA AFS transaction records. A sample AIRS Converter screen is depicted in Figure 5-2 and shows the various options available to the user for creating AFS transaction records from RAPIDS. The current version of this application only converts those data elements that are required to meet the minimum system requirements of AIRS and allow the submittal to be accepted; these data elements do not constitute an acceptable or complete SIP inventory submittal. The AIRS converter application will need to be upgraded to convert certain additional data elements in order to provide AIRS with all of the information required for a SIP submittal. The RAPIDS-to-AFS data converter will be tested under Phase Three as well as the AFS-to-RAPIDS data converter developed during Phase Three under the leadership of the state of Minnesota.

Figure 5-2: Sample AIRS Converter Screen



IMPLICATIONS FOR FIRE

The U.S. EPA Factor Information Retrieval (FIRE) system is used to populate the default emission factors in RAPIDS (i.e., type = G). The emission factors from the FIRE (Version 3.0, dated September 1994) were loaded into RAPIDS in 1995 and used in the SWLM pilot inventory. (The 4.0 version of FIRE was internal and never released; the 5.0 version contained structural changes only for use with the CD-ROM release.)

An updated version of FIRE (Version 5.1, dated September 1995) has been incorporated into RAPIDS for the eight-state effort. This version contains a revised data structure and numerous additional emission factors, and uses an updated version of the SCC-AMS codes. These codes have been expanded, including a new set of SCC codes starting with 6 that cover MACT sources, and have revised definitions that enhance their internal consistency. The updated SCC-AMS codes and definitions are included with the factor data in FIRE.

Emission Factor Development

The Great Lakes states are using emission factors from FIRE Version 3.0. The states recognize that, in some cases, the emission factors in FIRE are not specific enough to be fully applicable to the different chemical forms of certain pollutants. In some cases, it is not certain if an emission factor is for a pollutant or for one of its compounds. For example, it is not clear whether the emission factor in FIRE for SCC 10100202 (for mercury of 1.6e-5 lb/million BTU heat input) includes only elemental mercury, mercury contained in the compound, specific compounds of mercury or all compounds of mercury. This issue will require further consideration by the states.

Automated FIRE Upload

At the present time, the RAPIDS system cannot execute a direct upload of FIRE data. The following discussion presents some of the options the states will consider during the next phase of the project.

The most important FIRE data structure modifications are inclusion of fields that facilitate automated uploading of FIRE emission factors into RAPIDS. These changes were made by EPA in response to GLC/state requests to modify FIRE to facilitate the import of emission factors into RAPIDS. These fields, which are used by RAPIDS, are:

denominator unit (ef_units_d); and
denominator material (ef_mat).

These two fields were added to both factor tables (criteria and toxics) and to the SCC-AMS definition table, which contains the SCC-AMS standard units.

Required FIRE Data Modifications

As presently populated, these fields cannot be used to generate the RAPIDS-equivalent denominator unit and denominator material codes. The denominator material field has been only partially populated or is overly general (e.g., “coal” rather than “anthracite coal”). The denominator unit field is not consistently coded (e.g., Feet, Ft and Foot are all valid). These problems are primarily due to the fact that these two fields are not constrained to match any convention. In addition, there are some errors in the denominator unit data (e.g., acres/yr and BTU-hr).

In order to complete the RAPIDS FIRE Upload application, the denominator material and unit fields must be manually populated. However, if the subject FIRE fields are corrected and made consistent by EPA, this problem would be resolved.

Start and End Dates for Emission Factors

The FIRE system does not maintain any information on emission factors that are replaced (either because the value was revised or because of a change in the organization of SCC-AMS codes). The emission factors contained in any one version of FIRE are considered valid only during the release period of that version.

Emission calculations made using the Emission Estimator Application use the emission factors found in the RAPIDS Factor Table. Replacing previous FIRE factors with updated FIRE factors in RAPIDS will result in having calculated emissions for which the emission factor used is no longer in the database.

One possible solution is that the emission factors that are replaced could continue to be stored in RAPIDS by specifying a start date/time and end date/time over which those factors are valid. Unfortunately, there is currently no way to specify a start date/time and an end date/time for factors in RAPIDS. With the addition of start date/time and stop date/time fields to RAPIDS, the software will be able to store all emission factors (as well as any other factors that have a date range) ever used. Outdated factors will be able to be viewed along with current factors to identify changes that have occurred to these factors as the data in FIRE evolves.

The FIRE Upload Application would need to be run separately by each RAPIDS user in order to enter the date at which their system switched from one version of FIRE data to another.

IMPLICATIONS FOR THE FULL EIGHT-STATE REGIONAL INVENTORY AND NEXT STEPS

During the SWLM pilot inventory the Great Lakes states developed methodology and mechanisms with which to conduct a multistate inventory; the states are now poised for a successful regionwide, eight-state effort. Each Great Lakes state will follow the *Great Lakes Air Toxics Emissions Inventory Protocol* in developing a statewide inventory of emissions from point and area sources. The states will electronically populate the region’s inventory repository, assure the regional inventory’s quality and approve access to the data for U.S. EPA and state researchers. Data summaries and reports will be made available to policy-makers and the public via the Great Lakes Information Network on the Internet.

The first regional inventory effort will compile full state 1993 calendar year data for the eight Great Lakes states. This will be the second pilot implementation of the RAPIDS/protocol system. Beginning with 1995 calendar year data and thereafter, the states will compile yearly inventories, following the process developed under the SWLM pilot inventory and the first regional pilot inventory.

Base-year data with which to support public policy decisions under the terms of the governors’ agreement and CAA Section 112(m) will be released in 1996 and updated yearly thereafter.

The SWLM project began a unique process whereby multiple states collaborate on the development of common client/server software and populate and test a core system while working on their own jurisdiction-specific enhancements, making these modifications available to others to use as needed. States have agreed to maintain the ability to populate the regional repository core system, while modifying their state-specific systems to meet their own evolving needs. An important component of the success of the regional emissions inventory effort is the respect, cooperation and trust developed among the state air agencies and U.S. EPA personnel working on this project. Without this, the eight-state project would not have happened.

6. Appendices

Appendix A: Illinois Toxic Emissions Inventory

BACKGROUND

For its part in the pilot study, Illinois developed an air toxic emissions inventory for calendar year 1993 for the greater Chicago urban area, including the counties of Cook, DuPage, Grundy, Kane, Lake, McHenry and Will. The seven-county area has a 1990 population of 7,296,513, representing 80 percent of the total population of the overall study area. The table below provides a brief demographic overview of the seven counties included in Illinois' portion of the regional inventory.

Demographic Characteristics for the Illinois Region of the Southwest Lake Michigan Air Toxics Pilot Study Area

	Cook Co.	DuPage Co.	Grundy Co.	Kane Co.	Lake Co.	McHenry Co.	Will Co.
Total population, 1990	5,105,067	781,666	35,337	317,471	516,418	183,241	357,313
Urban population, 1990	5,093,221	773,284	15,918	271,246	483,419	138,746	299,126
Rural population, 1990	11,846	8,382	16,419	46,225	32,999	44,495	55,487

Source: U.S. Bureau of the Census

Illinois inventoried all sources, regardless of size. Data are provided for the total of all sources and for those sources under 25 tons per year of criteria pollutants. The data sources and calculation methods used by Illinois in preparing its portion of the emissions inventory are described below.

DATA SOURCES

The Illinois Environmental Protection Agency (IEPA) - Bureau of Air maintains several databases that include emissions data. Source identification for the Great Lakes Toxic Emission Inventory was made by using the existing state criteria pollutant inventory. No attempt was made to identify sources by any other means listed in Section 3.4 of the *Air Toxics Emissions Inventory Protocol*. If an additional reference was used to identify a source category, the description of such has been included below under *Calculation Methods.*

Emission Inventory System: The Bureau of Air maintains a point source inventory, the Emission Inventory System (EIS). This database resides on the state IBM mainframe and is an IMS database. This database maintains information on all permitted sources in Illinois. The EIS is the criteria pollutant emission inventory, although the number of pollutants inventoried can be expanded. Data stored include:

Facility Level: Id number, name, location address and contact, location coordinate, SIC, and emission rate (tons/year for potential, allowable, maximum and average).

Permit Level: Permit number, date last received, status (granted, denied, rejected), type (operating, construction, lifetime, FESOP), analyst, and expiration date.

Point Level: Identifier, point description, and permit number.

Mode Level: Identifier, mode description, number of identical points, SCC number, seasonal throughputs, heat input, fuel type, fuel sulfur content, fuel ash content, fuel heat content, operating hours (hr/day, day/wk, wk/yr for maximum and average), process weight rate (lb/hr for maximum and average), and operating rate (SCC units/hr for both maximum and average).

Emission Level: Pollutant, emission estimation method code, uncontrolled emission rate (lb/hr for maximum and average), controlled emission rate (lb/hr for maximum and average - calculated), allowable emission rate (lb/hr for maximum and average), potential emissions (tons/yr - calculated), maximum emissions (tons/yr - calculated), average emissions (tons/yr - calculated), and allowable emissions (tons/yr - calculated).

Control Level: Identifier, control description, control device code, and permit number.

Efficiency Level: Pollutant, maximum and average removal efficiency.

Stack Level: Identifier, height (ft), diameter (ft), exhaust flow rate (acfm for maximum and average) exhaust temperature (F for maximum and average), and location coordinate.

Capturing Level: Feeding point/mode or control identifier, capturing control or stack identifier, capture efficiency.

The relation between EIS and RAPIDS is as follows:

EIS Level	RAPIDS Level
Facility	Source
Permit	N/A
Point	Device
Mode	Process
Emission	Stream Activity
Control	Device
Efficiency	Stream Activity
Stack	Device
Capturing	Connections and Streams

Programs have been written that create ASCII records of EIS data that allow downloading to a PC. These files are then imported into FoxPro, allowing easier manipulation of the data. These data files were used to create the RAPIDS import files.

Data that existed in the EIS as of December 31, 1993, were downloaded into the FoxPro files. These data covered the entire state. Separate files were created for the data for the pilot study counties. A program was then run to read the FoxPro database and create another FoxPro database that had the fields and structure of RAPIDS. Once that file had been created, a tab-delimited file was created for import into RAPIDS. Because of the large volume of data, the import files were separated by county.

Computerized Annual Emission Reporting System (CAERS): Within the Bureau of Air, the Compliance and Systems Management Section maintains the Computerized Annual Emission Reporting System database (CAERS). This database is written in Oracle and resides on a separate server on the Bureau's LAN. This database maintains much of the same data as the EIS. The database structure of the EIS and CAERS are very similar.

In addition to the EIS data stored in CAERS, source-reported data (facility emissions, emission point emissions, operating hours, operating rates) are also maintained. This type of data exists for the calendar years of 1992, 1993, and 1994.

The detail of source-reported data varies depending upon the location and the potential emissions of the source. Sources located outside the ozone nonattainment areas (Cook, DuPage, Jersey, Kane, Lake, McHenry, Madison, Monroe, St. Clair and Will Counties and the townships of Aux Sable and Goose Lake in Grundy County and the township of Oswego in Kendall County) are required to report only source emissions. A source that is located in an ozone nonattainment area that has potential emissions of Volatile Organic Material (VOM) and Nitrogen Oxides (NOx) both less than 25 tons/yr also is required to only report source emissions.

Sources located in an ozone nonattainment area that have the potential to emit VOM or NOx in an amount greater than 25 tons/yr are required to not only report source emissions, but also operating hours, operating rates, hourly emissions, control device data and stack data for each VOM or NO_x emission point. Out of the approximately 8,000 sources required to submit an Annual Emission Report, only 1,000 fall into this category.

The annual emission reporting rule specifies that emissions must be reported for regulated pollutants. For the 1993 reporting year, the regulated pollutants were particulate matter, sulfur dioxide, nitrogen oxides, volatile organic material and carbon monoxide. No reporting of toxic pollutants was required. Therefore, very little toxic pollutant-specific emission rate data exists. Since many toxic pollutants have become regulated in the past year, subsequent reports will include these toxic emissions.

CAERS was not used to identify sources for the inventory. CAERS was initially loaded with data from the EIS so they were identical. CAERS will be a very good quality assurance/quality control (QA/QC) tool in revising operating rates that are specific to calendar year 1993. At this time, no QA/QC or analysis has been performed on the data reported for 1993.

Toxic Emission Inventory: Within the Bureau of Air, the Permit Section maintains a Toxic Emission Inventory. This database is written in Rbase and resides on the Bureau's LAN. This database maintains data for emission units at the process level on a per hour basis for pollutants of interest. Data regarding control devices (type and removal efficiency) and stacks (height, diameter, flow rate, temperature, building dimensions, property line distance) are also maintained.

Data enter the Toxic Emission Inventory by way of permit review. If a permit under review has emissions of a toxic material, the appropriate data are sent to the Technical Support Unit where a preliminary screening is done. The appropriate data are then entered into the system. The data provided to the database are based on permit application data and not actual usage data and are not specific for a year. In addition, the inventory is by no means complete. Updates to the database are made only at the time of permit renewal, normally every five years in Illinois. Since Illinois has no regulations dealing with emissions of toxic pollutants, no emissions of toxic materials were calculated by the Permittee or the Permit Section. Data were only provided in the cases where the specific pollutant being emitted was simple to determine.

For the above reasons, the Toxic Emission Inventory was not used in the initial compilation of the inventory. The Toxic Emission Inventory will serve as a good QA/QC check for the Great Lakes Toxic Inventory. Results obtained using RAPIDS can be compared to data existing in the Toxic Emission Inventory. The Toxic Emission Inventory could also be searched by pollutant to identify additional sources.

Ozone Regional Computer Inventory System (ORCIS): Within the Bureau of Air, the Air Quality Planning Section maintains an emission inventory named ORCIS. This database is written in FoxPro and stores information specific to the 1990 base-year ozone inventory. Therefore, it was not used as a source to identify sources or calculate emissions. It should be noted that data for ORCIS were originally downloaded from the EIS.

TRI Data: The Office of Chemical Safety, under the Environmental Programs Section maintains the Toxic Release Inventory (TRI) data. The database is not directly accessible to the Bureau of Air. The data included in the TRI database are specific to the TRI reporting requirement and do not include any appropriate key information to relate the TRI database to the EIS. For this reason, the TRI database was not used to identify sources. This database will be a good QA/QC check for the Great Lakes Toxic Emission Inventory, and EIS, when the time permits.

Area Source Database: Within the Bureau of Air, the Air Quality Planning Section maintains an emission inventory dealing with area source emissions. This inventory is maintained in a spreadsheet and stores information specific to the 1990 base-year ozone inventory. Therefore, it was not used as a source to identify sources or calculate emissions. Toxic pollutant emissions from mobile sources are not part of the scope of the pilot study and therefore are not included in this report.

CALCULATION METHODS

The following is an overview of how point source emission estimates were calculated for each source category. The tables list the number of sources and the number of emission points, as well as the number of each emitting less than 25 tons per years. The text then lists the SCC codes used for the source category and the resulting emission factors obtained from the GLC-FIRE Version 3.0 database.

External Combustion - Natural Gas Firing

	Sources <25 tons/year	All Sources
Number of Sources	215	1603

Total Emission Points	639	4956

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 10100601, 10100602, 10100604, 10200601-10200604, 10300601-10300603, 10500106 and 10500206. Permitting of external combustion emission points is required for boilers that have a heat input of one million BTU/hour or greater. This would account for the great number of emission points. Sources too small to be included in this category will be covered under area source emissions for natural gas combustion.

The GLC-FIRE database was then queried to obtain emission factors for the SCC range. The emission factors found were for mercury (SCC - 10100601) and POM (SCC - 10200601). It was assumed that the emission factors for these pollutant/SCC combinations also applied to all the SCCs identified above.

The emission factors identified were in terms of pounds of pollutant per 10^{12} BTU input. The EIS does not directly store this type of data. To determine the heat input in terms of BTUs, the operating rate (units of million cubic feet) were multiplied by the heat content (BTU/cubic foot) and then converted. This number was then multiplied by the emission factor to obtain the emission rate. The specific emission factors used for the point sources are listed below beginning with Table 2-9.

External Combustion - Fuel Oil Firing

	Sources <25 tons/year	All Sources
Number of Sources	254	411
Total Emission Points	429	874

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 10100401, 10100404, 10100405, 10100406, 10100501, 10100504, 10100505, 10200401, 10200404, 10200405, 10200501, 10200504, 10200505, 10300401, 10300404, 10300501, 10300501, 10500105 and 10500205. Permitting of external combustion emission points is required for boilers that have a heat input of one million BTU/hour or greater. This would account for the great number of emission points. Sources too small to be included in this category will be covered under area source emissions for fuel oil combustion.

The GLC-FIRE database was then queried to obtain emission factors for the SCC numbers listed above. Emission factors were found for the SCCs of 10100401, 10100404, 10200401, 10300401, 10100405, 10100501, 10200501 and 10300501.

The SCCs of 10100401, 10100404, 10200401 and 10300401 are similar processes, so the emission factors for the SCC 10100401 were used since they had a higher factor quality.

The SCCs of 10100405, 10100405, 10200404 and 10300404 are similar processes, so the emission factors for the SCC 10100405 were assumed to apply to the other SCCs of this group.

The SCCs 10100501, 10200501, 10300501, 10500105 and 10500205 are similar processes, so the emission factors for SCC 10100501 were assumed to apply to the other SCCs of this group. There was no emission factor for hexavalent chrome for this group of SCCs, so an emission factor was calculated using the average ratio of hexavalent chrome to total chrome for the other two SCC groups. It was determined that emissions of hexavalent chrome was approximately 21% of total chrome.

The emission factors identified were typically in terms of pounds of pollutant per 10^{12} (or 10^{6}) BTU input. The EIS does not directly store this type of data. To determine the heat input in terms of BTUs, the operating rate (units of 1000 gallons) was multiplied by the heat content (BTU/lb) and then converted. This number was then multiplied by the emission factor to obtain the emission rate. A density of 7.88 and 7.05 lb/gal was assumed for residual oil and distillate oil respectively.

External Combustion - Coal Firing

	Sources <25 tons/year	All Sources
Number of Sources	0	10
Total Emission Points	0	26

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 101002xx, 102002xx and 103002xx. It should be noted that no anthracite or lignite coal is burned in Illinois according to the EIS. Permitting of external combustion emission points is required for boilers that have a heat input of one million BTU/hour or greater.

The GLC-FIRE database was then queried to obtain emission factors for the SCC numbers listed above. Emission factors were found for the SCCs (that occurred in the EIS) of 10100202, 10200202, 10100203, 10100204, 10100212, 10200204 and 10300209.

The SCCs of 10200202 and 10100202 are similar processes, so where there was an emission factor for the SCC 10100202 and not for 10200202, the emission factor for 10100202 was used. This occurred for the pollutants of total chrome, manganese, mercury and nickel.

The emission factor for POM for the SCC 10100203 was a controlled emission factor (ESP), the removal efficiency was assumed to be 99.2% in order to calculate an uncontrolled emission factor.

The SCCs of 10100226 and 10100212 are similar processes, so the emission factors for the SCC 10100212 were used also for the SCC 10100226. Here again, a removal efficiency of 99.2% (ESP) was assumed for POM in order to calculate an uncontrolled emission factor.

The SCCs of 10100204, 10200204 and 10300209 are similar processes, so the emission factors for 10200204 were used for the group. The emission factor for total chrome was from the SCC 10100204. A removal efficiency of 94% was assumed for the pollutant POM (cyclone) and a removal efficiency of 97.2% (multiclone) was assumed for the pollutants PCDD and PCDF in order to calculate an uncontrolled emission factor.

The emission factors identified were typically in terms of pounds of pollutant per 10^{12} BTU input. The EIS does not directly store this type of data. To determine the heat input in terms of BTUs, the operating rate (units of tons) was multiplied by the heat content (BTU/lb) and then converted. This number was then multiplied by the emission factor to obtain the emission rate.

Internal Combustion

	Sources <25 tons/year	All Sources
Number of Sources	9	46
Total Emission Points	19	203

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 2xxxxxxx. Permitting of internal combustion emission points is required for combustion points that have a heat input of 1500 horsepower or greater. This is approximately equal to 3.8 million BTU/hr, so it is possible many internal combustion sources have not been inventoried.

The GLC-FIRE database was then queried to obtain emission factors for the SCC numbers listed above. Emission factors were found for the SCCs (that occurred in the EIS) of 20100101, 20200102, 20200201 and 20200202.

Emission factors were found for the pollutants arsenic, cadmium, total chrome, cobalt, copper, lead, manganese, mercury and nickel for the SCC 20100101. The SCCs of 20100102, 20200101 and 20200102 are similar processes that did not have emission factors, so the emission factors of 20100101 were assumed to apply. In the case of SCC 20200102, there was an emission factor for mercury, so this emission factor was used.

Emission factors were found for the pollutants cadmium, total chrome, copper, manganese, mercury, nickel and phenol for the SCC 20200201. The SCCs of 20100201, 20100202 and 20200202 are similar processes that did not have emission factors, so the emission factors of 20200201 were assumed to apply. In the case of SCC 20200202, there were emission factors for ethylbenzene and mercury, so these emission factors were used.

The emission factors identified were typically in terms of pounds of pollutant per 10^6 (or 10^{12}) BTU input. The EIS does not directly store this type of data. To determine the heat input in terms of BTUs, the operating rate was multiplied by the heat content and then converted. This number was then multiplied by the emission factor to obtain the emission rate. A density of 7.88 and 7.05 lb/gal was assumed for residual oil and distillate oil, respectively, when converting emission units that fired oil.

Chemical Manufacturing

No sources were inventoried for the chemical manufacturing SCCs (301xxxxx). These sources should be over 25 tons/year and have a Maximum Achievable Control Technology (MACT) category established for them.

Food and Agriculture

No sources were found for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties that had an SCC code of 302xxxxx and had an emission factor in GLC-FIRE.

Primary Metals Production - By-Product Coke Manufacturing

	Sources <25 tons/year	All Sources
Number of Sources	0	3
Total Emission Points	0	54

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30300301 and 30300399. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for POM for SCC 30300308 was a controlled emission factor (ESP). A removal efficiency of 95% was assumed to calculate an uncontrolled emission factor.

Primary Metals Production - Copper Smelting

	Sources <25 tons/year	All Sources
Number of Sources	0	1
Total Emission Points	0	1

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30300501 and 30300599. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for cadmium for SCC 30300517 was a controlled emission factor (ESP). A removal efficiency of 95% was assumed to calculate an uncontrolled emission factor.

Primary Metals Production - Iron Production

	Sources <25 tons/year	All Sources
Number of Sources	5	8
Total Emission Points	24	44

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30300801 and 30300899. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for cadmium for SCC 30300813 was a controlled emission factor (ESP). A removal efficiency of 95% was assumed to calculate an uncontrolled emission factor.

Primary Metals Production - Steel Production

	Sources <25 tons/year	All Sources
Number of Sources	13	32
Total Emission Points	51	197

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30300901 and 30300999. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for nickel for SCC 30300913 was a controlled emission factor (scrubber). A removal efficiency of 90% was assumed to calculate an uncontrolled emission factor.

The emission factor for nickel for SCC 30300928 was an average of the emission factors available in GLC-FIRE.

It should be noted that the emission factors in GLC-FIRE were different for stainless steel and alloy steel. The emission factors for alloy steel were used.

Primary Metals Production - Lead Production

	Sources <25 tons/year	All Sources
Number of Sources	1	2
Total Emission Points	2	29

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30301001 and 30301099. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for cadmium for SCCs 30301010, 30301011, 30301012 and 30301013 were controlled emission factors (miscellaneous devices). A removal efficiency of 95% was assumed to calculate an uncontrolled emission factor.

Secondary Metals Production - Copper/Brass

	Sources <25 tons/year	All Sources
Number of Sources	31	40
Total Emission Points	186	247

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400201 and 30400299. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for cadmium for SCC 30400217 was a controlled emission factor (baghouse). A removal efficiency of 99% was assumed to calculate an uncontrolled emission factor.

Secondary Metals Production - Gray Iron Foundries

	Sources <25 tons/year	All Sources
Number of Sources	14	21
Total Emission Points	116	223

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400301 and 30400399. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

Secondary Metals Production - Lead

	Sources <25 tons/year	All Sources
Number of Sources	19	22
Total Emission Points	59	63

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400401 and 30400499. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

Secondary Metals Production - Lead Battery Manufacture

	Sources <25 tons/year	All Sources
Number of Sources	3	3
Total Emission Points	41	41

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400501 and 30400599. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for arsenic for SCC 30400526 was a controlled emission factor (baghouse). A removal efficiency of 99% was assumed to calculate an uncontrolled emission factor.

The emission factor for lead for SCC 30400528 was a controlled emission factor (baghouse). A removal efficiency of 99% was assumed to calculate an uncontrolled emission factor.

Secondary Metals Production - Steel Foundries

	Sources <25 tons/year	All Sources
Number of Sources	45	68
Total Emission Points	219	399

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400701 and 30400799. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

Secondary Metals Production - Zinc

	Sources <25 tons/year	All Sources
Number of Sources	25	31
Total Emission Points	144	170

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30400801 and 30400899. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

The emission factors retrieved from the GLC-FIRE database were controlled emission factors. The control device listed for these emission factors was a fabric filter. A removal efficiency of 99% for cadmium was assumed. This factor was applied to the controlled emission factor to obtain an uncontrolled emission factor. To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the cadmium removal efficiency was assumed to be equivalent to the particulate removal efficiency.

The emission factor for the SCC 30400899 was not used. This SCC is for other operations not classified. It could not be determined how the emission factor, and units, applied to this source category.

Mineral Products - Asphaltic Concrete

	Sources <25 tons/year	All Sources
Number of Sources	30	51
Total Emission Points	92	206

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30500201 and 30500299. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The emission factor for arsenic for SCC 30500201 was a controlled emission factor (baghouse and multiclone). A removal efficiency of 99% was assumed to calculate an uncontrolled emission factor.

The emission factor for cadmium for SCC 30500201 was a controlled emission factor (knockout pot and venturi, or scrubber). A removal efficiency of 90% was assumed to calculate an uncontrolled emission factor and an average of the two was taken.

The emission factor for total chrome for SCC 30500201 was a controlled emission factor (scrubber). A removal efficiency of 90% was assumed to calculate an uncontrolled emission factor.

The emission factor for hexavalent chrome for SCC 30500201 was a controlled emission factor (scrubber). A removal efficiency of 90% was assumed to calculate an uncontrolled emission factor.

The emission factor for POM for SCC 30500201 was a controlled emission factor (cyclone plus scrubber). A removal efficiency of 95% was assumed to calculate an uncontrolled emission factor.

Mineral Products - Concrete Batching

	Sources <25 tons/year	All Sources
Number of Sources	117	128
Total Emission Points	401	448

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC between 30501101 and 30501199. The GLC-FIRE database was then queried to obtain emission factors for the SCC range.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

Organic Solvent Evaporation - Dry Cleaning

	Sources <25 tons/year	All Sources
Number of Sources	137	145
Total Emission Points	189	205

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 40100101 or 40100103. The emission rate of volatile organic material was then taken directly from the EIS to represent the emissions of perchloroethylene.

In the cases where there was control equipment, the removal efficiency for perchloroethylene was assumed to be equivalent to the removal efficiency of volatile organic material from the EIS.

The data obtained from the EIS is not representative of the entire population of dry cleaners. For sources using less than 360 gallons of perchloroethylene per year, a permit is not required. Since a permit is not required, very few dry cleaners exist in the stationary point source inventory. Where data does exist, it is out of date. Many dry cleaners have switched to dry-to-dry machines, greatly reducing emissions. As part of the NESHAP, extensive data are being made available regarding dry cleaners. This data will be evaluated an placed in the inventory and this report.

Organic Solvent Evaporation - Degreasers

	Sources <25 tons/year	All Sources
Number of Sources	182	240
Total Emission Points	244	376

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 40100202, 40100203, 40100204, 40100205, 40100222, 40100223, 40100224, 40100225, 40100252, 40100253, 40100254, 40100255, 40100259, 40100302, 40100304, 40100305 and 40100306. The emission rate of volatile organic material was then taken directly from the EIS to represent the emissions of the appropriate pollutant as described by the SCC.

In the cases where there was control equipment, the removal efficiency for the specific pollutant was assumed to be equivalent to the removal efficiency of volatile organic material from the EIS.

Data regarding cold cleaning degreasers, SCCs of 401003xx, is limited. Cold cleaning degreasers are not required to obtain a permit and therefore are not routinely in the inventory. Data regarding degreasers will be greatly expanded when the NESHAP is implemented.

Storage Tanks - Organic Material

	Sources <25 tons/year	All Sources
Number of Sources	83	174
Total Emission Points	823	1661

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 40703609, 40703610, 40706005, 40706006, 40706007, 40706008, 40706019, 40706020, 40706021, 40706022, 40706023, 40706024, 40706027, 40706028, 40708403, 40708404, 40722001, 40722002, 40722007, 40722008, 40722009, 40722010, 40722011, 40722012, 40722021 and 40722022. The emission rate of volatile organic material was then taken directly from the EIS to represent the emissions of the appropriate pollutant as described by the SCC.

In the cases where there was control equipment, the removal efficiency for the specific pollutant was assumed to be equivalent to the removal efficiency of volatile organic material from the EIS.

Data regarding storage tanks is limited. Storage tanks under 5000 gallons are not required to obtain a permit and therefore are not routinely in the inventory. Storage tanks of this size have small to negligible emissions. In addition, many storage tanks in the EIS have not had emissions calculated due to the small emissions from the tanks.

Storage Tanks - Petroleum Products

	Sources <25 tons/year	All Sources
Number of Sources	393	612
Total Emission Points	1712	3124

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 403xxxxx and 404xxxxx. No attempt was made to speciate emissions for these petroleum product storage tanks. A count of the sources and emission points has been provided.

Waste Disposal - Incineration

	Sources <25 tons/year	All Sources
Number of Sources	494	536
Total Emission Points	540	594

Data were obtained from the EIS for Cook, DuPage, Grundy, Kane, Lake, McHenry and Will Counties for emission points that had an SCC of 50100101, 50100505, 50100506, 50200101, 50200102, 50200103, 50200504, 50200505, 50200506, 50300101, 50300102, 50300103, 50300104, 50300114 and 50300506. The GLC-FIRE database was then queried to obtain emission factors for the SCC range. In order to reduce the number of emission factors, only the uncontrolled emission factors were selected from GLC-FIRE.

To calculate uncontrolled emissions, the operating rate from the EIS was multiplied by the appropriate emission factor. When calculating emissions from emission points that had a control device associated with it, the pollutant removal efficiency was assumed to be equivalent to the particulate removal efficiency from the EIS.

The SCCs of 50100101, 50200101, 50300101 and 50300114 are similar processes. Emission factors were found only for the SCC 50100101. The other SCCs were assumed to have the same emission factors. Emission factors for PCDD and PCDF were found for the SCC 50100101; however, they were deemed nonrepresentative since the source description was for manufacturing of wood doors.

The SCCs of 50100506, 50200506 and 50300506 are similar processes. Emission factors were found only for the SCC 50300506. The other SCCs were assumed to have the same emission factors.

The SCCs of 50100505, 50200504 and 50200505 are similar processes. Emission factors were found only for the SCC 50200505. The other SCCs were assumed to have the same emission factors.

The SCCs of 50200102, 50200103, 50300102, 50300103 and 50300104 did not have an emission factor in GLC-FIRE. Emission factors for these SCCs were obtained from the Chicago Area Source Inventory (Contract #68-D1-0031 Work Assignment 64 for Julian Jones).

Dry Cleaning Establishments (SIC 7211)

Number of Sources: 2990
Number of Dry-to-Dry Machines: 1133

Number of Transfer Machines: 105

The perchloroethylene consumption and dry cleaning equipment (machine type, number of machines and control equipment type) data were obtained from the 1993 Initial Notification Report submitted by dry cleaning establishments as required under the NESHAP standard. This included 2990 sources.

Perchloroethylene emissions were calculated by using the emission factor 0.7 lb perchloroethylene emitted per lb of perchloroethylene used for dry-to-dry machines. For transfer machines, a value of 0.82 was used. In the cases where a source had both types of equipment, the perchloroethylene usage was split evenly among the machines.

RESULTS

The tables below provide the results of Illinois' toxic emissions pilot inventory for the source categories listed above. The results are not analyzed, nor is there a determination of significant digits. The EIS can maintain emission estimates to four decimal places, so that precision was maintained. For dioxins and furans, the emission rate was extended to eight decimal places due to the extremely low emission rates obtained for those pollutants. The tables summarize the results according to county emissions, SIC emissions and pollutant emissions.

Data have been provided both for sources with criteria pollutant emissions less than 25 tons/year and for all sources for the county emission summary and pollutant emission summary. Data for the SIC emission summary were only provided for sources emitting less than 25 tons/year of criteria pollutants due to the extreme length. Data for emissions by SIC for all sources are available.

County Emission Summary: Table A-1 is a summary, by county, of the emissions calculated for the source categories listed above. For each pollutant, two numbers are given for each county. The number on the top represents all sources in that county that have total emissions of the criteria pollutants (carbon monoxide, nitrogen oxides, particulate matter, sulfur dioxide and volatile organic material) less than 25 tons/year. The number on the bottom represents emissions for all sources in that county, regardless of size.

SIC Emission Summary: Tables A-2 through A-8 are a summary, by SIC and county, of the emissions calculated for the source categories listed above. Results have been provided only for sources that have emissions less than 25 tons/year of criteria pollutants.

Pollutant Emission Summary: The source category contribution for each pollutant is summarized beginning on page 208. Contributions are shown both for sources emitting less than 25 tons per year as well as for all sources in the study area.

Emission Factor Summary: Tables A-9 through A-26 list the emission factors used for each source category, including the SCCs utilized, pollutants, uncontrolled emission factors, and the factor quality.

Appendix B: Indiana Toxic Emissions Inventory

BACKGROUND

Indiana prepared an inventory of toxic emissions for minor point sources for calendar year 1993 for Lake and Porter counties, located along the southwest shore of Lake Michigan. The two-county area has a 1990 population of 604,526, representing 6 percent of the total population of the overall study area. The table below provides a brief demographic overview of the two counties included in Indiana's portion of the regional inventory.

Demographic Characteristics for the Indiana Region of the Southwest Lake Michigan Air Toxics Pilot Study Area

	Lake Co.	Porter Co.
Total population, 1990	475,594	128,932
Urban population, 1990	453,887	86,403
Rural population, 1990	21,707	42,529

Source: U.S. Bureau of the Census

Despite limited resources, the *Air Toxics Emissions Protocol* was followed as much as possible. Previous to this project, Indiana did not have a database of toxic estimates for the 49 compounds covered by the pilot study. The RAPIDS software, available information from existing emissions statement databases, and the Factor Information Retrieval System (FIRE), Version 3.0, were used to calculate emissions for the inventory.

DATA SOURCES

The initial list of sources was taken from an emissions statements database similar in structure and content to AIRS (Aerometric Information Retrieval System). This database contains facilities required to report criteria pollutant emissions. Confidence in the data are substantial as data submitted by each facility are certified by the state and local agency inspectors and used as fee billing information. This list was reduced to include only minor sources that have actual annual emissions of less than 25 tons total criteria pollutants.

For the pilot study the primary interest is sources that are not applicable to Maximum Achievable Control Technology (MACT) standards, further reducing the number of sources included. Residential woodburning stoves were included to help keep the inventory consistent with the other pilot states' inventories. The information included in the inventory is limited to that which was available to staff and to sources for which Source Classification Codes (SCC) codes can be identified. The results listed below have not been reviewed by the individual plants for accuracy and, consequently, should be used with caution. Mobile and area sources (i.e., dry cleaners and gas stations) were not included as part of Indiana's contribution to the pilot study.

Information from the emissions inventory database was used to calculate toxic emissions for the processes within each facility. One disadvantage of using a criteria pollutant database for information is that the volatile organic compounds (VOCs) emissions are not broken down into the speciated compounds, and the fuel process rates are not always descriptive enough to be used with FIRE emission factors. Also, not enough information is provided on control efficiencies for air toxic compound emissions. The inventory data include the process description, SCC codes, and fuel process rates for each process within a facility. All SCC's of the selected sources are matched against available emission factors from FIRE Version 3.0 and then only these sources are included in the inventory. Most of the emission factors for the 49 GLC compounds are from FIRE. If a source-specific emission factor for lead was available for a particular source, then that emission factor was used.

The total number of sources in the point source inventory for Lake and Porter counties is under 200. This number may appear low in relation to Illinois and Wisconsin and the relative population levels in the three states. As noted in the introduction, differences among the three states' inventories may result from differing reporting requirements. Indiana's pilot inventory staff have reviewed this issue and verified the accuracy of their methodologies and calculations; the details in this regard are available in Indiana's project documentation file.

CALCULATION METHODS

The type of calculation method used throughout the inventory is generic emission factor, as referenced in the protocol. For all the sources calculated with results included in the inventory, this method is Priority 1. The priority numbers are used to determine which estimation method is best for that particular process, with 1 being the best choice. No speciation mass fractions are used to calculate emissions. Also, no mass balance methodology is used because, where this was a Priority 1 method, not enough information is available for these sources to calculate emissions. Sources that are known to be minor sources with available FIRE emission factors, but that lack enough information to calculate emissions, are excluded from the inventory. The SCCs for the five excluded sources are 30900199, 40100306, 30199999, and 40200701.

All data, except the geographic import files and emission estimates, were entered manually. RAPIDS' Emission Estimator is used to calculate emissions except where lead estimates are supplied by the facility. All calculations were verified with hand calculations and by a spreadsheet database in order to perform additional quality checks and to compare actual calculations performed in RAPIDS with calculations estimated using the spreadsheet. For 1993, the total number of sources with FIRE emission factors is 18; the total number of minor sources is 119; and the total number of criteria pollutant point sources in Indiana's emission statements database for Lake and Porter counties is 159.

As stated previously, consistency is needed between the state inventories so that they can be combined into a regional inventory. RAPIDS software helps ensure this by accepting only device codes, process codes, SCC codes and Standard Industrial Classification (SIC) codes that are in RAPIDS reference tables. This standard format requires that RAPIDS be used to load emission estimates to the U.S. EPA Great Lakes National Program Office in order for the data to be in the proper format for the regional database to accept it.

Felt Saturation

SIC Code: 2951
Number of Sources: 1
Pollutants: POM

Rotary Dryers

SIC Code: 2951
Number of Sources: 7
Pollutants: arsenic, benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chromium VI, chrysene, copper, fluoranthene, lead, manganese, mercury, naphthalene, nickel, PAH, POM

Drum Dryers

SIC Code: 2951
Number of Sources 1
Pollutants: arsenic, benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chromium VI, chrysene, copper, fluoranthene, manganese, mercury, naphthalene, nickel, TCE, 111

Wood Incineration

SIC Code: 3341
Number of Sources: 1
Pollutants: benz(a)anthracene, benzo(a)pyrene, fluoranthene

The source has a control device and the emission factors are uncontrolled, so it is assumed that the 70% overall control efficiency for PM could also be applied to these emissions.

Secondary Metal Production - Al Smelting Furnace

SIC Code: 3341
Number of Sources: 1
Pollutants: cadmium, lead, nickel

Distillate Boilers

SIC Codes: 2992, 2821, and 3312
Number of Sources: 3
Pollutants: arsenic, cadmium, lead, manganese, mercury, nickel, chromium, POM

Wood-Fired Boilers

SIC Code: 2448
Number of Sources: 1

Pollutants:	arsenic, benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chromium VI, chrysene, cobalt, fluoranthene, manganese, mercury, naphthalene, nickel

Chemical Manufacturing - Inorganic Pigments

SIC Code:	2819
Number of Sources:	2
Pollutants:	lead

Electric Induction Furnaces

SIC Code:	3316
Number of Sources:	1
Pollutants:	Manganese

Area: Residential Woodburning Stoves

The wood consumption rate for woodburning stoves is taken from the *Draft Indiana Greenhouse Gas Emissions and Sinks: Estimates for 1990* (IDEM, Nov. 1994). The annual fuel consumption is calculated using heating degree days and the number of housing units using wood as the primary fuel. The following SCC/AMS codes are associated with this process: 2104008010, 2104008050, and 10100903. Emissions are calculated for the following pollutants: arsenic, benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chromium VI, chrysene, cobalt, fluoranthene, manganese, mercury, naphthalene, nickel, PAH, PCDD, PCDF, Phenol, TCDD, 2378, and TCDF, 2378. Residential woodburning does not have an SIC code because it is not an industrial activity. SIC code 9999 will be used to identify this source.

RESULTS

The top five pollutants for small point sources, with respect to annual quantity emitted, are lead, manganese, nickel, polycyclic organic matter (POM), and naphthalene. Four source categories are represented in the inventory: petroleum and coal products, primary metal industries, lumber and wood products, and chemical and allied products. Processes included in these source categories are oil and wood combustion (10200501 and 10200903), chemical manufacturing (301%%%%%), secondary metal production (304%%%%%), asphaltic concrete manufacturing (305002%%), and solid waste incineration (50300105).

The complete results for Indiana are summarized in Table B-1 and Table B-2, which list emissions sorted by SIC and pollutant (in pounds) for Lake and Porter counties, respectively.

Table B-1: Lake County IN, Toxic Emissions Sorted by SIC and Pollutant (lbs)

	2448	2819	2951	2992	3312	3316	3341	9999	Total
Arsenic	0.0137		0.1936	0.984	0.0057			0.5003	1.70
Benz(a)anthracene	0.0003		0.0295				0.153	5.685	5.87
Benzo(a)pyrene	0.00003		0.0013				0.03	34.11	34.14
Cadmium	0.0027		2.7875	2.577	0.0015		1.25	0.1137	6.73
Chromium	0.0203		2.1112	11.247	0.0067			0	13.39
Chromium VI	0.0072		0.1744					0.2615	0.44
Chrysene	0.0067		0.0131					56.85	56.87
Cobalt	0.0203							0.7391	0.76
Copper			1.3448						1.34
Fluoranthene	0.014		0.1042				0.51	45.48	46.11
Lead	0.1716	627.165	0.9793	2.085	0.0013		2.5		632.90
Manganese	1.3884		7.3009	3.28	0.002	25.516		0.796	38.28
Mercury	0.001		0.4398	0.7029	0.0004			0.03695	1.18
Naphthalene	0.3588		22.8605					818.64	841.86
Nickel	0.0874		81.1869	4.218	0.0025		0.0632	0.1137	85.67
Phenol								45.48	45.48
PCDD, Total								0.01641	0.02
PCDF, Total								0.09057	0.09
PAH			2.5192					2842.5	2845.02
POM	0.4368		84.1234	5.1549	0.00309				89.72
2,3,7,8-TCDD								0.000042	0.00
2,3,7,8-TCDF								0.002501	0.00

Table B-2: Porter County IN, Toxic Emissions Sorted by SIC and Pollutant (lbs)

	2821	2951	9999	Total
Arsenic	0.0012	0.119	0.418	0.54
Benz(a)anthracene		0.0123	4.75	4.76
Benzo(a)pyrene		0.0027	28.5	28.50
Cadmium	0.0031	0.9826	0.095	1.08
Chromium	0.0135	0.3528	0	0.37
Chromium VI		0.0669	0.2185	0.29
Chrysene		0.0069	47.5	47.51
Cobalt			0.6175	0.62
Copper		0.5377		0.54
Fluoranthene		0.0434	38	38.04
Lead	0.0025	0.3687		0.37
Manganese and compounds	0.0039	557.5026	0.665	558.17
Mercury	0.0008	0.0227	0.03088	0.05
Naphthalene		11.2642	684	695.26
Nickel and compounds	0.005058	26.5901	0.095	26.69
Phenol			38	38.00
PCDD, Total			0.01371	0.01
PCDF, Total			0.07567	0.08
PAH		4.5418	2375	2379.54
POM	0.0062	7.4252		7.43
2,3,7,8-TCDD			0.000035	0.00
2,3,7,8-TCDF			0.00209	0.00
1,1,1-trichloroethane		14.43		14.43

Appendix C: Wisconsin Toxic Emissions Inventory

BACKGROUND

The State of Wisconsin conducted its air toxic emissions inventory for the pilot study in Milwaukee, Racine and Kenosha counties for calendar year 1993. With a 1990 population of 1,262,490, the three-county area represents 14 percent of the total population of the overall study area. The table below provides a brief demographic overview of the three counties included in Wisconsin's portion of the regional inventory.

Demographic Characteristics for the Wisconsin Region of the Southwest Lake Michigan Air Toxics Pilot Study Area

	Kenosha Co.	Milwaukee Co.	Racine Co.
Total population, 1990	128,181	959,275	175,034
Urban population, 1990	101,076	959,275	138,943
Rural population, 1990	27,105	0	36,091

Source: U.S. Bureau of the Census

The area sources inventoried are divided in two classes: individual "small" (or "minor") point sources that emit less that ten tons per year of any of the 49 pollutants; and "traditional" area sources. Wisconsin followed the *Air Toxics Emissions Inventory Protocol* in developing its contribution to the pilot study, as well the Factor Information Retrieval System (FIRE) and the Reference Tables in the Regional Air Pollution Inventory Development System (RAPIDS). An evaluation of the protocol document and an assessment of the emission estimation techniques used in the project are provided below.

DATA SOURCES

The majority of the emission sources included in the Wisconsin inventory were collected by the Wisconsin Department of Natural Resources (DNR) as part of its annual air emissions inventory process. State regulation, ch. NR 438, Wis. Adm. Code, requires detailed annual emission reports from any source with total, actual, annual emissions above a reporting threshold. The reporting threshold varies for each of the 500+ air contaminants covered by the rule, from as little as 0.0001 lb/yr for 2,3,7,8-TCDD to as much as 100,000 tons per year (TPY) for carbon dioxide. For most contaminants the reporting threshold is 3 TPY or less. As a result, Wisconsin's "point source" emissions inventory contains data from many sources that are traditionally considered "area sources" (i.e., minor sources emitting less than 10 TPY of a toxic contaminant).

For purposes of the pilot study, however, only data for the smaller point sources in Wisconsin's emissions inventory were included. Specifically, the scope was limited to point sources with actual annual emissions below 10 tons for each hazardous air pollutant covered by the Clean Air Act. The rationale for this decision is that sources with emissions above that level should be regulated by a federal MACT standard (Maximum Achievable Control Technology) for air toxics, while the Urban Area Study that the pilot study supports is intended to identify smaller “area” sources that might otherwise go unregulated.

Wisconsin’s annual emissions inventory is not limited to any particular type of industry or process. If the total emissions for a source exceed the reporting threshold for a given pollutant, the source is required to provide information on any process emitting any amount of that pollutant. All SIC and SCC codes are, in theory, covered by this effort. In practice, many SIC and SCC codes are not responsible for air emissions above any of the reporting thresholds. In the Wisconsin pilot inventory, a few of these types of sources have been inventoried using area-source methods. Wisconsin’s air emissions inventory rule includes all 49 pollutants covered by pilot study.

Each December, Wisconsin DNR mails hard copy and/or electronic update forms to every source on the existing emissions inventory. Sources are asked to update any out-of-date information and enter their activity data for that year. Responses are returned to the DNR and entered into the emissions inventory database. Sources are added to the mailing list when they are identified through permitting, compliance, or surveillance work. Annual emissions inventories are generally completed by August of the following year (e.g., the calendar year 1993 inventory was completed by August 1994).

The point source data submitted by Wisconsin are for calendar year 1993 and include emission estimates as reported by all sources in the three-county study area. Toxic emission estimates are made by sources and then reported to the DNR. Sources are required to report actual, annual emissions in lb/yr, and identify the method used to make the estimate (emission factor, stack test, material balance, MSDS, or “other”). These estimates account for any emission controls in place.

The DNR does not make its own estimates of toxic emissions for point sources. Instead, the DNR compliance inspector most familiar with the source is expected to review the reported emission estimates and verify their *reasonableness* (not necessarily their *accuracy*). In addition, the department runs a limited set of automated quality assurance checks once the data are entered into the electronic emissions inventory database. For the calendar year 1993 inventory, these internal quality assurance checks were not directly related to any of the quality assurance checks described in the protocol. They were intended to identify gross errors in the reported data. Any problems identified by the compliance inspector or the automated procedures are forwarded to the reporting source for correction. Reconciliation of point and area source data were unnecessary, since no sources on the point-source inventory came from the area-source categories evaluated. No attempt has been made to estimate how complete the point source inventory is, nor has any attempt been made to scale-up the point source emission estimates to account for missing sources.

CALCULATION METHODS

The following is a discussion of the methodology used for calculating point source emissions for the five source categories inventoried in the Wisconsin report. For each source category the process for identifying individual sources is reviewed, the methodology for estimating emissions is explained, sample calculations are shown, results are listed by county for each pollutant, references are cited, and the evaluation of and recommendations for the protocol is summarized.

Landfill Gas - Combustion and Fugitive Emissions

Landfill gas is produced by the anaerobic decomposition of organic materials, such as paper, food waste, yard waste, etc. Landfill gas production begins one to two years after waste placement, and may last from 10-60 years. Wisconsin requires that all landfills (operational or not) recover landfill methane for energy use, or flare the methane to reduce greenhouse gas emissions.

Source Identification

Protocol Section 3.2.1-SIC Codes
SIC code 4953- REFUSE SYSTEMS. This includes the category LANDFILL, SANITARY: Operation of.

Protocol Section 3.2.2-SCC/AMS Codes
SCC 50200601-Waste Gas Flares-provides emission factors [lb/MMBTU] for: benz(a)anthracene, benzo(a)pyrene, carbon tetrachloride, chrysene, fluoranthene, methylene chloride, naphthalene, PCBs, TCDD 2378, TCDF 2378, tetrachloroethene, 111 trichloroethane, trichloroethylene.

Protocol Section 3.2.3-New SCC/AMS Codes
The existing SCC/AMS codes adequately cover this category.

Protocol Section 3.3-Pollutants
13 pollutants were identified: arsenic, benz(a)anthracene, benzo(a)pyrene, carbon tetrachloride, chrysene, fluoranthene, methylene chloride, naphthalene, PCBs, TCDD 2378, TCDF 2378, tetrachloroethene, 111 trichloroethane, trichloroethylene.

Protocol Section 3.4-Identifying Facilities
While a complete inventory of operational landfill sites exists, comprehensive information on landfill sites that have closed up to 60 years ago does not exist. Wisconsin's total methane landfill gas produced (cu.ft.) was found from a Wisconsin Greenhouse Gas study (PSC/WDNR, 1995).

Air Toxic Emission Estimation

Protocol Section 4.1-Temporal Resolution
Methane production is presented for 1990 and 1995 in the Greenhouse Gas Emission study. The Wisconsin DNR Greenhouse Gas Group's database provided methane production for 1993. Methane production is assumed to be constant throughout the year.

Protocol Section 4.1- Spatial Resolution
The methane produced in the state was disaggregated to each county by the county's population fraction of the state.

Protocol Section 4.2-Emission Estimation Techniques (EETs)
Protocol Section 4.3-Overall Inventory Development
Protocol Section 4.4-Activity and Emission Units
Protocol Section 4.5-Scale-up for Missing Sources

The county methane volumes were doubled to account for CO_2 produced along with the methane, which is vented, rather than flared. The numbers were doubled again, to reflect the standard collection efficiency of 50%-- that is, 50% is collected and flared, while 50% escapes the flaring process despite the best available technology. When required, the methane was converted from cubic feet to MMBTU assuming $5*10^{-4}$ MMBTU per cuft. Emission factors from FIRE were then applied.

Sample Calculations

Emissions by county were calculated as follows:

When using SCC 50200601 emission factors, County_Emis =

Wis_methane_flared * 4 * 5E-4 MMBTU/cu ft * County_pop_fraction * Emis_factor [lbs/MMBTU]

When using SCC 50200601 emission factors, County_Emis =

Wis_methane_flared * 4 * County_pop_fraction * Emis_factor[lbs/cu.ft.]

Results

	Kenosha (pounds)	Milwaukee (pounds)	Racine (pounds)
Benz(a)anthracene	1.6E-05	1.2E-04	2.1E-05
Benzo(a)pyrene	2.8E-05	2.1E-04	3.9E-05
Carbon tet	0.18	1.3	0.25
Chrysene	0.007	0.05	0.01
Fluoranthene	0.18	1.3	0.25
Methylene Chloride	53	398	72.7
Naphthalene	270	2,000	370
PCBs	0.015	0.11	0.021
TCDD 2378	3.5E-05	2.6E-04	4.8E-05
TCDF 2378	4.4E-04	0.0033	6.0E-04
Tetrachloroethene	0.86	6.5	1.2
111 trichloroethane	2.5	19	3.5
Trichloroethylene	0.312	2.34	0.426

References

PSC/WDNR. Wisconsin Greenhouse Gas Emission Reduction Cost Study- Phase 2, Part A. Projections of Greenhouse Gas Emissions for Wisconsin. Public Service Corporation of Wisconsin/Wisconsin Department of Natural Resources. April, 1995.

Wisconsin Greenhouse Gas Emission Reduction Cost Study- Landfill Gas Production Spreadsheet. Public Service Corporation of Wisconsin/ Wisconsin Department of Natural Resources.

U.S. EPA. Air Emissions from Municipal Solid Waste Landfills- Background Information for Proposed Standards and Guidelines. EPA-450/3-90-011a. March 1991.

Evaluation of Protocol and Recommendations

The methodology of using emission factors (AP-42) for methane combustion is unsatisfactory for total landfill emissions. The emissions reported only represent toxics from the combustion and release of landfill gasses (CO_2 and CH_4.) A much larger source of air toxics from landfill sites may be from the volatilization of solvent and petroleum wastes, and heavy metals airborne in dust. Emissions are highly dependent on the content of the waste.

Residential Woodburning

Residential woodburning occurs in wood-burning stoves, wood-burning furnaces, fireplaces with and without inserts, firepits, and in combinations of these categories. Wood burned in fireplaces without inserts, fire pits, and wood burned in combination with other categories was classified as wood burned for pleasure use. The remainder of the wood is burned in wood-burning furnaces, wood- burning stoves, and fireplaces with inserts and was assumed to be used for primary and supplemental heating.

Source Identification

Protocol Section 3.2.1-SIC Codes
Residential woodburning is not an industrial activity covered by an SIC code.

Protocol Section 3.2.2-SCC/AMS Codes
Area Mobile Source codes available in FIRE (Factor Information Retrieval System) and AP-42 which cover residential woodburning were used to produce estimates of as many pollutants as possible. Seven AMS codes applied to residential woodburning. They are:

1. 2104008000 -- Total wood stoves and fireplaces.
2. 2104008001 -- Fireplaces -- general
3. 2104008010 -- Wood stoves residential-general.
4. 2104008030 -- Wood stoves-catalytic converters.
5. 2104008050 -- Non-catalytic, wood stoves-general.
6. 2104008051 -- Non-catalytic, wood stoves-conventional.
7. 2104008052 -- Non-catalytic, wood stoves- newer models.
8. 2104008053 -- Non-catalytic wood stoves-low emitting- pellet stoves.

SCC 10300903- Industrial Wood Fired Boilers was also used to provide emission factors when no better emission factor existed. This technique was not described in the protocol, but is widely used in the Wisconsin DNR (Hubbard), and was judged to be “reasonable” (McCrillis).

Emission estimates for residential woodburning were produced using appropriate SCC codes that pertain to fireplaces, wood stoves, and industrial boilers.

GLEI Protocol Section 3.2.3-New SCC/AMS Codes
The existing SCC/AMS codes adequately cover this category. The deviation in estimation technique is a result of inadequate emission factors for various toxics, rather than any problems with the SCC/AMS codes themselves.

GLEI Protocol Section 3.3-Pollutants

The Source Summary Database was used to construct a list of potential, expected target compounds emitted due to residential woodburning. Seven AMS codes were searched for residential woodburning and 17 expected pollutant emissions were identified. A search of the Source Summary Database for pollutants emitted from industrial wood-fired boilers (10100903) located an additional 7 possible target compounds.

Expected target compound emissions identified are:

SCC Code <u>2104008%%</u>	SCC Code <u>10100903</u>
1. 2,3,7,8 TCDD	1. Arsenic
2. 2,3,7,8 TCDF	2. Chromium VI
3. PCDD total	3. Cobalt
4. PCDF total	4. Lead
5. Ethelbenzene	5. POM
6. Benzo(a)pyrene	6. Mercury
7. Benz(a)anthracene	7. PCB
8. Cadmium	
9. Chromium	
10. Copper	
11. Manganese	
12. Naphthalene	
13. Phenol	
14. Chrysene	
15. Fluoranthene	
16. Nickel	
17. PAH's	

In order to compile the most extensive estimate of emissions due to residential woodburning in the state, Wisconsin’s methods deviated from the protocol in that all AMS codes were applied, in order of relevance, when calculating emissions. In the case of calculating emissions from wood-burning stoves, for example, factors found in the AMS codes 2104008010, 2104008050, and 10100903 were included.

Emission factors for 22 of the 24 total pollutants were gathered from the FIRE database. Benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chrysene, copper, fluoranthene, manganese, naphthalene, nickel, phenol, and PAH factors were obtained for AMS code 2104008050--Non-catalytic wood stoves-general.

2,3,7,8 TCDD, 2,3,7,8 TCDF, PCDD total, and PCDF total were obtained for AMS code 2104008010--Residential wood stoves general. Finally, emission factors for arsenic, chrome VI, cobalt, lead, mercury and POM were obtained from SCC 10100903--wood fired boilers.

Protocol Section 3.4-Identifying Facilities
1994 survey information (T. Mace, personal communication) regarding the volume of wood (in cords) burned in each Wisconsin Forest Survey Unit was provided for the pilot study. This information was provided as volume burned in stoves, furnaces, fireplace inserts, fireplaces, and combinations. Survey information contained the volume of wood (cords) burned for pleasure (all categories), secondary heat, and primary heat (Mace pers. comm.).

Air Toxic Emission Estimation

Protocol Section 4.1-Temporal Resolution
The data set quantifying residential wood use in Wisconsin is based on annual estimates of consumption by users. It is reasonable to assume that all residential woodburning occurs between September and April (six months). It was decided that the most accurate method of estimating wood use in subsequent years is to adjust the data set to reflect the number of heating-degree days for the given year of estimation. Data pertaining to residential wood use is not frequently gathered and may be scarce in other states.

Protocol Section 4.1-Spatial Resolution
Wood use estimates from Forest Survey Units were disaggregate to a county by county basis for calculation of emission estimates.

Protocol Section 4.2-Emission Estimation Techniques (EETs)
Protocol Section 4.3-Overall Inventory Development
Protocol Section 4.4-Activity and Emission Units
Protocol Section 4.5-Scale-up for Missing Sources
Expected pollutants located in the SSD are listed below. Emission factors, if available, were obtained from the most recent version of the FIRE database. No information is available on the proportion of the population with emission controls (catalytic wood stoves), or the effectiveness of these control measures over time. The population of catalytic wood stoves was assumed to be zero.

The estimates developed for the amount of wood burned are a representation of the total wood burned in each county. Therefore, no scale-up for missing sources is necessary. There is no possibility that emissions from residential woodburning were double counted.

1994 survey information regarding the volume of wood (in cords) burned in each Wisconsin Forest Survey Unit was supplied. This information was provided as volume burned in stoves, furnaces, fireplace inserts, fireplaces, and combinations. Survey information also contained the volume of wood (cords) burned for pleasure (all categories), secondary heat, and primary heat (Mace pers. comm.). Since the protocol dictates that counties serve as the functional unit, Forest Survey Unit data were disaggregate to county level as follows:

Pleasure and primary/secondary heating use was divided within each county based on the fraction of wood burned in wood-burning stoves, wood-burning furnaces, fireplaces with inserts, fireplaces (no insert), and firepits within the Forest Survey unit. Cords of wood burned in stoves, furnaces and fireplace inserts were summed, and wood burned in fireplaces, firepits, and combinations were summed. Emission factors of these two groups were assumed to be characterized as wood burning stoves and fireplaces.

The volume of wood was converted to weight, assuming 1.8 tons/cord (Mace pers. comm.) and normalized for the difference in heating degree days in 1993 compared to 1994- giving an estimate of 1993 consumption (Wisconsin Department of Administration 1994).

Cords of wood burned for pleasure were assumed to be proportional to the amount of single family detached housing in each county compared to the Forest Survey Unit total and that the number of fireplaces is equally distributed among counties. Cords burned for pleasure use in each county were calculated by multiplying the proportion of detached housing units in each county (U.S. Department of Commerce, Bureau of the Census 1990) relative to the survey unit total by the total number of cords burned for pleasure in the Forest Survey Unit.

Cords of wood burned for primary or secondary heat was assumed to be proportional to the number of households in the county that are primarily heated by wood compared to the total number of houses heated by wood within the Forest Survey Unit (U.S. Department of Commerce, Bureau of the Census 1990). Cords of wood burned in each county for primary and secondary heating was determined by multiplying the proportion of households in each county that are heated with wood relative to the survey unit total households heated with wood by the number of cords of wood burned as a primary or secondary heat source within the survey unit.

Sample Calculations

The following emission factors were derived from FIRE AMS code 2104008010 (wood-burning stoves): PCDDs, PCDFs, TCDD 2378, TCDF 2378.

The following emission factors were derived from FIRE AMS code 2104008050 (wood-burning stoves): benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chrysene, copper, fluoranthene, manganese, naphthalene, nickel, phenol, PAHs.

The following emission factors were derived from FIRE SCC code 10100903 (wood-fired boiler): arsenic, chrome VI, cobalt, lead, mercury, POM.

For Fireplace Calculations:

The following emission factors were derived from FIRE AMS code 2104008001 (Fireplaces): PCDDs, PCDFs, TCDD 2378.

The following emission factors were derived from FIRE AMS code 2104008010 (wood-burning stoves): TCDF 2378.

The following emission factors were derived from FIRE AMS code 2104008050 (wood-burning stoves): benz(a)anthracene, benzo(a)pyrene, cadmium, chromium, chrysene, copper, fluoranthene, manganese, naphthalene, nickel, phenol, PAHs.

The following emission factors were derived from FIRE SCC code 10100903 (wood-fired boiler): arsenic, chrome VI, cobalt, lead, mercury, POM.

Emission Calculation Example: Emissions of arsenic from residential wood stove use in Kenosha County:

$$EMS = AB * EF$$

where
EMS = Emissions of arsenic
AB = Annual wood fuel use in wood stoves (tons)
EF = Emission factor (FIRE)

Total annual pounds of arsenic emitted by wood fuel in wood stoves, Kenosha County, 1993:
AB = 8964 tons wood
EF = $8.8\text{x}10^{-5}$ lbs per ton

$$EMS = AB * EF$$
$$EMS = (8964 \text{ tons}) * (8.8\text{x}10^{-5} \text{ lbs per ton})$$
$$EMS = 0.789 \text{ lbs arsenic emitted}$$

Results

		Wood stoves (pounds)	Fireplaces (pounds)	TOTAL (pounds)
Kenosha	Arsenic	0.789	0.441	1.230

County	Benz(a)anthracene	8.964	5.015	13.979
	Benzo(a)pyrene	53.783	30.092	83.875
	Cd	0.179	0.100	0.280
	Cr	0.00E+00	0.00E+00	0.00E+00
	Chrome VI	0.412	0.231	0.643
	Chrysene	89.639	50.153	139.792
	Co	1.165	0.652	1.817
	Cu	3.048	1.705	4.753
	Fluoranthene	71.711	40.123	111.834
	Pb	9.860	5.517	15.377
	Mn and compounds	1.255	0.702	1.957
	Hg	0.058	0.033	0.091
	Naphthalene	1290.8	722.21	2013.00
	Ni and compounds	0.179	0.100	0.280
	phenol	71.711	40.123	111.834
	PCDDs	0.026	0.004	0.040
	PCDFs	0.143	2.51E-3	0.22
	PAHs	4481.93	2507.66	6989.59
	POM	25.995	14.544	22.36
	TCDD 2378	6.63E-05	1.40E-04	2.07E-04
	TCDF 2378	0.004	0.002	0.006

		Wood stoves (pounds)	Fireplaces (pounds)	TOTAL (pounds)
Milwaukee County	Arsenic	1.000	2.219	3.219
	Benz(a)anthracene	11.367	25.214	36.581
	Benzo(a)pyrene	68.204	151.282	219.486
	Cd	0.227	0.504	0.732
	Cr	0.00E+00	0.00E+00	0.00E+00
	Chrome VI	0.523	1.160	1.683
	Chrysene	113.673	252.137	365.810
	Co	1.478	3.278	4.756
	Cu	3.865	8.573	12.438
	Fluoranthene	90.938	201.709	292.648
	Pb	12.504	27.735	40.239
	Mn and compounds	1.591	3.530	5.121
	Hg	0.074	0.164	0.238
	Naphthalene	1636.89	3630.77	5267.66
	Ni and compounds	0.227	0.504	0.732
	phenol	90.938	201.709	292.648
	PCDDs	0.033	0.018	0.106
	PCDFs	0.181	1.3E-2	0.585
	PAHs	5683.65	12606.83	18290.48
	POM	32.965	73.120	58.53
	TCDD 2378	8.41E-05	7.06E-04	7.90E-04
	TCDF 2378	0.005	0.011	0.016

		Wood stoves (pounds)	Fireplaces (pounds)	TOTAL (pounds)
Racine County	Arsenic	1.183	0.572	1.755
	Benz(a)anthracene	13.444	6.495	19.939

Benzo(a)pyrene	80.664	38.973	119.637
Cd	0.269	0.130	0.399
Cr	0.00E+00	0.00E+00	0.00E+00
Chrome VI	0.618	0.299	0.917
Chrysene	134.440	64.955	199.395
Co	1.748	0.844	2.592
Cu	4.571	2.208	6.779
Fluoranthene	107.552	51.964	159.516
Pb	14.788	7.145	21.933
Mn and compounds	1.882	0.909	2.792
Hg	0.087	0.042	0.130
Naphthalene	1935.93	935.34	2871.28
Ni and compounds	0.269	0.130	0.399
phenol	107.552	51.964	159.516
PCDDs	0.039	0.005	0.056
PCDFs	0.214	3.2E-03	0.319
PAHs	6721.99	3247.73	9969.73
POM	38.988	18.837	31.9
TCDD 2378	9.95E-05	1.82E-04	2.81E-04
TCDF 2378	0.006	0.003	0.009

References

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Wisconsin Department of Administration, 1991. 1990 Housing by Number of Units in Structure for Wisconsin. Counties and Municipalities.- Demographic services.

U.S. Department of Commerce, Bureau of the Census. 1993. CH-2-51. 1990 Census of housing, detailed housing characteristics-Wisconsin.

Moran, D. 1995. Wisconsin Energy Bureau, Wisconsin Department of Administration. Personal Communication.

Wisconsin Energy Bureau, Wisconsin Department of Administration. 1994. Wisconsin Energy Statistics- 1994.

Evaluation of Protocol and Recommendations

Wisconsin deviated from the protocol in two instances. The Source Summary Database (SSD) was searched for a variety of process related SCC/AMS codes. The SCC/AMS codes were used for wood-burning stoves, fireplaces and wood-fired boilers and emission factors relating to woodburning stoves, fireplaces, and also wood-fired boilers were combined when producing emission estimations.

Including this composite of process-related emission factors results in the most complete estimates of emissions from residential wood use possible. It is recommended that other states follow this procedure of including emission factors derived for related processes for residential woodburning, and possibly in other cases, if the situation warrants.

Data quantifying residential wood fuel use may be limited or difficult to locate in other states. However, in Wisconsin, residential wood is a contributor to local air pollution. Other states are recommended to investigate the opportunity to obtain data for residential woodburning, to include this source in their toxic emission inventory.

Commercial Dry Cleaning Operations

Perchloroethylene (PERC, tetrachloroethene, tetrachloroethylene) is one of the most common solvents used by dry cleaning establishments. This section focuses on emissions from commercial facilities. The sources of emissions in dry cleaning operations are process vents from machines, equipment leaks and clothing transfer.

Two basic types of dry cleaning machines are considered: vented "dry-to-dry" and "transfer." Transfer machines have a separate washer and dryer; clothes have to be manually transferred from washer to dryer. Dry-to-dry machines combine the washer and dryer into one piece of equipment, eliminating the transfer step. Basic control devices for these machines are refrigerated condensers and carbon absorbers.

Source Identification

Protocol Section 3.2.1-SIC Codes
Dry Cleaning establishments are grouped under SIC code 7211 - Laundry, Cleaning, and Garment Services.

Protocol Section 3.2.2-SCC/AMS Codes
Protocol Section 3.3-Pollutants
The SSCs that describe PERC evaporation from dry cleaning operations are 40100101 (unit of activity in lbs PERC/lbs clothes) and 40100103 (unit of activity: lbs PERC/ton solvent consumed).

Protocol Section 3.4-Identifying Facilities
The PERC consumption and dry cleaning equipment (machine type and number, and control equipment type) data were obtained from the 1993 Initial Notification Report submitted by dry cleaning establishments as required under the NESHAP standard. The information collected from the initial notification document provided data for a total of 94 facilities that reported PERC as their main dry cleaning agent. Of the 94 facilities, 65 were located in Milwaukee County, 16 in Racine and 13 in Kenosha County.

Air Toxic Emission Estimation

Protocol Section 4.1-Temporal Resolution
Emission estimates are presented on an annual basis.

Protocol Section 4.1-Spatial Resolution
Individual facilities reported PERC consumption.

Protocol Section 4.2-Emission Estimation Techniques (EETs)
Protocol Section 4.3-Overall Inventory Development
Protocol Section 4.4-Activity and Emission Units
Protocol Section 4.5-Scale-up for Missing Sources
No generic emission factors were available in FIRE to calculate PERC emissions based on PERC consumption data. Therefore, emissions estimates were produced based on emission factors derived from information on the type of machine, control type and amount of PERC consumption.

The U.S. EPA has established the consumption levels of PERC that results in emitting 10 tons of PERC into the air to be 2100 gallons for dry-to-dry machines, and 1800 gallons for transfer machines (Federal Register vol 58, no.182, 1993; MPCA, 1995). Since the density of PERC is 13.55 lbs per gallon, 2100 gallons and 1800 gallons of PERC represent 14.2 tons and 12.2 tons of PERC, respectively.

Therefore, the fraction of PERC consumed by a dry-to-dry machine released into the air is:
10 Ton/12.2 Ton = 0.70 (or 70 percent.)

The fraction of PERC consumed by a transfer machine released into the air is:
10 Ton/14.2 Ton = 0.82 (or 82 percent.) The remainder of the PERC goes into waste.

Based on emissions data from Morris and Kepford (1990), for a dry-to-dry machine: 55 percent of the air releases are process emissions, while 45 percent are fugitive emissions. For transfers machines: 55 percent of the emissions are associated with fugitive emissions and 45 percent from process emissions. With process controls (carbon absorber, refrigerate condenser), the percent emissions from a dry-to-dry machine are reduced to 52 percent. For transfer machines emissions are reduced to 69 percent (Morris and Kepford, 1990; Smith, 1995).

Sample Calculations

The emission factors used to estimate county-wide PERC emissions were derived as follows:

Emissions [lbs PERC/Gallon of PERC consumed]=
[gallons PERC consumed]*[density of PERC (13.55lbs/gal)] x [type/control factor]

Where [type/control factor]= 0.70 for Dry-to-dry, no control
0.52 for Dry-to-dry, controlled
0.82 for Transfer, no control
0.69 for Transfer, controlled

Emission Calculation Example:

For Kenosha County, Dry-to-dry machines, with emission controls:
Emissions = 1901 gal * 13.55 lb/gal * [0.52] = 13394 lbs.

For Kenosha County, Dry-to-dry machines, with no emission control:
Emissions = 394 gal * 13.55 lb/gal * [0.70] = 3737 lbs.

Results

County	Machine Type	Control	Factor (lbs/gal)	Perc Used (gal/yr)	Emissions (lbs/yr)
Kenosha	DRY-TO-DRY	Y	7.046	1901	13394.44
	DRY-TO-DRY	N	9.48	394	3735.12
	TRANSFER	Y	9.35	200	1870
	TRANSFER	N	11.11	165	1833.15
	TOTAL			2660	20832.71
Milwaukee	DRY-TO-DRY	Y	7.046	15801	111333.8
	DRY-TO-DRY	N	9.48	1290	12229.2
	TRANSFER	Y	9.35	8442	78932.7
	TRANSFER	N	11.11	160	1777.6
	TOTAL			25693	204273.3
Racine	DRY-TO-DRY	Y	7.046	1200	8455.2
	DRY-TO-DRY	N	9.48	380	3602.4
	TRANSFER	Y	9.35	2550	23842.5
	TRANSFER	N	11.11	0	0
	TOTAL			4130	35900.1

References

"Health Based Review of the NESHAP for Perchloroethylene (PCE) Dry Cleaning Facilities", Report Draft Version 5.1, Edited by Chun Yi Wu, Minnesota Pollution Control Agency, Air Quality Division, April, 1995.

"Documentation of Revised Emission Factors for the Dry Cleaning Industry" Memorandum from Carolyn Norris and Kim Kepford, Radian Corporation. To: Dry Cleaning NESHAP Project File. December 14, 1990. EPA Docket No. A-88-11, Document No. II-B-35, Research Triangle Park, Raleigh, NC, 27711.

Federal Register, Vol. 58 No. 182. Sept. 22, 1993. United States Government Printing Office, Superintendent of Documents. Washington, DC 20402.

Gasoline Service Stations

Source Identification

Protocol Section 3.2.1-SIC Codes

The primary SIC code for this category is 5541 (Gasoline Service Stations). There are no other applicable SIC codes.

Protocol Section 3.2.2-SCC/AMS Codes
The RAPIDS SCC/AMS table was used to identify appropriate SCC and AMS codes for this source category. Filtering on SOURCE CODE = "COM/INS,SIC5541" yielded the following results:

1. Gasoline Retail Operations (SCCs 4-06-003-%%). Also known as Stage I, this refers to emissions from filling of storage tanks at gas stations. Specific codes are -01,-02,-05,-06,-07,-99.

2. Filling Vehicle Gas Tanks (SCCs 4-06-004-%%). Also known as Stage II, this refers to emissions from vehicle refueling at gas stations. Specific codes are -01,-02,-03,-99.

3. Petroleum & Petroleum Product Storage, Gasoline Service Stations (AMSs 25-01-060-%%%). This group of AMS codes covers all area source gas station emissions for gasoline products. Specific codes are -000,-050,-051,-052,-053,-100,-101,-102,-103,-200,-201.

4. Petroleum & Petroleum Product Storage, Diesel Service Stations (AMSs 25-01-070-%%%). This group of AMS codes covers all area source gas station emissions for diesel products. Specific codes are -000,-050,-051,-052,-053,-100,-101,-102,-103,-200,-201.

Protocol Section 3.2.3-New SCC/AMS Codes
The existing SCC and AMS codes appear to adequately cover this source category. No requests for new codes are necessary.

Protocol Section 3.3 -Pollutants
Sales of leaded gasoline in 1993 were assumed to be negligible (i.e., 0); these fuels have been phased out. Evaporative emissions from diesel fuels at service stations were also assumed to be negligible, diesel fuel has relatively low volatility. Therefore, only the expected pollutants from evaporative emissions of unleaded gasoline were considered. A review of the source summary databases indicated that gasoline service stations are a source of emissions for at least eight target pollutants: ethylbenzene, naphthalene, 1,2-dichloroethane, phenol, carbon tetrachloride, trichloroethylene, 1,1,1-trichloroethane, and PCDFs (1,2,3,6,7,8-HCDF also specifically identified). However, Wisconsin was unable to find any means of estimating emissions for the last five (i.e., nothing in AP-42, no FIRE 1994 emission factors, not identified in speciation profiles, no models, and no equations). Only ethylbenzene, naphthalene, and 1,2-dichloroethane were inventoried.

Protocol Section 3.4-Identifying Facilities
Due to its use of data that is not commonly available to other states, Wisconsin's methodology deviated from the protocol. Wisconsin has developed a database of gas stations in ozone non-attainment counties (which includes the entire study area) to facilitate Stage II vapor recovery compliance tracking. This database contains one record for each gas station which responded to a State notification requirement. The data include name of station, location, facility contacts, and

average monthly sales of unleaded gasoline (i.e., diesel not included) for a 24-month period covering 1991 and 1992. This database is considered to be the most accurate and complete electronically-available database on this subject in the State. It includes over 400 gas stations in the three county study area.

Emission Estimation

Protocol Section 4.1 -Temporal Resolution
Monthly gasoline sales for the inventory year (1993) were assumed to be identical to monthly sales over the two-year period represented in the database (1991-1992). Furthermore, each facility in the database was assumed to have been in business for the entirety of 1993. Monthly average sales numbers in the database are therefore multiplied by 12 to get total 1993 sales estimates for the sources in the database.

Protocol Section 4.1 -Spatial Resolution
Even though data are available at the source level for non-attainment counties, gasoline stations were treated as county-wide area sources in this study for the following reasons:

1. Other states will probably treat gas stations as an area source (data consistency);
2. Wisconsin will have to treat gas stations in ozone attainment counties as an area source (data consistency);
3. In the judgement of the Wisconsin inventory preparers, the end use of the SWLM inventory does not demand point source accuracy for these sources.

Protocol Section 4.3 -EETs
Table 4-3 of the protocol indicates that emission factors are to be used as the first priority to estimate emissions from SCC-AMS codes 4-06-%%%-%%.

> For 4-06-003-%%, emission factors are available for 1,2-dichloroethane and ethylbenzene. However, the ethylbenzene factor in RAPIDS appears to be in error. It is expressed as lb/gal gas when it correctly should be lb/1000gal gas, as corrected in FIRE 1994. As for 4-06-004-%%, emission factors are only available for 1,2-dichloroethane.
>
> A source-specific speciation profile was found in Table 3-2 of EPA's Stage II Technical Guidance (EPA-450/3-91-022a, November 1991). Since the profile in SPECIATE is rated C, and the profile in the technical guidance is considered better, it was assumed at least C-rated and thus acceptable for use. The source-specific and the generic speciation profiles both give data for two of the target pollutants: ethylbenzene and naphthalene.
>
> In summary, the EET for 1,2-dichloroethane was generic emission factors, while the EET for ethylbenzene and naphthalene was source-specific speciation.

Protocol Section 4.3 -Facility and Area Source Reconciliation
Although the Wisconsin point-source inventory included a few gasoline stations, there were no emission estimates for any of them. This assures that the area-source calculation is not double-counting emissions from point sources.

Protocol Section 4.3 -Emission Controls

(Stage 1.) It was considered most consistent with the protocol to avoid the use of emission factors that include controls. Uncontrolled emission factors were used, and a control efficiency was back-calculated by comparing the uncontrolled and controlled emission factors in FIRE. This results in an estimated control efficiency of 95.5%, which is consistent with AP-42 (Stage I vapor recovery control typically 93 to 100% effective). This assumes that the control efficiency for volatile HAPs is identical to that for total VOC.

(Stage 2.) The DNR only approves Stage 2 vapor recovery devices certified by the California Air Resources Board (CARB) and CARB only certifies devices that are 95% effective or better. The control efficiency for the pilot study inventory for Stage II processes with vapor recovery devices was assumed to be 95%. Again, this assumes that the control efficiency for volatile HAPs is identical to that for total VOC. Most service stations did not have Stage 2 vapor recovery in place for the inventory year, 1993. Emission estimates are made based on vapor recovery installation dates as recorded in the state's compliance tracking database.

Protocol Section 4.3 -Scale-Up For Missing Sources
As expected, less than a 100% response was received to the information request that was used to generate the gas station database. After months of follow-up, data are still being added. More than 90% of the sources are now estimated to be in the database. Taking a conservative approach, 10% of the sources that should be in the database were assumed not to be, and therefore the throughput data were scaled up appropriately. Furthermore, the data are based on responses to a notification requirement which did not apply to sources with tanks smaller than 2000 gallons. Based on Table 4-3 from EPA's Stage II Technical Guidance, 2.4% of gasoline sales were estimated to come from sources with tanks smaller than 2000 gallons. An additional adjustment was made to the throughput to account for these unregulated small sources.

Sample Calculations

(1) Estimated average monthly gasoline sales from stations in DNR Database (MONAVG):

Kenosha	4,924,245.4 gal
Milwaukee	26,286,881.2 gal
Racine	5,011,560.3 gal

(2) Estimated Annual Gasoline Sales for ALL Stations (TOTAL):

Annualize, Scale-Up for Missing Sources, Scale-Up for Unregulated Small Sources.
i.e., TOTAL = MONAVG*12*1.100*1.024

Kenosha	66,560,041 gal/yr
Milwaukee	355,314,516 gal/yr
Racine	67,740,258 gal/yr

(3) Estimated throughput for Stage 1 displacement losses:

a. Uncontrolled sources (2.4% of all sales, i.e., ST1U = TOTAL*0.024)

Kenosha	1,597,441 gal/yr
Milwaukee	8,527,548 gal/yr

Racine 1,625,766 gal/yr

b. Controlled sources (ST1C = TOTAL-ST1U)

Kenosha	64,962,600 gal/yr
Milwaukee	346,786,968 gal/yr
Racine	66,114,492 gal/yr

(4) Estimated throughput for Stage 2 displacement losses:

a. Controlled sources (ST2C; estimate based on compliance tracking database)

Kenosha	6,410,157 gal/yr
Milwaukee	45,399,805 gal/yr
Racine	6,526,695 gal/yr

b. Uncontrolled sources (TOTAL-ST2C)

Kenosha	60,149,884 gal/yr
Milwaukee	309,914,711 gal/yr
Racine	61,213,563 gal/yr

(5) Estimated Stage 1 Displacement Emissions:

CE = 0.000 for uncontrolled splash-fill
CE = 0.955 for controlled submerged-fill

a. 1,2-Dichloroethane

EF = 1.53E-06 lb/gal for uncontrolled splash-fill
EF = 9.76E-07 lb/gal for uncontrolled submerged-fill

Kenosha: 1.53E-06 * 1,597,441 = 2.4441 lb (from uncontrolled sources)
9.76E-07 * 64,962,600 * (1-0.955) = 2.8532 lb (from controlled sources)

Milw.: 1.53E-06 * 8,527,548 = 13.0471 lb (from uncontrolled sources)
9.76E-07 * 346,786,968 * (1-0.955) = 15.2309 lb (from controlled sources)

Racine: 1.53E-06 * 1,625,766 = 2.4874 lb (from uncontrolled sources)
9.76E-07 * 66,114,492 * (1-0.955) = 2.9037 lb (from controlled sources)

b. Ethylbenzene (based on source-specific speciation)

EF = 0.001 * EF_{VOC}
EF_{VOC} = 0.0115 lb/gal for uncontrolled splash-fill
EF_{VOC} = 0.0073 lb/gal for uncontrolled submerged-fill
EF = 1.15E-05 lb/gal for uncontrolled splash-fill
EF = 7.3E-06 lb/gal for uncontrolled submerged-fill

Kenosha: 1.15E-05 * 1,597,441 = 18.3706 lb (from uncontrolled sources)
7.3E-06 * 64,962,600 * (1-0.955) = 21.3402 lb (from controlled sources)

Milw.: 1.15E-05 * 8,527,548 = 98.0668 lb (from uncontrolled sources)
7.3E-06 * 346,786,968 * (1-0.955) = 113.9195 lb (from controlled sources)

Racine: 1.15E-05 * 1,625,766 = 18.6963 lb (from uncontrolled sources)

7.3E-06 * 66,114,492 * (1-0.955) = 21.7186 lb (from controlled sources)

c. Naphthalene (based on source-specific speciation)

$EF = 0.005 * EF_{VOC}$
EF_{VOC} = 0.0115 lb/gal for uncontrolled splash-fill
EF_{VOC} = 0.0073 lb/gal for uncontrolled submerged-fill
EF = 5.75E-05 lb/gal for uncontrolled splash-fill
EF = 3.65E-05 lb/gal for uncontrolled submerged-fill

Kenosha: 5.75E-05 * 1,597,441 = 91.8529 lb (from uncontrolled sources)
3.65E-05 * 64,962,600 * (1-0.955) = 106.7011 lb (from controlled sources)

Milw.: 5.75E-05 * 8,527,548 = 490.3340 lb (from uncontrolled sources)
3.65E-05 * 346,786,968 * (1-0.955) = 569.5976 lb (from controlled sources)

Racine: 5.75E-05 * 1,625,766 = 93.4815 lb (from uncontrolled sources)
3.65E-05 * 66,114,492 * (1-0.955) = 108.5931 lb (from controlled sources)

(6) Estimated Stage 2 Displacement and Spillage Emissions:

CE = 0.000 for displacement losses from uncontrolled vehicle refueling
CE = 0.950 for displacement losses from controlled vehicle refueling
Throughput for spillage emissions = TOTAL

a. 1,2-Dichloroethane

EF = 1.46E-06 lb/gal for displacement losses from vehicle refueling
EF = 8.85E-08 lb/gal for spillage losses

Kenosha: 1.46E-06 * 60,149,884 = 87.8188 lb (displacement - uncontrolled sources)
1.46E-06 * 6,410,157 * (1-0.95) = 0.4679 lb (displacement - controlled sources)
8.85E-08 * 66,560,041 = 5.8906 lb (spillage from all sources)

Milw.: 1.46E-06 * 309,914,711 = 452.4755 lb (displacement - uncontrolled sources)
1.46E-06 * 45,399,805 * (1-0.95) = 3.3142 lb (displacement - controlled sources.)
8.85E-08 * 355,314,516 = 31.4453 lb (spillage from all sources)

Racine: 1.46E-06 * 61,213,563 = 89.3718 lb (displacement - uncontrolled sources)
1.46E-06 * 6,526,695 * (1-0.95) = 0.4764 lb (displacement - controlled sources)
8.85E-08 * 67,740,258 = 5.9950 lb (spillage from all sources)

b. Ethylbenzene (based on source-specific speciation)

$EF = 0.001 * EF_{VOC}$
EF_{VOC} = 1.1E-02 lb/gal for displacement losses from vehicle refueling
EF_{VOC} = 7.0E-04 lb/gal for spillage losses
EF = 1.1E-05 lb/gal for displacement losses from vehicle refueling
EF = 7.0E-07 lb/gal for spillage losses

Kenosha: 1.1E-05 * 60,149,884 = 661.6487 lb (displacement - uncontrolled sources)
1.1E-05 * 6,410,157 * (1-0.95) = 3.5256 lb (displacement - controlled sources)
7.0E-07 * 66,560,041 = 46.5920 lb (spillage from all sources)

Milw.: 1.1E-05 * 309,914,711 = 3409.0618 lb (displacement - uncontrolled sources)
1.1E-05 * 45,399,805 * (1-0.95) = 24.9699 lb (displacement - controlled sources.)
7.0E-07 * 355,314,516 = 248.7202 lb (spillage from all sources)

Racine: 1.1E-05 * 61,213,563 = 673.3492 lb (displacement - uncontrolled sources)
1.1E-05 * 6,526,695 * (1-0.95) = 3.5897 lb (displacement - controlled sources)
7.0E-07 * 67,740,258 = 47.4182 lb (spillage from all sources)

c. Naphthalene (based on source-specific speciation)

$EF = 0.005 * EF_{VOC}$
EF_{VOC} = 1.1E-02 lb/gal for displacement losses from vehicle refueling
EF_{VOC} = 7.0E-04 lb/gal for spillage losses
EF = 5.5E-05 lb/gal for displacement losses from vehicle refueling
EF = 3.5E-06 lb/gal for spillage losses

Kenosha: 5.5E-05 * 60,149,884 = 3308.2436 lb (displacement - uncontrolled sources)
5.5E-05 * 6,410,157 * (1-0.95) = 17.6279 lb (displacement - controlled sources)
3.5E-06 * 66,560,041 = 232.9601 lb (spillage from all sources)

Milw.: 5.5E-05 * 309,914,711 = 17045.3091 lb (displacement - uncontrolled sources)
5.5E-05 * 45,399,805 * (1-0.95) = 124.8495 lb (displacement - controlled sources.)
3.5E-06 * 355,314,516 = 1243.6008 lb (spillage from all sources)

Racine: 5.5E-05 * 61,213,563 = 3366.7460 lb (displacement - uncontrolled sources)
5.5E-05 * 6,526,695 * (1-0.95) = 17.9484 lb (displacement - controlled sources)
3.5E-06 * 67,740,258 = 237.0909 lb (spillage from all sources)

Results

Estimated Calendar Year 1993 Air Emissions (in pounds)

Pollutant	Kenosha	Milwaukee	Racine
1,2-Dichloroethane	99.5	515.5	101.2
Ethylbenzene	751.5	3894.7	764.8
Naphthalene	3757.4	19473.7	3823.9

References

1. U.S. EPA. Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities. EPA-450/3-91-022. November 1991.
2. DNR Database of Average Monthly Gasoline Sales in Ozone Non-Attainment Counties (MONAVG). Unpublished. May 1995.

Publicly Owned Treatment Works

Pollutants are emitted from wastewater treatment plants depending on contents of the inflow stream. Publicly Owned Treatment Works (POTW) inflow rates and air toxic emissions were estimated in the

WDNR Study: Hazardous Air Pollutant Emission from Wastewater Treatment Plants (1990). The Wisconsin report uses data from the previous report scaled-up for 1993 population figures.

Source Identification

Protocol Section 3.2.1-SIC Codes
SIC code 4952 was used in covering sewerage systems in reporting of POTW air emissions.

Protocol Section 3.2.2-SCC/AMS Codes
When searching for potential pollutants SCC 501007%%, which was found in the FIRE database, was used.

Protocol Section 3.2.3-New SCC/AMS Codes
No new SCC's are required.

Protocol Section 3.3-Pollutants
A search of the Source Summary Database located 23 (from the GLC list of 49) possible toxic emissions.

Protocol Section 3.4-Identifying Facilities
Generally, there is one POTW in each county, with some of the heavily populated counties having more. In the 1990 report POTW's were identified. Larger POTW's are required to report as point sources and consequently were not included in the pilot study report. In the spatial scope of this project there were two POTW's for which estimates were made: 1) Kenosha County and 2) Racine County.

Air Toxic Emission Estimation

Protocol Section 4.1-Temporal Resolution
Emission estimates are presented on an annual basis.

Protocol Section 4.1-Spatial Resolution
Emission estimates are presented at the individual POTW level. Emissions from each POTW are then included in the county-wide estimate. In the counties in this report there is one POTW per county.

Protocol Section 4.2-Emission Estimation Techniques (EETs)
Process simulation software (NOCEPM model) was used in the 1990 report to estimate emissions at POTW's. Input data for the process simulation was provided by the POTW's to the DNR. The inflow to POTW's was assumed to be the same in 1993 as when the estimates were produced. The estimated amount of toxics emitted by the increased population was then estimated.

Protocol Section 4.3-Overall Inventory Development
Protocol Section 4.4-Activity and Emission Units
Protocol Section 4.5-Scale-up for Missing Sources
In the estimate of 1993 emissions from POTW's, data collected previously, available in an existing Wisconsin database, was used. All estimates were provided in pounds produced annually. No scale-up for missing sources is considered necessary.

Sample Calculations

Estimated methylene chloride emissions at the Kenosha County POTW 1993

Estimated methylene chloride emissions in 1986 = 683 lbs

Population increase 1986-1993 = 5.94%

Methylene chloride emission estimate for 1993 = 683 x 1.0594 = 723.6 lbs

Results

Only one POTW (in Kenosha County) reported emissions of any toxics in the protocol. Estimated emission for 1993 was calculated to be 723.6 lbs of methylene chloride.

References

WDNR Bureau of Air Management. 1990. Hazardous Air Pollutant Emissions from Wastewater Treatment Plants. Pub. AM 050-090.

Non-road Engines

Emissions from non-road engines includes diesel engines (construction equipment), gasoline four-stroke engines (construction equipment, lawn and garden equipment,"inboard" boat motors, etc.), and gasoline two-stroke engines ("outboard" boat motors, lawn and garden equipment, snowmobiles, etc...).

Information regarding emission factors for these sources is sparse. A literature search was performed and emission factors were composed using the best information available, often using engineering estimations.

Wisconsin offers exceptional opportunity for recreational boating and snowmobiling. Wisconsin's emissions from these types of two-stroke motors are probably higher (per capita) than for most other states. Emissions from recreational marine and snowmobile use are specifically determined from Wisconsin survey and registration data.

Source Identification

GLEI Protocol Section 3.2.1-SIC Codes
Non-road engines, as applied, are not an industrial activity covered by an SIC code.

GLEI Protocol Section 3.2.2-SIC/AMS Codes
AMS codes available in FIRE and AP-42 which cover internal combustion of appropriate fuels were used to produce estimates of as many pollutants as possible. These are:

1. SIC 20200102 -- Internal Combustion, Industrial, Diesel Fuel, Uncontrolled
2. SIC 20100101 -- Turbine, Electric Generation, Diesel/Fuel oil, assume uncontrolled
3. SIC 20200301 -- Reciprocating, Gasoline, Uncontrolled
4. SIC 20300301 -- Reciprocating, Gasoline, Uncontrolled

5. A2201001000 -- Gasoline: Light Duty Highway Vehicles

Speciation profiles for VOC and Particulate Matter from the California Air Resources Board (CARB, 1991) were used when no better emission factor existed. Emission factors from scientific literature were used and engineering estimates were performed when these sources were considered defensible.

GLEI Protocol Section 3.2.3-New SCC/AMS Codes
No new codes are required.

GLEI Protocol Section 3.3-Pollutants
Emission factors were derived from a variety of sources:

Diesel Engines: emission factors from the FIRE database were obtained from:

SIC code 20200102 (Reciprocating Diesel)--benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, mercury, naphthalene, PAH, VOC and PM.

CARB particulate speciation profile No. 118 (Vehicular Sources- Diesel) speciates cadmium, manganese, and mercury. CARB VOC speciation profile No. 561 (Diesel Exhaust (aldehydes in emissions)) speciates ethylbenzene.

SIC Code 20100101 (Diesel/Fuel Oil Turbine)--arsenic, chromium, chrysene, cobalt, copper, nickel.

Four-Stroke Gasoline Engines. Emission factors from the FIRE database were obtained from:

SIC code 20200301/20300301--hydrocarbons and particulate matter.

For small four-stroke engines, emission factors for hydrocarbons (VOC) and particulate matter were derived or taken from SAE paper No. 910560 specifically for engines of 4 horsepower (HP), 12 HP, and 18 HP.

CARB particulate speciation profile No. 117 (Vehicular Sources- Gasoline) speciates chromium, cobalt, copper, manganese, nickel. CARB VOC speciation profile No. 527 (Non-Catalyst Exhaust (Aldehydes in Emissions)) speciates ethylbenzene.

AMS code 2201001000 (Light Duty Highway Vehicles)-- naphthalene.

In addition, some emission factors were determined from SAE paper No. 902116, using Volkswagen Jetta and Audi 100 data (leaded fuel, no catalytic converter)--benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and PAH.

Two-Stroke Engines: emission factors for two-stroke engines were the most complicated to determine.

For 5 horsepower and 0.8 horsepower engines, SAE paper No. 910560 was used to determine PM and HC.

For snowmobiles, information from SAE paper No. 740735 was used to determine PM and HC.

For outboard motors, SAE paper No. 740737, No. 901597, and the U.S. EPA Non-Road study were used to determine Hydrocarbons. Particulate matter was estimated.

CARB particulate speciation profile No. 115 (Static IC Engines-Gasoline) provided chromium, cobalt, copper, manganese, nickel. CARB VOC speciation profile No. 502 (Non-Catalyst Light Duty Vehicles- Exhaust) provided ethylbenzene.

For two-stroke engines, information from U.S. EPA (Stage II vehicle refueling) was used to determine naphthalene and 1,2 dichloroethane, based on ethylbenzene.

Pollutants Identified for Non-road Engines

Pollutants Identified	Diesel Engines	Two-Stroke Engines	Four-Stroke Engines
Arsenic	X	--	--
Benz(a)anthracene	X	X	X
Benzo(a)pyrene	X	X	X
Cadmium	X	--	--
Chromium	X	X	X
Chrysene	X	X	X
Cobalt	X	X	X
Copper	X	X	X
Dioxins*	--	--	--
Ethylbenzene	X	X	X
Fluoranthene	X	X	X
Lead	X	--	--
Manganese & comps	X	X	X
Mercury	X	--	--
Naphthalene	X	X	X
Nickel & comps.	X	X	X
PAHs	X	X	X

* Dioxins are expected; no reliable emission factor could be determined

GLEI Protocol Section 3.4-Identifying Facilities

Information regarding diesel engine population, two-stroke motors except for snowmobiles and recreational marine, and four-stroke motors except for recreational marine, were obtained from the Wisconsin DNR-Bureau of Air Management (WDNR).

Information regarding recreational marine use came from the Wisconsin DNR-Bureau of Air Management and Bureau of Research (WDNR 1993 and WDNR 1991).

Information regarding snowmobile use came from the Wisconsin DNR-Bureau of Community Assistance (WDNR 1995) and Wisconsin Department of Development, Division of Tourism (Tourism 1993).

Air Toxic Emission Estimation

GLEI Protocol Section 4.1-Temporal Resolution

Diesel use and general small engine use (two-and four-stroke, does not include snowmobile and recreational marine) is based on estimated annual consumption.

Recreational marine emissions occur during the six month period between April and October. Snowmobile emissions are assumed to occur between October and April.

GLEI Protocol Section 4.1-Spatial Resolution
Emissions were calculated on a county-by-county basis.

Diesel emissions and general gasoline engine emission required a disaggregation, based on population fraction, of Wisconsin's six-county ozone non-attainment area (**Kenosha**, **Milwaukee**, **Racine**, Ozaukee, Washington, and Waukesha Counties).

For recreational marine, data regarding fuel sales and boating activity were provided at the county level.

For snowmobile use, registration was provided on a county level for Wisconsin residents and by the state or province (Canada) for out-of-state registered snowmobiles. It was considered most reasonable to assign this total pool of snowmobilers to the counties based on the fraction of Snowmobile Trail Miles that each county has in the state.

GLEI Protocol Section 4.2-Emission Estimation Techniques (EETS)

Determining the emissions from internal combustion engines burning gasoline or diesel is a difficult problem. For many compounds of interest, the emissions associated with the use of one engine is near the limit of detection. However, multiplying this small emission per engine by the widespread population of internal combustion engines may result in considerable total emissions.

The emission factor from each engine often depends very strongly on the duty cycle, or conditions of use, under which the engine operates. Uncertainty in the operating conditions of a "typical" engine could be a major source of error in determining emissions.

Determining the population of engines, and amount of use, is challenging. Often, an engine will operate in a different location than where the engine is registered. For example, a snowmobile may be registered in a large city, yet operate entirely several hundred miles away. Voluntary surveys of amount of recreational use are prone to wide errors, compared to actual use. For example, survey respondents may subconsciously report the amount of time they *wish* they used their boat, rather than their actual activity.

One particularly surprising result was that in general, a two-stroke engine (such as found on a common walk-behind lawn mower, outboard motor or snowmobile) exhausts about 25-35% of the gasoline put in the tank as uncombusted hydrocarbons (raw fuel) (SAE No. 740735, Mele, Lein). The U.S. EPA has developed new phase 1 and phase 2 emissions standards for small engines for May 1996 and May 1997. While hydrocarbon emissions for utility engines are expected to drop 90% and marine engines by 70%, the U.S. EPA does not expect the complete turnover of pre-standard engines until the year 2020, at the earliest (WDNR 1994).

GLEI Protocol Section 4.3-Overall Inventory Development
Development of Emission Factors:

Diesel emission factors were selected from FIRE SIC 20200102 (reciprocating diesel engines) when available, from SIC 20100101 (diesel/fuel oil turbines) when no better data were available, and speciated from VOC and PM emission factors from SIC 20200102.

Diesel Emission Factors

Compound	SIC 20200102 (lb/MMBTU)	SIC20100101 (lb/MMBTU)	derived from PM species 118 (lb/MMBTU)	derived from VOC species 561 (lb/MMBTU)	FACTOR USED: (lb/MMBTU)
Arsenic		4.90E-06	9.30E-07		4.90E-06

Benz(a)anthracene	1.68E-06				1.68E-06
Benzo(a)pyrene	1.88E-07				1.88E-07
Cd		4.20E-06	2.08E-05		2.08E-05

Cr		4.70E-05	2.79E-06		4.70E-05
Chrysene	3.53E-07				3.53E-07
Co		9.10E-06	1.86E-06		9.10E-06

Cu		1.30E-03	9.30E-05		1.30E-03
1,2 Dichloroethane					
Dioxins; 2378 Equiv					

Ethylbenzene				1.93E-02	1.93E-02
Fluoranthene	7.61E-06				7.61E-06
Pb		5.80E-05			5.80E-05

Mn and compounds			7.13E-06		7.13E-06
Hg	3.01E-07		7.75E-06		7.75E-06
Naphthalene	8.48E-05				8.48E-05

Ni and compounds		1.20E-03			1.20E-03
PAHs	1.68E-04				1.68E-04
VOC	32.1				

particulate matter	0.31					

Four-Cycle Emission Factors for Generic "Car-like" Engines

Compound	SIC 20200301 /SIC20300301 leaded fuel (g/HP-hr)	A2201001000 Light Duty Hwy Vehicles (g/HP-hr)	SAE #902116 Jetta/Audi 100 leaded fuel (g/HP-hr)	U.S. EPA Non-road (g/HP-hr)	From CARB VOC sp. 527 PM sp. 117 (g/HP-hr)	FACTORS USED (lb/gal)	FACTORS USED (g/HP-hr)
Arsenic							
Benz(a)anthracene		7.33E-07 *	1.68E-05			4.57E-07	1.68E-05
Benzo(a)pyrene			1.34E-05			3.64E-07	1.34E-05
Cd							
Cr					3.0E-05	8.15E-07	3.00E-05
Chrysene			2.74E-05			7.44E-07	2.74E-05
Co					3.0E-05	8.15E-07	3.00E-05
Cu					3.0E-05	8.15E-07	3.00E-05
1,2 Dichloroethane							
Dioxins; 2378 Equiv							
Ethylbenzene					0.047428	1.29E-03	4.74E-02
Fluoranthene			1.41E-04			3.84E-06	1.41E-04
Pb							
Mn and comp.					3.0E-05	8.15E-07	3.00E-05
Hg							
Naphthalene		4.08E-3				1.11E-04	4.08E-03
Ni and compounds					3.0E-05	8.15E-07	3.00E-05
PAHs			3.98E-04			1.08E-05	3.98E-04
particulate matter	0.327			0.06		1.63E-03	6.00E-02
hydrocarbons	6.68					1.81E-01	6.68

* Benz(a)anthracene average of two factors provided by FIRE for LDHWV

Factors from SIC 20200301/20300301 and EPA Non-Road were given in grams per horsepower hour (g/HP-hr). Factors from AMS 220100000 and SAE paper number 902116 were given in grams per mile traveled.

Assuming 25 miles per gallon, knowing 2.2044 E-3 pounds per gram, and using 38.809 g/HP-hr per lb/gal (derived from the U.S. EPA Non-Road study), units are converted to pounds/gallon-of-gasoline and pounds/HP-hr.

Emission Factors for Small Four-Cycle Engines

Compound	generic- car-like (g/HP-hr)	<4.5 HP 4-stroke (g/HP-hr)	12 HP 4-stroke (g/HP-hr)	18 HP 4-stroke (g/HP-hr)

Arsenic				
Benz(a)anthracene	1.68E-05	1.68E-05	1.68E-05	1.68E-05

Benzo(a)pyren	1.34E-05	1.34E-05	1.34E-05	1.34E-05
Cd				

Cr	3.00E-05	3.12E-04	3.00E-05	1.00E-04
Chrysene	2.74E-05	2.74E-05	2.74E-05	2.74E-05

Co	3.00E-05	3.12E-04	3.00E-05	1.00E-04
Cu	3.00E-05	3.12E-04	3.00E-05	1.00E-04

1,2 Dichloroethane					
Dioxins; 2378 Equiv					

Ethylbenzene	4.74E-02	1.80E-01	4.07E-02	4.22E-02
Fluoranthene	1.41E-04	1.41E-04	1.41E-04	1.41E-04

Pb				
Mn and compounds	3.00E-05	3.12E-04	3.00E-05	1.00E-04

Mercury				
Naphthalene	4.08E-03	4.08E-03	4.08E-03	4.08E-03

Ni and compounds	3.00E-05	3.12E-04	3.00E-05	1.00E-04
PAHs	3.98E-04	3.98E-04	3.98E-04	3.98E-04

VOC	6.68	24.37	5.5	5.70
particulate matter	0.06	0.62	0.06	0.20

hydrocarbons	6.68	24.37	5.5	5.70

Emissions for small four-stroke engines use the "generic car-like" emissions as a baseline when no better emission factors could be determined.

SAE paper No. 910560 (White, Carroll and Hare) presents hydrocarbon and particulate matter data for three different walk-behind mowers, all around 4 HP. These emissions were averaged for hydrocarbon and particulate matter emission factor for four-stroke engines less than 4.5 HP. Hydrocarbon and particulate matter emission factors were also given for four-stroke 12 HP and 18 HP utility engines.

An assumption was made that 100% of hydrocarbon emissions are VOC. CARB particulate matter and VOC speciation profiles were used to improve the specific engine emission factors for ethylbenzene, chromium, cobalt, copper, manganese, and nickel.

Two-Stroke Emission Factors

	generic-	5hp	0.8hp	6.4 HPave use	65hp	Wis. SIP

Compound

Arsenic						

Benz(a)anthracene	1.68E-05	1.68E-05	1.68E-05	1.68E-05	1.68E-05	4.57E-07

Benzo(a)pyrene	1.34E-05	1.34E-05	1.34E-05	1.34E-05	1.34E-05	3.64E-07

Cd						

Cr	3.00E-05	3.55E-03	2.25E-03	3.07E-03	3.19E-03	4.98E-05

Chrysene	2.74E-05	2.74E-05	2.74E-05	2.74E-05	2.74E-05	7.44E-07

Co	3.00E-05	3.55E-03	2.25E-03	3.07E-03	3.19E-03	4.98E-05

Cu	3.00E-05	3.55E-03	2.25E-03	3.07E-03	3.19E-03	4.98E-05

1,2 Dichloroethane		1.24E-01	1.12E-01	5.90E-02	8.18E-02	1.28E-03

Ethylbenzene	4.74E-02	1.38E+00	1.24E+00	6.60E-01	9.10E-01	1.42E-02

Fluoranthene	1.41E-04	1.41E-04	1.41E-04	1.41E-04	1.41E-04	3.84E-06

Pb						

Mn and compounds	3.00E-05	3.55E-03	2.25E-03	3.07E-03	3.19E-03	4.98E-05

Hg						

Naphthalene	4.08E-03	9.30E-01	8.40E-01	4.40E-01	6.15E-01	9.60E-03

Ni and compounds	3.00E-05	3.55E-03	2.25E-03	3.07E-03	3.19E-03	4.98E-05

PAHs	3.89E-04	3.98E-04	3.98E-04	3.98E-04	3.98E-04	1.08E-05

particulate matter	0.06	7.1	4.5	6.13	6.38	0.1

hydrocarbons	6.68	186	168	88.6	123	1.92

Emissions for two-stroke engines use the "generic car-like" four-stroke emissions as a base when no better emission factors could be determined.

SAE paper No. 910560 (White, Carroll and Hare) presents hydrocarbon and particulate matter emission factors for a 5 HP walk behind mower and a 0.8 HP string trimmer.

SAE paper No. 740735 (Hare, Springer and Huls) presents hydrocarbon and particulate matter emission factors for a variety of snowmobiles. The 32 HP Arctic Cat 440 (Kawasaki), running at an average of 6.4 HP was selected to represent Wisconsin's snowmobiles.

SAE paper No. 740735 (Hare, Springer and Huls) presents hydrocarbon emission factors for a variety of two-stroke outboard motors. The 65 HP Mercury Marine engine was selected to represent Wisconsin's outboard motors. The average Wisconsin boat motor is 55 HP (WDNR 1991). When emission factors are needed per gallon of gasoline, the hydrocarbon factor derived for the Wisconsin Ozone SIP for hydrocarbons from "small" outboard was used.

For outboard motors, particulate matter emissions were derived assuming the ratio of particulate matter to hydrocarbons was the same as that of the snowmobile. It was assumed that 100% of hydrocarbon emissions are VOC (WDNR 1993).

CARB particulate matter and VOC speciation profiles were used to improve the specific engine emission factors for ethylbenzene, chromium, cobalt, copper, manganese, and nickel.

It was assumed that ethylbenzene emissions are entirely from uncombusted fuel. Emissions of naphthalene and 1,2 dichloroethane are from, or derived from, gasoline evaporation data (U.S. EPA 1991). For outboard motors, ethylbenzene, 1,2 dichloroethane, and naphthalene emissions are reduced 25% to account for water cooling emissions that mix in to lake water and do not volatilize.

GLEI Protocol Section 4.4-Activity and Emission Units

An extensive database of 1990 diesel, four-stroke, and two-stroke small engine use (not including snowmobiles or recreational marine) in Milwaukee, Racine, Kenosha, and Washington, Ozaukee, and Waukesha counties was kindly made available (Lein). Equipment population, hours of use per year, power, and load factors were provided.

This information was disaggregated to the county level based on population fraction. No attempt was made to include population growth from 1990 to 1993, as this factor is below the expected accuracy of the data.

Recreational marine use was determined by an extensive survey of Wisconsin boating habits (WDNR 1991). The sample size was 53,559. Responses regarding fuel purchased per year and time-on-the-water was provided at the county level. Emissions were calculated using both pieces of information; emissions from reported use were about twice the emissions from reported fuel purchased. The emission technique based on reported fuel purchased was used, because it is conservative, and seems less prone to reporting errors.

Snowmobile use is based on total snowmobiles registered in the state, including out-of-state owners (WDNR 1995). Use is disaggregated to the county level based on total county, state, and federal supported snowmobile trail miles per county. The average snowmobile is assumed to operate 60 hours per year (SAE No. 740735). This is in close agreement with industry estimates of an average of 63 gallons of gasoline consumed per snowmobile per year (Klim).

For both two- and four-stroke engine inventories, emission factors from the most similarly sized engine of the same type were used.

GLEI Protocol Section 4.5-Scale-up for Missing Sources
No scale-up for missing sources is considered necessary.

Sample Calculations

The calculations appear simple, because many details were handled when compiling the emission factors.

$$\text{Weight of pollutant j} = \text{Activity}_j * \text{Ef}_j$$

Results

Emissions from Off-road Diesel Engines

Compound	Kenosha	Milwaukee	Racine	TOTAL

	(pounds)	(pounds)	(pounds)	(pounds)

Arsenic	0.59	4.40	0.80	5.79

Benz(a)anthracene	0.20	1.51	0.28	1.99

Benzo(a)pyrene	0.02	0.17	0.03	0.22

Cadmium	2.49	18.66	3.40	24.55

Chromium	5.64	42.22	7.70	55.56

Chrysene	0.04	0.32	0.06	0.42

Cobalt	1.09	8.17	1.49	10.76

Copper	156	1,168	213	1,537

1,2 Dichloroethane				

Ethylbenzene	2,312	17,300	3,157	22,768

Fluoranthene	0.9	6.8	1.2	9.00

Lead	7.0	52.1	9.5	68.56

Manganese	0.9	6.4	1.2	8.43

Mercury	0.9	7.0	1.3	9.16

Naphthalene	10.2	76.2	13.9	100.25

Ni and compounds	144	1,078	197	1,419

PAHs	20.16	150.90	27.53	198.60

PM	37,207	278,448	50,807	366,462

VOC	3,852,728	28,832,868	5,260,986	37,946,583

Emissions from Two-stroke Engines, Not Including Recreational Marine or Snowmobile

Compound	Kenosha	Milwaukee	Racine	TOTAL
	(pounds)	(pounds)	(pounds)	(pounds)

Benz(a)anthracene	0.09	0.66	0.12	0.87

Benzo(a)pyrene	0.07	0.53	0.10	0.69

Cadmium					

Chromium	16.24	121.54	22.18	159.96

Chrysene	0.14	1.07	0.20	1.41

Cobalt	16.24	121.54	22.18	159.96

Copper	16.24	121.54	22.18	159.96

1,2 dichloroethane	354	2,648	483	3485

Ethylbenzene	3,952	29,577	5,397	38,926

Fluoranthene	0.74	5.53	1.01	7.27

Lead					

Mn and compounds	16.24	121.54	22.18	159.96

Mercury				

Naphthalene	2,642	19,774	3,608	26,025

Ni and compounds	16.24	121.54	22.18	159.96

PAHs	2.08	15.60	2.85	20.53

particulate matter	32,482	243,090	44,355	319,928

hydrocarbons	531,177	3,975,201	725,335	5,231,713

Emissions from Four-stroke Engines, Not Including Recreational Marine or Snowmobile

Compound	Kenosha	Milwaukee	Racine	TOTAL

	(pounds)	(pounds)	(pounds)	(POUNDS)

Benz(a)anthracene	0.25	1.90	0.35	2.50

Benzo(a)pyrene	0.20	1.51	0.28	1.99

Cadmium					

Cr	1.29	9.63	1.76	12.68

Chrysene	0.41	3.09	0.56	4.07

Co	1.29	9.63	1.76	12.68

Cu	1.29	9.63	1.76	12.68

1,2 dichloroethane				

Ethylbenzene	988	7,394	1,349	9,731

Fluoranthene	2.13	15.93	2.91	20.96

Lead					

Mn and compounds	1.29	9.63	1.76	12.68

Mercury					

Naphthalene	62.58	460.83	84.08	606.49

Ni and compounds	1.29	9.63	1.76	12.68

PAHs	6.01	44.95	8.20	59.16

particulate matter	2,575	19,270	3,516	25,361

hydrocarbons	134,723	1,008,236	183,968	1,326,927

Emissions from Two-stroke Recreational Marine

Compound	Kenosha	Milwaukee	Racine	TOTAL
	(pounds)	(pounds)	(pounds)	(pounds)

Benz(a)anthracene	0.11	0.03	0.08	0.23

Benzo(a)pyrene	0.09	0.03	0.07	0.18

Cadmium				

Chromium	12.11	3.80	9.16	25.07

Chrysene	0.18	0.06	0.14	0.37

Cobalt	12.11	3.80	9.16	25.07

Copper	12.11	3.80	9.16	25.07

1,2 Dichloroethane	311	97	235	643

Ethylbenzene	3,458	1,084	2,615	7,157

Fluoranthene	0.93	0.29	0.71	1.93

Lead				

Mn and compounds	12.11	3.80	9.16	25.07

Mercury				

Naphthalene	2336.48	732.57	1766.56	4,836

Ni and compounds	12.11	3.80	9.16	25.07

PAHs	2.63	0.82	1.99	5.44

particulate matter	24,229	7,597	18,319	50,145

hydrocarbons	467,297	146,514	353,311	967,122

Emissions from Four-stroke Recreational Marine

Compound	Kenosha	Milwaukee	Racine	TOTAL

	(pounds)	(pounds)	(pounds)	(pounds)

Benz(a)anthracene	0.15	0.23	0.18	0.56

Benzo(a)pyrene	0.12	0.18	0.14	0.44

Cadmium					

Chromium	0.27	0.40	0.32	1.00

Chrysene	0.25	0.37	0.29	0.91

Cobalt	0.27	0.40	0.32	1.00

Copper	0.27	0.40	0.32	1.00

1,2 Dichloroethane				

Ethylbenzene	428	637	511	1,575

Fluoranthene	1.28	1.90	1.52	4.70

Lead				

Mn and compounds	0.27	0.40	0.32	1.00

Mercury				

Naphthalene	36.77	54.75	43.90	135.42

Ni and compounds	0.27	0.40	0.32	1.00

PAHs	3.59	5.34	4.28	13.21

particulate matter	541	806	646	1,993

hydrocarbons	60,244	89,696	71,921	221,861

Snowmobile Emissions

Compound	Kenosha	Milwaukee	Racine	TOTAL

	(pounds)	(pounds)	(pounds)	(pounds)

Benz(a)anthracene	0.01	0.002	0.02	0.04

Benzo(a)pyrene	0.01	0.002	0.02	0.03

Cadmium					

Chromium	2.3	0.3	4.0	6.66

Chrysene	0.02	0.003	0.04	0.06

Cobalt	2.3	0.3	4.0	6.66

Copper	2.3	0.3	4.0	6.66

1,2 Dichloroethane	44.9	6.7	76.6	128.14

Ethylbenzene	502.0	75.0	856.4	1,433

Fluoranthene	0.1	0.02	0.2	0.31

Lead				

Mn and compounds	2.3	0.3	4.0	6.66

Mercury				

Naphthalene	334.7	50.0	570.9	955.61

Ni and compounds	2.3	0.3	4.0	6.66

PAHs	0.3	0.05	0.5	0.88

particulate matter	4,663	697	7,954	13,313

hydrocarbons	67,393	10,073	114,960	192,425

Total Emissions from All Non-road Engines

Compound	Kenosha	Milwaukee	Racine	TOTAL

	(pounds)	(pounds)	(pounds)	(pounds)

Arsenic	0.6	4.4	0.8	5.8

Benz(a)anthracene	0.8	4.3	1.0	6.2

Benzo(a)pyrene	0.5	2.4	0.6	3.6

Cd	2.5	18.7	3.4	25

Cr	37.9	177.9	45.1	261

Chrysene	1.0	4.9	1.3	7.3

Co	33.3	143.9	38.9	216

Cu	188.3	1,303.4	250.5	1,742

1,2 dichlorethane	709.6	2,752.1	794.8	4,256

Ethylbenzene	11,639.5	56,066.6	13,884.0	81,590

Fluoranthene	6.1	30.5	7.6	44

Pb	7.0	52.1	9.5	69

Mn	33.1	142.1	38.6	214

Hg	0.9	7.0	1.3	9.2

Naphthalene	5,422.0	21,148.7	6,087.5	32,658

Ni and compounds	176.3	1,213.6	234.1	1,624

PAHs	34.8	217.7	45.4	298

PM	101,697.2	549,907.1	125,597.2	777,202

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Evaluation of Protocol and Recommendations

The protocol is satisfactory for the calculation of emissions from non-road engines. The difficulty is a lack of accepted emission factors and accepted average duty cycles for these engines.

The best conservative calculations used in developing Wisconsin's portion of the regional inventory indicate that emissions from this source are worth consideration. More investigation and research about emissions from small engines (and internal combustion engines in general), as well as the typical conditions under which these engines operate, is indicated.

RESULTS

The complete results for Wisconsin are summarized in Tables C-1, C-2 and C-3 beginning on page 270. The tables list emissions sorted by SIC and pollutant (in pounds) for Kenosha, Milwaukee, and Racine counties, respectively. Table C-4 lists the total emissions of each pollutant by county and for the three-county area.

IMPLICATIONS FOR THE PROTOCOL

Small Point Sources

Toxic emission estimates are made by sources, then reported to the Wisconsin Department of Natural Resources (WDNR). Sources are required to report actual, annual emissions in lb/yr, and identify the method used to make the estimate. The WDNR does not make its own estimates of toxic emissions for point sources, except in a quality control capacity.

Issues

1) Different states have different reporting requirements; Wisconsin has access to more data due to stricter legislation. The data generated as a result of the stricter reporting requirement is invaluable in understanding the affect that smaller sources have on Wisconsin's environmental loading.

2) While the data from small point sources is valuable, there is still a question about pollutants generated from these sources below the reporting limit. In aggregate, small emissions from all small point sources could be significant.

Landfills

Comprehensive information on landfill sites that have closed up to 60 years ago does not exist, yet they emit gas, as well as contributing to water leaching. It is impossible to know what is in old sites, and very difficult to determine what is going in to present day landfills.

Using emission factors (AP-42) for methane combustion is unsatisfactory for <u>total</u> landfill emissions. A major source of air toxics from landfill sites may be from the volatilization of solvent and petroleum wastes. Metals may be airborne in dust generated by wind and earth moving equipment. Emissions are highly dependent on the content of the waste, which is largely unknown.

Residential Woodburning

In order to compile the most extensive estimate of emissions due to residential woodburning in Wisconsin, the state's methods deviated from the protocol in that all AMS codes were applied, in order of relevance, when calculating emissions.

Issues

1) Wisconsin used SCC 10300903, Industrial Wood Fired Boilers, to provide emission factors when no better emission factor existed. Residential wood stove emission factors were applied to fireplace combustion processes when no better emission factor existed. This technique was not described in the protocol, but is widely used in the WDNR.

Wisconsin officials felt that including this composite of process-related emission factors results in the most complete estimates of emissions from residential wood use possible. They recommend that other states follow this procedure of including emission factors derived for related processes for residential woodburning, and possibly in other cases, if the situation warrants.

2) Wisconsin has extensive wood combustion survey data available. Data quantifying residential wood fuel use may be limited or difficult to locate in other states. In Wisconsin, residential woodburning is a contributor to local air pollution. Wisconsin officials recommend that other states investigate the opportunity to obtain data for residential woodburning and to include this source in their toxic emission inventory.

Dry Cleaning Operations

No generic emission factors were available in FIRE to calculate PERC emissions based on PERC consumption data. Emission estimates were produced based on emission factors derived from EPA information on the type of machine, control type and amount of PERC consumption.

Gasoline Service Stations

Issues

1) Wisconsin has developed a database of gas stations in ozone non-attainment counties, based on a State notification requirement. The data included name of station, location, facility contacts, and average monthly sales of unleaded gasoline for a 24-month period covering 1991 and 1992. This information was invaluable in understanding the role of gasoline service stations on environmental loading.

Note: Wisconsin did not include tank breathing losses in this pilot. It was expected that these losses will be worthy of consideration, and this source of emissions will be included in the next phase of the project.

Non-road Engines

The protocol is--technically--satisfactory for the calculation of emissions from non-road engines.

Great difficulty lies in a lack of accepted emission factors and accepted average duty cycles for these engines. Wisconsin's best conservative calculations indicate that emissions from this source are well worth consideration.

Issues

1) Emission factors for most of the 49 pollutants were not available through U.S. EPA.

Scientific papers, CARB Particulate Speciation Profiles and VOC Speciation Profiles were used when emission factors were not available. For two-stroke engines, information from U.S. EPA Stage II vehicle refueling was used to determine naphthalene and 1,2 dichloroethane.

2) Determining the population of engines, and amount of use, is challenging. Often, an engine will operate in a different location than where the engine is registered. Voluntary questionnaires of recreational use are prone to wide errors, compared to different measures of use.

3) One surprising result was that a two-stroke engines (such as on a walk-behind lawn mower, outboard motor or snowmobile) are very "dirty." Such engines exhaust 25 -35% of the gasoline used as uncombusted fuel.

Table C-1: Kenosha County WI, Emissions by SIC

		SIC Code								TOTAL
	Compound (POUNDS)	3931	4911	4952	4953	5541	7211	8221	9999	(pounds)
1	Arsenic		112						1.83	114
2	Atrazine									
3	Benz(a)anthracene				1.55E-05				14.78	15
4	Benzo(a)pyrene				2.83E-05				84.37	84
5	Cadmium								2.78	3
6	Carbon tetrachloride				1.80E-01					1.8E-01
7	Chlordane									
8	Chromium								37.90	38
9	Chrome VI								0.64	0.64
10	Chrysene				7.35E-03				140.79	141
11	Cobalt		55						35.12	90
12	Coke oven emiss.									
13	Copper								193.05	193
14	1,2 Dichloroethane					99.5			709.60	809
15	Diethylhexyl phthalate									
16	Di-n-butyl phthalate									
17	Di-n-octyl phthalate									
18	Dioxins; 2378 Equiv									
19	Ethylbenzene					751.5			11,640	12,391
20	Fluoranthene				1.80E-01				117.93	118
21	Heptachlor									
22	Hexachlorobenzene									
23	Hexachlorobutadiene									
24	Hexachloroethane									
25	Lead								22.38	22
26	Alkylated Pb compounds									
27	Manganese & compounds								35.06	35
28	Mercury								0.99	1
29	Methoxychlor									
30	Methylene Chloride			723.6	53.2					777
31	Naphthalene				2.48	3757			7,435	11,192
32	Nickel & compounds		211						176.58	388
33	Parathion									
34	Pentachloronitrobenzene									
35	Pentachlorophenol									
36	phenol								111.83	112
37	PCBs				1.51E-02					1.51E-02
38	PCDDs								0.04	0.04
39	PCDFs								0.22	0.22
40	PAHs								7,024	7,024
41	POM							0.0551	22.36	22
42	TCDD 2378				3.52E-05				2.1E-04	2.50E-04
43	TCDF 2378				4.37E-04				6.2E-03	0.01
44	Tetrachloroethylene (PERC)				8.63E-01		20,833			20,833
45	Trichlorethene	6,680			0.312					6,680
46	111 trichloroethane	15,919			2.53					15,921
47	245 trichlorophenol									
48	246 trichlorophenol									
49	Trifluralin									

Table C-2: Milwaukee County WI, Emissions by SIC

		SIC Code								
	Compound (POUNDS)	2099	2434	2541	2671	2752	2816	2851	2869	2891
1	Arsenic	7.6E-06								
2	Atrazine									
3	Benz(a)anthracene									
4	Benzo(a)pyrene									
5	Cadmium	1.92E-05								
6	Carbon tetrachloride									
7	Chlordane									
8	Chromium									
9	Chrome VI						21.45	1.0		
10	Chrysene									
11	Cobalt									
12	Coke oven emiss.									
13	Copper	5.10E-04								
14	1,2 Dichloroethane									
15	Diethylhexyl phthalate									
16	Di-n-butyl phthalate									
17	Di-n-octyl phthalate									
18	Dioxins; 2378 Equiv									
19	Ethylbenzene			1.0	43.1	1,342		6,212		
20	Fluoranthene									
21	Heptachlor									
22	Hexachlorobenzene									
23	Hexachlorobutadiene									
24	Hexachloroethane									
25	Lead									
26	Alkylated Pb compounds									
27	Manganese & compounds	7E-07								
28	Mercury									
29	Methoxychlor									
30	Methylene Chloride					83.0			13,537	6,490
31	Naphthalene									
32	Nickel & compounds	3.09E-04								
33	Parathion									
34	Pentachloronitrobenzene									
35	Pentachlorophenol									
36	phenol									
37	PCBs									
38	PCDDs									
39	PCDFs									
40	PAHs									
41	POM									
42	TCDD 2378									
43	TCDF 2378									
44	Tetrachloroethylene (PERC)									
45	Trichlorethene									1,151
46	111 trichloroethane		15,984	356				76		7,015
47	245 trichlorophenol									
48	246 trichlorophenol									
49	Trifluralin									

Table C-2: Milwaukee County WI, Emissions by SIC

		SIC Code								
	Compound (POUNDS)	2951	3089	3321	3325	3351	3412	3441	3442	3449
1	Arsenic			66.43						
2	Atrazine									
3	Benz(a)anthracene									
4	Benzo(a)pyrene				0.16					
5	Cadmium									
6	Carbon tetrachloride		0.5							
7	Chlordane									
8	Chromium									
9	Chrome VI									
10	Chrysene									
11	Cobalt					1.09				
12	Coke oven emiss.									
13	Copper				1.5E-03	1,264				
14	1,2 Dichloroethane									
15	Diethylhexyl phthalate									
16	Di-n-butyl phthalate									
17	Di-n-octyl phthalate									
18	Dioxins; 2378 Equiv									
19	Ethylbenzene							60		
20	Fluoranthene									
21	Heptachlor									
22	Hexachlorobenzene									
23	Hexachlorobutadiene									
24	Hexachloroethane									
25	Lead									
26	Alkylated Pb compounds									
27	Manganese & compounds				93.84					
28	Mercury									
29	Methoxychlor									
30	Methylene Chloride						8,867		10,500	
31	Naphthalene									
32	Nickel & compounds		25.6	400	503.61					
33	Parathion									
34	Pentachloronitrobenzene									
35	Pentachlorophenol									
36	phenol									
37	PCBs									
38	PCDDs									
39	PCDFs									
40	PAHs									
41	POM	65.9								
42	TCDD 2378									
43	TCDF 2378									
44	Tetrachloroethylene (PERC)									
45	Trichlorethene									6,424
46	111 trichloroethane									
47	245 trichlorophenol									
48	246 trichlorophenol									
49	Trifluralin									

Table C-2: Milwaukee County WI, Emissions by SIC

		SIC Code								
	Compound (POUNDS)	3462	3471	3479	3499	3519	3532	3541	3565	3567
1	Arsenic	0.9								
2	Atrazine									
3	Benz(a)anthracene									
4	Benzo(a)pyrene									
5	Cadmium	0.74	3.73			21				
6	Carbon tetrachloride									
7	Chlordane									
8	Chromium									
9	Chrome VI		18.2	293.3	1.22	144				
10	Chrysene									
11	Cobalt									
12	Coke oven emiss.									
13	Copper	13.1		0.14						
14	1,2 Dichloroethane									
15	Diethylhexyl phthalate									
16	Di-n-butyl phthalate									
17	Di-n-octyl phthalate									
18	Dioxins; 2378 Equiv									
19	Ethylbenzene				752.03	7,836				
20	Fluoranthene									
21	Heptachlor									
22	Hexachlorobenzene									
23	Hexachlorobutadiene									
24	Hexachloroethane									
25	Lead			0.09	133.38					
26	Alkylated Pb compounds									
27	Manganese & compounds	1.2		0.24	9.28		2,259			
28	Mercury									
29	Methoxychlor									
30	Methylene Chloride			18,240		13,086	10,247		1,671	
31	Naphthalene			156.61	11,688					1,853
32	Nickel & compounds	59.5				197.37	202			
33	Parathion									
34	Pentachloronitrobenzene									
35	Pentachlorophenol									
36	phenol									
37	PCBs									
38	PCDDs									
39	PCDFs									
40	PAHs									
41	POM									
42	TCDD 2378									
43	TCDF 2378									
44	Tetrachloroethylene (PERC)									
45	Trichlorethene		7,560							
46	111 trichloroethane	9,900			22,352			18,878	11,336	
47	245 trichlorophenol									
48	246 trichlorophenol									
49	Trifluralin									

Table C-2: Milwaukee County WI, Emissions by SIC

		SIC Code								
	Compound (POUNDS)	3585	3625	3661	3694	3822	3844	4226	4613	4911
1	Arsenic									218
2	Atrazine									
3	Benz(a)anthracene									
4	Benzo(a)pyrene									
5	Cadmium									
6	Carbon tetrachloride									
7	Chlordane									
8	Chromium									
9	Chrome VI		36							
10	Chrysene									
11	Cobalt									71
12	Coke oven emiss.									
13	Copper									
14	1,2 Dichloroethane									
15	Diethylhexyl phthalate									
16	Di-n-butyl phthalate									
17	Di-n-octyl phthalate									
18	Dioxins; 2378 Equiv									
19	Ethylbenzene							64.49	6.7	
20	Fluoranthene									
21	Heptachlor									
22	Hexachlorobenzene									
23	Hexachlorobutadiene									
24	Hexachloroethane									
25	Lead									
26	Alkylated Pb compounds									
27	Manganese & compounds									
28	Mercury									
29	Methoxychlor									
30	Methylene Chloride		13,291			105.86	1,789			
31	Naphthalene			874				12.67	0.2	
32	Nickel & compounds									410
33	Parathion									
34	Pentachloronitrobenzene									
35	Pentachlorophenol									
36	phenol									
37	PCBs									
38	PCDDs									
39	PCDFs									
40	PAHs									
41	POM									
42	TCDD 2378									
43	TCDF 2378									
44	Tetrachloroethylene (PERC)									
45	Trichlorethene		10,300							
46	111 trichloroethane	2,645			20,467		18,508			
47	245 trichlorophenol									
48	246 trichlorophenol									
49	Trifluralin									

Table C-2: Milwaukee County WI, Emissions by SIC

	(POUNDS)	SIC Code 4952	4953	4961	5093	5171	5541	7211	8221	9999	TOTAL (pounds)
1	Arsenic			104						7.62	397
2	Atrazine										
3	Benz(a)anthracene		1.16E-04							40.88	41
4	Benzo(a)pyrene		2.12E-04							221.89	222
5	Cadmium	22.25		17						19.07	84
6	Carbon tetrachloride		1.30								1.8
7	Chlordane										
8	Chromium									177.90	178
9	Chrome VI									1.68	517
10	Chrysene		1.00E-01							390.71	391
11	Cobalt				19.36					148.66	240
12	Coke oven emiss.										
13	Copper	244.51								1,316	2,838
14	1,2 Dichloroethane						515.5			2,752	3,268
15	Diethylhexyl phthal										
16	Di-n-butyl phthalate										
17	Di-n-octyl phthalate										
18	Dioxins; 2378 Equiv										
19	Ethylbenzene					387.65	3,895			56,067	76,666
20	Fluoranthene		1.30							323.15	323
21	Heptachlor										
22	Hexachlorobenzene										
23	Hexachlorobutadien										
24	Hexachloroethane										
25	Lead									92.34	226
26	Alkylated Pb com										
27	Manganese &com									147.22	2,511
28	Mercury	118.20		25						7.24	150
29	Methoxychlor										
30	Methylene Chloride		398.3								98,304
31	Naphthalene		18.6			0.04	19,474			26,417	60,492
32	Nickel & compounds	282.04		552	225.8					1,214	4,072
33	Parathion										
34	Pentachloronitro										
35	Pentachlorophenol										
36	phenol					7.0				292.65	300
37	PCBs		1.00E-01								0.1
38	PCDDs									0.11	0.11
39	PCDFs									0.585	0.59
40	PAHs									18,508	18,508
41	POM								0.32	58.53	124
42	TCDD 2378		2.64E-04							7.90E-04	1.05E-03
43	TCDF 2378		3.27E-03							2.00E-02	0.02
44	(PERC)		6.50					204,273			204,280
45	Trichlorethene		2.34								25,437
46	111 trichloroethane		18.9								127,536
47	245 trichlorophenol										
48	246 trichlorophenol										
49	Trifluralin										

Table C-3: Racine County WI, Emissions by SIC

		SIC Code							
	Compound (POUNDS)	3069	3325	3398	3499	3523	3639	3714	3931
1	Arsenic								
2	Atrazine								
3	Benz(a)anthracene								
4	Benzo(a)pyrene								
5	Cadmium								
6	Carbon tetrachloride								
7	Chlordane								
8	Chromium								
9	Chrome VI								
10	Chrysene								
11	Cobalt								
12	Coke oven emiss.								
13	Copper		321						
14	1,2 Dichloroethane								
15	Diethylhexyl phthalate								
16	Di-n-butyl phthalate								
17	Di-n-octyl phthalate								
18	Dioxins; 2378 Equiv								
19	Ethylbenzene					13,302			
20	Fluoranthene								
21	Heptachlor								
22	Hexachlorobenzene								
23	Hexachlorobutadiene								
24	Hexachloroethane								
25	Lead								
26	Alkylated Pb compounds								
27	Manganese & compounds								
28	Mercury								
29	Methoxychlor								
30	Methylene Chloride	34,669							
31	Naphthalene		2,905						
32	Nickel & compounds								
33	Parathion								
34	Pentachloronitrobenzene								
35	Pentachlorophenol								
36	phenol			4,338					
37	PCBs								
38	PCDDs								
39	PCDFs								
40	PAHs								
41	POM								
42	TCDD 2378								
43	TCDF 2378								
44	Tetrachloroethylene (PERC)	2,848							
45	Trichlorethene	11,338			6,884			14,682	6,680
46	111 trichloroethane	426					9,699		15,919
47	245 trichlorophenol								
48	246 trichlorophenol								
49	Trifluralin								

Table C-3: Racine County WI, Emissions by SIC

		SIC Code					TOTAL
	Compound (POUNDS)	4953	5541	7211	8221	9999	(pounds)
1	Arsenic					2.80	3
2	Atrazine						
3	Benz(a)anthracene	2.1E-05				21.00	21
4	Benzo(a)pyrene	3.9E-05				120.60	120
5	Cadmium					3.80	3
6	Carbon tetrachloride	2.5E-01					2.5E-01
7	Chlordane						
8	Chromium					45.10	45
9	Chrome VI					1	0.92
10	Chrysene	1.0E-02				200.30	201
11	Cobalt					41.90	42
12	Coke oven emiss.						
13	Copper					257.5	578
14	1,2 Dichloroethane		101			794.80	896
15	Diethylhexyl phthalate						
16	Di-n-butyl phthalate						
17	Di-n-octyl phthalate						
18	Dioxins; 2378 Equiv						
19	Ethylbenzene		765			13,884	27,950
20	Fluoranthene	2.5E-01				167.6	167
21	Heptachlor						
22	Hexachlorobenzene						
23	Hexachlorobutadiene						
24	Hexachloroethane						
25	Lead					31.50	31
26	Alkylated Pb compounds						
27	Manganese & compounds					41.60	42
28	Mercury					1.43	1.43
29	Methoxychlor						
30	Methylene Chloride	72.7					34,741
31	Naphthalene	3.4	3824			8,959	15,691
32	Nickel & compounds					234.5	235
33	Parathion						
34	Pentachloronitrobenzene						
35	Pentachlorophenol						
36	phenol					160	4,497
37	PCBs	2.1E-02					2.10E-02
38	PCDDs					0.06	0.06
39	PCDFs					0.32	0.32
40	PAHs					10,015	10,015
41	POM				0.14	32	32
42	TCDD 2378	4.8E-05				2.8E-04	3.3E-04
43	TCDF 2378	6.0E-04				8.8E-03	9.4E-03
44	Tetrachloroethylene (PERC)	1.2E-01		35,900			38,748
45	Trichlorethene	0.426					39,584
46	111 trichloroethane	3.5					26,047
47	245 trichlorophenol						
48	246 trichlorophenol						
49	Trifluralin						

Table C-4: Summary; Kenosha, Milwaukee, and Racine County WI, Totals

	COMPOUND	Kenosha (pounds)	Milwaukee (pounds)	Racine (pounds)
1	Arsenic	114	397	3
2	Atrazine			
3	Benz(a)anthracene	15	41	21
4	Benzo(a)pyrene	84	222	120
5	Cadmium	3	84	3
6	Carbon tetrachloride	0.18	1.8	0.25
7	Chlordane			
8	Chromium	38	178	45
9	Chrome VI	0.64	516.86	0.92
10	Chrysene	141	391	201
11	Cobalt	90	240	42
12	Coke oven emiss.			
13	Copper	193	2,838	578
14	1,2 Dichloroethane	809	3,268	896
15	Diethylhexyl phthalate			
16	Di-n-butyl phthalate			
17	Di-n-octyl phthalate			
18	Dioxins; 2378 Equiv			
19	Ethylbenzene	12,391	76,666	27,950
20	Fluoranthene	118	323	167
21	Heptachlor			
22	Hexachlorobenzene			
23	Hexachlorobutadiene			
24	Hexachloroethane			
25	Lead	22	226	31
26	Alkylated Pb compounds			
27	Manganese & compounds	35	2,511	41
28	Mercury	0.99	150.44	1.43
29	Methoxychlor			
30	Methylene Chloride	777	98,304	34,741
31	Naphthalene	11,192	60,492	15,691
32	Nickel & compounds	388	4,072	235
33	Parathion			
34	Pentachloronitrobenzene			
35	Pentachlorophenol			
36	phenol	112	300	4,498
37	PCBs	1.51E-02	0.1	2.10E-023
38	PCDDs	0.03	0.05	
39	PCDFs	0.15	0.18	
40	PAHs	7,024	18,508	10,015
41	POM	41	172	58
42	TCDD 2378	2.10E-04	1.05E-03	3.3E-04
43	TCDF 2378	6.19E-03	2.03E-02	9.4E-03
44	Tetrachloroethylene (PERC)	20,833	204,280	38,748
45	Trichlorethene	6,680	25,437	39,584
46	111 trichloroethane	15,921	127,536	26,047
47	245 trichlorophenol			
48	246 trichlorophenol			
49	Trifluralin			

Appendix D: Index of SIC Codes

SIC	DESCRIPTION
01	Agricultural Production-crops
011	Cash Grains
0111	Wheat
0112	Rice
0115	Corn
0116	Soybeans
0119	Cash Grains Nec
0130	Field Crops, Except Cash Grains
0131	Cotton
0132	Tobacco
0133	Sugar Crops
0134	Irish Potatoes
0139	Field Crops Except Cash Grains
016	Vegetables and Melons
0161	Vegetables and Melons
017	Fruits and Tree Nuts
0171	Berry Crops
0172	Grapes
0173	Tree Nuts
0174	Citrus Fruits
0175	Deciduous Tree Fruits
0179	Fruits and Tree Nuts Nec
018	Horticultural Specialties
0181	Ornamental Nursery Products
0182	Food Crops Grown under Cover
0189	Horticultural Specialties Nec
019	General Farms, Primarily Crop
0191	General Farms Primarily Crop
02	Agricultural Production-livestock & Animal Special
021	Livestock, Except Dairy and Poultry
0211	Beef Cattle Feedlots
0212	Beef Cattle Except Feedlots
0213	Hogs
0214	Sheep and Goats
0219	General Livestock Nec
024	Dairy Farms
0241	Dairy Farms
025	Poultry and Eggs
0251	Broiler, Fryer, and Roaster Chickens
0252	Chicken Eggs
0253	Turkeys and Turkey Eggs
0254	Poultry Hatcheries
0259	Poultry and Eggs Nec
027	Animal Specialties
0271	Fur-bearing Animals and Rabbit
0272	Horses and Other Equines
0273	Animal Aquaculture
0279	Animal Specialties Nec
029	General Farms, Primarily Livestock and Animal Specialties
0291	Gen Farms Primarily Livestock
07	Agricultural Services

SIC	DESCRIPTION
071	Soil Preparation Services
0711	Soil Preparation Services
072	Crop Services
0721	Crop Planting and Protection
0722	Crop Harvesting
0723	Crop Prep Services for Market
0724	Cotton Ginning
0729	General Crop Services
074	Veterinary Services
0741	Veterinary Serv Farm Livestock
0742	Veterinary Serv Specialties
075	Animal Services, Except Veterinary
0751	Livestock Serv Exc Specialties
0752	Animal Specialty Services
076	Farm Labor and Management Services
0761	Farm Labor Contractors
0762	Farm Management Services
078	Landscape and Horticultural Services
0781	Landscape Counseling and Planning
0782	Lawn and Garden Services
0783	Ornamental Shrub and Tree Serv
08	Forestry
081	Timber Tracts
0811	Timber Tracts
0821	Forest Nurseries & Seed Gather
083	Forest Nurseries & Gathering of Forest Products
0831	Forest Products
0843	Extraction of Pine Gum
0849	Gathering of Forest Products
085	Forestry Services
0851	Forestry Services
09	Fishing, Hunting and Trapping
091	Commercial Fishing
0912	Finfish
0913	Shellfish
0919	Miscellaneous Marine Products
092	Fish Hatcheries and Preserves
0921	Fish Hatcheries and Preserves
097	Hunting, Trapping, & Game Propagation
0971	Hunting,trapping, & Game Propagation
10	Metal Mining
101	Iron Ores
1011	Iron Ores
102	Copper Ores
1021	Copper Ores
103	Lead and Zinc Ores
1031	Lead and Zinc Ores
104	Gold and Silver Ores
1041	Gold Ores
1044	Silver Ores
1051	Bauxite and Other Aluminum Ore
106	Ferroalloy Ores, Except Vanadium

SIC	DESCRIPTION
1061	Ferroalloy Ores Exc Vanadium
108	Metal Mining Services
1081	Metal Mining Services
109	Miscellaneous Metal Ores
1092	Mercury Ores
1094	Uranium-radium-vanadium Ores
1099	Metal Ores Nec
1111	Anthracite
1112	Anthracite Mining Services
12	Coal Mining
1211	Bituminous Coal and Lignite
1213	Bituminous & Lignite Mine Serv
122	Bituminous Coal and Lignite Mining
1221	Bituminous Coal & Lignite - Surface
1222	Bituminous Coal & Lignite - Underground
123	Anthracite Mining
1231	Anthracite Mining
124	Coal Mining Services
1241	Coal Mining Services
13	Oil and Gas Extraction
131	Crude Petroleum and Natural Gas
1311	Crude Petroleum & Natural Gas
132	Natural Gas Liquids
1321	Natural Gas Liquids
138	Oil and Gas Field Services
1381	Drilling Oil and Gas Wells
1382	Oil and Gas Exploration Service
1389	Oil and Gas Field Services Nec
14	Mining and Quarrying of Nonmetallic Minerals
141	Dimension Stone
1411	Dimension Stone
142	Crushed & Broken Stone, Including Riprap
1422	Crushed and Broken Limestone
1423	Crushed and Broken Granite
1429	Crushed and Broken Stone Nec
144	Sand and Gravel
1442	Construction Sand and Gravel
1446	Industrial Sand
145	Clay, Ceramic, and Refractory Minerals
1452	Bentonite
1453	Fire Clay
1454	Fullers Earth
1455	Kaolin and Ball Clay
1459	Clay and Related Minerals Nec
147	Chemical & Fertilizer Mineral Mining
1472	Barite
1473	Fluorspar
1474	Potash Soda & Borate Minerals
1475	Phosphate Rock
1476	Rock Salt
1477	Sulfur
1479	Chemical and Fertilizer Mining
148	Nonmetallic Minerals Services, Except Fuels
1481	Nonmetallic Minerals Services
149	Miscellaneous Nonmetallic Minerals, Except Fuels
1492	Gypsum
1496	Talc Soapstone & Pyrophyllite
1499	Nonmetallic Minerals, Nec
15	Building Construction-general Contractors & Bldrs

SIC	DESCRIPTION
152	Gen Building Contractors-residential Buildings
1521	Single-family Housing Construction
1522	Residential Construction Nec
153	Operative Builders
1531	Operative Builders
154	Gen Building Contractors-nonresidential Buildings
1541	Industrial Building/warehouses
1542	Nonresidential Construction Nec
16	Heavy Construction Other than Bldg Constr-contract
161	Highway & Street Construction, Except Elevated Highway
1611	Highway and Street Construction
162	Heavy Construction, Except Highway & Street Construction
1622	Bridge Tunnel & Elevated Hgwy
1623	Water Sewer and Utility Lines
1629	Heavy Construction Nec
17	Construction-special Trade Contractors
171	Plumbing, Heating, and Air-conditioning
1711	Plumbing Heating Air Condition
172	Ainting and Paper Hanging
1721	Painting and Paper Hanging
173	Electrical Work
1731	Electrical Work
174	Masonry, Stoneworks, Tile Setting, & Plastering
1741	Masonry and Other Stonework
1742	Plastering Drywall/insulation
1743	Terrazzo Tile Marble Mosaic Work
175	Carpentry and Floor Work
1751	Carpentry Work
1752	Floor Laying & Floor Work Nec
176	Roofing, Siding, and Sheet Metal Work
1761	Roofing and Sheet Metal Work
177	Concrete Work
1771	Concrete Work
178	Water Well Drilling
1781	Water Well Drilling
179	Misc Special Trade Contractors
1791	Structural Steel Erection
1793	Glass and Glazing Work
1794	Excavating and Foundation Work
1795	Wrecking and Demolition Work
1796	Installing Building Equipment
1799	Special Trade Contractors Nec
20	Food and Kindred Products
201	Meat Products
2011	Meat Packing Plants
2013	Sausages & Other Prepared Meat
2015	Poultry Slaughtering & Processing
2016	Poultry Dressing Plants
2017	Poultry and Egg Processing
202	Dairy Products
2021	Creamery Butter
2022	Cheese Natural and Processed
2023	Condensed and Evaporated Milk
2024	Ice Cream and Frozen Desserts
2026	Fluid Milk
203	Preserved Fruits and Vegetables

SIC	DESCRIPTION
2032	Canned Specialties
2033	Canned Fruits and Vegetables
2034	Dehydrated Fruits Vegs Soups
2035	Pickles Sauces and Salad Dress
2037	Frozen Fruits and Vegetables
2038	Frozen Specialties
204	Grain Mill Products
2041	Flour & Other Grain Mill Prod
2042	Grain Mill Products
2043	Cereal Breakfast Foods
2044	Rice Milling
2045	Blended and Prepared Flour
2046	Wet Corn Milling
2047	Dog Cat and Other Pet Food
2048	Prepared Feeds Nec
205	Bakery Products
2051	Bread Cake and Related Product
2052	Cookies and Crackers
2053	Frozen Bakery Products, Except Bread
206	Sugar and Confectionery Products
2061	Raw Cane Sugar
2062	Cane Sugar Refining
2063	Beet Sugar
2064	Candy and Other Confectionery Products
2065	Confectionery Products
2066	Chocolate and Cocoa Products
2067	Chewing Gum
2068	Salted and Roasted Nuts and Seeds
207	Fats and Oils
2074	Cottonseed Oil Mills
2075	Soybean Oil Mills
2076	Vegetable Oil Mills Nec
2077	Animal and Marine Fats and Oil
2079	Shortening and Cooking Oils
208	Beverages
2082	Malt Beverages
2083	Malt
2084	Wines Brandy & Brandy Spirits
2085	Distilled Liquor Except Brandy
2086	Bottled and Canned Soft Drinks
2087	Flavoring Extracts and Syrups,nec
209	Misc Food Preparations & Kindred Products
2091	Canned and Cured Seafoods
2092	Fresh or Frozen Packaged Fish
2095	Roasted Coffee
2096	Potato Chips and Similar Snacks
2097	Manufactured Ice
2098	Macaroni and Spaghetti
2099	Food Preparations Nec
21	Tobacco Products
211	Cigarettes
2111	Cigarettes
212	Cigars
2121	Cigars
213	Chewing and Smoking Tobacco and Snuff
2131	Chewing and Smoking Tobacco
214	Tobacco Stemming and Redrying
2141	Tobacco Stemming and Redrying
22	Textile Mill Products
221	Broadwoven Fabric Mills, Cotton
2211	Weaving Mills, Cotton

SIC	DESCRIPTION
222	Broadwoven Fabric Mills, Manmade Fiber & Silk
2221	Weaving Mills, Synthetics
223	Broadwoven Fabric Mills, Wool (Including Dyeing & Finishing)
2231	Weaving & Finishing Mills Wool
224	Narrow Fabric & Smallwares Mills: Cotton, Wool, Silk, & Manmade Fiber
2241	Narrow Fabric Mills
225	Knitting Mills
2251	Women's Hosiery, Except Socks
2252	Hosiery, Nec
2253	Knit Outerwear Mills
2254	Knit Underwear Mills
2257	Circular Knit Fabric Mills
2258	Warp Knit Fabric Mills
2259	Knitting Mills, Nec
226	Dyeing & Finishing Textiles, Except Wool Fabrics & Knit Goods
2261	Finishing Plants, Cotton
2262	Finishing Plants, Synthetics
2269	Finishing Plants, Nec
227	Carpets and Rugs
2271	Woven Carpets and Rugs
2272	Tufted Carpets and Rugs
2273	Carpets and Rugs
2279	Carpets and Rugs, Nec
228	Yarn and Thread Mills
2281	Yarn Mills, Except Wool
2282	Throwing and Winding Mills
2283	Wool Yarn Mills
2284	Thread Mills
229	Miscellaneous Textile Goods
2291	Felt Goods Exc Woven Felt/hats
2292	Lace Goods
2293	Padding & Upholstery Filling
2294	Processed Textile Waste
2295	Coated Fabrics, Not Rubberized
2296	Tire Cord and Fabric
2297	Nonwoven Fabrics
2298	Cordage and Twine
2299	Textile Goods, Nec
23	Apparel & Other Finished Products Made from Fabric
231	Men's and Boys' Suits, Coats, & Overcoats
2311	Men's and Boys' Suits and Coat
232	Men's & Boys' Furnishings, Work Clothing, & Allied Garments
2321	Men & Boys Shirts/nightwear
2322	Men's and Boy's Underwear
2323	Men's and Boys' Neckwear
2325	Men's and Boy's Trousers and Slacks
2326	Men's and Boy's Work Clothing
2327	Men & Boys Separate Trousers
2328	Men's and Boys' Work Clothing
2329	Men's and Boys' Clothing, Nec
233	Outerwear: Women, Misses, & Juniors
2331	Women's & Misses' Blouses & Shirts
2335	Women's and Misses' Dresses
2337	Women's & Misses Suits & Coats
2339	Women's & Misses Outerwear Nec

SIC	DESCRIPTION
234	Undergarments: Women, Misses, Childrens, & Infants
2341	Women's & Children's Underwear
2342	Brassieres and Allied Garments
235	Hats, Caps, and Millinery
2351	Millinery
2352	Hats & Caps Exc Millinery
2353	Hats, Caps and Millinery
236	Outerwear: Girls, Children, & Infants
2361	Children's Dresses and Blouses
2363	Children's Coats and Suits
2369	Children's Outerwear, Nec
237	Fur Goods
2371	Fur Goods
238	Miscellaneous Apparel & Accessories
2381	Fabric Dress and Work Gloves
2384	Robes and Dressing Gowns
2385	Waterproof Outergarments
2386	Leather & Sheep Lined Clothing
2387	Apparel Belts
2389	Apparel and Accessories, Nec
239	Misc Fabricated Textile Products
2391	Curtains and Draperies
2392	House Furnishings, Nec
2393	Textile Bags
2394	Canvas and Related Products
2395	Pleating and Stitching
2396	Automotive & Apparel Trimmings
2397	Schiffli Machine Embroideries
2399	Fabricated Textile Products
24	Lumber & Wood Products, Except Furniture
241	Logging
2411	Logging
242	Sawmills and Planing Mills
2421	Sawmills & Planing Mills General
2426	Hardwood Dimension & Flooring
2429	Special Product Sawmills, Nec
243	Millwork, Veneer, Plywood & Structural Members
2431	Millwork
2434	Wood Kitchen Cabinets
2435	Hardwood Veneer and Plywood
2436	Softwood Veneer and Plywood
2439	Structural Wood Members, Nec
244	Wood Containers
2441	Nailed Wood Boxes and Shook
2448	Wood Pallets and Skids
2449	Wood Containers, Nec
245	Wood Buildings and Mobile Homes
2451	Mobile Homes
2452	Prefabricated Wood Buildings
249	Miscellaneous Wood Products
2491	Wood Preserving
2492	Particleboard
2493	Reconstituted Wood Products
2499	Wood Products, Nec
25	Furniture and Fixtures
251	Household Furniture
2511	Wood Household Furniture
2512	Upholstered Household Furniture
2514	Metal Household Furniture
2515	Mattresses and Bedsprings

SIC DESCRIPTION

2517	Wood TV and Radio Cabinets
2519	Household Furniture, Nec
252	Office Furniture
2521	Wood Office Furniture
2522	Metal Office Furniture
253	Public Building & Related Furniture
2531	Public Building & Related Furniture
254	Partitions, Shelving, Lockers, & Office & Store Fixtures
2541	Wood Partitions and Fixtures
2542	Metal Partitions and Fixtures
259	Miscellaneous Furniture and Fixtures
2591	Drapery Hardware/blinds/shades
2599	Furniture and Fixtures, Nec
26	Paper and Allied Products
261	Pulp Mills
2611	Pulp Mills
262	Paper Mills
2621	Paper Mills Exc Building Paper
263	Paperboard Mills
2631	Paperboard Mills
2641	Paper Coating and Glazing
2642	Envelopes
2643	Bags, Except Textile Bags
2645	Die-cut Paper and Board
2646	Pressed and Molded Pulp Goods
2647	Sanitary Paper Products
2648	Stationery Products
2649	Converted Paper Products, Nec
265	Paperboard Containers and Boxes
2651	Folding Paperboard Boxes
2652	Set-up Paperboard Boxes
2653	Corrugated and Solid Fiber Box
2654	Sanitary Food Containers
2655	Fiber Cans Drums like Products
2656	Sanitary Food Containers
2657	Folding Paperboard Boxes
2661	Building Paper and Board Mills
267	Converted Paper & Paperboard Products, Except Containers & Boxes
2671	Paper Coated and Laminated Packaging
2672	Paper Coated and Laminated, Nec
2673	Bags: Plastics, Laminated and Coated
2674	Bags: Uncoated Paper and Multiwall
2675	Die-cut Paper and Board
2676	Sanitary Paper Products
2677	Envelopes
2678	Stationery Products
2679	Converted Paper Products, Nec
27	Printing, Publishing and Allied Industries
271	Newspapers: Publishing, or Publishing & Printing
2711	Newspapers
272	Periodicals: Publishing, or Publishing & Printing
2721	Periodicals
273	Books
2731	Book Publishing
2732	Book Printing
274	Miscellaneous Publishing
2741	Miscellaneous Publishing
275	Commercial Printing
SIC	**DESCRIPTION**

2751	Commercial Printing Letterpress
2752	Commercial Printing Lithograph
2753	Engraving and Plate Printing
2754	Commercial Printing, Gravure
2759	Commercial Printing, Nec
276	Manifold Business Forms
2761	Manifold Business Forms
277	Greeting Cards
2771	Greeting Card Publishing
278	Blankbooks, Looseleaf Binders, & Bookbinding & Related Work
2782	Blankbooks & Looseleaf Binders
2789	Bookbinding and Related Work
279	Service Industries for the Printing Trade
2791	Typesetting
2793	Photoengraving
2794	Electrotyping and Stereotyping
2795	Lithographic Platemaking Services
2796	Platemaking Services
28	Chemicals and Allied Products
281	Industrial Inorganic Chemicals
2812	Alkalies and Chlorine
2813	Industrial Gases
2816	Inorganic Pigments
2819	Industrial Inorganic Chemicals
282	Plastics Materials and Synthetics
2821	Plastics Materials and Resins
2822	Synthetic Rubber
2823	Cellulosic Man-made Fibers
2824	Organic Fibers, Noncellulosic
283	Drugs
2831	Biological Products
2833	Medicinals and Botanicals
2834	Pharmaceutical Preparations
2835	Diagnostic Substances
2836	Biological Products, Except Diagnostic
284	Soap, Cleaners, and Toilet Goods
2841	Soap and Other Detergents
2842	Polishes and Sanitation Goods
2843	Surface Active Agents
2844	Toilet Preparations
285	Paints, Varnishes, Lacquers, Enamels, & Allied Products
2851	Paints and Allied Products
286	Industrial Organic Chemicals
2861	Gum and Wood Chemicals
2865	Cyclic Crudes and Intermediate
2869	Industrial Organic Chemicals,nec
287	Agricultural Chemicals
2873	Nitrogenous Fertilizers
2874	Phosphatic Fertilizers
2875	Fertilizers, Mixing Only
2879	Agricultural Chemicals, Nec
289	Miscellaneous Chemical Products
2891	Adhesives and Sealants
2892	Explosives
2893	Printing Ink
2895	Carbon Black
2899	Chemical Preparations, Nec
29	Petroleum Refining and Related Industries
291	Petroleum Refining
2911	Petroleum Refining
SIC	**DESCRIPTION**

SIC	DESCRIPTION
295	Asphalt Paving and Roofing Materials
2951	Paving Mixtures and Blocks
2952	Asphalt Felts and Coatings
299	Misc Petroleum and Coal Products
2992	Lubricating Oils and Greases
2999	Petroleum and Coal Products, Nec
30	Rubber and Miscellaneous Plastics Products
301	Tires and Inner Tubes
3011	Tires and Inner Tubes
302	Rubber and Plastics Footwear
3021	Rubber and Plastics Footwear
3031	Reclaimed Rubber
3041	Rubber & Plastics Hose and Belting
305	Gaskets, Packing, Sealing Devices, & Rubber & Plastics Hose & Belting
3052	Rubber and Plastics Hose and Belting
3053	Gaskets, Packing and Sealing Devices
306	Fabricated Rubber Products, Nec
3061	Mechanical Rubber Goods
3069	Fabricated Rubber Products, Nec
3079	Miscellaneous Plastics Products
308	Miscellaneous Plastics Products, Nec
3081	Unsupported Plastics Film and Sheet
3082	Unsupported Plastics Profile Shapes
3083	Laminated Plastics Plate and Sheet
3084	Plastics Pipe
3085	Plastics Bottles
3086	Plastics Foam Products
3087	Custom Compound Purchased Resins
3088	Plastics Plumbing Fixtures
3089	Plastics Products, Nec
31	Leather and Leather Products
311	Leather Tanning and Finishing
3111	Leather Tanning and Finishing
313	Boot & Shoe Cut Stock & Findings
3131	Boot and Shoe Cut Stock and Findings
314	Footwear, Except Rubber
3142	House Slippers
3143	Men's Footwear, Except Athletic
3144	Women's Footwear, Except Athletic
3149	Footwear, Except Rubber, Nec
315	Leather Gloves and Mittens
3151	Leather Gloves and Mittens
316	Luggage
3161	Luggage
317	Handbags and Personal Leather Goods
3171	Women's Handbags and Purses
3172	Personal Leather Goods, Nec
319	Leather Goods, Nec
3199	Leather Goods, Nec
32	Stone, Clay, Glass and Concrete Products
321	Flat Glass
3211	Flat Glass
322	Glass and Glassware, Pressed or Blown
3221	Glass Containers
3229	Pressed and Blown Glass, Nec
323	Glass Products, Made of Purchased Glass
3231	Products of Purchased Glass
324	Cement, Hydraulic
3241	Cement, Hydraulic
325	Structural Clay Products
3251	Brick and Structural Clay Tile

SIC	DESCRIPTION
3253	Ceramic Wall and Floor Tile
3255	Clay Refractories
3259	Structural Clay Products, Nec
326	Pottery and Related Products
3261	Vitreous Plumbing Fixtures
3262	Vitreous China Food Utensils
3263	Fine Earthenware Food Utensils
3264	Porcelain Electrical Supplies
3269	Pottery Products, Nec
327	Concrete, Gypsum, and Plaster Products
3271	Concrete Block and Brick
3272	Concrete Products, Nec
3273	Ready-mixed Concrete
3274	Lime
3275	Gypsum Products
328	Cut Stone and Stone Products
3281	Cut Stone and Stone Products
329	Abrasive, Asbestos, & Misc Nonmetallic Mineral Products
3291	Abrasive Products
3292	Asbestos Products
3293	Gaskets/packing/sealing Device
3295	Minerals, Ground or Treated
3296	Mineral Wool
3297	Nonclay Refractories
3299	Nonmetallic Mineral Products
33	Primary Metal Industries
331	Steel Works, Blast Furnaces, & Rolling & Finishing Mills
3312	Blast Furnaces and Steel Mills
3313	Electrometallurgical Products
3315	Steel Wire and Related Products
3316	Cold Finishing of Steel Shapes
3317	Steel Pipe and Tubes
332	Iron and Steel Foundries
3321	Gray Iron Foundries
3322	Malleable Iron Foundries
3324	Steel Investment Foundries
3325	Steel Foundries, Nec
333	Primary Smelting & Refining of Nonferrous Metals
3331	Primary Copper
3332	Primary Lead
3333	Primary Zinc
3334	Primary Aluminum
3339	Primary Nonferrous Metals, Nec
334	Secondary Smelting & Refining of Nonferrous Metals
3341	Secondary Nonferrous Metals
335	Rolling, Drawing, & Extruding of Nonferrous Metals
3351	Copper Rolling and Drawing
3353	Aluminum Sheet Plate & Foil
3354	Aluminum Extruded Products
3355	Aluminum Rolling & Drawing Nec
3356	Nonferrous Rolling and Drawing
3357	Nonferrous Wire Drawing/insulating
336	Nonferrous Foundries (Castings)
3361	Aluminum Foundries
3362	Brass Bronze & Copper Foundry
3363	Aluminum Die-castings
3364	Nonferrous Die-castings, Except Aluminum

SIC	DESCRIPTION
3365	Aluminum Foundries
3366	Copper Foundries
3369	Nonferrous Foundries, Nec
339	Miscellaneous Primary Metal Products
3398	Metal Heat Treating
3399	Primary Metal Products, Nec
34	Fabricated Metal Products, Except Machinery & Tran
341	Metal Cans and Shipping Containers
3411	Metal Cans
3412	Metal Barrels, Drums & Pails
342	Cutlery, Handtools, and General Hardware
3421	Cutlery
3423	Hand and Edge Tools, Nec
3425	Hand Saws and Saw Blades
3429	Hardware, Nec
343	Heating Equipment, Except Electric & Warm Air; & Plumbing Fixtures
3431	Metal Sanitary Ware
3432	Plumbing Fittings & Brass Good
3433	Heating Equipment, Except Elec
344	Fabricated Structural Metal Products
3441	Fabricated Structural Metal
3442	Metal Doors, Sash, and Trim
3443	Fabricated Plate Work (Boiler Shops)
3444	Sheet Metal Work
3446	Architectural Metal Work
3448	Prefabricated Metal Buildings
3449	Miscellaneous Metal Work
345	Screw Machine Products, Bolts, Nuts, Screws, Rivets, and Washers
3451	Screw Machine Products
3452	Bolts Nuts Rivets & Washers
346	Metal Forgings and Stampings
3462	Iron and Steel Forgings
3463	Nonferrous Forgings
3465	Automotive Stampings
3466	Crowns and Closures
3469	Metal Stampings, Nec
347	Coating, Engraving, and Allied Services
3471	Electroplating,polishing,anodizing, and Coloring
3479	Metal Coating and Allied Services,nec
348	Ordnance and Accessories, Except Vehicles and Guided Missiles
3482	Small Arms Ammunition
3483	Ammunition, Exc. For Small Arm
3484	Small Arms
3489	Ordnance and Accessories, Nec
349	Misc Fabricated Metal Products
3491	Industrial Valves
3492	Fluid Power Valves and Hose Fittings
3493	Steel Springs, Except Wire
3494	Valves and Pipe Fittings
3495	Wire Springs
3496	Misc. Fabricated Wire Products
3497	Metal Foil and Leaf
3498	Fabricated Pipe and Fittings
3499	Fabricated Metal Products, Nec
35	Industrial and Commercial Machinery & Computer Equ
351	Engines and Turbines

SIC	DESCRIPTION
3511	Turbines and Turbine Generator
3519	Nternal Combustion Engines
352	Farm and Garden Machinery and Equipment
3523	Farm Machinery and Equipment
3524	Lawn and Garden Equipment
353	Construction, Mining, and Materials Handling Machinery & Equipment
3531	Construction Machinery
3532	Mining Machinery
3533	Oil Field Machinery
3534	Elevators and Moving Stairways
3535	Conveyors and Conveying Equipment
3536	Hoists, Cranes, and Monorails
3537	Industrial Trucks and Tractors
354	Metalworking Machinery and Equipment
3541	Machine Tools Metal Cutting Types
3542	Machine Tools Metal Forming Types
3543	Industrial Patterns
3544	Special Dies/tools/jigs/fixtures
3545	Machine Tool Accessories
3546	Power Driven Hand Tools
3547	Rolling Mill Machinery
3548	Welding Apparatus
3549	Metalworking Machinery, Nec
355	Special Industry Machinery, Except Metalworking Machinery
3551	Food Products Machinery
3552	Textile Machinery
3553	Woodworking Machinery
3554	Paper Industries Machinery
3555	Printing Trades Machinery
3556	Food Products Machinery
3559	Special Industry Machinery Nec
356	General Industrial Machinery and Equipment
3561	Pumps and Pumping Equipment
3562	Ball and Roller Bearings
3563	Air and Gas Compressors
3564	Blowers and Fans
3565	Packaging Machinery
3566	Speed Changers Drives & Gears
3567	Industrial Furnaces and Ovens
3568	Power Transmission Equipment
3569	Gen Industrial Machinery, Nec
357	Computer and Office Equipment
3571	Electronic Computers
3572	Computer Storage Devices
3573	Electronic Computing Equipment
3574	Calculating & Accounting Mach
3575	Computer Terminals
3576	Scales & Balances Exc Lab
3577	Computer Peripheral Equipment, Nec
3578	Calculating and Accounting Equipment
3579	Office Machines, Nec
358	Refrigeration & Service Industry Machinery
3581	Automatic Vending Machines
3582	Commercial Laundry Equipment
3585	Refrigeration & Heating Equipment
3586	Measuring and Dispensing Pumps
3589	Service Industry Machinery Nec
359	Misc Industrial & Commercial Machinery and Equipment

3592	Carburetors, Pistons, Rings, & Valves
3593	Fluid Power Cylinders and Actuators
3594	Fluid Power Pumps and Motors
3596	Scales and Balances, Except Laboratory
3599	Machinery Exc Electrical Nec
36	Electronic & Other Electrical Equipment & Components
361	Electric Transmission and Distribution Equipment
3612	Transformers
3613	Switchgear & Switchboard Apparatus
362	Electrical Industrial Apparatus
3621	Motors and Generators
3622	Industrial Controls
3623	Welding Apparatus, Electric
3624	Carbon and Graphite Products
3625	Relays and Industrial Controls
3629	Elec Industrial Apparatus, Nec
363	Household Appliances
3631	Household Cooking Equipment
3632	Household Refrigerators/freezers
3633	Household Laundry Equipment
3634	Electric Housewares and Fans
3635	Household Vacuum Cleaners
3636	Sewing Machines
3639	Household Appliances, Nec
364	Electric Lighting and Wiring Equipment
3641	Electric Lamps
3643	Current-carrying Wiring Device
3644	Noncurrent-carrying Wiring Devices
3645	Residential Lighting Fixtures
3646	Commercial Lighting Fixtures
3647	Vehicular Lighting Equipment
3648	Lighting Equipment, Nec
365	Household Audio and Video Equipment, and Audio Recordings
3651	Radio and TV Receiving Sets
3652	Phonograph Records
366	Communications Equipment
3661	Telephone/telegraph Apparatus
3662	Radio & TV Communication Equipment
3663	Radio and TV Communications Equipment
3669	Communications Equipment, Nec
367	Electronic Components and Accessories
3671	Electron Tubes, Receiving Type
3672	Printed Circuit Boards
3673	Electron Tubes, Transmitting
3674	Semiconductors & Related Devices
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils & Transformer
3678	Electronic Connectors
3679	Electronic Components, Nec
369	Misc Electrical Machinery, Equipment, and Supplies
3691	Storage Batteries
3692	Primary Batteries, Dry and Wet
3693	X-ray Apparatus and Tubes
3694	Engine Electrical Equipment
3695	Magnetic and Optical Recording Media
3699	Electrical Equipment & Supply
37	Transportation Equipment
SIC	**DESCRIPTION**

371	Motor Vehicles & Motor Vehicle Equipment
3711	Motor Vehicles and Car Bodies
3713	Truck and Bus Bodies
3714	Motor Vehicle Parts & Accessories
3715	Truck Trailers
3716	Motor Homes
372	Aircraft and Parts
3721	Aircraft
3724	Aircraft Engines & Engine Part
3728	Aircraft Equipment, Nec
373	Ship and Boat Building and Repairing
3731	Ship Building and Repairing
3732	Boat Building and Repairing
374	Railroad Equipment
3743	Railroad Equipment
375	Motorcycles, Bicycles, and Parts
3751	Motorcycles Bicycles & Parts
376	Guided Missiles and Space Vehicles and Parts
3761	Guided Missiles and Space Vehicles
3764	Missile/space Propulsion Units & Parts
3769	Space Vehicle Equipment, Nec
379	Miscellaneous Transportation Equipment
3792	Travel Trailers and Campers
3795	Tanks and Tank Components
3799	Transportation Equipment, Nec.
38	Measuring, Analyzing & Controlling Instruments
381	Search and Navigation Equipment
3811	Engineering & Scientific Instruments
3812	Search and Navigation Equipment
382	Lab Apparatus, Analytical, Optical, Measure,&control Instruments
3821	Laboratory Apparatus and Furniture
3822	Environmental Controls
3823	Process Control Instruments
3824	Fluid Meters & Counting Device
3825	Instruments to Measure Elec
3826	Analytical Instruments
3827	Optical Instruments and Lenses
3829	Measuring & Controlling Device
3832	Optical Instruments and Lenses
384	Surgical, Medical, Dental Instruments & Supplies
3841	Surgical & Medical Instruments
3842	Surgical Appliances & Supplies
3843	Dental Equipment and Supplies
3844	X-ray Apparatus and Tubes
3845	Electromedical Equipment
385	Ophthalmic Goods
3851	Ophthalmic Goods
386	Photographic Equipment and Supplies
3861	Photograph Equipment & Supplies
387	Watches, Clocks, Clockwork Operated Devices, & Parts
3873	Watches Clocks & Watchcases
39	Miscellaneous Manufacturing Industries
391	Jewelry, Silverware, and Plated Ware
3911	Jewelry, Precious Metal
3914	Silverware and Plated Ware
3915	Jewelers' Materials & Lapidary
393	Musical Instruments
SIC	**DESCRIPTION**

SIC	DESCRIPTION
3931	Musical Instruments
394	Dolls, Toys, Games and Sporting and Athletic Goods
3942	Dolls
3944	Games/toys/children's Vehicles
3949	Sporting & Athletic Goods Nec
395	Pens, Pencils, and Other Artists' Materials
3951	Pens and Mechanical Pencils
3952	Lead Pencils and Art Goods
3953	Marking Devices
3955	Carbon Paper and Inked Ribbons
396	Costume Jewelry and Notions, Except Precious Metal
3961	Costume Jewelry
3962	Artificial Flowers
3963	Buttons
3964	Needles, Pins, and Fasteners
3965	Fasteners, Buttons, Needles and Pins
399	Miscellaneous Manufacturing Industries
3991	Brooms and Brushes
3993	Signs and Advertising Displays
3995	Burial Caskets
3996	Hard Surface Floor Coverings
3999	Manufacturing Industries, Nec
40	Railroad Transportation
401	Railroads
4011	Railroads, Line-haul Operating
4013	Switching & Terminal Services
4041	Railway Express Service
41	Local & Suburban Transit & Interurban Highway Pass
411	Local and Suburban Passenger Transportation
4111	Local and Suburban Transit
4119	Local Passenger Transportation
412	Taxicabs
4121	Taxicabs
413	Intercity and Rural Bus Transportation
4131	Intercity Hgwy Transportation
414	Bus Charter Service
4141	Local Passenger Charter Service
4142	Charter Service, Except Local
415	School Buses
4151	School Buses
417	Terminal & Service Facilities: Motor Vehicle Passenger Transportation
4171	Bus Terminal Facilities
4172	Bus Service Facilities
4173	Bus Terminal and Service Facilities
42	Motor Freight Transportation and Warehousing
421	Trucking and Courier Services, Except Air
4212	Local/trucking Without Storage
4213	Trucking, Except Local
4214	Local Trucking and Storage
4215	Courier Services, Except by Air
422	Public Warehousing and Storage
4221	Farm Product Warehousing/store
4222	Refrigerated Warehousing
4224	Household Goods Warehousing
4225	General Warehousing & Storage
4226	Special Warehousing & Storage
423	Terminal & Joint Terminal Maintenance Facilities: Motor Freight Trans
4231	Trucking Terminal Facilities
43	United States Postal Service
431	Unite States Postal Service
4311	United States Postal Service
44	Water Transportation
441	Deep Sea Foreign Transportation of Freight
4411	Deep Sea Foreign Transportation
4412	Deep Sea Foreign Transportation of Freight
442	Deep Sea Domestic Transportation of Freight
4421	Noncontiguous Area Transportation
4422	Coastwise Transportation
4423	Intracoastal Transportation
4424	Deep Sea Domestic Transportation of Freight
443	Freight Transportation on the Great Lakes-st Lawrence Seaway
4431	Great Lakes Transportation
4432	Freight Transportation on the Great Lakes
444	Water Transportation of Freight, Nec
4441	Transport on Rivers & Canals
4449	Water Transportation of Freight, Nec
4452	Ferries
4453	Lighterage
4454	Towing and Tugboat Service
4459	Local Water Transportation Nec
4463	Marine Cargo Handling
4464	Canal Operation
4469	Water Transportation Services
448	Water Transportation of Passengers
4481	Deep Sea Passenger Transportation, Except by Ferry
4482	Ferries
4489	Water Passenger Transportation, Nec
449	Water Transportation Services
4491	Marine Cargo Handling
4492	Towing and Tug Boat Service
4493	Marinas
4499	Water Transportation Services, Nec
45	Transportation by Air
451	Air Transportation, Scheduled, & Air Courier Services
4511	Certificated Air Transportation
4512	Air Transportation, Scheduled
4513	Air Courier Services
452	Air Transportation, Nonscheduled
4521	Noncertified Air Transportation
4522	Air Transportation, Non-scheduled
458	Airports, Flying Fields, and Airport Terminal Services
4581	Airports, Flying Fields, and Services
4582	Airports and Flying Fields
4583	Airport Terminal Services
46	Pipelines, Except Natural Gas
461	Pipelines, Except Natural Gas
4612	Crude Petroleum Pipe Lines
4613	Refined Petroleum Pipe Lines
4619	Pipe Lines, Nec
47	Transportation Services
4712	Freight Forwarding
472	Passenger Transportation Arrangement
4722	Passenger Transport Arrangement

SIC DESCRIPTION

4723	Freight Transport Arrangement
4724	Travel Agencies
4725	Tour Operators
4729	Passenger Transport Management, Nec
473	Freight and Cargo Transportation Arrangement
4731	Freight Transportation Management
474	Rental of Railroad Cars
4741	Rental of Railroad Cars
4742	Railroad Car Rental with Serv
4743	Railroad Rental Car W/o Serv
478	Miscellaneous Transportation Services
4782	Inspection & Weighing Services
4783	Packing and Crating
4784	Fixed Facilities for Vehicles
4785	Inspection and Fixed Facilities
4789	Transportation Services, Nec
48	Communications
481	Telephone Communications
4811	Telephone Communication
4812	Radio Telephone Communications
4813	Telephone Communications, Except Radio
482	Telegraph and Other Message Communications
4821	Telegraph Communication
4822	Telegraph and Other Communications
483	Radio & Television Broadcasting Stations
4832	Radio Broadcasting
4833	Television Broadcasting
484	Cable and Other Pay Television Services
4841	Cable and Other Pay TV Services
489	Communications Services, Nec
4899	Communication Services, Nec
49	Electric, Gas and Sanitary Services
491	Electric Services
4911	Electric Services
492	Gas Production and Distribution
4922	Natural Gas Transmission
4923	Gas Transmission and Distribution
4924	Natural Gas Distribution
4925	Gas Production/distribution
493	Combination Electric, Gas, and Other Utility Services
4931	Elec & Other Services Combined
4932	Gas & Other Services Combined
4939	Combination Utility Services
494	Water Supply
4941	Water Supply
4950	Sanitary Services
4952	Sewerage Systems
4953	Refuse Systems
4959	Sanitary Services, Nec
496	Steam and Air-conditioning Supply
4961	Steam Supply
497	Irrigation Systems
4971	Irrigation Systems
50	Wholesale Trade-durable Goods
501	Motor Vehicles, Parts, and Supplies
5012	Autos & Other Motor Vehicles
5013	Automotive Parts and Supplies
5014	Tires and Tubes
5015	Motor Vehicle Parts, Used
SIC	**DESCRIPTION**

502	Furniture and Homefurnishings
5021	Furniture
5023	Home Furnishings
503	Lumber and Construction Materials
5031	Lumber, Plywood and Millwork
5032	Brick, Stove, and Related Materials
5033	Roofing, Siding and Insulation
5039	Construction Materials, Nec
504	Professional and Commercial Equipment and Supplies
5041	Sporting & Recreational Goods
5042	Toys & Hobby Goods and Supplies
5043	Photograph Equipment & Supply
5044	Office Equipment
5045	Computers, Peripherals, and Software
5046	Commercial Equipment, Nec
5047	Medical and Hospital Equipment
5048	Ophthalmic Goods
5049	Professional Equipment, Nec
505	Metals and Minerals, Except Petroleum
5051	Metals Serv Centers & Offices
5052	Coal & Other Minerals & Ores
506	Electrical Goods
5063	Elec Apparatus & Equipment
5064	Elec Appliances TV & Radios
5065	Electronic Parts and Equipment
507	Hardware, Plumbing, Heating Equipment and Supplies
5072	Hardware
5074	Plumbing/hydronics Heat Supply
5075	Warm Air Heat & Air Condition
5078	Refrigeration Equip & Supplies
508	Machinery, Equipment, and Supplies
5081	Commercial Machines & Equipment
5086	Professional Equipment & Supplies
5087	Service Establishment Equipment
5088	Transportation Equipment & Sup
509	Miscellaneous Durable Goods
5091	Sporting and Recreational Goods
5092	Toys and Hobby Goods and Supplies
5093	Scrap and Waste Materials
5094	Jewelry, Watches, & Precious Stones
5099	Durable Goods, Nec
51	Wholesale Trade-nondurable Goods
511	Paper and Paper Products
5111	Printing and Writing Paper
5112	Stationery Supplies
5113	Industrial & Personal Service
512	Drugs, Drug Proprietaries, & Druggists' Sundries
5122	Drugs, Proprietaries, and Sundries
513	Apparel, Piece Goods, and Notions
5131	Piece Goods and Notions
5133	Piece Goods
5134	Notions and Other Dry Goods
5136	Men's Clothing and Furnishings
5137	Women's and Children's Clothing
5139	Footwear
514	Groceries and Related Products
5141	Groceries, General Line
5142	Frozen Foods
5143	Dairy Products
SIC	**DESCRIPTION**

5144	Poultry and Poultry Products
5145	Confectionery
5146	Fish and Seafoods
5147	Meats and Meat Products
5148	Fresh Fruits and Vegetables
5149	Groceries and Related Products
515	Farm-product Raw Materials
5152	Cotton
5153	Grain
5154	Livestock
5159	Farm-product Raw Materials, Nec
516	Chemicals and Allied Products
5161	Chemicals and Allied Products
5162	Plastics Materials and Basic Shapes
5169	Chemicals and Allied Products, Nec
517	Petroleum and Petroleum Products
5171	Petroleum Bulk Stations & Terminals
5172	Petroleum Products, Nec
518	Beer, Wine, and Distilled Alcoholic Beverages
5181	Beer and Ale
5182	Wines and Distilled Beverages
519	Misc Nondurable Goods
5191	Farm Supplies
5192	Books, Periodicals and Newspapers
5193	Flowers and Florists Supplies
5194	Tobacco and Tobacco Products
5198	Paints, Varnishes, and Supplies
5199	Nondurable Goods, Nec
52	Building Materials, Hardware, Garden Supply, Mobil
521	Lumber and Other Building Materials Dealers
5211	Lumber and Other Building Materials
523	Paint, Glass, and Wallpaper Stores
5231	Paint, Glass, and Wallpaper Stores
525	Hardware Stores
5251	Hardware Stores
526	Retail Nurseries, Lawn & Garden Supply Stores
5261	Retail Nurseries and Garden Stores
527	Mobile Home Dealers
5271	Mobile Home Dealers
53	General Merchandise Stores
531	Department Stores
5311	Department Stores
533	Variety Stores
5331	Variety Stores
539	Misc. General Merchandise Stor
5399	Misc. General Merchandise Stores
54	Food Stores
541	Grocery Stores
5411	Grocery Stores
542	Meat and Seafood Markets, Including Freezer Provisioners
5421	Meat and Fish Markets
5422	Freezer and Locker Meat Provisions
5423	Meat and Fish (Seafood) Market
543	Fruit and Vegetable Markets
5431	Fruit Stores and Vegetable Markets
544	Candy, Nut, and Confectionery Stores
5441	Candy, Nut, and Confectionery

SIC	DESCRIPTION
545	Dairy Products Stores

5451	Dairy Products Stores
546	Retail Bakeries
5461	Retail Bakeries
5462	Retail Bakeries-baking and Selling
5463	Retail Bakeries-selling Only
5490	Miscellaneous Food Stores
5499	Miscellaneous Food Stores
55	Automotive Dealers and Gasoline Service Stations
551	Motor Vehicle Dealers (New & Used)
5511	New and Used Car Dealers
552	Motor Vehicle Dealers (Used Only)
5521	Used Car Dealers
553	Auto and Home Supply Stores
5531	Auto and Home Supply Stores
554	Gasoline Service Stations
5541	Gasoline Service Stations
555	Boat Dealers
5551	Boat Dealers
556	Recreational Vehicle Dealers
5561	Recreational Vehicle Dealers
557	Motorcycle Dealers
5571	Motorcycle Dealers
559	Automotive Dealer, Nec
5599	Automotive Dealers, Nec
56	Apparel and Accessory Stores
561	Men's & Boys' Clothing & Accessory Stores
5611	Men's & Boys' Clothing & Accessory Stores
562	Women's Clothing Stores
5621	Women's Ready-to-wear Stores
563	Women's Accessory & Specialty Stores
5631	Women's Accessory and Specialty Stores
5632	Women's Accessory and Specialty Stores
564	Children's & Infants' Wear Stores
5641	Children's and Infants' Wear Stores
565	Family Clothing Stores
5651	Family Clothing Stores
566	Shoe Stores
5661	Shoe Stores
5681	Furriers and Fur Shops
569	Misc Apparel & Accessory Stores
5699	Miscellaneous Apparel & Access
57	Home Furniture, Furnishings & Equipment Stores
571	Home Furniture & Furnishings Stores
5712	Furniture Stores
5713	Floor Covering Stores
5714	Drapery and Upholstery Stores
5719	Misc Home Furnishings Stores
572	Household Appliance Stores
5722	Household Appliance Stores
573	Radio, Television, Consumer Electronics, and Music Stores
5731	Radio, Television and Electronic Stores
5732	Radio and Television Stores
5733	Music Stores
5734	Computer and Software Stores
5735	Record and Prerecorded Tape Stores
5736	Musical Instrument Stores
58	Eating and Drinking Places
581	Eating and Drinking Places

SIC	DESCRIPTION
5812	Eating Places

5813	Drinking Places
59	Miscellaneous Retail
591	Drug Stores and Proprietary Stores
5912	Drug Stores and Proprietary Stores
592	Liquor Stores
5921	Liquor Stores
593	Used Merchandise Stores
5931	Used Merchandise Stores
5932	Used Merchandise Stores
594	Misc Shopping Goods Stores
5941	Sporting Goods and Bicycle Shops
5942	Book Stores
5943	Stationery Stores
5944	Jewelry Stores
5945	Hobby, Toy, and Game Shops
5946	Camera & Photographic Supply Stores
5947	Gift, Novelty, and Souvenir Shops
5948	Luggage and Leather Goods Stor
5949	Sewing, Needlework, and Piece Goods Stores
596	Nonstore Retailers
5961	Mail Order Houses
5962	Merchandising Machine Operator
5963	Direct Selling Organizations
598	Fuel Dealers
5982	Fuel and Ice Dealers, Nec
5983	Fuel Oil Dealers
5984	Liquefied Petroleum Gas Dealers
5989	Fuel Dealers, Nec
599	Retail Stores, Nec
5992	Florists
5993	Cigar Stores and Stands
5994	News Dealers and Newsstands
5995	Optical Goods Stores
5999	Miscellaneous Retail Stores, N
60	Depository Institutions
601	Central Reserve Depository Institutions
6011	Federal Reserve Banks
6019	Central Reserve Depository, Nec
602	Commercial Banks
6021	National Commercial Banks
6022	State Banks, Federal Reserve
6023	State Banks, Not Fed. Reserve,
6024	State Banks, Not Fed Res., Not
6025	National Banks, Federal Reserve
6026	National Banks, Not Fed. Res.,
6027	National Banks, Not Fdic
6028	Private Banks, Not Incorp., No
6029	Commercial Banks, Nec
603	Savings Institutions
6032	Mutual Savings Banks, Federal
6033	Mutual Savings Banks, Nec
6034	Mutual Savings Banks, Not Fdic
6035	Federal Savings Institutions
6036	Savings Institutions, Except Federal
6042	Nondeposit Trusts, Federal Res
6044	Nondeposit Trusts, Not Fdic
6052	Foreign Exchange Establishment
6054	Safe Deposit Companies
6055	Clearinghouse Associations
6056	Corporations for Banking Abroad

SIC	DESCRIPTION
6059	Functions Related to Banking,

606	Credit Unions
6061	Federal Credit Unions
6062	State Credit Unions
608	Foreign Banking and Branches & Agencies of Foreign Banks
6081	Foreign Bank and Branches and Agencies
6082	Foreign Trade and International Banks
609	Depository Banking Functions
6091	Nondeposit Trust Facilities
6099	Functions Related to Deposit Banking
61	Nondepository Credit Institutions
611	Federal & Federally-sponsored Credit Agencies
6111	Federal and Federally-sponsored Credit
6112	Rediscounting, Not for Agriculture
6113	Rediscounting, for Agriculture
6122	Federal Saving & Loan Associations
6123	State Associations, Insured
6124	State Associations, Noninsured
6125	State Associations, Noninsured
6131	Agricultural Credit Institutions
614	Personal Credit Institutions
6141	Personal Credit Institutions
6142	Federal Credit Unions
6143	State Credit Unions
6144	Nondeposit Industrial Loan Companies
6145	Licensed Small Loan Lenders
6146	Installment Sales Finance Companies
6149	Misc. Personal Credit Institutions
615	Business Credit Institutions
6153	Short-term Business Credit
6159	Misc Business Credit Institute
616	Mortgage Bankers and Brokers
6162	Mortgage Bankers and Correspondents
6163	Loan Brokers
62	Security & Commodity Brokers, Dealers, Exchanges
621	Security Brokers, Dealers, & Flotation Companies
6211	Security Brokers and Dealers
622	Commodity Contracts Brokers & Dealers
6221	Commodity Contracts Brokers, Dealers
623	Security and Commodity Exchanges
6231	Security and Commodity Exchanges
628	Exchange of Security and Commodity Services
6281	Security and Commodity Service
6282	Investment Advice
6289	Security and Commodity Services, Nec
63	Insurance Carriers
631	Life Insurance
6311	Life Insurance
632	Accident & Health Insurance & Medical Service Plans
6321	Accident and Health Insurance
6324	Hospital and Medical Service Plans
633	Fire, Marine, and Casualty Insurance
6331	Fire, Marine, and Casualty Ins
635	Surety Insurance
6351	Surety Insurance
636	Title Insurance

SIC	DESCRIPTION
6361	Title Insurance

637	Pension, Health, and Welfare Funds
6371	Pension, Health, and Welfare Funds
639	Insurance Carriers, Nec
6399	Insurance Carriers, Nec
64	Insurance Agents, Brokers and Service
641	Insurance Agents, Brokers, and Service
6411	Insurance Agents, Brokers & Service
65	Real Estate
651	Real Estate Operators (Exceptrvice Developers) & Lessors
6512	Nonresidential Building Operators
6513	Apartment Building Operators
6514	Dwelling Operators, Exc. Apart
6515	Mobile Home Site Operators
6517	Railroad Property Lessors
6519	Real Property Lessors, Nec
653	Real Estate Agents and Managers
6531	Real Estate Agents and Manager
654	Title Abstract Offices
6541	Title Abstract Offices
655	Land Subdividers and Developers
6552	Subdividers & Developers, Exc Cemeteries
6553	Cemetery Subdividers and Developers
6611	Combined Real Estate, Insurance
67	Holding and Other Investment Offices
671	Holding Offices
6711	Holding Offices
6712	Bank Holding Companies
6719	Holding Companies, Nec
672	Investment Offices
6722	Management Investment, Open-end
6723	Management Investment, Closed-end
6724	Unit Investment Trusts
6725	Face-amount Certificate Offices
6726	Investment Offices, Nec
673	Trusts
6732	Educational, Religious, Etc. T
6733	Trusts, Nec
679	Miscellaneous Investing
6792	Oil Royalty Traders
6793	Commodity Traders
6794	Patent Owners and Lessors
6798	Real Estate Investment Trusts
6799	Investors, Nec
70	Hotels, Rooming Houses, Camps & Other Lodging Plac
701	Hotels and Motels
7011	Hotels and Motels
702	Rooming and Boarding Houses
7021	Rooming and Boarding Houses
703	Camps and Recreational Vehicle Parks
7032	Sporting and Recreational Camp
7033	Recreational Vehicle Parks and Campsites
704	Membership-basis: Organization Hotels & Lodging Houses
7041	Membership-basis Organization
72	Personal Services
721	Laundry, Cleaning, and Garment Services
7211	Power Laundries, Family & Commercial
7212	Garment Pressing & Cleaners' Agents
7213	Linen Supply
7215	Coin-operated Laundries and Drycleaning
7216	Dry Cleaning Plants, Except Rugs
7217	Carpet and Upholstery Cleaning
7218	Industrial Launderers
7219	Laundry and Garment Services,
722	Photographic Studios, Portrait
7221	Photographic Studios, Portrait
723	Beauty Shops
7231	Beauty Shops
724	Barber Shops
7241	Barber Shops
725	Shoe Repair and Shoeshine Parlors
7251	Shoe Repair Shops and Shoeshine Parlors
726	Funeral Service and Crematories
7261	Funeral Service and Crematories
729	Miscellaneous Personal Services
7291	Tax Return Preparation Services
7299	Miscellaneous Personal Service
73	Business Services
731	Advertising
7311	Advertising Agencies
7312	Outdoor Advertising Services
7313	Radio, TV, Publisher Advertising Representatives
7319	Advertising, Nec
732	Credit & Mercantile Reporting, Adjustment & Collection Agencies
7321	Credit Reporting and Collection
7322	Adjustment and Collection Services
7323	Credit Reporting Services
733	Mailing,reproduction,commercial Art, Photography, & Steno Services
7331	Direct Mail Advertising Service
7332	Blueprinting and Photocopying
7333	Commercial Photography and Art
7334	Photocopying and Duplicating Services
7335	Commercial Photography
7336	Commercial Art and Graphic Design
7338	Secretarial and Court Reporting
7339	Stenographic and Reproduction,nec
734	Services to Dwellings & Othernec Buildings
7341	Window Cleaning
7342	Disinfecting and Exterminating
7349	Building Maintenance Services,
735	Misc Equipment Rental & Leasing
7351	News Syndicates
7352	Medical Equipment Rental
7353	Heavy Construction Equipment Rental
7359	Equipment Rental and Leasing, Nec
736	Personnel Supply Services
7361	Employment Agencies
7362	Temporary Help Supply Services
7363	Help Supply Services
7369	Personnel Supply Services, Nec
737	Computer and Data Processing Services
7371	Custom Computer Programming Services
7372	Prepackaged Software
7373	Computer Integrated Systems Design
7374	Data Processing Services
7375	Information Retrieval Services
SIC	**DESCRIPTION**
SIC	**DESCRIPTION**
7214	Diaper Service

SIC	DESCRIPTION
7376	Computer Facilities Management
7377	Computer Rental and Leasing
7378	Computer Maintenance and Repair
7379	Computer Related Services, Nec
738	Miscellaneous Business Services
7381	Detective and Armored Car Services
7382	Security Systems Services
7383	News Syndicate
7384	Photofinishing Laboratories
7389	Business Services, Nec
7391	Research & Development Laboratories
7392	Management and Public Relations
7393	Detective and Protective Services
7394	Equipment Rental and Leasing
7395	Photofinishing Laboratories
7396	Trading Stamp Services
7397	Commercial Testing Laboratories
7399	Business Services, Nec
75	Automotive Repair, Services & Parking
751	Automotive Rental and Leasing, Without Drivers
7512	Passenger Car Rental and Leasing
7513	Truck Rental and Leasing
7514	Passenger Car Rental
7515	Passenger Car Leasing
7519	Utility Trailer Rental
752	Automobile Parking
7521	Automobile Parking
7523	Parking Lots
7525	Parking Structures
753	Automotive Repair Shops
7531	Top and Body Repair Shops
7532	Top and Body Repair and Paint Shops
7533	Auto Exhaust System Repair Shops
7534	Tire Retreading and Repair Shops
7535	Paint Shops
7536	Automotive Glass Replacement Shops
7537	Automotive Transmission Repair Shops
7538	General Automotive Repair Shop
7539	Automotive Repair Shops, Nec
754	Automotive Services, Except Repair
7542	Car Washes
7549	Automotive Services, Nec
76	Miscellaneous Repair Services
7620	Electrical Repair Shops
7622	Radio and Television Repair
7623	Refrigeration Service and Repair Shops
7629	Electrical Repair Shops, Nec
763	Watch, Clock, and Jewelry Repair
7631	Watch, Clock, and Jewelry Repair Shops
764	Reupholstery and Furniture Repair
7641	Reupholstery and Furniture Repair
769	Misc Repair Shops and Related Services
7692	Welding Repair
7694	Armature Rewinding Shops
7699	Repair Services, Nec
78	Motion Pictures
781	Motion Picture Production & Allied Services
7812	Motion Picture and Video Production
7813	Motion Picture Production, Except TV
7814	Motion Picture Production for TV
7819	Services Allied to Motion Pictures

SIC	DESCRIPTION
782	Motion Picture Distribution & Allied Services
7822	Motion Picture and Tape Distribution
7823	Motion Picture Film Exchanges
7824	Film or Tape Distribution for TV
7829	Motion Picture Distribution Services
783	Motion Picture Theaters
7832	Motion Picture Theaters, Except Drive-ins
7833	Drive-in Motion Picture Theaters
784	Video Tape Rental
7841	Video Tape Rental
79	Amusement and Recreation Services
791	Dance Studios, Schools, & Halls
7911	Dance Halls, Studios, and Schools
792	Theatrical Producers (Non Motion Picture), Orchestras, Entertainers
7922	Theatrical Producers and Services
7929	Entertainers & Entertainment Groups
793	Bowling Centers
7932	Billiard and Pool Establishments
7933	Bowling Alleys
794	Commercial Sports
7941	Sports Clubs and Promoters
7948	Racing, Including Track Operation
799	Misc Amusement and Recreation Services
7991	Physical Fitness Facilities
7992	Public Golf Courses
7993	Coin-operated Amusement Device
7996	Amusement Parks
7997	Membership Sports & Recreation Clubs
7999	Amusement and Recreation, Nec
80	Health Services
801	Offices & Clinics of Medical Doctors
8011	Offices of Physicians
802	Offices and Clinics of Dentists
8021	Offices of Dentists
803	Offices of Osteopathic Doctors
8031	Offices of Osteopathic Physicians
804	Offices & Clinics of Other Health Practitioners
8041	Offices of Chiropractors
8042	Offices of Optometrists
8043	Offices and Clinics of Podiatrists
8049	Offices of Health Practitioner
805	Nursing and Personal Care Facilities
8051	Skilled Nursing Care Facilities
8052	Intermediate Care Facilities
8059	Nursing and Personal Care, Nec
806	Hospitals
8061	Hospitals
8062	General Medical & Surgical Hospitals
8063	Psychiatric Hospitals
8069	Specialty Hospitals, Except Psychiatric
807	Medical and Dental Laboratories
8071	Medical Laboratories
8072	Dental Laboratories
808	Home Health Care Services
8081	Outpatient Care Facilities
8082	Home Health Care Services
809	Misc Health & Allied Services, Nec
8091	Health and Allied Services, Nec
8092	Kidney Dialysis Centers

SIC	DESCRIPTION
8093	Specialty Outpatient Clinics, Nec
8099	Health and Allied Services, Nec
81	Legal Services
811	Legal Services
8111	Legal Services
82	Educational Services
821	Elementary and Secondary Schools
8211	Elementary and Secondary Schools
822	Colleges, Universities, Professional Schools, & Junior Colleges
8221	Colleges and Universities, Nec
8222	Junior Colleges
823	Libraries
8231	Libraries and Information Centers
824	Vocational Schools
8241	Correspondence Schools
8243	Data Processing Schools
8244	Business and Secretarial Schools
8249	Vocational School,nec
829	Schools & Educational Services, Nec
8299	Schools & Educational Services
83	Social Services
832	Individual and Family Social Services
8321	Individual and Family Services
8322	Individual and Family Services
833	Job Training, Vocational Rehabilitation Services
8331	Job Training and Related Services
835	Child Day Care Services
8351	Child Day Care Services
836	Residential Care
8361	Residential Care
839	Social Services, Nec
8399	Social Services, Nec
84	Museums, Art Galleries & Botanical & Zoological Ga
841	Museums and Art Galleries
8411	Museums and Art Galleries
8412	Museums and Art Galleries
842	Arboreta, Botanical, or Zoological Gardens
8421	Botanical and Zoological Garden s
8422	Botanical and Zoological Gardens
86	Membership Organizations
861	Business Associations
8611	Business Associations
862	Professional Membership Organizations
8621	Professional Organizations
863	Labor Unions/similar Labor Organizations
8631	Labor Organizations
864	Civic, Social, & Fraternal Associations
8641	Civic and Social Associations
865	Political Organizations
8651	Political Organizations
866	Religious Organizations
8661	Religious Organizations
869	Membership Organizations, Nec
8699	Membership Organizations, Nec
87	Engineering, Accounting, Research, Management
871	Engineering, Architectural, & Surveying Services
8711	Engineering Services

SIC	DESCRIPTION
8712	Architectural Services
8713	Surveying Services
872	Accounting, Auditing, & Bookkeeping Services
8721	Accounting, Auditing, and Bookkeeping
873	Research, Development, & Testing Services
8731	Commercial Physical Research
8732	Commercial Nonphysical Research
8733	Noncommercial Research Organizations
8734	Testing Laboratories
874	Management & Public Relations Services
8741	Management Services
8742	Management Consulting Services
8743	Public Relations Services
8744	Facilities Support Services
8748	Business Consulting, Nec
88	Private Households
881	Private Households
8811	Private Households
89	Services Not Elsewhere Classified
8911	Engineering & Architectural Services
8922	Noncommercial Research Organizations
8931	Accounting, Auditing & Bookkeeping
899	Services, Nec
8999	Services, Nec
91	Executive, Legislative & General Government Exc Fi
911	Executive Offices
9111	Executive Offices
9120	Legislative Bodies
9121	Legislative Bodies
913	Executive & Legislative Offices Combined
9131	Executive and Legislative Combined
919	General Government, Nec
9199	General Government, Nec
92	Justice, Public Order and Safety
921	Courts
9211	Courts
922	Public Order and Safety
9221	Police Protection
9222	Legal Counsel and Prosecution
9223	Correctional Institutions
9224	Fire Protection
9229	Public Order and Safety, Nec
93	Public Finance, Taxation & Monetary Policy
931	Public Finance, Taxation, & Monetary Policy
9311	Finance, Taxation & Monetary Policy
94	Administration of Human Resource Programs
941	Educational Programs Administration
9411	Educational Programs Administration
943	Public Health Programs Administration
9431	Public Health Program Administration
944	Social, Human Resource & Income Maintenance Program Administration
9441	Admin of Social & Manpower Programs
945	Veterans' Affairs (Except Health & Insurance) Administration
9451	Administration of Veterans' Affairs
95	Admin. Of Environmental, Quality & Housing Program
951	Environmental Quality Programs Administration

9511	Air, Water & Solid Waste Management
9512	Land, Mineral, Wildlife Conservation
953	Housing & Urban Development Programs Administration
9531	Housing Programs
9532	Urban and Community Development
96	Administration of Economic Programs
961	General Economic Program Administration
9611	Admin of General Economic Programs
962	Transportation Programs Regulation & Administration
9621	Regulation, Admin. Of Transportation
963	Communications, electric, gas, & Utilities Regulation & Administration
9631	Regulation, Admin of Utilities
964	Agricultural Marketing & Commodities Regulation
9641	Regulation of Agricultural Marketing & Commodities
965	Misc Commercial Sectors Regulation, Licensing, & Inspection
9651	Regulation Misc. Commercial Sectors
966	Space Research and Technology
9661	Space Research and Technology
97	National Security and International Affairs
971	National Security
9711	National Security
972	International Affairs
9721	International Affairs
999	Nonclassifiable Establishments
9999	Nonclassifiable Establishments

Appendix E

Table E-1: Carcinogenicity Ratings for Target Compounds Included in the Regional Toxic Air Emissions Inventory Based on the U.S. EPA's Integrated Risk Information System (IRIS) Database (September 1995)

	Pollutant	Key for USEPA IRIS Ratings	CAS #
1)	Arsenic	A	7440-38-2
2)	Atrazine	Under Review	1912-24-9
3)	Benz(a)anthracene	B2	56-55-3
4)	Benzo(a)pyrene	B2	50-32-8
5)	Cadmium	B1	7440-43-9
6)	Carbon tetrachloride	B2	56-23-5
7)	Chlordane	B2	57-74-9
8)	Chromium	Under review	7440-47-3
9)	Chrome VI	A	18540-29-9
10)	Chrysene	B2	218-01-9
11)	Cobalt	D	7440-48-4

	Pollutant	Key for USEPA IRIS Ratings	CAS #
12)	Coke oven emissions	A	8007-45-2
13)	Copper	D	7440-50-8
14)	1,2-Dichloroethane	B2	107-06-2
15)	Diethylhexyl phthalate	B2	117-81-7
16)	Di-n-butyl phthalate	D	84-74-2
17)	Di-n-octyl phthlate	Under Review	117-84-0
18)	Dioxins	Not listed as a group	
19)	Ethylbenzene	D	100-41-4
20)	Fluoranthene	D	206-44-0
21)	Heptahclor	B2	76-44-8
22)	Hexachlorobenzene	C	118-74-1
23)	Hexachlorobutadiene	C	87-68-3
24)	Hexachloroethane	C	67-72-1
25)	Lead	B2	7439-92-1
26)	Akylated lead compounds	B2	7439-92-1
27)	Manganese & compounds	D	
28)	Mercury	Hg, elem.=D, (HgCl2=C)	7439-97-6 (7487-94-7)
29)	Methoxychlor	D	72-43-5
30)	Methylene chloride	B2	75-09-2
31)	Naphthalene	D	91-20-3
32)	Nickel & compounds	Ni carbonyl=B2 Ni cyanide=under review Ni subsulfide=A (in refining dust) Ni soluble salts=not evaluated	13463-39-3 557-19-7 12035-72-2 various
33)	Parathion	C	56-38-2
34)	Pentachloronitrobenzene	Under Review	82-68-8
35)	Pentachlorophenol	B2	87-86-5
36)	Phenol	D	108-95-2
37)	Total PCB's	B2	1336-36-3 (11097-69-1)
38)	Total PCDD's	B**	
39)	Total PCDF's	B**	
40)	Total PAH's	See below	
41)	Polycyclic Organic Matter	Under review	
42)	TCDD	B**	1746-01-6
43)	TCDF	B**	51207-31-9
44)	Tetrachloroethene (PERC)	Under review	127-18-4
45)	Trichlorethene	In preparation	79-01-6
46)	1,1,1-trichloroethane	D	71-55-6
47)	2,4,5-trichlorophenol	To be reviewed	95-95-4
48)	2,4,6-trichlorophenol	B2	88-06-2
49)	Trifluralin	C	1582-09-8
*	PAH's: (EPA's 16 PAH approach)		
	Naphthalene	D	91-20-3
	Acenapthene	Under review	83-32-9
	Acenaphthylene	D	208-96-8
	Fluorene	D	86-73-7

	Pollutant	Key for USEPA IRIS Ratings	CAS #
	Phenanthrene	D	85-01-8
	Anthracene	D	120-12-7
	Fluoranthene	D	206-44-0
	Pyrene	D	129-00-0
	Benzo(ghi)perylene	D	191-24-2
	Benz(a)anthracene	B2	56-55-3
	Chrysene	B2	218-01-9
	Benzo(b)fluoranthene	B2	205-99-2
	Benzo(k)fluoranthene	B2	207-08-9
	Benzo(a)pyrene	B2	50-32-8
	Dibenz(a,h)anthracene	B2	53-70-3
	Indeno(1,2,3-cd)pyrene	B2	193-39-5

**Not specifically listed or rated in IRIS, but CDD's and CDF's are regarded as likely to present a cancer hazard to humans in the U.S. EPA draft reassessment for 2,3,7,8-TCDD and related compounds.

Key
A=human carcinogen
B=probable human carcinogen
B1=limited human evidence
B2=sufficient evidence in animals, inadequate evidence in humans
C=possible human carcinogen
D=not classifiable as to human carcinogenicity
E=evidence of non-carcinogenicity for humans

Ratings are from U.S. EPA's Integrated Risk Information System (IRIS) database, containing agency consensus positions on the potential adverse human health effects of approximately 500 substances, updated monthly. The ratings provided above are from September 1995.

Appendix F

Great Lakes Commission Regional Emission Inventory of Toxic Air Contaminants Steering Committee

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