

2005 ESTIMATES OF ANTHROPOGENIC MERCURY AIR EMISSIONS IN MICHIGAN

November 2011



Michigan Department of Environmental Quality
Air Quality Division

TABLE OF CONTENTS

2005 ESTIMATES OF ANTHROPOGENIC MERCURY AIR EMISSIONS IN MICHIGAN.....	i
Table 1. 2005 ESTIMATES OF ANTHROPOGENIC MERCURY.....	iii
AIR EMISSIONS IN MICHIGAN	1
FUEL COMBUSTION	1
<i>Coal Combustion</i>	1
<i>Oil Combustion</i>	3
<i>Natural Gas Combustion</i>	5
<i>Wood Combustion</i>	19
<i>Petroleum Refining</i>	20
<i>Residential LPG (Propane) Combustion</i>	21
INCINERATION	21
<i>Sewage Sludge Incineration</i>	21
<i>Municipal Waste Incineration</i>	23
<i>Hazardous Waste Incineration</i>	23
<i>Hospital Medical Infectious Waste Incineration</i>	24
INDUSTRIAL SOURCES.....	25
<i>Cement Manufacturing</i>	25
<i>Taconite Processing</i>	26
<i>Dental Amalgam Manufacturing</i>	27
<i>Lime Manufacturing</i>	27
<i>Brick Manufacturing</i>	28
<i>Coke Production</i>	28
<i>Medical Waste Autoclave</i>	28
PRODUCTION OF METALS.....	29
<i>BOFs in primary metal production (Steel Manufacturing)</i>	29
<i>EAFs in primary metal production (Steel Manufacturing)</i>	29
<i>EAFs & EIFs in Secondary metal production (Steel Foundries)</i>	30
<i>Secondary metal production (Grey Iron)</i>	31
<i>Cupolas in Secondary metal production (Grey Iron)</i>	31
<i>EAFs & EIFs in Secondary metal production (Grey Iron)</i>	33
<i>Auto Switches-shredding of autos (point source)</i>	34
AREA SOURCES	35
MERCURY IN PRODUCTS.....	35
<i>Dental Amalgam</i>	35
<i>Fluorescent Lamps</i>	36
<i>Auto Switches-shredding of autos (area source)</i>	38
<i>Switches and Relays</i>	39
<i>Thermostats</i>	39
<i>Measurement and Control Devices</i>	41
<i>Thermometers</i>	41
<i>Non-fluorescent lamps</i>	42
<i>Bulk Mercury</i>	43
<i>Volatilization during solid waste collection and processing</i>	43
<i>Landfill volatilization</i>	44
<i>Human Cremation</i>	45
<i>Volatilization: land application of sewage sludge</i>	45
<i>Contaminated Site Remediation</i>	45
MOBILE SOURCES.....	46
ON-ROAD.....	46
NON-ROAD	46
REFERENCES	47

Table 1. 2005 ESTIMATES OF ANTHROPOGENIC MERCURY

Emission Source	Hg (lbs/yr) in 2005	Hg(p)	RGM	Hg(0)
FUEL COMBUSTION				
COAL COMBUSTION				
Electric Utilities	2948.51	516.60	869.62	1562.23
Residential	8.03	1.61	2.41	4.02
Industrial/Commercial	311.09	62.22	93.33	155.54
OIL COMBUSTION				
Electric Utilities	10.08	2.02	3.02	5.04
Residential	41.30	8.26	12.39	20.65
Industrial/Commercial Boilers	1.56	0.31	0.47	0.78
NATURAL GAS COMBUSTION				
Electric Utilities	1.20E-05	2.40E-06	3.60E-06	6.00E-06
Residential	2.90E-04	5.80E-0	8.70E-05	1.45E-04
Industrial/Commercial Boilers	5.00E-05	1.E-05	1.50E-05	2.50E-05
Stationary Internal Combustion Engines	2.28E-05	4.56E-06	6.84E-06	1.14E-05
WOOD COMBUSTION				
Electric Utilities	29.89	6.25	9.37	15.62
Residential	NA	NA	NA	NA
Industrial/Commercial	25.20	4.77	7.16	11.93
PETROLEUM REFINING	4.01	0.58	0.86	1.44
RESIDENTIAL LPG PROPANE COMBUSTION	4.22	0.84	1.27	2.11
TOTAL FUEL COMBUSTION	3383.89	603.68	1000.25	1779.96
INCINERATION				
Sewage Sludge Incineration	287.86	57.57	166.96	63.33
Municipal Waste	30.78	6.16	17.85	6.77
Hazardous Waste Incineration	7.45	1.49	4.32	1.64
Hospital Medical Infectious Waste Incineration	5.84	1.17	4.38	0.29
Pathological Waste Incineration	0.04	0.01	0.03	0.00
INCINERATION TOTALS	331.97	66.39	193.54	72.03
INDUSTRIAL SOURCES				
Cement Manufacturing	628.00	17.58	489.04	121.38
Taconite processing	59.36	5.94	5.94	47.49
Lime Manufacturing	46.86	4.69	4.69	37.49
Dental Amalgam Manufacturing	4.00	0.00	0.00	4.00
Brick Manufacturing	1.23	0.12	0.12	0.98

Coke Production	2.59	0.26	0.26	2.07
Thermometer Manufacturing	0.00	0.00	0.00	0.00
Medical Waste Autoclave	NA	NA	NA	NA
Auto Switches-shredding of autos (point source)	10.7	1.07	1.07	8.56
Relay/Switch Manufacturing	148	NA	NA	148
PRODUCTION OF METALS				
Primary metal production (Blast/BOF Steel Manufacturing)	107.30	10.70	10.70	85.84
EAFs in primary metal production (Steel Manufacturing)	88.57	8.86	8.86	70.86
EAFs & EIFs in secondary metal production (Steel Foundries)	130.08	13.01	13.01	104.06
Secondary metal production (Grey Iron), excluding EAFs	122-158	12-16	12-16	97-126
EAFs & EIFs in Secondary metal production (Grey Iron)	26-99	3-10	3-10	21-79
INDUSTRIAL SOURCE TOTALS	1375-1483	77-88	549-559	749-836
AREA SOURCES				
MERCURY CONTAINING PRODUCTS				
Dental Amalgam	103.86	0.00	0.00	103.86
Auto Switches-shredding of autos (area source)	86.13	8.61	8.61	68.90
Switches & Relays (includes thermostats)	89.26	0.00	0.00	89.26
Measurement and Control Devices (includes thermometers)	54.49	0.00	0.00	54.49
Consumer Use of Bulk Mercury	20	0.00	0.00	20.00
Thermostats	13.90			
Fluorescent Lamp Breakage	5.07	0.00	0.00	5.07
Fluorescent Lamp Recycling	5.26	0.00	0.00	5.26
Drum-top Crushing (none permitted in 2005) (should we display this as NA or as zeroes?)	0.00	0.00	0.00	0.00
Non-fluorescent Lamp Breakage	2.08	0.00	0.00	2.08
WASTE DISPOSAL				
Volatilization during solid waste collection & processing	731.00	73.10	73.10	584.80
<i>Fluorescent lamps</i>	62.59			
<i>Switches and Relays (includes thermostats)</i>	37.81			
<i>Measurement and Control Devices (includes thermometers)</i>	39.25			
<i>Thermometers</i>	20.02			
<i>Thermostats</i>	13.23			
<i>Non-fluorescent lamps</i>	6.79			
<i>Bulk Mercury</i>	7			

<i>Dental Amalgam</i>	0.37			
Landfill volatilization	66.51	6.65	6.65	53.21
<i>Switches and Relays (includes thermostats)</i>	9.09			
<i>Measurement and Control Devices (includes thermometers)</i>	13.12			
<i>Non-fluorescent lamps</i>	0.44			
<i>Thermostats</i>	7.00			
<i>Fluorescent lamps</i>	4.43			
<i>Dental Amalgam</i>	2.14			
<i>Thermometers</i>	1.28			
Disposal of products in burn barrels	111.18	22.24	33.35	55.59
<i>Switches and Relays (includes thermostats)</i>	32.21			
<i>Measurement and Control Devices (includes thermometers)</i>	50.90			
<i>Thermostats</i>	24.25			
<i>Fluorescent lamps</i>	8.53			
<i>Thermometers</i>	5.45			
<i>Non-fluorescent lamps</i>	0.84			
Cremation	15-65	3-13	8-38	3-14
Disposal of Bulk Hg to Clean Sweep Sites	7.00	0.00	0.00	7.00
Volatilization: land application of sludge	3.47	0.35	0.35	2.78
Contaminated Site Remediation	9.00	1.80	5.22	1.98
AREA SOURCE TOTALS	1308-1360	116-126	136-165	1057-1069
MOBILE SOURCES				
On Road	0.19-0.50	0.02-0.03	0.04-0.09	0.13-0.38
Non-Road	0.22-10.06	0.03-1.51	0.06-2.92	0.12-5.63
MOBILE SOURCE TOTALS	0.41-10.56	0.05-1.54	0.11-3.01	0.25-6.02
TOTAL Hg AIR EMISSIONS	6400-6569	863-885	1878-1921	3659-3763

AIR EMISSIONS IN MICHIGAN

FUEL COMBUSTION

Coal Combustion

Electric Utilities

The amount of mercury released from coal-fired electric utilities was extracted from the Michigan Mercury Electric Utility Workgroup Report. Data was obtained from the United States Environmental Protection Agency's (USEPA's) Information Collection Rule database or communications with the utilities ([MMEUW, 2005](#)). The coal consumed, or throughput, is expressed in tons.

Table 2.

Facility Name	SRN	Throughput (tons)	Emission factor	Lbs emitted
ESCANABA POWER PLANT	B1573	87,151.00	4.1600E-04	36.2548
MARQUETTE BOARD OF LIGHT & POWER	B1833	206,031.40	NA (TRI est)	17.0000
WHITE PINE ELECTRIC POWER LLC	B1966	74,910.00	NA (TRI est)	31.2000
J. B. SIMS GENERATING STATION	B1976	208,597.80	NA (TRI est)	17.3000
WYANDOTTE DEPT MUNICIPAL POWER	B2132	179,596.00	NA (TRI est)	8.7900
HOLLAND BPW, GENERATING STATION & WWTP	B2357	175,800.61	NA (TRI est)	7.6900
ECKERT & MOORES PARK STATION	B2647	1,222,610.00	NA (TRI est)	134.6700
ST. CLAIR / BELLE RIVER POWER PLANT	B2796	8,683,110.00	NA (TRI est)	541.7000
DETROIT EDISON RIVER ROUGE	B2810	456,059.41	NA (TRI est)	120.0000
DETROIT EDISON TRENTON CHANNEL	B2811	757,107.74	NA (TRI est)	210.0000
HARBOR BEACH POWER PLANT	B2815	171,578.00	NA (TRI est)	9.9000
DETROIT EDISON/MONROE POWER	B2816	3,350,691.00	NA (TRI est)	780.0000
J. H. CAMPBELL PLANT	B2835	4,828,185.00	NA (TRI est)	401.9000
B. C. COBB PLANT	B2836	1,068,363.00	NA (TRI est)	88.9000
KARN - WEADOCK FACILITY	B2840	2,928,707.00	NA (TRI est)	249.1000
J.R. WHITING CO	B2846	1,281,553.00	NA (TRI est)	106.7000
LANSING BOARD OF WATER & LIGHT, ERICKSON STATION	B4001	615,437.00	NA (TRI est)	68.1900
UPPCO JOHN WARDEN STATION	B4260	-	4.1600E-04	0.0000
WISCONSIN ELECTRIC POWER COMPANY	B4261	1,564,523.00	4.1600E-04	97.0300
WISCONSIN ELECTRIC POWER COMPANY	B4261	352,425.00	8.3000E-05	4.3000
MI SO CENTRAL POWER AGENCY	B6611	200,652.38	NA (TRI est)	16.6500
TES FILER CITY STATION	N1685	199,968.70	NA (TRI est)	1.2400
TOTAL				2,948.5148

Residential

Residential fuel combustion estimates were generated as part of Michigan's submittal to the USEPA's National Emissions Inventory (NEI) and the Great Lakes Commission's (GLC's) 2005 Inventory of Toxic Air Emissions for the Great Lakes Region. For residential coal combustion, an emission factor of 0.00042 lbs/ton was used along with year 2000 Census data on household heating and 2005 statewide fuel consumption data from the Energy Information Administration (EIA) of the United States Department of Energy to generate estimated emissions of mercury (DEQ, 2009).

Table 3.

Category	Throughput (tons)	Emission Factor	Lbs emitted
RESIDENTIAL COAL COMBUSTION	19,130.00	4.20E-04	8.0346

Industrial/Commercial

Point source estimates such as those for Industrial and Commercial combustion of coal were collected from the Michigan Air Emissions Reporting System (MAERS). These point source estimates were generated as part of Michigan's submittal to USEPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (McGeen, 2009).

The following industrial and commercial sources of coal combustion were included in the estimate:

Table 4.

Facility Name	SRN	Throughput (tons)	Emission factor	Lbs emitted
ESCANABA PAPER COMPANY	A0884	180,179.00	4.1600E-04	14.9549
S. D. WARREN, MUSKEGON, MI, OPERATIONS	A4203	158,820.70	4.1600E-04	13.1821
FORD MOTOR COMPANY WIXOM ASSEMBLY PLANT	A5260	0.00	4.1600E-04	0.0000
DELPHI SAGINAW STEERING SYSTEMS, HOLLAND ROAD	A6175	39,026.00	4.1600E-04	16.2348
CARGILL SALT INC.	A6240	34,668.35	4.1600E-04	14.4220
ABBOTT LABORATORIES-ROSS PRODUCTS DIVISION	A6380	9,034.00	4.1600E-04	3.7581
MANISTIQUE PAPERS INC	A6475	44,619.00	4.1600E-04	18.5615
NEENAH PAPER - MICHIGAN INC	B1470	53,940.00	4.1600E-04	22.4390
DECORATIVE PANELS INTERNATIONAL, INC	B1476	38,684.00	4.1600E-04	16.0925
GREAT LAKES TISSUE	B1563	14,198.33	4.1600E-04	5.9065
GENERAL MOTORS CORPORATION - VAN SLYKE COMPLEX	B1606	0.00	4.1600E-04	0.0000
GM GRAND BLANC MANUFACTURING	B1610	10,673.00	4.1600E-04	4.4400
W. SAGINAW STREET COMPLEX LANSING PLANT (2,3,6)	B1639	0.00	4.1600E-04	0.0000
MORTON SALT SPECIALTY MAGNESIA	B1824	44,055.00	4.1600E-04	3.0000
MENOMINEE PAPER COMPANY	B1855	18,594.50	4.1600E-04	7.7353
DELPHI E & C SYSTEMS - SAGINAW OPERATIONS	B1993	8,007.00	4.1600E-04	3.3309
MICHIGAN SUGAR COMPANY - SEBEWAING FACTORY	B2873	25,270.00	4.1600E-04	10.5123
MICHIGAN SUGAR COMPANY, CARO FACTORY	B2875	22,816.00	4.1600E-04	9.4915
MICHIGAN SUGAR COMPANY, CROSWELL FACTORY	B2876	22,436.00	4.1600E-04	9.3334
PHARMACIA & UPJOHN CO LLC, A SUBSIDIARY OF PFIZER	B3610	64,308.85	4.1600E-04	26.7525

PACKAGING CORPORATION OF AMERICA - FILER CITY MILL	B3692	120,845.00	4.1600E-04	50.2715
GENERAL MOTORS PONTIAC SITE OPERATIONS	B4032	911.00	4.1600E-04	0.3790
PHARMACIA & UPJOHN COMPANY LLC	B4288	11,188.00	4.1600E-04	4.6542
E.B. EDDY PAPER INC.	B6420	59,457.00	4.1600E-04	4.9349
VERSO PAPER - QUINNESEC	B7192	4,100.00	4.1600E-04	1.7056
GENERAL MOTORS CORPORATION - ORION ASSEMBLY	B7227	15,754.00	4.1600E-04	6.5537
RIVERSIDE CORRECTIONAL FACILITY	K2120	3,234.32	4.1600E-04	1.3455
MICHIGAN STATE UNIVERSITY	K3249	246,645.60	8.2994E-05	20.4700
STEELCASE INC.- KENTWOOD COMPLEX	N0677	20,502.40	4.1600E-04	8.5290
STEELCASE INC. - GRAND RAPIDS COMPLEX	N0980	23,504.30	4.1600E-04	9.7778
KINROSS CORRECTIONAL FACILITY	N2955	5,573.00	4.1600E-04	2.3184
TOTAL:				311.0869

Oil Combustion

Electric Utilities

Mercury emissions from oil-fired electric utilities were estimated using data from MAERS as part of Michigan's submittal to USEPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (DEQ, 2009). The oil combustion, or throughput, is expressed in thousands of gallons (E3GAL).

The following sources were included in the estimate:

Table 5.

Facility Name	SRN	Throughput (E3GAL)	Emission Factor	Lbs emitted
ESCANABA POWER PLANT	B1573	823.69	1.64E-04	0.1354
MARQUETTE BOARD OF LIGHT & POWER	B1833	66.15	4.20E-04	0.0278
DETROIT PUBLIC LIGHTING	B2185	0.00	4.20E-04	0.0000
DETROIT PUBLIC LIGHTING	B2185	0.00	4.20E-04	0.0000
DETROIT PUBLIC LIGHTING	B2185	0.00	1.13E-04	0.0000
ECKERT & MOORES PARK STATION	B2647	443.70	4.20E-04	0.1864
ST. CLAIR / BELLE RIVER POWER PLANT	B2796	3,491.59	4.20E-04	1.4665
ST. CLAIR / BELLE RIVER POWER PLANT	B2796	0.00	1.13E-04	0.0000
DETROIT EDISON SUPERIOR	B2806	37.14	1.64E-04	0.0061
DETROIT EDISON NORTHEAST STATION	B2808	41.70	1.64E-04	0.0069
DETROIT EDISON TRENTON CHANNEL	B2811	325.62	4.20E-04	0.1368
HARBOR BEACH POWER PLANT	B2815	173.46	4.20E-04	0.0729
DETROIT EDISON/MONROE POWER	B2816	1,642.20	4.20E-04	0.6897
J. H. CAMPBELL PLANT	B2835	0.93	4.20E-04	0.0000
J. H. CAMPBELL PLANT	B2835	1,188.16	4.20E-04	0.4990
KARN - WEADOCK FACILITY	B2840	0.55	4.13E-05	0.0000
KARN - WEADOCK FACILITY	B2840	1,102.18	4.20E-04	0.4629
KARN - WEADOCK FACILITY	B2840	23,210.65	1.13E-04	2.6228
J.R. WHITING CO	B2846	401.18	4.20E-04	0.1685
PALISADES PLANT	B2934	5.37	4.20E-04	0.0023
DETROIT THERMAL WILLIS HEATING PLANT	B3011	0.00	4.20E-04	0.0000
LANSING BOARD OF WATER & LIGHT, ERICKSON STATION	B4001	134.00	4.20E-04	0.0563

AEP COOK NUCLEAR PLANT	B4252	4.28	4.20E-04	0.0018
WISCONSIN ELECTRIC POWER COMPANY	B4261	854.90	4.20E-04	0.3591
FERMI ENERGY CENTER	B4321	164.90	1.64E-04	0.0271
VANDYKE GENERATING PLANT	B5421	0.24	4.13E-05	0.0000
DETROIT EDISON GREENWOOD ENERGY CENTER	B6145	1,427.01	1.13E-04	0.5993
DETROIT EDISON GREENWOOD ENERGY CENTER	B6145	21,903.92	4.20E-04	2.4751
MIDLAND COGENERATION VENTURE	B6527	17.11	4.13E-05	0.0007
MI SO CENTRAL POWER AGENCY	B6611	46.33	4.20E-04	0.0195
EASTERN MI UNIVERSITY	H5877	92.91	4.20E-04	0.0390
CENTRAL MICHIGAN UNIVERSITY	K2460	0.00	4.20E-04	0.0000
UNIVERSITY OF MICHIGAN	M0675	2.49	4.20E-04	0.0010
UNIVERSITY OF MICHIGAN FLINT	M3641	0.00	4.20E-04	0.0000
NORTHERN MICHIGAN UNIVERSITY	M3792	1.22	4.20E-04	0.0005
DELTA COLLEGE	N5930	0.00	4.20E-04	0.0000
HOLLAND BOARD OF PUBLIC WORKS	N6000	0.96	1.64E-04	0.0002
WOLVERINE POWER, TOWER POWER PLANT	N6171	71.14	1.64E-04	0.0117
WOLVERINE POWER, VESTABURG POWER PLANT	N6249	0.00	1.64E-04	0.0000
DEARBORN INDUSTRIAL GENERATION	N6631	2.26	4.13E-05	0.0001
NEW COVERT GENERATING COMPANY LLC / COVERT GEN FAC	N6767	0.31	4.13E-05	0.0000
WOLVERINE POWER, GAYLORD GENERATING STATION	N6833	0.54	4.13E-05	0.0000
TOTAL				10.0754

Residential

Residential fuel combustion estimates were generated as part of Michigan's submittal to the USEPA's NEI and the GLC's 2005 Inventory of Toxic Air Emissions for the Great Lakes Region. For residential oil combustion, an emission factor of 0.00042 lbs/1000 gallons was used along with year 2000 Census data on household heating and 2005 statewide fuel consumption data from the EIA of the US Department of Energy to generate estimated emissions of mercury (DEQ, 2009).

Table 6.

Category	Throughput (E3GAL)	Emission Factor	Lbs emitted
RESIDENTIAL OIL COMBUSTION	98,381.00	4.200E-04	41.30

Industrial/Commercial

Point source estimates such as those for Industrial and Commercial combustion of oil were collected from the Michigan Air Emissions Reporting System (DEQ, 2009). These point source estimates were generated as part of Michigan's submittal to USEPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (DEQ, 2009).

The following industrial and commercial sources of oil combustion were included in the estimate:

Table 7.

Facility Name	SRN	Throughput (E3GAL)	Emission factor	Lbs emitted
OTSEGO PAPER INC	A0023	0.04	4.20E-04	0.0000
ESCANABA PAPER COMPANY	A0884	3,296.63	1.13E-04	0.3725
ACCESS BUSINESS GROUP, LLC	A2402	0.97	4.20E-04	0.0004
WACKER CHEMICAL CORP	A2849	0.00	4.20E-04	0.0000
ANDERSON DEVELOPMENT CO	A2851	0.00	4.20E-04	0.0000
S. D. WARREN, MUSKEGON, MI, OPERATIONS	A4203	273.90	1.13E-04	0.0310
FEDERAL MOGUL CORP.	A5098	0.00	4.20E-04	0.0000
MEAD JOHNSON & COMPANY	A5858	21.32	4.20E-04	0.0088
DUNN PAPER, INC.	A6218	0.00	4.20E-04	0.0000
CARGILL SALT INC.	A6240	0.00	4.20E-04	0.0000
MANISTIQUE PAPERS INC	A6475	0.00	4.20E-04	0.0000
NEENAH PAPER - MICHIGAN INC	B1470	0.50	4.20E-04	0.0002
BPB MANUFACTURING, INC.	B1479	0.00	4.20E-04	0.0000
MICHIGAN PAPERBOARD CO, LP	B1534	3,387.01	1.13E-04	0.3827
RALSTON FOODS	B1537	0.00	4.20E-04	0.0000
KRAFT FOODS GLOBAL, INC.	B1548	30.00	4.20E-04	0.0126
KRAFT FOODS GLOBAL, INC.	B1548	0.00	1.13E-04	0.0000
GENERAL MOTORS CORPORATION - VAN SLYKE COMPLEX	B1606	0.15	4.20E-04	0.0001
CYTEC INDUSTRIES	B1677	0.00	1.13E-04	0.0000
FORD MOTOR COMPANY-VAN DYKE PLANT	B1771	0.00	1.13E-04	0.0000
WARREN POWERTRAIN	B1798	329.11	1.13E-04	0.0372
EMPIRE IRON MINING PARTNERSHIP	B1827	0.00	4.20E-04	0.0000
COVALENCE SPECIALTY COATINGS, LLC	B2013	1,290.00	1.13E-04	0.1458
WHITE PIGEON PAPER COMPANY	B2024	3,213.20	1.13E-04	0.3631
WHITE PIGEON PAPER COMPANY	B2024	6.01	4.20E-04	0.0025
GM POWERTRAIN GROUP WILLOW RUN PLANT	B2052	0.00	4.20E-04	0.0000
EATON CORP	B2209	55.57	4.13E-05	0.0023
PFIZER GLOBAL R&D	B2328	13.27	4.13E-05	0.0007
PARKEDALE PHARMACEUTICALS, INC.	B2329	0.00	1.67E-04	0.0000
PFIZER GLOBAL MANUFACTURING, HOLLAND PLANT	B2331	2.40	4.20E-04	0.0010
GM POWERTRAIN GROUP BAY CITY PLANT	B2460	0.08	4.20E-04	0.0000
U.S. ARMY GARRISON-MICHIGAN (DETROIT ARSENAL)	B2763	5.40	4.20E-04	0.0023
KENT COUNTY DISTRICT HEATING AND COOLING	B2838	391.00	1.13E-04	0.0442
AUTOMOTIVE COMPONENTS HOLDINGS-YPSILANTI	B2901	0.00	1.13E-04	0.0000
EDW. C. LEVY CO. PLANT 2 PORTABLE CRUSHER	B3534	10.68	4.13E-05	0.0004
PHARMACIA & UPJOHN CO LLC, A SUBSIDIARY OF PFIZER	B3610	0.00	4.20E-04	0.0000
GM TECHNICAL CENTER	B4049	0.00	1.13E-04	0.0000
RIETH RILEY CONSTRUCTION CO., INC.	B4058	10.13	4.13E-05	0.0004
ROCK-TENN CO	B4072	0.00	4.20E-04	0.0000
U S GYPSUM CO	B4102	3.37	4.13E-05	0.0001
RIETH RILEY CONSTRUCTION CO INC	B4147	24.43	4.13E-05	0.0010
BOLEN ASPHALT PAVING, INC.	B4164	19.40	4.13E-05	0.0008
PHARMACIA & UPJOHN COMPANY LLC	B4288	0.00	4.20E-04	0.0000

KASSON SAND AND GRAVEL	B4383	21.74	4.13E-05	0.0009
HONEYWELL	B5558	0.00	4.13E-05	0.0000
E.B. EDDY PAPER INC.	B6420	22.04	4.20E-04	0.0093
CLINTON VILLAGE OF	B6508	0.59	4.13E-05	0.0000
HURON CASTING INC.	B7013	2.55	1.64E-04	0.0004
GUARDIAN FIBERGLASS INC	B7205	5.76	4.13E-05	0.0002
WEYERHAEUSER COMPANY	B7302	0.67	4.13E-05	0.0000
TUSCOLA MINERALS COMPANY	B7748	65.10	4.13E-05	0.0027
MEMORIAL HOSPITAL	C5704	0.00	4.20E-04	0.0000
DART CONTAINER CORPORATION OF MICHIGAN	D8065	0.00	4.20E-04	0.0000
SELFRIDGE AIR NATIONAL GUARD BASE	F3254	20.58	1.64E-04	0.0034
HACKLEY HOSPITAL	F8375	0.00	4.20E-04	0.0000
OAKLAND CO. SERVICE CENTER - CENTRAL STEAM PLANT	G5252	188.90	1.13E-04	0.0213
B.O.P. FEDERAL CORRECTIONAL INSTITUTE	K2688	0.00	4.20E-04	0.0000
ST JOSEPH MERCY HOSPITAL	M3431	5.78	4.20E-04	0.0024
V A MEDICAL CENTER	M3653	17.10	4.20E-04	0.0072
WALTER P. REUTHER PSYCHIATRIC HOSPITAL	M4132	2.80	4.20E-04	0.0012
NORTHWEST AIRLINES	M4164	1.20	4.13E-05	0.0000
SORA LIMESTONE, INC.	M4722	178.00	4.13E-05	0.0073
AJAX PAVING INDUSTRIES, INC.	M4731	66.00	4.13E-05	0.0027
FORD MOTOR CO ELM ST BOILERHOUSE	M4764	0.00	4.20E-04	0.0000
A T & T	M4787	0.12	1.64E-04	0.0000
PAYNE & DOLAN INC C22	N0436	22.70	4.13E-05	0.0009
LYON SAND & GRAVEL CO	N0503	14.90	4.13E-05	0.0006
STEELCASE INC.- KENTWOOD COMPLEX	N0677	0.10	1.64E-04	0.0000
STATE OF MICHIGAN	N0710	3.60	4.13E-05	0.0001
LOUISIANA-PACIFIC CORP NEWBERRY PLANT	N0780	0.00	4.20E-04	0.0000
DAIMLERCHRYSLER TECHNOLOGY CENTER	N1436	18.91	4.20E-04	0.0079
WELCH FOODS INC	N1461	0.00	1.13E-04	0.0000
SEARLES CONSTRUCTION - 36 PLANT	N1588	1.82	4.13E-05	0.0001
RIETH RILEY CONSTRUCTION CO, INC.	N1594	0.00	4.13E-05	0.0000
ALBRECHT SAND AND GRAVEL	N1656	28.59	4.13E-05	0.0012
BOLEN ASPHALT PAVING, INC.	N1905	20.50	4.13E-05	0.0008
AJAX PAVING INDUSTRIES, INC.	N1917	98.50	4.13E-05	0.0041
RIETH RILEY CONSTRUCTION CO INC	N2184	44.13	4.13E-05	0.0018
RECYCLED AGGREGATES, LLC	N2627	25.30	4.13E-05	0.0010
AMERICAN AGGREGATES OF MICHIGAN ELJAY 54	N3152	18.92	4.13E-05	0.0008
AGGREGATE INDUSTRIES - AC3 PORTABLE PLANT	N3177	42.30	4.13E-05	0.0017
A & E AGG. INC (PLANT 1)	N3396	6.20	4.13E-05	0.0003
BALKEMA EXCAVATING/AGGREGATE RESOURCES PLANT 102	N3435	6.86	4.13E-05	0.0003
PHARMACIA & UPJOHN COMPANY LLC	N3519	16.38	4.13E-05	0.0007
BALKEMA EXCAVATING/AGGREGATE RESOURCES PLANT 103	N5131	10.39	4.13E-05	0.0004
INTERNATIONAL MATERIALS INC	N5180	0.10	4.13E-05	0.0000
SYLVANIA MINERALS, LLC	N5241	75.00	4.13E-05	0.0031
OTTAWA AGGREGATES INC	N5287	6.18	4.13E-05	0.0003
R E GLANCY INC	N5476	7.75	4.13E-05	0.0003

R E GLANCY INC	N5477	42.89	4.13E-05	0.0018
R E GLANCY INC	N5478	0.00	4.13E-05	0.0000
R E GLANCY INC	N5480	4.00	4.13E-05	0.0002
SAGINAW ASPHALT COMPANY - PLANT 4	N5597	11.28	4.13E-05	0.0005
ELMER'S CRANE & DOZER, INC	N5748	31.57	4.13E-05	0.0013
ELMER'S CRANE & DOZER, INC	N5818	35.11	4.13E-05	0.0014
ELMERS CRANE & DOZER, INC	N5819	53.34	4.13E-05	0.0022
HALLIDAY SAND & GRAVEL INC - PLANT #2	N5841	25.00	4.13E-05	0.0010
HALLIDAY SAND & GRAVEL INC - PLANT #3	N5842	27.00	4.13E-05	0.0011
R E GLANCY INC	N5963	64.06	4.13E-05	0.0026
AGGREGATE INDUSTRIES - NORDBERG HP300 PLANT	N5998	37.85	4.13E-05	0.0016
AJAX PAVING INDUSTRIES, INC.	N6003	13.00	4.13E-05	0.0005
GENESYS REGIONAL MEDICAL CENTER	N6016	3.50	4.20E-04	0.0015
RIETH RILEY CONSTRUCTION CO., INC.	N6022	3.47	4.13E-05	0.0001
AGGREGATE INDUSTRIES - AC2 PORTABLE PLANT	N6197	35.82	4.13E-05	0.0015
MORROW COMBUSTION TURBINE PLANT	N6252	0.14	4.13E-05	0.0000
RECYCLED AGGREGATES, L.L.C.	N6253	0.00	4.13E-05	0.0000
AGGREGATE INDUSTRIES - AC1 PORTABLE PLANT	N6283	32.32	4.13E-05	0.0013
BRADLEY SAND AND GRAVEL INC	N6289	1.46	4.13E-05	0.0001
HANLEE EQUIPMENT LLC (FORMERLY ALLIED CONCRETE)	N6306	18.70	4.13E-05	0.0008
HALLIDAY SAND & GRAVEL, PLANT #1 225-97A	N6307	29.00	4.13E-05	0.0012
CHAMPAGNE & MARX EXC INC	N6325	20.10	4.13E-05	0.0008
WEBER SAND & GRAVEL - CONCRETE RECYCLE PLANT	N6328	15.31	4.13E-05	0.0006
R.E. GLANCY, INC.	N6355	26.52	4.13E-05	0.0011
MID MICHIGAN MATERIALS INC	N6385	13.30	4.13E-05	0.0005
RIETH RILEY CONSTRUCTION CO., INC.	N6413	29.62	4.13E-05	0.0012
HALLIDAY SAND & GRAVEL (945 CONE)	N6429	16.00	4.13E-05	0.0007
HALLIDAY SAND AND GRAVEL	N6430	8.00	4.13E-05	0.0003
ELMER'S CRANE & DOZER, INC	N6453	7.38	4.13E-05	0.0003
C H SMITH CO INC	N6482	0.00	4.13E-05	0.0000
DRENTH BROTHERS, INC.	N6508	11.19	4.13E-05	0.0005
NATIONAL ASPHALT PRODUCTS INC	N6533	46.80	4.13E-05	0.0019
OTTAWA AGGREGATES INC	N6548	1.73	4.13E-05	0.0001
MATHY CONSTRUCTION CO PLANT 2 PTI#386-98	N6566	0.00	4.13E-05	0.0000
NATIONAL ASPHALT PRODUCTS INC	N6568	0.00	4.13E-05	0.0000
BALKEMA EXCAVATING, INC. -- PORTABLE PLANT 101	N6589	0.00	4.13E-05	0.0000
FLORENCE CEMENT COMPANY, INC.	N6599	2.35	4.13E-05	0.0001
FLORENCE CEMENT CO. INC.	N6600	2.89	4.13E-05	0.0001
REITH RILEY CONSTRUCTION CO., INC.	N6608	16.41	4.13E-05	0.0007
R.E. GLANCY, INC.	N6634	48.58	4.13E-05	0.0020
MOOSE LAKE AGGREGATE	N6661	6.74	4.13E-05	0.0003
HUBSCHER & SON, INC. - PIONEER 50VE PORTABLE	N6704	1.88	4.13E-05	0.0001
HUBSCHER AND SON, INC- CEDARAPIDS 443	N6705	4.14	4.13E-05	0.0002
HUBSCHER & SON, INC. - HP200	N6706	5.63	4.13E-05	0.0002
CHAMPAGNE & MARX EXCAVATING INC.	N6709	11.33	4.13E-05	0.0005
CARRICK GRAVEL AND CRUSHING	N6749	26.00	4.13E-05	0.0011
ELMER'S CRANE & DOZER, INC	N6750	43.87	4.13E-05	0.0018
DYKEMA EXCAVATORS INC.	N6762	12.35	4.13E-05	0.0005

KLETT RECYCLE, LLC	N6804	20.73	4.13E-05	0.0009
GERKIN MATERIALS INC	N6834	22.78	4.13E-05	0.0009
ROCK RECYCLERS	N6837	37.85	4.13E-05	0.0016
ROBERT BAILEY CONTRACTORS, INC. - CR1 PLANT	N6845	0.00	4.13E-05	0.0000
ROBERT BAILEY CONTRACTORS, INC. - CR2 PLANT	N6846	4.45	4.13E-05	0.0002
PARKER EXCAVATING GRAVEL & RECYCLING INC	N6848	6.54	4.13E-05	0.0003
PARKER EXCAVATING GRAVEL & RECYCLE INC	N6849	2.97	4.13E-05	0.0001
PARKER EXCAVATING GRAVEL & RECYCLE INC	N6850	1.09	4.13E-05	0.0000
PARKER EXCAVATING GRAVEL & RECYCLE INC	N6851	7.29	4.13E-05	0.0003
NORTHERN CRUSHING AND RECYCLING, LLC	N6861	43.00	4.13E-05	0.0018
WATERLAND TRUCKING	N6896	33.60	4.13E-05	0.0014
R SMITH & SONS, INC. - PLANT #1	N6901	21.29	4.13E-05	0.0009
R SMITH & SONS - SOUTHWEST GRAVEL, INC.	N6902	0.00	4.13E-05	0.0000
SEARLES CONSTRUCTION - EXTEC PLANT	N6910	3.62	4.13E-05	0.0001
SEARLES CONSTRUCTION - 45 PLANT	N6913	22.29	4.13E-05	0.0009
SEARLES CONSTRUCTION - WASH PLANT	N6914	7.23	4.13E-05	0.0003
LYON SAND & GRAVEL-CR JAW	N6923	0.00	4.13E-05	0.0000
FONSON, INC.	N6932	7.53	4.13E-05	0.0003
INDEPENDENCE RECYCLING INC	N6948	0.00	4.13E-05	0.0000
HALLIDAY SAND AND GRAVEL INC. (6000 CONE PLANT)	N6957	28.00	4.13E-05	0.0012
GROSSO TRUCKING AND SUPPLY COMPANY	N7011	4.80	4.13E-05	0.0002
WEBER SAND & GRAVEL, INC. - EL JAY PLANT	N7028	0.90	4.13E-05	0.0000
CHAMPAGNE & MARX EXCAVATING INC	N7050	12.75	4.13E-05	0.0005
ELMER'S CRANE & DOZER, INC	N7052	2.71	4.13E-05	0.0001
WEBER SAND & GRAVEL, INC. - SAGINAW ASPHALT PLANT	N7106	7.79	4.13E-05	0.0003
ELMER'S CRANE AND DOZER, INC	N7120	17.29	4.13E-05	0.0007
JK INDUSTRIAL PROCESSING LLC - TELSMITH 52S PLANT	N7136	19.49	4.13E-05	0.0008
PAUL BECHTEL SAND AND GRAVEL	N7151	10.35	4.13E-05	0.0004
JK INDUSTRIAL PROCESSING LLC - TELSMITH 52G PLANT	N7168	0.00	4.13E-05	0.0000
ALPENA AGGREGATE INC.	N7259	74.19	4.13E-05	0.0031
PYRAMID PAVING & CONTRACTING	N7271	32.00	4.13E-05	0.0013
WEBER SAND AND GRAVEL, INC. - CEDARAPIDS	N7288	19.12	4.13E-05	0.0008
ASC INCORPORATED	N7322	4.00	1.68E-04	0.0007
LES MILLER & SONS SAND & GRAVEL, INC.	N7361	0.00	4.13E-05	0.0000
AMERICAN AGGREGATES OF MICHIGAN, INC. CONE CRUSHER	N7375	32.28	4.13E-05	0.0013
BALKEMA EXCAVATING INC.-PLANT 104	N7390	0.80	4.13E-05	0.0000
WIEGAND'S CRUSHING, INC.	N7391	0.00	4.13E-05	0.0000
BARBER CREEK SAND AND GRAVEL, INC.	N7407	4.50	4.13E-05	0.0002
A & E AGG. INC. (PLANT 2-PONTIAC CRUSHED CEMENT	N7444	9.90	4.13E-05	0.0004
SOUTHERN MICHIGAN RECYCLING	N7492	4.97	4.13E-05	0.0002
HAYES WASHED SAND & GRAVEL CO. INC.	N7495	1.84	4.13E-05	0.0001
RON WEAVER GRAVEL CO INC	N7542	9.00	4.13E-05	0.0004
	TOTAL			1.5550

Natural Gas Combustion

Electric Utilities

Mercury emissions from natural gas-fired electric utilities were estimated using an emission factor published by the Electric Power Research Institute (EPRI 1996) for natural gas combustion. Throughput, or natural gas consumption, is expressed in millions of cubic feet (MMCF). The EPRI factor of 8.00E-10 LB/MMCF is several orders of magnitude lower than the USEPA emission factor used in MAERS, which is 2.6E-04 LB/MMCF. The result is that the estimated mercury emissions for this category drop to 1.2E-05 lbs statewide, compared to the MAERS estimate of 3.8793 lbs for 2005.

Sources included in the estimate for emissions from natural gas-fired electric utilities:

Table 8.

Facility Name	SRN	Throughput (MMCF)	Emission factor	Lbs emitted
WHITE PINE ELECTRIC POWER LLC	B1966	9.56	8.00E-10	0.000000
J. B. SIMS GENERATING STATION	B1976	19.91	8.00E-10	0.000000
WYANDOTTE DEPT MUNI POWER	B2132	24.30	8.00E-10	0.000000
HOLLAND BPW, GENERATING STATION & WWTP	B2357	11.13	8.00E-10	0.000000
ST. CLAIR / BELLE RIVER POWER PLANT	B2796	281.15	8.00E-10	0.000000
DETROIT EDISON RIVER ROUGE	B2810	662.30	8.00E-10	0.000001
DETROIT EDISON CONNERS CREEK	B2812	1,306.53	8.00E-10	0.000001
DETROIT EDISON, MARYSVILLE POWER PLANT	B2813	0.00	8.00E-10	0.000000
DETROIT THERMAL BEACON HEATING PLANT	B2814	2,133.62	8.00E-10	0.000002
B. C. COBB PLANT	B2836	859.66	8.00E-10	0.000001
KENT COUNTY DISTRICT HEATING AND COOLING	B2838	821.40	8.00E-10	0.000001
KARN - WEADOCK FACILITY	B2840	4,592.98	8.00E-10	0.000004
UPPCO JOHN WARDEN STATION	B4260	0.00	8.00E-10	0.000000
DETROIT EDISON GREENWOOD ENERGY CENTER	B6145	4,197.74	8.00E-10	0.000003
TOTAL				0.000012

Residential

For residential natural gas combustion, the EPRI emission factor of 8.0E-10 LB/MMCF was used along with year 2000 Census data on household heating and 2005 statewide fuel consumption data from the EIA of the U.S. Department of Energy to generate estimated emissions of mercury (DEQ, 2009). This resulted in statewide total emissions from this

category of 2.9E-04 lbs, compared to the MAERS estimate of 93.25 lbs, which was based on the standard USEPA factor.

Table 9.

Category	Throughput (MMCF)	Emission Factor	Lbs emitted
RESIDENTIAL NATURAL GAS COMBUSTION	358,658.00	8.00E-10	0.00029

Industrial/Commercial Boilers

For natural gas combustion from Industrial and Commercial boilers, the EPRI emission factor of 8.0E-10 LB/MMCF was utilized, along with activity data from MAERS. The statewide total mercury emissions estimated for this category were 0.00005 lbs. The MAERS estimate, based on the standard USEPA factor, was 15.8552 lbs for this category.

The following industrial and commercial sources of natural gas combustion were included in the estimate:

Table 10.

Facility Name	SRN	Throughput (MMCF)	Emission factor	Lbs emitted
OTSEGO PAPER INC	A0023	36.19	8.00E-10	2.90E-08
HASTINGS MANUFACTURING COMPANY	A0171	4.19	8.00E-10	3.35E-09
MENASHA PACKAGING COMPANY,LLC - COLOMA PLANT	A0402	32.79	8.00E-10	2.62E-08
KELLOGG USA INC.	A0563	474.56	8.00E-10	3.80E-07
ESCANABA PAPER COMPANY	A0884	1,227.78	8.00E-10	9.82E-07
DELPHI FLINT EAST	A1177	549.66	8.00E-10	4.40E-07
GENERAL MOTORS CORP. POWERTRAIN FLINT NORTH	A1178	642.33	8.00E-10	5.14E-07
GENERAL MOTORS LANSING FACILITY - PLANT 1	A1641	116.1	8.00E-10	9.29E-08
KALSEC, INCORPORATED	A1991	40.2	8.00E-10	3.22E-08
LEON PLASTICS	A2396	0.02	8.00E-10	1.60E-11
ACCESS BUSINESS GROUP, LLC	A2402	236.46	8.00E-10	1.89E-07
KEELER BRASS COMPANY	A2464	61.98	8.00E-10	4.96E-08
DELPHI ENERGY & CHASSIS SYSTEMS - GRAND RAPIDS	A2620	186	8.00E-10	1.49E-07
WACKER CHEMICAL CORP	A2849	117	8.00E-10	9.36E-08
ANDERSON DEVELOPMENT CO	A2851	54	8.00E-10	4.32E-08
FORD MOTOR COMPANY - STERLING PLANT	A3567	373.28	8.00E-10	2.99E-07
DU PONT MT. CLEMENS PLANT	A3569	7.28	8.00E-10	5.82E-09
THE DOW CHEMICAL COMPANY U.S.A., MIDLAND	A4033	216.4	8.00E-10	1.73E-07
DOW CORNING - MIDLAND PLANT	A4043	96.69	8.00E-10	7.74E-08
IKO MONROE INC	A4074	12.67	8.00E-10	1.01E-08
S. D. WARREN, MUSKEGON, MI, OPERATIONS	A4203	1,109.80	8.00E-10	8.88E-07
LORIN INDUSTRIES	A4285	56.1	8.00E-10	4.49E-08
DANA CORPORATION - SANFORD STREET FACILITY	A4302	20.9	8.00E-10	1.67E-08
GERBER PRODUCTS CO	A4338	669.43	8.00E-10	5.36E-07
MICHIGAN SEAMLESS TUBE, LLC	A4741	79.4	8.00E-10	6.35E-08

FORD MOTOR COMPANY WIXOM ASSEMBLY PLANT	A5260	29.86	8.00E-10	2.39E-08
GENERAL MOTORS CORP. - MILFORD PROVING GROUND	A5262	368.7	8.00E-10	2.95E-07
SMURFIT-STONE CONTAINER ENTERPRISES, INC.	A5754	122.29	8.00E-10	9.78E-08
JPS AUTOMOTIVE INC.	A5764	229.6	8.00E-10	1.84E-07
SARA LEE FOODS - ZEELAND FACILITY	A5806	141.2	8.00E-10	1.13E-07
MEAD JOHNSON & COMPANY	A5858	213.6	8.00E-10	1.71E-07
EAGLE OTTAWA GRAND HAVEN	A5866	122.4	8.00E-10	9.79E-08
HART & COOLEY, INC.	A5884	7	8.00E-10	5.60E-09
EATON CORP	A6177	81.08	8.00E-10	6.49E-08
DUNN PAPER, INC.	A6218	396.16	8.00E-10	3.17E-07
ACHESON COLLOIDS CO	A6237	60.4	8.00E-10	4.83E-08
CARGILL SALT INC.	A6240	692.24	8.00E-10	5.54E-07
ABBOTT LABORATORIES-ROSS PRODUCTS DIVISION	A6380	215.9	8.00E-10	1.73E-07
TRELLEBORG YSH INC	A6445	14.77	8.00E-10	1.18E-08
MANISTIQUE PAPERS INC	A6475	23.51	8.00E-10	1.88E-08
GEORGIA PACIFIC CORP	A6714	63.4	8.00E-10	5.07E-08
DARLING INTERNATIONAL INC	A6902	59.35	8.00E-10	4.75E-08
U S SILICA CO	A7757	42.45	8.00E-10	3.40E-08
U S STEEL GREAT LAKES WORKS	A7809	596.6	8.00E-10	4.77E-07
DURR SYSTEMS, INC.	A8448	29.21	8.00E-10	2.34E-08
BURNERS INC.	A8557	0.02	8.00E-10	1.60E-11
DAIMLER CHRYSLER PLYMOUTH RD	A8627	93.16	8.00E-10	7.45E-08
DETROIT DIESEL CORPORATION	A8638	467	8.00E-10	3.74E-07
FORD MOTOR CO/ LIVONIA TRANSMISSION	A8645	584.49	8.00E-10	4.68E-07
FORD MOTOR CO ROUGE COMPLEX	A8648	51.8	8.00E-10	4.14E-08
FORD MOTOR CO/ WAYNE COMPLEX	A8650	157.76	8.00E-10	1.26E-07
FORD MOTOR COMPANY, WOODHAVEN STAMPING PLANT	A8651	28.7	8.00E-10	2.30E-08
MARATHON PETROLEUM COMPANY LLC	A9831	697.9	8.00E-10	5.58E-07
NEENAH PAPER - MICHIGAN INC	B1470	0.08	8.00E-10	6.40E-11
DECORATIVE PANELS INTERNATIONAL, INC	B1476	558	8.00E-10	4.46E-07
MICHIGAN SUGAR COMPANY - BAY CITY	B1493	1,257.44	8.00E-10	1.01E-06
DARLING INTERNATIONAL INC.	B1526	161.74	8.00E-10	1.29E-07
MICHIGAN PAPERBOARD CO, LP	B1534	672.35	8.00E-10	5.38E-07
RALSTON FOODS	B1537	143.62	8.00E-10	1.15E-07
KRAFT FOODS GLOBAL, INC.	B1548	617.96	8.00E-10	4.94E-07
GREAT LAKES TISSUE	B1563	0	8.00E-10	0.00E+00
FLINT WATER POLLUTION CONTROL FACILITY	B1598	143.9	8.00E-10	1.15E-07
GM SERVICE PARTS OPERATION	B1604	205.07	8.00E-10	1.64E-07
GENERAL MOTORS CORPORATION - VAN SLYKE COMPLEX	B1606	813.9	8.00E-10	6.51E-07
W. SAGINAW STREET COMPLEX LANSING PLANT (2,3,6)	B1639	398.08	8.00E-10	3.18E-07
CYTEC INDUSTRIES	B1677	378.79	8.00E-10	3.03E-07
GRAPHIC PACKAGING INTERNATIONAL, INC.	B1678	1,640.23	8.00E-10	1.31E-06
AMERICAN SEATING COMPANY	B1713	29.34	8.00E-10	2.35E-08
GRAND RAPIDS METAL FABRICATION	B1726	168.14	8.00E-10	1.35E-07

TECUMSEH COMPRESSOR CO	B1761	33.3	8.00E-10	2.66E-08
FORD MOTOR COMPANY-VAN DYKE PLANT	B1771	176.79	8.00E-10	1.41E-07
WARREN POWERTRAIN	B1798	169.6	8.00E-10	1.36E-07
DAIMLERCHRYSLER CORP. STERLING STAMPING PLANT	B1801	270	8.00E-10	2.16E-07
MORTON SALT SPECIALTY MAGNESIA	B1824	2.33	8.00E-10	1.86E-09
EMPIRE IRON MINING PARTNERSHIP	B1827	91.29	8.00E-10	7.30E-08
MENOMINEE PAPER COMPANY	B1855	9.2	8.00E-10	7.36E-09
BRUNSWICK BOWLING AND BILLIARDS	B1904	72.65	8.00E-10	5.81E-08
YALE LIFT-TECH	B1913	50.76	8.00E-10	4.06E-08
HAYES LEMMERZ INTERNATIONAL - MONTAGUE	B1925	115.9	8.00E-10	9.27E-08
GIBRALTAR NATIONAL CORPORATION	B1945	16	8.00E-10	1.28E-08
GM POWERTRAIN GROUP - SAGINAW METAL CASTING	B1991	0.48	8.00E-10	3.84E-10
DELPHI E & C SYSTEMS - SAGINAW OPERATIONS	B1993	13.24	8.00E-10	1.06E-08
COVALENCE SPECIALTY COATINGS, LLC	B2013	82.95	8.00E-10	6.64E-08
DAY INTERNATIONAL, INC.	B2014	75.3	8.00E-10	6.02E-08
WHITE PIGEON PAPER COMPANY	B2024	1.28	8.00E-10	1.02E-09
MARYSVILLE NPDC	B2032	4,186.39	8.00E-10	3.35E-06
GM POWERTRAIN GROUP WILLOW RUN PLANT	B2052	908.96	8.00E-10	7.27E-07
ACH SALINE PLANT	B2063	39.5	8.00E-10	3.16E-08
FORD MOTOR CO/RAWSONVILLE PLANT	B2064	300.59	8.00E-10	2.40E-07
DETROIT WASTEWATER TREATMENT PLANT	B2103	50.11	8.00E-10	4.01E-08
DETROIT STEEL CO TRENTON	B2116	0	8.00E-10	0.00E+00
WYANDOTTE DEPT MUNI POWER	B2132	24.3	8.00E-10	1.94E-08
EXXONMOBIL WOODHAVEN TERMINAL	B2158	313	8.00E-10	2.50E-07
THYSSENKRUPP BUDD	B2162	103.5	8.00E-10	8.28E-08
ARKEMA, INC.	B2173	1,000.30	8.00E-10	8.00E-07
EATON RESEARCH CENTER	B2217	16	8.00E-10	1.28E-08
PFIZER GLOBAL R&D	B2328	450.9	8.00E-10	3.61E-07
PARKEDALE PHARMACEUTICALS, INC.	B2329	25.89	8.00E-10	2.07E-08
PFIZER GLOBAL MANUFACTURING, HOLLAND PLANT	B2331	720.8	8.00E-10	5.77E-07
VCF FILMS, INC.	B2337	75.6	8.00E-10	6.05E-08
BIRDS EYE FOODS INC.	B2359	72.1	8.00E-10	5.77E-08
GM POWERTRAIN GROUP BAY CITY PLANT	B2460	289.73	8.00E-10	2.32E-07
PACKAGING CORPORATION OF AMERICA	B2561	48.9	8.00E-10	3.91E-08
MICHNER PLATING CO	B2591	65.8	8.00E-10	5.26E-08
HEMLOCK SEMICONDUCTOR CORPORATION	B2644	277.1	8.00E-10	2.22E-07
MERILLAT INDUSTRIES	B2671	12.25	8.00E-10	9.80E-09
OPTERA, INC.	B2751	36.29	8.00E-10	2.90E-08
U.S. ARMY GARRISON-MICHIGAN (DETROIT ARSENAL)	B2763	201.31	8.00E-10	1.61E-07
DAIMLERCHRYSLER AG, WARREN TRUCK ASSEMBLY PLANT	B2767	583.39	8.00E-10	4.67E-07
RUTHERFORD CHEMICALS, LLC	B2817	67.67	8.00E-10	5.41E-08
MICHIGAN SUGAR COMPANY - SEBEWAING FACTORY	B2873	13	8.00E-10	1.04E-08
MICHIGAN SUGAR COMPANY - CARROLLTON FACTORY	B2874	15	8.00E-10	1.20E-08
MICHIGAN SUGAR COMPANY, CARO FACTORY	B2875	0.42	8.00E-10	3.36E-10

MICHIGAN SUGAR COMPANY, CROSWELL FACTORY	B2876	0.29	8.00E-10	2.32E-10
AUTOMOTIVE COMPONENTS HOLDINGS-YPSILANTI	B2901	104.4	8.00E-10	8.35E-08
PHARMACIA & UPJOHN CO, LLC, A SUBSIDIARY OF PFIZER	B2924	13.4	8.00E-10	1.07E-08
SUNOCO PARTNERS M & T, L.P. - RIVER ROUGE TERMINAL	B2926	13.96	8.00E-10	1.12E-08
SILBOND CORP	B2952	14.82	8.00E-10	1.19E-08
FORD MOTOR CO NEW MODEL PROGRAM CTR	B2956	105	8.00E-10	8.40E-08
WOLVERINE WORLD WIDE TANNERY	B2979	9.39	8.00E-10	7.51E-09
DETROIT THERMAL BLVD HEATING PLANT	B3012	113.92	8.00E-10	9.11E-08
FITZGERALD FINISHING LLC	B3037	87.99	8.00E-10	7.04E-08
FORD MOTOR CO BROWNSTOWN	B3241	53.99	8.00E-10	4.32E-08
GIBRALTAR NATIONAL CORP	B3291	22.8	8.00E-10	1.82E-08
DAIMLERCHRYSLER TRENTON ENGINE	B3350	326.9	8.00E-10	2.62E-07
MERIDAN AUTOMOTIVE SYSTEMS	B3509	89.43	8.00E-10	7.15E-08
PHARMACIA & UPJOHN CO LLC, A SUBSIDIARY OF PFIZER	B3610	284.57	8.00E-10	2.28E-07
PACKAGING CORPORATION OF AMERICA - FILER CITY MILL	B3692	231.86	8.00E-10	1.85E-07
MACDONALD'S INDUSTRIAL PRODUCTS - PLANT #3	B3718	22.9	8.00E-10	1.83E-08
INTERNATIONAL PAPER COMPANY	B4004	52.79	8.00E-10	4.22E-08
GENERAL MOTORS CORPORATION, PONTIAC ASSY CENTER	B4031	364.5	8.00E-10	2.92E-07
GENERAL MOTORS PONTIAC SITE OPERATIONS	B4032	1,043.83	8.00E-10	8.35E-07
GMC PONTIAC CENTERPOINT CAMPUS - VALIDATION	B4033	11.18	8.00E-10	8.94E-09
GM TECHNICAL CENTER	B4049	864.38	8.00E-10	6.92E-07
ROCK-TENN CO	B4072	762.7	8.00E-10	6.10E-07
FRENCH PAPER COMPANY	B4238	139.29	8.00E-10	1.11E-07
UPPCO JOHN WARDEN STATION	B4260	0	8.00E-10	0.00E+00
FLINT GROUP PIGMENTS	B4264	105	8.00E-10	8.40E-08
MARYSVILLE GAS LIQUIDS COMPANY	B4282	365	8.00E-10	2.92E-07
PHARMACIA & UPJOHN COMPANY LLC	B4288	104.79	8.00E-10	8.38E-08
ESCO COMPANY LIMITED PARTNERSHIP	B4302	56.4	8.00E-10	4.51E-08
QUANEX CORP MACSTEEL DIVISION	B4306	96.13	8.00E-10	7.69E-08
ADM GRAIN CO	B4311	16.51	8.00E-10	1.32E-08
HICKMAN WILLIAMS CO	B4320	64.77	8.00E-10	5.18E-08
BASF CORP	B4359	561	8.00E-10	4.49E-07
OWENS CORNING TRUMBULL DIVISION	B4752	143.18	8.00E-10	1.15E-07
TILDEN MINING COMPANY L.C.	B4885	809	8.00E-10	6.47E-07
O-N MINERALS CALCITE OPERATIONS	B4925	55.32	8.00E-10	4.43E-08
DOW AGROSCIENCES LLC	B4942	797.12	8.00E-10	6.38E-07
PINNACLE FOODS CORPORATION	B4977	132.97	8.00E-10	1.06E-07
KNOLL INC	B5191	202	8.00E-10	1.62E-07
NATIONAL STANDARD COMPANY	B5417	160	8.00E-10	1.28E-07
AJAX METAL PROCESSING INC.	B5830	181.37	8.00E-10	1.45E-07
DETROIT NEWSPAPERS - NORTH PLANT FACILITY	B5853	55.71	8.00E-10	4.46E-08
SUN CHEMICAL CORP	B5966	240	8.00E-10	1.92E-07
DELPHI AUTOMOTIVE SYSTEMS-ADRIAN	B6027	146.39	8.00E-10	1.17E-07
LOCKHART CHEMICAL COMPANY	B6179	58	8.00E-10	4.64E-08

E.B. EDDY PAPER INC.	B6420	55.19	8.00E-10	4.42E-08
MIDLAND COGENERATION VENTURE	B6527	3.81	8.00E-10	3.05E-09
HENKEL TECHNOLOGIES	B6569	27.8	8.00E-10	2.22E-08
AMERICAN AXLE & MANUFACTURING, INC	B6633	73.3	8.00E-10	5.86E-08
BAYER CROPSCIENCE LP	B6643	146.94	8.00E-10	1.18E-07
DELPHI CORPORATION ENERGY & CHASSIS SYSTEMS	B7038	44.29	8.00E-10	3.54E-08
MACSTEEL MONROE INC	B7061	110.87	8.00E-10	8.87E-08
AUTOMOTIVE COMPONENTS HOLDINGS, LLC HEADQUARTERS	B7071	56.25	8.00E-10	4.50E-08
VERSO PAPER - QUINNESEC	B7192	233.92	8.00E-10	1.87E-07
GENERAL MOTORS CORPORATION - ORION ASSEMBLY	B7227	1,492.50	8.00E-10	1.19E-06
PACKERLAND PACKING	B7244	169.9	8.00E-10	1.36E-07
DAIMLER CHRYSLER STERLING HEIGHTS ASSEMBLY PLANT	B7248	711.06	8.00E-10	5.69E-07
L PERRIGO CO	B7276	53.9	8.00E-10	4.31E-08
FEDERAL MOGUL CORP	B7288	41.5	8.00E-10	3.32E-08
WEYERHAEUSER COMPANY	B7985	70.36	8.00E-10	5.63E-08
EVERGREEN PACKAGING INC.	B8574	6.67	8.00E-10	5.34E-09
SPRINGS WINDOW FASHIONS, LLC	B8707	15.45	8.00E-10	1.24E-08
ADM GRAIN COMPANY	B8863	5.01	8.00E-10	4.01E-09
MEMORIAL HOSPITAL	C5704	282.6	8.00E-10	2.26E-07
ANDREWS UNIVERSITY	C5728	145.74	8.00E-10	1.17E-07
DART CONTAINER CORPORATION OF MICHIGAN	D8065	275.4	8.00E-10	2.20E-07
COOK COMPOSITES AND POLYMERS CO.	E4569	61.34	8.00E-10	4.91E-08
PAULSTRA CRC CORPORATION	E5094	50.8	8.00E-10	4.06E-08
SELFRIIDGE AIR NATIONAL GUARD BASE	F3254	225.96	8.00E-10	1.81E-07
HACKLEY HOSPITAL	F8375	0.66	8.00E-10	5.28E-10
OAKLAND COMMUNITY COLLEGE-ORCHARD RIDGE CAMPUS	G2516	63.2	8.00E-10	5.06E-08
WILLIAM BEAUMONT HOSPITAL	G5067	508.26	8.00E-10	4.07E-07
OAKLAND CO. SERVICE CENTER - CENTRAL STEAM PLANT	G5252	40.84	8.00E-10	3.27E-08
EDWARDS BROTHERS, INC.	H5265	25	8.00E-10	2.00E-08
EASTERN MI UNIVERSITY	H5877	473.41	8.00E-10	3.79E-07
OAKWOOD HOSPITAL	J4912	138	8.00E-10	1.10E-07
OAKWOOD HEALTHCARE	K1260	98.2	8.00E-10	7.86E-08
HENRY FORD HOSPITAL	K1271	279	8.00E-10	2.23E-07
CITY OF DEARBORN DPW	K1636	0.4	8.00E-10	3.20E-10
WESTERN MICHIGAN UNIVERSITY	K2131	625.27	8.00E-10	5.00E-07
FERRIS STATE UNIVERSITY	K2155	272.35	8.00E-10	2.18E-07
MI DEPT COMMUNITY HEALTH	K2194	35.78	8.00E-10	2.86E-08
CENTRAL MICHIGAN UNIVERSITY	K2460	137.3	8.00E-10	1.10E-07
B.O.P. FEDERAL CORRECTIONAL INSTITUTE	K2688	54.01	8.00E-10	4.32E-08
BOTSFORD HOSPITAL	K2729	102.16	8.00E-10	8.17E-08
MICHIGAN STATE UNIVERSITY	K3249	295.73	8.00E-10	2.37E-07
UNIVERSITY MI DEARBORN	K5375	124.9	8.00E-10	9.99E-08
WAYNE STATE UNIVERSITY	M0239	136	8.00E-10	1.09E-07
UNIVERSITY OF MICHIGAN	M0675	3,217.78	8.00E-10	2.57E-06

ST JOHN HOSPITAL & MEDICAL CENTER	M1812	141	8.00E-10	1.13E-07
PROVIDENCE HOSPITAL AND MEDICAL CENTERS	M1967	136.42	8.00E-10	1.09E-07
ST JOSEPH MERCY HOSPITAL	M3431	228.63	8.00E-10	1.83E-07
UNIVERSITY OF MICHIGAN FLINT	M3641	130.56	8.00E-10	1.04E-07
V A MEDICAL CENTER	M3653	264.3	8.00E-10	2.11E-07
NORTHERN MICHIGAN UNIVERSITY	M3792	394	8.00E-10	3.15E-07
ADM GRAIN COMPANY	M3912	5.09	8.00E-10	4.07E-09
MICHIGAN WASTE SERVICES	M4139	50.26	8.00E-10	4.02E-08
HOPE COLLEGE	M4153	127.41	8.00E-10	1.02E-07
DETROIT METROPOLITAN WAYNE COUNTY AIRPORT	M4174	415.42	8.00E-10	3.32E-07
FORD MOTOR CO	M4175	170.99	8.00E-10	1.37E-07
GENERAL MOTORS HAMTRAMCK	M4199	76.27	8.00E-10	6.10E-08
HURON VALLEY - SINAI HOSPITAL	M4232	57	8.00E-10	4.56E-08
PRAXAIR, INC	M4347	95.33	8.00E-10	7.63E-08
FRITZ PRODUCTS	M4547	85.29	8.00E-10	6.82E-08
FORD MOTOR CO ELM ST BOILERHOUSE	M4764	1,356.91	8.00E-10	1.09E-06
FLAT ROCK METAL INC	M4768	92.02	8.00E-10	7.36E-08
WAYNE CO COMM COLLEGE WESTERN	M4772	8.8	8.00E-10	7.04E-09
WAYNE CO COMM COLLEGE DOWNRIVER	M4773	22.9	8.00E-10	1.83E-08
WAYNE CO COMM COLLEGE EASTERN	M4774	22.5	8.00E-10	1.80E-08
GM POWERTRAIN ROMULUS ENGINEERING CTR	M4781	77.79	8.00E-10	6.22E-08
WAYNE CO COMM COLLEGE NORTHWEST	M4833	22.6	8.00E-10	1.81E-08
MERITOR LLC	N0041	24.7	8.00E-10	1.98E-08
KRUGER COMMODITIES	N0547	219.56	8.00E-10	1.76E-07
STEELCASE INC.- KENTWOOD COMPLEX	N0677	174.91	8.00E-10	1.40E-07
STATE OF MICHIGAN	N0710	3.6	8.00E-10	2.88E-09
PETRO-CHEM & SOLVENT DISTILLERS GROUPS OF NORTRU.	N0731	18.86	8.00E-10	1.51E-08
GAGE PRODUCTS COMPANY	N0842	50	8.00E-10	4.00E-08
GREEN BAY PACKAGING INC-KALAMAZOO CONTAINER DIV.	N0888	57.55	8.00E-10	4.60E-08
VIKING ENERGY OF LINCOLN, INC.	N0890	1.02	8.00E-10	8.16E-10
MERIDIAN AUTOMOTIVE SYSTEMS	N0923	95.66	8.00E-10	7.65E-08
AUTO ALLIANCE INTL	N0929	81.98	8.00E-10	6.56E-08
STEELCASE INC. - GRAND RAPIDS COMPLEX	N0980	0.57	8.00E-10	4.56E-10
VIKING ENERGY OF MCBAIN	N1160	2.29	8.00E-10	1.83E-09
DENSO MANUFACTURING MICHIGAN, INC.	N1192	7.3	8.00E-10	5.84E-09
GEORGIA PACIFIC CHEMICALS LLC	N1237	6.03	8.00E-10	4.82E-09
GMC PONTIAC CENTERPOINT CAMPUS - WEST ENGINEERING	N1294	10.64	8.00E-10	8.51E-09
MI-ROP-N1336-2004	N1336	43.4	8.00E-10	3.47E-08
DAIMLERCHRYSLER TECHNOLOGY CENTER	N1436	450.41	8.00E-10	3.60E-07
WELCH FOODS INC	N1461	201.48	8.00E-10	1.61E-07
KENT COUNTY WASTE TO ENERGY FACILITY	N1604	95	8.00E-10	7.60E-08
POLLARD (U.S.) LTD	N1622	36.4	8.00E-10	2.91E-08
MORBARK INC	N1701	66.8	8.00E-10	5.34E-08
MAGNA DONNELLY CORPORATION	N1781	21.7	8.00E-10	1.74E-08

ADA COGENERATION	N1784	241.2	8.00E-10	1.93E-07
FALCON FOAM, A DIVISION OF ATLAS ROOFING CORP.	N1794	57.6	8.00E-10	4.61E-08
DAIMLERCHRYSLER JEFFERSON NORTH	N2155	267.9	8.00E-10	2.14E-07
ITW FOILS (FORMERLY MAPLE ROLL LEAF CO.)	N2344	12.3	8.00E-10	9.84E-09
GRAYLING GENERATING STATION LTD PTNR	N2388	0.55	8.00E-10	4.40E-10
MOSAIC POTASH HERSEY LLC	N2954	675.6	8.00E-10	5.40E-07
KENT CAREER TECHNICAL CENTER	N3225	24	8.00E-10	1.92E-08
ROMEO GAS PROCESSING PLANT	N3391	50.75	8.00E-10	4.06E-08
LYMTAL INTERNATIONAL, INC.	N3417	4.58	8.00E-10	3.66E-09
OAKLAND UNIVERSITY	N3422	249.8	8.00E-10	2.00E-07
PHARMACIA & UPJOHN COMPANY LLC	N3519	71.97	8.00E-10	5.76E-08
SFK PULP RECYCLING US INC	N3929	810.83	8.00E-10	6.49E-07
WILLIAM BEAUMONT HOSPITAL	N3987	144.1	8.00E-10	1.15E-07
MICHIGAN POWER LIMITED PARTNERSHIP	N4975	360.17	8.00E-10	2.88E-07
MAGNA DONNELLY CORPORATION - NEWAYGO	N5056	17.33	8.00E-10	1.39E-08
TERRY MATERIALS OF MICHIGAN, INC.	N5224	58.3	8.00E-10	4.66E-08
TWEDDLE LITHO CO	N5767	17.18	8.00E-10	1.37E-08
BOAR'S HEAD PROVISIONS COMPANY, INC.	N5797	84.28	8.00E-10	6.74E-08
METAL TECHNOLOGIES, INC. - RAVENNA DUCTILE IRON	N5866	38.15	8.00E-10	3.05E-08
DELTA COLLEGE	N5930	91.08	8.00E-10	7.29E-08
GENESYS REGIONAL MEDICAL CENTER	N6016	126.27	8.00E-10	1.01E-07
DETROIT THERMAL HENRY HEATING PLANT	N6358	48.88	8.00E-10	3.91E-08
ND INDUSTIRES, INC.	N6577	21.8	8.00E-10	1.74E-08
DEARBORN INDUSTRIAL GENERATION	N6631	0	8.00E-10	0.00E+00
HEAT TREATING SERVICES CORP	N6726	125.55	8.00E-10	1.00E-07
NEW COVERT GENERATING COMPANY LLC / COVERT GEN FAC	N6767	29.8	8.00E-10	2.38E-08
GEORGIA PACIFIC CORPORATION/ PREMIER CORRUGATED	N6866	69.59	8.00E-10	5.57E-08
GENERAL MOTORS CORPORATION-LANSING DELTA TOWNSHIP	N6950	41.41	8.00E-10	3.31E-08
HUNINGTON FOAM CORPORATION	N6976	63.7	8.00E-10	5.10E-08
WMU ENERGY RESOURCE CENTER	N6980	51.67	8.00E-10	4.13E-08
MICHIGAN ETHANOL LLC	N6996	1,681.40	8.00E-10	1.35E-06
JACOBS SVERDRUP	N7081	59.45	8.00E-10	4.76E-08
HEAT TREATING SERVICES CORP OF AMERICA	N7096	26.2	8.00E-10	2.10E-08
SUN GRO HORTICULTURE	N7132	71.31	8.00E-10	5.70E-08
NESTLE WATERS NORTH AMERICA	N7149	19.82	8.00E-10	1.59E-08
RAINBOW BRIDGE	N7158	7	8.00E-10	5.60E-09
SCA PACKAGING NORTH AMERICA, INC.	N7289	106.8	8.00E-10	8.54E-08
BLUEWATER GAS STORAGE FACILITY	N7303	38.99	8.00E-10	3.12E-08
OAKLAND COMMUNITY COLLEGE-HIGHLAND LAKES CAMPUS	N7380	22.3	8.00E-10	1.78E-08
OAKLAND COMMUNITY COLLEGE - AUBURN HILLS CAMPUS	N7381	69.4	8.00E-10	5.55E-08
MAGNA DONNELLY CORP.	N7395	52.42	8.00E-10	4.19E-08
CONAGRA	N7402	50.39	8.00E-10	4.03E-08
BAKERY CHEF	N7543	19	8.00E-10	1.52E-08

JSP	N7623	55.4	8.00E-10	4.43E-08
CROSS HULLER A.K.A. GIDDINGS & LEWIS	N7636	0.09	8.00E-10	7.20E-11
TOTAL				0.000050

Stationary Internal Combustion Engines

Stationary Internal Combustion Engine emissions were calculated similarly to Industrial/ Commercial Boilers that combust natural gas. The EPRI factor produced a statewide estimate of 2.28E-05 lbs, compared to the MAERS estimate, which produced an estimate of 217.443 lbs using the USEPA factor.

The following sources of natural gas combustion were included in the estimate:

Table 11.

Facility Name	SRN	Throughput (MMCF)	Emission factor	Lbs emitted
KELLOGG USA INC.	A0563	0	8.00E-10	0.00E+00
DETROIT DIESEL CORPORATION	A8638	0.6	8.00E-10	4.80E-10
MARATHON PETROLEUM COMPANY LLC	A9831	194.4	8.00E-10	1.56E-07
REED CITY COMPRESSOR STATION	B3721	181.94	8.00E-10	1.46E-07
MERIT ENERGY CO. - KALKASKA GAS PLANT	B4292	1,110.39	8.00E-10	8.88E-07
DOW AGROSCIENCES LLC	B4942	797.12	8.00E-10	6.38E-07
VANDYKE GENERATING PLANT	B5421	38.4	8.00E-10	3.07E-08
GM POWERTRAIN ROMULUS ENGINE PLANT	B5815	0.21	8.00E-10	1.68E-10
MID MICHIGAN GAS STORAGE CO - CAPAC	B6481	152.25	8.00E-10	1.22E-07
CLINTON VILLAGE OF	B6508	0	8.00E-10	0.00E+00
RAY COMPRESSOR STATION	B6636	102.7	8.00E-10	8.22E-08
ST. CLAIR COMPRESSOR STATION	B6637	53.51	8.00E-10	4.28E-08
ANR STORAGE COMPANY - EXCELSIOR COMPRESSOR STATION	B7196	150.9	8.00E-10	1.21E-07
ANR -- RAPID RIVER COMPRESSOR STATION	B7197	111.75	8.00E-10	8.94E-08
ANR-COLDSPRINGS/ BLUE LAKE GAS STORAGE COMPANY	B7198	569.93	8.00E-10	4.56E-07
ANR PIPELINE CO. SOUTH CHESTER COMPRESSOR STATION	B7219	94.93	8.00E-10	7.59E-08
ANR PIPELINE CO - WOOLFOLK COMPRESSOR STATION	B7220	642.6	8.00E-10	5.14E-07
ANR PIPELINE - CENTRAL CHARLTON COMPRESSOR STATION	B7390	77.62	8.00E-10	6.21E-08
MUTTONVILLE COMPRESSOR STATION	B8337	30.18	8.00E-10	2.41E-08
GREAT LAKES GAS TRANSMISSION STATION #11	B8573	2,322.35	8.00E-10	1.86E-06
DAIMLERCHRYSLER MACK AVE	M4085	0.13	8.00E-10	1.04E-10
ROUSH INDUSTRIES	M4780	0	8.00E-10	0.00E+00
OMIMEX ENERGY- CLAYBANKS 2 FACILITY	N2096	29.46	8.00E-10	2.36E-08
GREAT LAKES GAS TRANSMISSION STATION #7	N2168	2,671.95	8.00E-10	2.14E-06
MUSKEGON RIVER COMPRESSOR STATION	N2901	83.8	8.00E-10	6.70E-08
MOSAIC POTASH HERSEY LLC	N2954	675.6	8.00E-10	5.40E-07
SOUTH ROMEO GAS STORAGE CO	N2988	25.64	8.00E-10	2.05E-08
EATON RAPIDS GAS STORAGE SYSTEM	N3022	148.18	8.00E-10	1.19E-07
ROMEO GAS PROCESSING PLANT	N3391	226	8.00E-10	1.81E-07

TAGGART COMPRESSOR STATION	N3392	339.61	8.00E-10	2.72E-07
GREAT LAKES GAS TRANSMISSION STATION #10	N3758	2,182.36	8.00E-10	1.75E-06
GREAT LAKES GAS TRANSMISSION STATION #9	N3759	1,039.82	8.00E-10	8.32E-07
GREAT LAKES GAS TRANSMISSION STATION #8	N3760	3,018.89	8.00E-10	2.42E-06
GREAT LAKES GAS TRANSMISSION STATION #13	N3818	2,163.14	8.00E-10	1.73E-06
ANR PIPELINE COMPANY - HAMILTON COMPRESSOR STATION	N5574	24.62	8.00E-10	1.97E-08
ANR PIPELINE COMPANY - HAMILTON COMPRESSOR STATION	N5574	561.77	8.00E-10	4.49E-07
ANR PIPELINE COMPANY - BRIDGMAN COMPRESSOR STATION	N5575	790.15	8.00E-10	6.32E-07
ANR PIPELINE COMPANY - BRIDGMAN COMPRESSOR STATION	N5575	197.35	8.00E-10	1.58E-07
ANR PIPELINE CO. - GOODWELL COMPRESSOR STATION	N5576	73.11	8.00E-10	5.85E-08
ANR PIPELINE CO. - WINFIELD COMPRESSOR STATION	N5578	33.2	8.00E-10	2.66E-08
MID MICHIGAN GAS STORAGE CO- ORIENT COMPRESSOR STA	N5580	15.96	8.00E-10	1.28E-08
FARWELL COMPRESSOR STATION NO 12	N5581	1,054.64	8.00E-10	8.44E-07
FARWELL COMPRESSOR STATION NO 12	N5581	564.08	8.00E-10	4.51E-07
ANR PIPELINE COMPANY LINCOLN COMPRESSOR STATION	N5586	291.5	8.00E-10	2.33E-07
CITY OF ST. LOUIS	N5724	0.25	8.00E-10	2.00E-10
OVERISEL COMPRESSOR STATION	N5792	0	8.00E-10	0.00E+00
CORE ENERGY, LLC., CHESTER 10 CO2 RECOVERY	N5798	5.3	8.00E-10	4.24E-09
PARTELLO COMPRESSOR STATION	N6015	0.62	8.00E-10	4.96E-10
FEDERATED OIL & GAS PROP - CHARLTON 16	N6239	0	8.00E-10	0.00E+00
FEDERAL MOGUL POWERTRAIN INC	N6266	0	8.00E-10	0.00E+00
WESTSIDE GAS PRODUCERS, LLC	N6512	29.8	8.00E-10	2.38E-08
DEARBORN INDUSTRIAL GENERATION	N6631	4,707.45	8.00E-10	3.77E-06
VECTOR PIPELINE L.P., HIGHLAND COMPRESSOR STATION	N6838	894.92	8.00E-10	7.16E-07
TOTAL				2.28E-05

Wood Combustion

Electric Utilities

Mercury emissions from wood-fired electric utilities were estimated using data from MAERS as part of Michigan's submittal to EPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (McGeen, 2009). Wood consumption, or throughput, is expressed in tons.

Wood-fired Electric Utilities included in the estimate:

Table 12.

Facility	SRN	Throughput (tons)	Emission factor	Lbs emitted
CADILLAC RENEWABLE ENERGY FACILITY	N1395	375,036.00	3.64E-05	13.6513
GRAYLING GENERATING STATION LTD PTNR	N2388	378,776.00	1.97E-06	2.0000
HILLMAN POWER CO	N1266	201,247.00	3.64E-05	7.3254
VIKING ENERGY OF LINCOLN, INC.	N0890	164,368.00	3.64E-05	5.9830
VIKING ENERGY OF MCBAIN	N1160	173,191.41	5.15E-06	0.8919
WHITE PINE ELECTRIC POWER LLC	B1966	7,140.00	5.15E-06	0.0368
TOTAL				29.8884

Industrial/Commercial

Point source estimates such as those for Industrial and Commercial combustion of wood were collected from MAERS (DEQ, 2009). These point source estimates were generated as part of Michigan's submittal to EPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (DEQ, 2009).

Facilities included in the estimate:

Table 13.

Facility	SRN	Throughput (tons)	Emission factor	Lbs emitted
AMERIWOOD INDUSTRIES	A0749	7,459.00	3.640E-05	0.27151
ARROW DOOR	B8603	407.00	3.640E-05	0.01481
BANKS HARDWOODS, INC.	N2206	7,069.00	3.640E-05	0.03641
BESSEMER PLYWOOD CORP	N1393	10,023.00	3.395E-05	0.34028
CENTRAL MICHIGAN UNIVERSITY	K2460	36,821.44	3.64E-05	1.3403
CONNOR AGA SPORTS FLOORING CORP	B7099	2,000.00	5.150E-06	0.01030
DECORATIVE PANELS INTERNATIONAL, INC	B1476	9,200.00	3.150E-05	0.2898
DECORATIVE PANELS INTERNATIONAL, INC	B1476	5,259.30	3.395E-05	0.178553
ESCANABA PAPER COMPANY	A0884	297,411.00	3.395E-05	10.09710
HOWARD MILLER COMPANY	A5937	1,521.50	5.150E-06	0.00784
LOUISIANA-PACIFIC CORP NEWBERRY PLANT	N0780	9,478.00	5.150E-06	0.04881
LOUISIANA-PACIFIC CORP SAGOLA PLANT	N1315	19,505.00	5.150E-06	0.10045
MANTHEI INC - VENEER MILL	A0998	4,123.00	3.395E-05	0.13998
MICHIGAN MAPLE BLOCK CO	A0999	2,447.30	5.150E-06	0.01260
NEENAH PAPER - MICHIGAN INC	B1470	0.00	3.395E-05	0.00000
POTLATCH FOREST PRODUCTS CORP	N5940	28,367.00	5.150E-06	0.14609

S. D. WARREN, MUSKEGON, MI, OPERATIONS	A4203	41,043.10	3.395E-05	1.39341
SLIGH FURNITURE COMPANY	B5453	602.00	5.150E-06	0.00310
SPRINGS WINDOW FASHIONS, LLC	B8707	807.00	5.150E-06	0.00416
VERSO PAPER - QUINNESEC	B7192	316,312.00	3.395E-05	10.73879
WOLVERINE HARDWOODS INC.	N2454	618.00	3.640E-05	0.02250
TOTAL				25.19679

Petroleum Refining

Marathon Ashland Petroleum (A9831), the only petroleum refinery in the state, emitted 4.01 lbs of mercury in 2005 according to data gathered from MAERS as part of Michigan's submittal to EPA's NEI and GLC's 2005 Inventory of Toxic Air Emissions to the Great Lakes Region (McGeen, 2009).

Table 14.

Facility	SRN	Throughput (MMCF)	Emission factor	Lbs emitted
MARATHON PETROLEUM REFINING	A9831	898.8	4.23E-04	0.3797
MARATHON PETROLEUM REFINING	A9831	1330.3	2.73E-03	3.6317
TOTAL				4.0114

Residential LPG (Propane) Combustion

Residential fuel combustion estimates were generated as part of Michigan's submittal to the EPA's NEI and the GLC's 2005 Inventory of Toxic Air Emissions for the Great Lakes Region. For residential Liquefied Petroleum Gas (LPG) or propane combustion, an emission factor of 0.000012 lbs/1,000 gallons was used along with year 2000 Census data on household heating and 2005 statewide fuel consumption data from the EIA of the US Department of Energy to generate estimated emissions of mercury (DEQ, 2009). LPG consumption, or throughput, is expressed in thousand of gallons.

Table 15.

Category	Throughput (E3GAL)	Emission Factor	Lbs emitted
RESIDENTIAL LPG (PROPANE) COMBUSTION	351,681.00	1.200E-05	4.22

INCINERATION

Sewage Sludge Incineration

When possible, specific facility information was collected and used to compute emissions. The Battle Creek Wastewater Treatment Plant has two multiple hearth sewage sludge incinerators, which have venturi scrubber, impingement scrubber, quencher, and afterburner controls. Both incinerators had stack testing conducted on them in 2001. According to facility reported MAERS data, the Battle Creek Wastewater Treatment Plant emitted 0.00 lbs of mercury in 2005 due to incineration (DEQ, 2009). Results from a mercury audit conducted on the Detroit WWTP in 2003 found that the sludge had an average mercury content of 1.43 mg/kg. According to MAERS, 127,660.80 tons of biosolids were incinerated at the Detroit WWTP in 2005 (McGeen, 2009). Assuming the venturi scrubber, impingement scrubber, and demister controls remove 30% of the mercury in the biosolids, 255.32 lbs of Hg were likely released to the air from this facility in 2005. The Flint Water Pollution Control Plant has an afterburner, venturi and impingement tray scrubber and mist eliminator controls. A stack test from 2001, and 2005 MAERS operating data, were used to compute emissions (McGeen, 2009). Emissions in 2005 from the Ypsilanti Community Utilities Authority (YCUA) were estimated to be about 0.10 lbs/yr (McGeen, 2009). This was based on 2007 stack test data obtained from the new incinerator, as the previous unit, a multiple hearth incinerator was permanently closed in 2004. YCUA now operates a fluidized bed incinerator with venturi and impingement scrubbers, wet electrostatic precipitator, and carbon adsorption. The East Lansing POTW shut down their incinerator in 2002, and hence it was not included in this inventory. The Trenton WWTP removed their incinerator in 2003 and it was also not accounted for in this inventory.

EI Toolkit, the AQD's internal version of MAERS, was used to look up Source Classification Codes (SCCs) and control technologies for the other incinerators (DEQ, 2009). An emission factor from FIRE was then applied to these facilities' throughput information (USEPA, 2009).

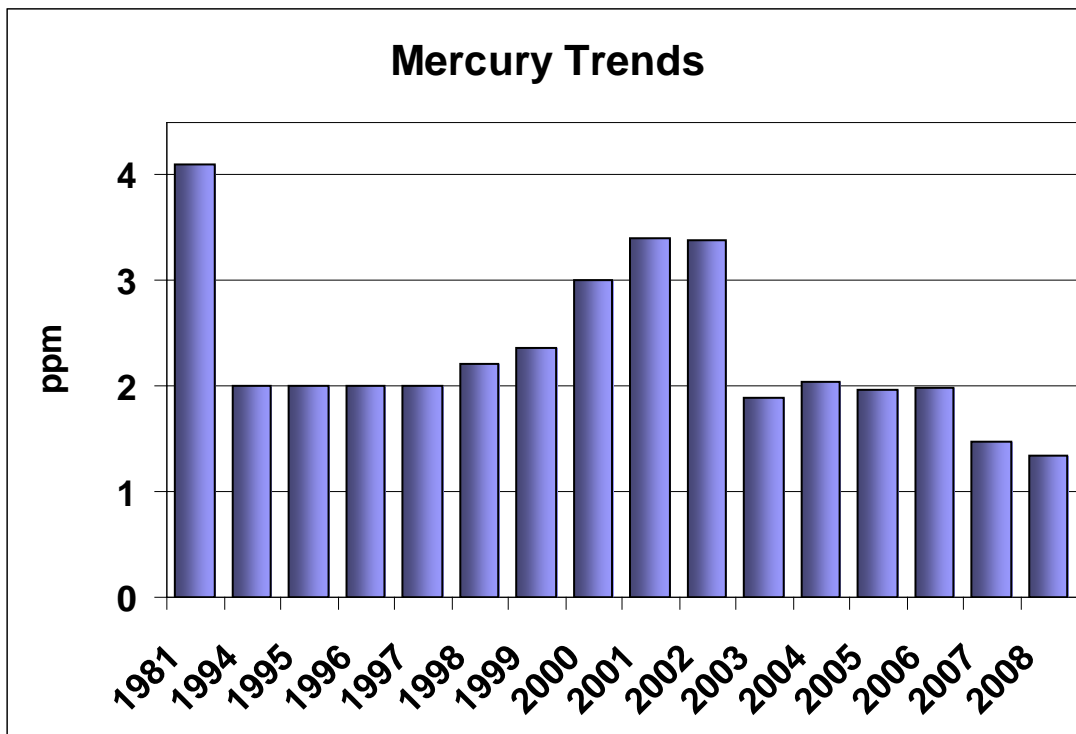
The following sewage sludge incinerators were included in the calculation:

Table 16.

Facility Name	SRN	Throughput (tons)	MAERS value in lbs	Lbs emitted (final value)	Emission factor (lb/ton)	Source
ANN ARBOR WASTEWATER TREATMT PLT	B2060	0.00	0.00	0.00		
CITY OF BATTLE CREEK WASTEWATER TREATMENT PLANT	B6307	1,352.00	0.00	0.00		Reported by owner
DETROIT WWTP	B2103	127,660.80	0.01	255.32	2.00E-03	Factor from 2003 Hg audit; 2005 throughput
FLINT WATER POLLUTION CONTROL FACILITY	B1598	3,962.00	18.23	9.41		2001 stack test
PONTIAC WWTP	B1950	7,156.70	NA	10.02	1.40E-03	FIRE, and 2006 throughput
PORT HURON WWTP	L0058	1,277.00	NA	2.00	1.40E-03	FIRE, and 2002 throughput
WARREN WASTE WATER TREATMENT PLANT	B1792	5,795.00	26.66	11.01	1.90E-03	FIRE
YPSILANTI COMM. UTILITIES AUTHORITY	B6237	0.00	0.00	0.10		2007 stack test
TOTALS			44.90	287.86		

There were 1.96 ppm mercury in biosolids in Michigan in 2005 (MDEQ, Water Bureau). Minnesota reported 1.4 ppm mercury in biosolids in 2000 (MPCA, 2004). Oregon reported levels between 1.71 ppm and 2.06 ppm mercury in Oregon sewage sludge in 1999 (Weiss & Wright, 2001).

Trends for Mercury in Michigan Biosolids (MDEQ, Water Bureau):



Municipal Waste Incineration

Three municipal waste combustors were operating in Michigan in 2005. Kent County Waste-to-Energy submitted facility-verified estimates of 7.00 lbs of mercury to MAERS for the 2005 operating year (MAERS, 2009). An emission factor for the Kent facility was calculated based on 2002 stack testing data and throughput information from EI Toolkit. An emission factor for the Jackson County Waste to Energy facility was calculated based on the facility's 2005 stack testing data (DEQ, 2010) and hourly operating data (MAERS, 2010), and yielded an emission estimate of 8.11 lbs for 2005. Michigan Waste-to-Energy (Greater Detroit Resource Recovery Facility) conducted stack testing on all three of its municipal solid waste combustors in 2005 (Environmental Test Report, Volume 1, 2005). The combustors at the Greater Detroit facility had combined emissions of 14.93 lbs of Hg, based on continuous operation 24 hours per day, 365 days per year, as substantiated by the facility's 2005 MAERS submittal. The Central Wayne Energy Recovery facility permits were voided in 2004 as the facility was no longer operational.

The following Municipal Waste Incinerators were included in the calculations:

Table 17.

Facility Name	SRN	Throughput (tons MSW)	Emission factor (lb/ton)	Lbs emitted	COMMENTS
KENT COUNTY WASTE TO ENERGY FACILITY	N1604	88,470	6.55E-04	5.24	Reported by owner (stack test)
KENT COUNTY WASTE TO ENERGY FACILITY	N1604	88,470	3.02E-04	2.50	Reported by owner (stack test)
JACKSON CO WASTE TO ENERGY	N1125	50,670	2005 stack tests, hourly rates	8.11	ERA estimate based on 2005 stack test data and hourly emission rates, times 24 hrs x 365 days/yr
GREATER DETROIT RESOURCE RECOVERY	M4148	649,580	2005 stack test, hourly rates	14.93	ERA estimate based on 2005 stack test data and hourly emission rate, times 24 hrs x 365 days/yr
TOTALS				30.78	

Hazardous Waste Incineration

Two facilities operate hazardous waste incinerators in Michigan, Dow (A4033) and Pharmacia and Upjohn (B3610). In 2003, Dow began operating a new incinerator, the 32 Incinerator, to replace the existing 830 Building and 703 Building Incinerators. Stack testing was conducted on the 32 Incinerator in 2004. An average of less than 1.55E-03 pounds of Hg per hour were emitted from this facility (URS Corp, 2004). Data from EI Toolkit revealed that the Dow 32 incinerator operates up to 24 hours a day, 182 days a year, per the facility's 2005 operating schedule (MAERS, 2009). This extrapolates to yearly emissions of 6.77 pounds of mercury.

Pharmacia and Upjohn reported 20 lbs of Hg air emissions from their facility to the USEPA TRI database in 2005 (DEQ, 2009). The Pharmacia and Upjohn hazardous waste incinerator (Building 172 Incinerator) had an emissions limit in their Permit To Install No. 137-03A of 0.0000633 lbs/hr (Schleusener, 2010), which is stricter than the applicable Maximum Achievable Control Technology (MACT) standard. This translates to 0.45 lbs/year, assuming emissions 24 hours a day, 300 days per year based on operational data from EI Toolkit. Neither stack testing nor an emission factor was available for this facility. The incinerator was reported as removed on December 31, 2006 (MAERS, 2010).

Table 18.

Facility Name	SRN	Emission factor (lb/hr)	Lbs emitted	COMMENT
DOW CHEMICAL	A4033	1.55E-03	7	Based on 2004 stack test
PHARMACIA & UPJOHN	B3610	6.33E-05	0.45	Based on permitted limit of 6.33E-05 lb/hr. This source was incorrectly identified as B2924 in the 2002 mercury report, and emission factor was incorrectly reported at 6.33e-03 lb/hr.
TOTALS			7.45	

Hospital Medical Infectious Waste Incineration

Only one dedicated medical waste incineration facility was operating in Michigan in 2005, City Medical Waste (M4139) in Hamtramck. This Hospital Medical Infectious Waste Incinerator (HMIWI) stopped operating on July 28, 2008, per the date of the court order which required the company to cease operation of the facility (McLemore, 2010). The ROP was voided on December 15, 2008 (Foy, 2010). Using an emission factor from a 2002 stack test and 2005 throughput data, an estimate of 5.84 lbs was calculated for 2005.

Table 19.

SRN	Facility Name	Throughput (tons)	Emission factor (lb/ton)	Source of factor	Lbs emitted
M4139	CITY MEDICAL WASTE	3592.9	1.63E-03	AQD estimate based on 2002 stack test emission factor and 2005 annual throughput	5.8385
	TOTALS				5.8385

Human and Animal Cremation (Point Source)

Two universities and three animal/veterinary cremation facilities reported the combustion of animal and/or human remains in 2005 (the MAERS system specifies “medical waste” as the allowable material code for Source Classification Code 5-02-005-05, therefore the facilities indicated in their Operator’s Description field that the waste was actually animal and/or human remains for cremation). A total of 1.01E-05 lbs of emissions were estimated from the point source human and animal cremation category.

Table 20.

SRN	Facility Name	Throughput (tons)	Emission factor (lb/ton)	Source of factor*	Lbs emitted
K3249	MICHIGAN STATE UNIVERSITY	683.44	1.38E-08	factor based on Takoaka study	9.43E-06
M0239	WAYNE STATE UNIVERSITY	19.35	1.38E-08	factor based on Takoaka study	2.67E-07
N6494	VETERINARIAN CREMATION SERVICE	27	1.38E-08	factor based on Takoaka study	3.73E-07
N6543	MONROE CO ANIMAL CONTROL	1.41	1.38E-08	factor based on Takoaka study	1.95E-08
N7158	RAINBOW BRIDGE	2.5	1.38E-08	factor based on Takoaka study	3.45E-08
	TOTALS				1.01E-05

* 0.94 mg Hg/body (w/o fillings) used for human and/or animal remains; assumes 100 lbs/body per study "Mercury emission from crematories in Japan" (Takaoka, Oshita, Takeda and Morisawa, 2010).

Pathological Waste Incineration

Pharmacia & Upjohn Company LLC (N3519), a medical research and development facility, reported 0.04 lbs of mercury from the disposal of pathological waste in their pathological waste incinerator. This was based on their use of a MAERS emission factor.

Table 21.

SRN	Facility Name	Throughput (tons)	Emission factor (lb/ton)	Source of factor	Lbs emitted
N3519	PHARMACIA & UPJOHN COMPANY LLC	52.6	7.34E-04	MAERS	0.0386

INDUSTRIAL SOURCES

Cement Manufacturing

There are three cement manufacturing facilities in Michigan: Holcim, Lafarge, and Cemex. Throughput values for all of the facilities were obtained from EI Toolkit. According to MAERS, Holcim estimated their facility's 2005 emissions of mercury to be 53.00 lbs, through stack testing. Holcim ceased operating the cement kilns in 2009 and is expected to void the kiln permits in 2010. The facility will continue only as a cement terminal with bagging operation (Maillard, 2009). Lafarge's own 2005 estimate of mercury from their cement manufacturing facility was 520.00 lbs, as reported to MAERS. Speciation data was obtained from a 2007 report prepared for the company (Advanced Environmental Management Group, 2007).

Table 22.

B1477 (Lafarge) processes, for 2005	Hg in lbs	Particulate divalent speciation factor	Gaseous divalent speciation factor	Elemental gaseous speciation factor	Hg(p) in lbs	RGM in lbs	Hg(0) in lbs
KILN 19	47.00	0.01	0.85	0.14	0.47	39.95	6.58
KILN 20	54.00	0.01	0.85	0.14	0.54	45.90	7.56
KILN 21	51.00	0.01	0.85	0.14	0.51	43.35	7.14
KILN 22	160.00	0.01	0.91	0.08	1.60	145.60	12.80
KILN 23	204.00	0.01	0.91	0.08	2.04	185.64	16.32
RAW MATERIAL GRINDING AND DRYING	4.00	0.17	0.38	0.45	0.68	1.52	1.80
TOTAL	520.00				5.84	461.96	52.20

Both Holcim and Lafarge control emissions using a baghouse. Since stack testing was not available for Cemex, TRI data was utilized to estimate emissions of Hg for 2005 (DEQ, 2009). Cemex has an electrostatic precipitator to control emissions. A total of 628 lbs of Hg were estimated from cement manufacturing in Michigan in 2005.

The following Cement Manufacturing facilities were included in the inventory:

Table 23.

SRN	Facility	Throughput (tons)	Source for best estimate	Lbs Hg Emitted (best estimate)	TRI data (lbs Hg)	MAERS Estimate
B1743	Holcim	866,671	owner reported value in MAERS, 2005	53.00	61.10	53.00
B1477	Lafarge	4,763,719	owner reported value in MAERS, 2005	520.00	520.04	520.00
B1559	Cemex	1,919,733	TRI, 2005	55.00	55.00	422.34
			Total	628.00	636.14	995.34

Taconite Processing

Michigan has two taconite processing plants, Empire and Tilden, which are located in the Marquette Range of the Upper Peninsula of Michigan. According to Cleveland-Cliffs' MAERS submittals (Cleveland-Cliffs is the owner of Tilden and Empire), Tilden produced 7.94 million tons of taconite pellets in 2005, and Empire produced 3.21 million tons of coal-fired taconite pellets in 2005. A 2002 stack test for Tilden found it emitted about 0.035916 tons/yr of mercury (71.83 lbs/yr), based on reported operation of 8760 hours each year. Based on the 2005 operating schedule for coal-fired pellet production from MAERS (6840 hours for the Unit 1 kiln and 5160 hours for the Unit 2 kiln), an estimate of 49.20 lbs was created for 2005. Tilden processes both hematite and magnetite. Empire only produces taconite from magnetite. Based on an emission factor of 3.54E-06 lb Hg/long ton of coal-fired pellets made (3.161E-06 lb/ton) from Jiang (1999), and the 2005 production value of 3.21 million tons from coal firing, 10.16 lbs of Hg were likely emitted from Empire for 2005. Total mercury emissions from Taconite processing amount to 59.36 lbs.

Dental Amalgam Manufacturing

There is one dental amalgam manufacturer in Michigan, Kerr Industries (B2658) in Romulus. Based on the average mercury concentration inside the building and the ventilation rate of the building, one can estimate that less than four pounds of Hg are emitted from this facility every year. Lumex RA915+ monitoring inside the building yielded an estimated average mercury concentration of $\sim 500 \text{ ng/m}^3$ for the entire building. The building has a volume of $44,309 \text{ m}^3$ and has nine air exchanges per hour.

Lime Manufacturing

Throughput values for facilities with lime kilns were obtained using EI Toolkit. These throughputs were then multiplied by an emission factor to estimate mercury emissions. The emission factor of 1.2×10^{-4} lbs of Hg per ton of lime produced corresponds to facilities that manufacture lime (Pilgrim, 1998). The emission factor from FIRE for lime kilns used by the paper manufacturing industry (2.90×10^{-7} lbs of Hg per ton of lime produced) was used to estimate emissions from Escanaba Paper Company and Verso Paper - Quinnesec. Approximately 46.86 pounds of mercury were emitted to the air in 2005 from lime manufacturing kilns. Western Lime Corporation's permit was approved in August 2005 but the facility did not begin operations until May 14, 2007, therefore this source was not included in the 2005 inventory.

The following lime kilns were included in the calculation:

Table 24.

Facility Name	SRN	Throughput (tons)	emission factors*	Lbs emitted	2005 TRI data
CARMEUSE LIME/ RIVER ROUGE	B2169	281,667.00	1.20E-04	33.80	4.20
ESCANABA PAPER COMPANY	A0884	89,621.00	2.90E-07	0.03	38.90
HARBISON WALKER REFRACTORIES CO	A3933	0.00	1.20E-04	0.00	
MARTIN MARIETTA MAGNESIA SPECIALTIES, LLC	A3900	108,302.00	1.20E-04	13.00	
THE DOW CHEMICAL COMPANY, CALCIUM CHLORIDE PRODS	B1846	0.00	1.20E-04	0.00	
VERSO PAPER - QUINNESEC	B7192	105,241.00	2.90E-07	0.03	
WESTERN LIME CO**	N7362	0.00	1.20E-04	0.00	
TOTAL				46.86	43.10

* 1.2E-04 LB/TON from Pilgrim, 1998; 2.9E-07 LB/TON from FIRE

** WESTERN LIME CO DID NOT BEGIN OPERATIONS UNTIL 5/14/07

Phosphate Mills

Michigan does not have any phosphate mills. Based on a query of the SCC codes involving phosphates, superphosphates, and ammonium phosphates, the only facility in MAERS dealing with use of phosphates is B1989, Agrium Advanced Technologies (U.S.) Inc., whose NAICS code of 325314 indicates “Fertilizer (Mixing Only) Manufacturing.”

Brick Manufacturing

Hanson Brick (A6497) in Corruna, MI emitted 1.23 lbs from its two gas-fired kilns in 2005, based on the facility reported throughput and the application of a standard EPA emission factor by the MAERS emission estimator.

Table 25.

Facility Name	SRN	Throughput (tons)	Emission Factors	Lbs Emitted
HANSON BRICK	A6497	81222.74	7.5E-06	0.6092
HANSON BRICK	A6497	82928.64	7.5E-06	0.6220
TOTAL				1.2311

Coke Production

Michigan has one coke battery, the EES Coke Battery, LLC (A7809) on Zug Island, River Rouge. According to a “Summary of Mercury Emissions for EES PTI,” EES Coke Battery emitted 2.59 lbs of Hg to the atmosphere from 2004-2005.

Summary of Mercury Emissions for EES PTI (modified from Yanochko, 2006)

Table 26.

Emission Source	Baseline ('04-'05) (Pounds/Year)	Excluded (1,300,000 TPY) (Pounds/Year)	Projected (1,365,000 TPY) (Pounds/Year)	Projected Change (Pounds/Year)
Charging	6.65×10^{-5}	7.64×10^{-5}	7.64×10^{-5}	0.00
Charging Lid Leaks	1.30×10^{-5}	1.30×10^{-5}	1.30×10^{-5}	0.00
Door Leaks	1.82×10^{-3}	1.82×10^{-3}	1.82×10^{-3}	0.00
Offtake Leaks	4.32×10^{-5}	4.32×10^{-5}	4.32×10^{-5}	0.00
Pushing	8.66×10^{-3}	8.78×10^{-3}	9.22×10^{-3}	$+4.4 \times 10^{-4}$
Quenching				
Combustion Stack	0.830	0.846	0.888	+0.042
Flare	1.75	1.78	1.75	-0.03
River Rouge PP				-0.312
Totals	2.59			-0.2996

Medical Waste Autoclave

There were two medical waste autoclaves operating in Michigan in 2005. One was Michigan Waste Services (M4139) in Grand Blanc. This facility, which utilized a medical waste incinerator as well as the autoclave, is no longer operating. This source ceased operations on July 28, 2008, per the date of the court order which required the company to cease operation of the facility (McLemore, 2010). The other medical waste autoclave was Agility (N7568), in Kentwood. This facility was later known as Stericycle, Inc. This source started operation on October 7, 2004, and closed in 2010 (Charley, 2010).

PRODUCTION OF METALS

Primary Metal production refers to metal created from ore; whereas, secondary metal production refers to the production of alloys from ingots and to the recovery of metal from scrap and salvage (USEPA, 1986). Metal production that uses scrap is of more concern for mercury emissions, because of the wide application of mercury-containing convenience light switches and antilock brake switches used in vehicles until 2003.

BOFs in primary metal production (Steel Manufacturing)

Basic Oxygen Furnaces (BOFs) are used to make steel from molten metal and scrap. The input material is typically 70 percent molten pig iron and 30 percent scrap (Grinstern, 2010). The input material is refined by injecting high-purity oxygen into the furnace; the oxygen reacts with carbon and other impurities in the metal to remove them from the metal. Basic oxygen process steelmaking is executed in large refractory lined pear-shaped furnaces (USEPA,1986).

There are two facilities in Michigan that make steel using the basic oxygen process, Severstal (formerly Rouge Steel) (A8640) and US Steel (A7809). Severstal recently estimated their 2004 emissions to be 76 lbs/yr for a permit review, and for 2005 reported 77.00 lbs of mercury emissions to USEPA's TRI (DEQ, 2009). TRI data from 2005 indicates that US Steel emitted 2.00 lbs of Hg in that year. In total, it is estimated that facilities engaged in steelmaking via the Blast/BOF process emitted 79.00 lbs of Hg to the atmosphere in 2005.

Table 27.

FACILITY	SRN	EMISSIONS IN LBS	SOURCE OF DATA
SEVERSTAL (FORMERLY ROUGE STEEL)	A8640	77.00	2005 TRI
US STEEL	A7809	2.00	2005 TRI
TOTAL		79.00	

EAFs in primary metal production (Steel Manufacturing)

Electric arc furnaces are the most common type of furnace used for the electric production of steel. EAFs are capable of melting small amounts of iron scrap, pig iron, and direct reduced iron, but primarily melt scrap (Energy International, 2005). According to the AP-42 Compilation of Emission Factors, about 57% of total steel produced in the U.S. comes from EAFs in operations called minimills (USEPA, 2010). Minimills use 100% scrap charge (Metals Advisor).

The EI Toolkit was utilized to find throughput information for EAFs used in primary metal production. MAC Steel Jackson (B4306) in Jackson, MI conducted stack testing in December 2004. This stack test estimated emissions of 0.009 tons of Hg per year (18 lbs/yr) assuming 7,000 hours per year production potential (White, 2005). Based on the stack test emission factor, and the 2005 operating schedule of 7224 hours reported to MAERS, 19.50 lbs are estimated for 2005 from this facility. MAC Steel Monroe (B7061) estimated, in their 2005 MAERS report, that their mercury emissions for the year were 0.03 lbs. This is based on baghouse dust analysis, for emissions of particle bound mercury. The MAC Steel Jackson stack test emission factor was applied to this facility's throughput data to estimate elemental and gaseous reactive mercury from the EAF. Accordingly, a total estimate of 18.76 lbs of mercury was estimated for MAC Steel Monroe. Ervin Amasteel (B1754) reported 2005 throughput data of 100,060 tons for their EAF. An emission factor from *Toxics in Vehicles: Mercury* was then

applied since FIRE was lacking an emission factor for this category (Ecology Center & Great Lakes United, 2001). 69.04 lbs are estimated for Ervin Amasteel, accordingly.

Table 28.

Facility Name	SRN	SCC	Throughput	Emission factor*	Lbs emitted from EAF	Activity data for MAC Steel Monroe, for purposes of estimating particle bound mercury emissions (from baghouse)	Elemental and gaseous reactive mercury from MAC Steel Monroe	TOTALS	COMMENTS
MACSTEEL MONROE INC	B7061	30300908	6,936	2.7E-03 lb/hr	18.73	524,101 tons carbon steel	0.03	18.76	FOR MACSTEEL MONROE, TOTAL IS SUM OF ELEMENTAL AND GASEOUS REACTIVE MERCURY (EAF) AND PARTICLE BOUND MERCURY BAGHOUSE)
	B4306	30300904	7,224 hours	2.7E-03 lb/hr	19.5048			19.5048	EAF
ERVIN AMASTEEL DIVISION	B1754	30400701	100,060.00 tons steel	6.90E-04 lb/ton	69.04			69.04	EAF
TOTAL								107.30	

*2.70E-03 lb/hr is a factor derived from stack testing at the MAC Steel Jackson facility

EAFs & EIFs in Secondary Metal Production (Steel Foundries)

EAFs and EIFs are used by the steel industry to melt and formulate steel. EAFs are large, welded steel cylindrical vessels with removable roofs through which three retractable carbon electrodes are lowered; metal charge is melted by the resistive heating generated from electrical current flowing among the electrodes and through the charge. EAFs are used to produce carbon and alloy steels. The input material to an EAF is typically 100 percent scrap (USEPA, 1986).

EIFs are cylindrical or cup-shaped vessels that are surrounded by electrical coils. The coils are energized with an alternating current to produce a fluctuating magnetic field that heats the metal charge (USEPA, 1986).

Throughput information for secondary metal production (Steel Foundries) was obtained using the EI toolkit. An emission factor from *"Toxics in Vehicles: Mercury"* was then applied since FIRE was lacking an emission factor for this category (Ecology Center & Great Lakes United, 2001). EAFs and EIFs engaged in Secondary metal production (Steel Foundries) emitted approximately 130.08 lbs of Hg in 2005.

The following EAFs & EIFs in steel foundries were included in the calculation:

Table 29.

Facility Name	SRN	Throughput (tons)	Emission factor	Lbs emitted
GENERAL MOTORS - POWERTRAIN GROUP SAGINAW	A6174	109,885.80	6.90E-04	75.82
MICHIGAN STEEL, INC.	B1929	9,339.20	6.90E-04	6.44
GM POWERTRAIN GROUP - SAGINAW METAL CASTING	B1991	-	6.90E-04	0.00
HURON CASTING INC.	B7013	50,873.00	6.90E-04	35.10
TEMPERFORM CORP	B7357	1,166.00	6.90E-04	0.80
EAGLE ALLOY INC	B7870	17,256.26	6.90E-04	11.91
TOTALS				130.08

Cannon Muskegon Corp. (A4315) was not included for mercury estimates since they do not melt any automotive or common white goods scrap. They only use high quality/purity metals due to the products they produce, therefore any mercury emitted would have to come from the metal itself as opposed to contamination from mercury switches (Grinstern, 2010).

Table 30. Supporting data from *Toxics in Vehicles: Mercury* (Ecology Center & Great Lakes United, 2001)

Table 16: Mercury Emission Factors for EAFs (1997 - 2000 test data)

Company	State	Production ^a Capacity Short Tons/year	Estimated Hg Emissions Low Lbs/yr	Estimated Hg Emissions High Lbs/yr	Average Estimated Hg Emissions Lbs/yr	Average Emission Factor	
						Lbs Hg /ton	Kg Hg /metric ton
Marion Steel	OH	365,000	371	572	514	0.0014	0.0007
Co-Steel Sayreville	NJ	750,000	24	4,730	597	0.00080	0.00040
North Star Steel	MN	465,000 ^b	136	136	136	0.00029	0.00011
Co-Steel Raritan	NJ	800,000	129	323	224	0.00028	0.00014
Overall average emission factor						0.00069	0.00035

Note: Except for NSS, estimated mercury emissions are based on actual stack-test data for pounds of mercury emitted per hour times the allowable operating hours per year. NSS mercury emissions are based on actual stack-test data times the annual hours the EAF is under power.

^a Except for NSS, production capacity data from Iron & Steel Maker, EAF Roundup, May 2000.

^b Based on estimated 1998 production instead of capacity.

Secondary metal production (Grey Iron)

Grey iron is a type of cast iron with 3.5% carbon and is used in industry. Much of the carbon in this type of cast iron separates out as graphite giving grey iron its grey appearance (Dictionary.com). This broad grouping includes the following two categories, cupolas in secondary metal production (grey iron) and EAFs/EIFs in secondary metal production (grey iron).

Cupolas in Secondary metal production (Grey Iron)

The cupola is a type of furnace used in the iron foundry industry. It uses coke as a fuel and is typically composed of a cylindrical steel shell with a refractory-lined or water-cooled inner wall (USEPA, 1986).

Stack testing data from cupolas engaged in secondary metal production of grey iron was not available. Throughput data was gathered using the EI Toolkit. This throughput data was then multiplied by an emission factor. For facilities where control information was unknown, the uncontrolled emission factor from FIRE was utilized. The emission factor from FIRE is based on compliance testing for one baghouse from December 1990. The “New Jersey” emission factor was generated based on stack tests from three facilities between 1993 and 1999 (Ecology Center & Great Lakes United, 2001). For Kurdziel Iron of Rothbury, a Lumex flux calculation used the concentration of mercury in the ambient air (as measured by a Lumex RA915+), an estimate of the plume volume, and wind speed to approximate how much Hg was being emitted from the facility. According to the data available, between 121.72 and 157.91 lbs of Hg were emitted from cupolas in Michigan in 2005.

The following cupolas engaged in the production of grey iron were included in the inventory:

Table 31.

Facility Name	SRN	Throughput (tons)	EF (FIRE) IN LB/TON*	LBS MERCURY EMITTED PER FIRE	EF (NJ) IN LB/TON	LBS MERCURY EMITTED PER NJ
EAST JORDAN IRON WORKS	A0767	186,149.00	1.59E-04	29.60	2.50E-04	46.54
GREAT LAKES CASTINGS LLC	A3934	47,646.00	3.48E-04	16.58	2.50E-04	11.91
DANA CORPORATION - SANFORD STREET FACILITY	A4302	9,830.00	1.59E-04	1.56	2.50E-04	2.46
GREDE FOUNDRIES INC	B1577	105,378.00	1.59E-04	16.76	2.50E-04	26.34
CWC TEXTRON	B1909	60,221.00	1.59E-04	9.58	2.50E-04	15.06
KURDZIEL IRON OF ROTHBURY	B1961	60,165.29	LUMEX	2.00	LUMEX	2.00
GM POWERTRAIN GROUP - SAGINAW METAL CASTING	B1991	-	3.48E-04	-	2.50E-04	-
GREDE FOUNDRIES, INC.	B2043	61,125.39	3.48E-04	21.27	2.50E-04	15.28
CADILLAC CASTING, INC	B2178	112,139.00	1.59E-04	17.83	2.50E-04	28.03
ROBERT BOSCH CORPORATION CHASSIS DIVISION	B2404	41,147.00	1.59E-04	6.54	2.50E-04	10.29
TOTAL				121.72		157.91

Schwarb Foundry (B1786) closed in 2003 per MAERS.

N5795, Sparta Foundry Inc., became permanently inoperable on 11/19/04.

Dana Corporation (A4302) closed foundry in late 2005

Kurdziel Iron of Rothbury (B1961) has not operated since early 2009.

Robert Bosch Corporation (B2404) no longer operates their foundry.

Grede Foundries Inc. (B2043) is now Metavation Vassar LLC and is no longer owned by Grede LLC.

* 1.59e-04 lb/ton is controlled factor from FIRE reflecting application of a baghouse; 3.48e-04 lb/ton is an uncontrolled factor from FIRE

Table 32. Supporting data from *Toxics in Vehicles: Mercury* (Ecology Center & Great Lakes United, 2001)

Table 20: Mercury Emissions from New Jersey Foundries

Facility	Permitted Production Capacity (short tons/yr)	Mercury Permit Limit (lbs/yr)	Stack Test Date	Mercury Emissions (lbs/yr)	Average Mercury Emission Factor	
					(lbs/short ton)	(kg/metric ton)
Atlantic States Iron Pipe Co.	234,000	137	11/93	40	0.00032	0.000016
			11/99	108		
Griffin Pipe Products	182,000	312	9/97	10	0.000055	0.000027
U.S. Pipe and Foundry, Inc.	262,964	80	9/97	96	0.00037	0.00018
Average Emission Factor					0.00025	0.00012

Source: Agrawal, Sunila, NJ DEP, October 30, 2000.¹⁴⁸

EAFs & EIFs in Secondary metal production (Grey Iron)

An EAF is a large, welded steel cylindrical vessel with a removable roof through which three retractable carbon electrodes are lowered and energized, creating arcs that melt metallic charge with their heat. EIFs are cylindrical or cup-shaped vessels that are surrounded by electrical coils, which are energized to produce an electromagnetic field that heats the metal charge (USEPA, 1986).

Stack testing was not available for EAFs and EIFs involved in the secondary metal production of grey iron. Throughput information was obtained from the EI Toolkit. The emission factor was obtained from the Indiana Department of Environmental Management's "Summary of Mercury Emissions from Non-Electric Generating Units (IDEM, 2004)." This emission factor was then compared to the emission factors corresponding to grey iron production from FIRE to generate a range (USEPA, 2009).

The following EAFs and EIFs engaged in the production of grey iron in 2005 were included in the calculations:

Table 33.

Facility Name	SRN	Throughput (tons)	Emission factor from FIRE	Lbs Hg emitted per FIRE	Emission factor from IDEM	Lbs Hg emitted per IDEM
THUNDER BAY MFG CORP.	A0095	12,582.00	7.20E-05	0.91	2.70E-04	3.40
HASTINGS MANUFACTURING COMPANY	A0171	23.18	7.20E-05	0.00	2.70E-04	0.01
PIONEER FOUNDRY CO INC	B1661	1,265.00	7.20E-05	0.09	2.70E-04	0.34
FEDERAL-MOGUL POWERTRAIN SYSTEMS	B1709	22,703.04	7.20E-05	1.63	2.70E-04	6.13
BETZ INDUSTRIES INC	B1716	35,763.00	7.20E-05	2.57	2.70E-04	9.66
KENT FOUNDRY CO.	B1737	3,340.20	7.20E-05	0.24	2.70E-04	0.90
METAL TECHNOLOGIES, INC. THREE RIVERS GRAY IRON	B2015	154,312.00	7.20E-05	11.11	2.70E-04	41.66
BLACKMER	B4538	2,747.00	7.20E-05	0.20	2.70E-04	0.74
ASAMA COLDWATER MANUFACTURING, INC.	N5814	34,249.00	7.20E-05	2.47	2.70E-04	9.25
METAL TECHNOLOGIES, INC. - RAVENNA DUCTILE IRON	N5866	97,958.70	7.20E-05	7.05	2.70E-04	26.45
TOTALS				26.27		98.54

A6177, EATON CORP, DID NOT OPERATE ITS THREE EAFs IN 2005 AND HAS SINCE CLOSED.
 B1547, HAYES ALBION CORPORATION, CLOSED IN 2002.
 B1786, SCHWARB FOUNDRY, CLOSED IN 2003.

EAFs & EIFs engaged in the production of grey iron produced between 26.27 and 98.54 lbs of mercury emissions in 2005. Three sources included in the 2002 mercury inventory have not been included in the 2005 inventory. Eaton Corp. (A6177) did not operate its EAFs in 2005 and has since closed. Hayes Albion Corporation (B1547) closed in 2002, and B1786, Schwarb Foundry, closed in 2003. Accordingly, these three sources were excluded from the 2005 inventory.

Auto Switches-shredding of autos (point source)

Mercury emissions from the shredding of automobiles have a point source component (from permitted facilities) as well as an area source component from unpermitted facilities.

Table 34.

Category	2005 mercury emissions in lbs
Point source auto shredding	10.70
Area source auto shredding	86.13
Statewide totals: auto shredding	96.83

Using Michigan data about scrapped vehicles, an estimated total of 43.92 kg or 96.83 lbs of Hg were emitted statewide to the atmosphere from shredding. It was estimated that 10.7 lbs were emitted by point sources, per the table below. Estimates were based on stack test data and Lumex monitoring.

In the area source section, the methodology for estimating the area source component of auto shredding emissions (86.13 lbs) will be presented.

Table 35. Shredders in Michigan with Hg Emissions Testing

Company	SRN	Emission Control Equipment	Emissions (lbs/yr)	Source
Louis Padnos Iron & Metal Co., 2001 Turner Ave NW, Grand Rapids, MI 49504	A2457	Shredder has "water only" spray in the hammer mill.	5.6	2003 Lumex Monitoring (assuming 8 hour workday/ 365 days/yr)
Fritz Enterprises, 23550 Pennsylvania Rd, Taylor, MI 48180	B3240	Water spray and cyclone on shredder.	1	2003 Lumex Monitoring (assuming 8 hour workday/ 365 days/yr)
Strong Steel Products, 6464 Strong, Detroit, MI 48211	N6293	Shredder has water added to control emissions.	1	2005 Lumex Monitoring (5008 max. operating hours)

Rifkin Scrap Iron & Metal, 1445 N. Niagara Street, Saginaw, MI 48602	N0844	Shredder enclosed by a metal hood and ducted to a cyclone followed by a wet venturi scrubber.	2.7	2004 stack test at baghouse (assuming operating 24 hr/d, 365 d/yr)
SLC Recycling, Inc. (Ferrous Processing & Trading)	A4750	Baghouse	0.4	2001 stack test
TOTALS			10.7	

Relay Manufacturers

MDI (Mercury Displacement Industry, SRN # N5886) operates in Edwardsburg, Michigan. According to the facility's TRI report, it emitted 148 lbs of mercury in 2005. According to the 2005 NATA, the mercury emissions are elemental mercury.

AREA SOURCES

MERCURY IN PRODUCTS

Incineration of wastes contaminated with mercury-containing products have been known for some time to release mercury to the air, but other pathways for atmospheric mercury emissions from products have received little attention. Emissions from products in this inventory were calculated using the flow model approach. The flow pathway technique was pioneered by the Swedish Nation Chemicals Inspectorate (KEMI), which estimated releases from batteries, fluorescent lamps and sewage sludge. Barr Engineering Company (Barr) and Minnesota Pollution Control Agency (MPCA) used the KEMI approach to estimate the quantity of mercury releases from products in Minnesota. The Minnesota study expanded the KEMI technique to include additional release pathways and additional products. The Minnesota study looked at releases to air, water, and land. The flow model developed during the Minnesota study has since been used to estimate emissions in studies conducted by the Wisconsin Department of Natural Resources and USEPA Region 5 with assistance from Barr (WDNR, 2006). The estimates for emissions from products in this inventory used the most recent model that was updated by USEPA Region 5. Michigan specific data was incorporated into the model when possible. Since the purpose of this inventory is to quantify air emissions, releases to land and water were not included. The methodology used for each specific product is described below.

Dental Amalgam

Substituting Michigan data for national data in the USEPA Mercury Flow Diagram, emissions from dental amalgam were calculated. Emissions in this category can be further subdivided into four categories: emissions from the dental office, emissions from the consumer "in use," emissions from recycling, and emissions from dental amalgam in the solid waste stream.

Emissions from dental offices are based on the fact that there were 6,444 licensed dentists in Michigan in 2005, per the *Michigan Department of Community Health FY2005 Boilerplate Reporting Requirement: Report on dentist participation in the Michigan Medicaid Program*. Assuming the continuation of trends in place in 2000, 51% of licensed dentists used mercury amalgams in 2005, these dentists completed about 1,670,285 amalgams, and there were 0.000340 kilograms of Hg in each amalgam (remaining after placement) in 2005. Therefore, approximately 568 kilograms of Hg were used in the placement of dental amalgams in 2005.

This corresponds to 38.89 kg (85.74 lbs) of Hg emissions, assuming that 7% of the mercury in an amalgam volatilizes to the air during the placement of that amalgam.

Additionally, it was estimated that 21.65 kg (47.73 lbs) of mercury returned to the dental office from the replacement of existing amalgam.

Consumer “in use” emissions were estimated to be 8.22 kg (18.12 lbs). This estimate was based on the assumption that 76 percent of the Hg input to dental offices goes to the consumer. A release factor of 0.02 was used to estimate the amount of Hg that would be exhaled to the air.

Mercury from storage, transit and transfer en route to municipal solid waste landfills was estimated at 0.17 kg or 0.37 lbs. Mercury from disposal as municipal solid waste was estimated at 0.97 kg or 2.14 lbs.

Cremation of human bodies and the associated amalgams was estimated by the USEPA Mercury Flow Diagram to emit 88.47 kg (195.04 lbs) of Hg in Michigan in 2005. This estimate was not included in the 2005 mercury inventory. Instead, between 14.61 and 65.20 lbs of mercury were likely emitted to the atmosphere from human cremations in Michigan in 2005, based on a study in Japan (Takaoka, Oshita, Takeda and Morisawa, 2010). This was treated as a separate area source category (see Cremation on page 47).

3.67 kg from mass burn and refuse derived fuel (RDF) was estimated by the USEPA model, but since this category is already accounted for in the point source inventory, this estimate was not included in the Michigan 2005 mercury inventory.

103.86 lbs of Hg were estimated for the category of dental amalgams in 2005, for the placement of dental amalgams and consumer “in use” emissions. This represents a 26% drop since 2002. This does not include the emission estimates from cremation and the solid waste stream, which are separate area source categories.

Fluorescent Lamps

Substituting Michigan data for national data in the USEPA Mercury Flow Diagram, an emissions estimate for fluorescent lamp breakage was calculated. The flow model assumes that 680 million lamps were sold in the US in 2004, based on data from NEMA. For the estimation of Michigan’s 2005 emissions, it was assumed that 2005 lamp sales in the US were the same as in 2004. Using Michigan and national population data for 2005, it was assumed that Michigan received a proportionate percentage of these lamps (3.4%, or 23,120,000 lamps). This number was increased to account for an additional 0.5% broken at retail locations (for 23,235,600 lamps), and an additional 5.0% broken prior to delivery to retail locations (production total of 24,397,380 lamps). The quantity of lamps in retail and the quantity of lamps purchased by consumers were then multiplied by release factors to estimate the amount of mercury emitted when a fraction of these lamps were broken. The release factor for breakage during retail was 0.002, and the release factor for consumer breakage was 0.01. It was assumed that each lamp manufactured in 2005 contained 0.008 g of Hg (NEMA, 2000). This method yielded an emissions estimate of 2.22 kg (4.89 lbs) of Hg emitted from lamp breakage by retailers and consumers, plus an additional 0.08 kg (0.18 lbs) of Hg from lamps broken at production facilities for a total of 2.30 kg (5.07 lbs) directly from lamp breakage.

The USEPA Flow Diagram was also used to estimate emissions from the disposal of lamps in the municipal solid waste (MSW) stream. Of the total number of disposed fluorescent lamps (364 kg/yr in Michigan based on the estimate of lamps being discarded in 2005, which are assumed to have been manufactured in 2000 with a higher mercury content than lamps manufactured in 2005, per NEMA), 78% or 283.92 kg likely ended up in the solid waste stream. Assuming 10% of the mercury in each lamp was released while in transit, 28.39 kg (62.59 lbs) of Hg emissions would be attributable to the collection and processing of lamp-containing MSW.

Assuming 84% of lamps in municipal solid waste end up in landfills, and 1% of the mercury is released, 2.01 kg (4.43 lbs) of mercury emissions can be attributed to landfill emissions from disposed fluorescent lamps. Another 3.87 kg (8.53 lbs) of emissions were likely due to the 2% of lamps in MSW that are burned in burn barrels, assuming a 90% release factor. 16.80 kg (37.04 lbs) of emissions were estimated from lamps incinerated in mass burn/RDF combustion. However, Michigan's 2005 mercury inventory already accounts for solid waste incineration under point sources, so the 37.04 lbs of area source mercury emissions estimated by the USEPA Mercury Flow Diagram for mass burn/RDF has been omitted from the Michigan 2005 inventory.

Using the USEPA Mercury Flow Diagram and assuming that Michigan recycles lamps at the same rate as the national average, 22%, about 4.8 million lamps should have been recycled in Michigan in 2005 (US Census Bureau). Approximately 0.80 kilogram (1.76 lbs) of mercury was likely released during the transport of lamps to the recycling facility based on a 1% release factor.

It can be estimated that the four companies in Michigan with fluorescent lamp recyclers emit 3.5 pounds of mercury per year, assuming that they are emitting the maximum amount allowed by their permit conditions.

These six facilities are not required to report to the Michigan Air Emissions Reporting System. Therefore, it was not known where they operated and emitted in 2005. Due to this uncertainty, they were not included in the 2005 toxics inventory.

Table 36.

Facility	SRN	Portable or Stationary	Permit Limit	Max. Hg Emitted (lbs)
Valley City	N5941, N5942, N5614	Each facility is portable	0.004 g/hr for each portable lamp recycler	0.231
Greenlites (Cleanlites)	N5948	Stationary	0.08 g/hr	1.5
Reliable Relamping	N6821	Facility is permitted as both a portable and a stationary source	0.01 g/hr	0.19
Greenlite Lamp Recycling	N5549	Stationary	0.08 g/hr	1.55
Total				3.5

Hence, fluorescent lamp breakage and recycling and the solid waste stream are estimated to have released 55.76 kg (122.92) pounds of mercury to the atmosphere in 2005. Lamp breakage is estimated to have released 5.07 lbs of mercury by itself, and fluorescent lamp recycling is estimated to have released 5.26 lbs.

Drum-Top Crushers

As of 2011, seven permits have been issued by DEQ for drum-top crushers (DTCs). The information available for these sources is summarized below. Based on the maximum allowed number of lamps to be crushed each year (5,000 per facility with 90% control for carbon filters, per Joy Taylor Morgan, DEQ), the annual amount emitted from this category can be estimated at a minimum of 0.07 lbs and a maximum of 0.16 lbs. The emissions from this sector will not be included in the 2005 EI since the permitted sources were not operating then.

Table 37.

Applicant	SRN	Site City	Permit No.	Received	Approved	Voided	Rolled into Renewable Operating Permit
SHAHEEN CHEVROLET, INC	N7614	LANSING	138-06	4/11/2006	7/13/2006		
BLUE STAR, INC	N7728	DEARBORN	351-06	11/17/2006	11/17/2006	12/11/2006	
ADRIAN COLLEGE	E8510	ADRIAN	23-10	12/11/2009	2/3/2010		
MCPHEE ELECTRIC	P0063	POTTERVILLE	40-10	2/4/2010	3/8/2010		
MARQUETTE COUNTY WASTE	N5245	MARQUETTE	117-10	4/19/2010	7/19/2010		
AUTO ALLIANCE INTERNATIONAL	N0929	FLAT ROCK	112-10	5/26/2010	6/9/2010	5/19/2011	X
HYBRA RECYCLING, LLC	P0231	TRAVERSE CITY	49-11	3/29/2011	5/4/2011		

Auto Switches-shredding of Autos (area source)

Area source mercury emissions from the shredding of automobiles were calculated by substituting Michigan data for national data in the USEPA Flow Diagram.

Using Michigan data about scrapped vehicles, an estimated 43.92 kg or 96.83 lbs of Hg were emitted to the atmosphere from shredding, in total. It was estimated that 250.51 kg (552.27 lbs) of Hg were present in switches in end-of-life vehicles in Michigan in 2005, based on the estimated number of vehicles scrapped in Michigan (5.62 % or 463,902) and assuming an average of 0.54 switches per vehicle with an average of 1 gram of Hg per switch. Ninety-nine percent of these vehicles were assumed to be sent to scrap yards/dismantlers, with the remaining 1% being disposed of in some other manner. Based on a 2006 report (End-of-Life-Vehicle Solutions, 2006) which estimated that 100.96 lbs of mercury were recovered from end of life vehicles, a similar amount (18.69% or 102.19 lbs of the 2005 end of life vehicles sent to scrap yards) was estimated to have been recovered during 2005, since Michigan's mercury switch recovery program has been in place since 2004 (DEQ, 2010). Sixty-six percent of the vehicles sent to scrap yards/dismantlers were assumed to be shredded. Per the USEPA Flow Diagram, it was estimated that 22% or 36.60 kg (80.69 lbs) of mercury in these vehicles will be released during the shredding process. This release factor was based on the *North Star Steel Mercury Mass Balance Report*, prepared by Barr in 1999. Another 7.32 kg (16.14 lbs) of Hg should be released from auto fluff, assuming a 25% release factor per the Barr report.

This results in a total of 43.92 kg or 96.83 lbs from the auto shredding sector. Following the deduction of 10.70 lbs of mercury estimated for the point source component of auto shredding, the area source component is estimated to be 86.13 lbs in 2005.

Switches and Relays

Using national data in the *USEPA Flow Diagram*, emissions from switches and relays were estimated as a proportion of national emissions. Michigan accounted for 3.4% of the US population in 2005 so national values were scaled down to reflect Michigan's proportion of the national population.

Approximately 1.80 kg (3.97 lbs) of mercury were emitted from the retail of switches and relays, assuming 0.1% of mercury in switches and relays is released during retail in 2005. For consumer breakage of switches and relays a 0.05% release factor was used. It is estimated that 32.38 kg (71.39 lbs) of mercury were emitted from consumer breakage in 2005, for a total of 75.36 lbs from the consumer and retail category.

During the storage, transit, and transfer of MSW, 7.35 kg (16.20 lbs) of mercury were likely released assuming a 1.5% release factor. Another 9.8 kg (21.61 lbs) of mercury were released in 2005 during the storage and transfer of switches and relays bound for recycling. Approximately 40 percent of the mercury in discarded switches and relays is sent on for recycling. 37.81 lbs total were released from storage, transfer and transit of MSW, or of material en route to recycling.

The switches and relays in MSW which reach landfills contributed 3.40 kg (7.50 lbs) of mercury emissions under the assumption that 1% of the mercury is released. An additional 0.72 kg (1.59 lbs) was estimated due to air releases from switches ending up in compost.

Another 9.60 kg (21.16 lbs) of mercury was likely released due to recycling switches and relays, assuming a 1% release factor and will be added to the 75.36 lbs from consumer and retail losses. The mercury model projected that 47.63 kg more would be lost due to mass burning and RDF combustion, but this was not included in the switch and relay area source estimate as the incineration category has already been accounted for under point sources. Three percent of switches and relays in MSW were likely burned in burn barrels releasing 90% of the mercury contained in them, or 14.61 kg (32.21 lbs).

In total, 175.63 lbs of mercury were likely released from activities associated with mercury-containing switches and relays in 2005. This includes the solid waste stream.

Including 13.9 lbs of emissions from the thermostats category (below), 89.26 lbs of mercury are listed in Table 1 for the Switches & Relays category. This includes only the emissions from retail and consumer breakage. The remaining emissions, from activities such as storage, transfer, transit and recycling, are reported in Table 1 under the Waste Disposal category.

Thermostats

Emissions from thermostats were estimated by substituting Michigan data for national data in the *USEPA Flow Diagram*. Emissions were estimated from production, retail, and consumers.

A 2003 Frost and Sullivan report provided an estimate of North American sales of electro-mechanical thermostats. Using Michigan population data to apportion the U.S. proportion of those sales, 144,113 thermostats containing mercury were estimated to be sold in Michigan in 2003. This includes sales for new construction, and sales for the replacement of older units. This estimate assumes that Michigan received an even percentage of the national number of

thermostats produced, that thermostats contain an average of 3.67 g Hg/unit, and that 75% of the electro-mechanical thermostats sold contained mercury.

In July 2005, the housing market peaked per David Seiders, National Association of Homebuilders, but new construction in Michigan appears to have already been declining. In 2005, new construction of housing units in Michigan authorized by building permits declined 15.92% from 2003 levels, per the U.S. Bureau of Census. Therefore, the estimate of thermostat sales derived from the 2003 Frost and Sullivan report was modified. It was assumed that 30% of thermostats sold were for the new construction market. This estimate was applied to the Michigan estimate of thermostat sales (144,113 units), and the resulting number (43,234) was multiplied by 15.92% to determine the decline in thermostat units sold due to the decline in new construction. Therefore, 6,883 fewer thermostats (137,230) containing mercury were estimated to be sold to consumers in 2005 than in 2003 in Michigan. It was assumed that 0.2% of the mercury in new electro-mechanical thermostats was emitted during production, resulting in 1.01 kg (2.23 lbs) of mercury emissions. Another 0.2% of the mercury in thermostats was emitted from breakage during retail. This likely contributed 1.01 kg (2.23 lbs) of Hg emissions in 2005. An estimated 4.28 kg (9.44 lbs) of Hg were emitted from consumer breakage. During consumer use, 1% percent of the mercury in thermostats was expected to have volatilized due to breakage. 13.9 lbs is the total emission estimate from retail and consumer breakage.

Based on state and national population data, and national estimates for the number of thermostats replaced, an estimated 119,000 mercury-containing thermostats were replaced (discarded by consumers) in Michigan in 2005. This estimate assumes that Michigan accounted for an even percentage of the national number of thermostats replaced, that thermostats contain an average of 3.67 g Hg/unit, and that 70% of the thermostats removed contained mercury (an increasing share of replaced thermostats is expected to be non-mercury, based on the gradual increase since the 1990s in the sale of non-mercury thermostats).

9.21 kg or 20.30 pounds of mercury from discarded thermostats were recycled in Michigan in 2005 (Thermostat Recycling Corporation, 2009). Of the remaining 427.51 kg or 942.50 lb of mercury in replaced thermostats, 88% likely entered the solid waste stream. During the storage, transit and transfer of MSW, thermostats contributed about 6 kg (13.23 lbs) of emissions. Three percent of thermostats in MSW were likely burned in burn barrels emitting 90% or 11 kg (24.25 lbs) of the mercury they contained. Three kilograms (7 lbs) of mercury was likely released due to the 75% of the thermostats in the MSW stream that were landfilled, assuming 1% of the mercury would volatilize.

An additional 1.25 kg or 2.76 lbs were emitted from the 10% of discarded thermostats that ended up in demolition debris. These emissions occurred during the storage, transit, transfer and disposal in demolition debris landfills.

There are also wastewater treatment and sludge disposal emission components for thermostats which enter the MSW stream. 1.08 kg (2.38 lbs) of mercury emissions were estimated from wastewater treatment. Another 0.54 kg (1.19 lbs) were estimated from land application air emissions, but this category has been estimated as a separate area source. 1.09 kg estimated by the USEPA Mercury Flow Diagram was not included, since the category of WWTP incineration is addressed under point sources.

Not including the emissions from wastewater treatment and land application, 81.44 pounds of mercury were likely emitted due to thermostats in 2005. Of this, 13.9 lbs were emitted directly from retail and consumer breakage.

Combined, the categories of switches and relays and thermostats released 89.26 lbs of mercury from retail and consumer breakage (Table 1). The remaining emissions from disposal activities were reported in Table 1 under the waste disposal category.

Measurement and Control Devices

Emissions from measurement and control devices were estimated as a proportion of national emissions using the *USEPA Flow Diagram*. Michigan accounted for 3.4% of the US population in 2005 so national values were adjusted accordingly to generate Michigan-specific values.

Approximately 1.33 kg (2.93 lbs) of mercury were emitted from the retail of measurement and control devices assuming 0.1% of mercury in measurement and control devices is released during retail. For consumer breakage of measurement and control devices a 0.2% release factor was used. 17.32 kilograms (38.18 lbs) of mercury were emitted from consumer breakage in 2005, for a total of 41.11 lbs from retail and consumer breakage. During the storage, transit, and transfer of measurement and control devices as MSW, 11.61 kg (25.60 lbs) of mercury were likely released assuming a 1.5% release factor. Another 6.19 kg (13.65 lbs) of mercury were release during storage and transfer of measurement and control devices bound for recycling. Approximately forty percent of the mercury in discarded measurement and control devices is sent on for recycling. Another 6.07 kg (13.38 lbs) of mercury was likely released due to recycling assuming a 1% release factor and will be grouped with retail and consumer losses. This totals 54.49 lbs as presented in Table 1. The storage and transfer emissions of 39.25 lbs are listed under the Waste Disposal section of Table 1.

Three percent of measurement and control devices in MSW were likely burned in a burn barrel releasing 90% of the mercury contained in them. Accordingly, 23.09 kilograms (50.90 lbs) of mercury were released due to measurement and control devices being burned in burn barrels. Seventy-five percent of measurement and control devices in MSW are sent to landfills. Measurement and control devices in landfills contribute 5.37 kg (11.84 lbs) of mercury emissions assuming 1% of the mercury is released.

In total, 70.98 kg (156.48) lbs of mercury were likely released from all activities associated with mercury-containing measurement and control devices in 2005.

Thermometers

In 2003, Michigan PA 578 banned the sale of mercury thermometers in Michigan, or for use in the State of Michigan. The only exceptions are if a mercury thermometer is sold or offered for one of the following:

- a) A use for which a mercury thermometer is required by state or federal statute, regulation or administrative rule;
- b) Pharmaceutical research purposes; or
- c) By prescription.

Mercury thermometers which were broken and discarded during household use in 2005 were assumed to have been purchased in 2000 (5 year life span), prior to the ban imposed by PA 578. Mercury thermometers used in hospitals were assumed to have a 1 year life span prior to breakage and disposal, therefore it was assumed no hospital mercury thermometers were in use in 2005, following the ban put in place in 2003.

Of the mercury available for release from household breakage, 75% went to the MSW stream and 25% was discharged to water. Of unbroken thermometers which were discarded, 25% went to recycling and 75% went to MSW. Of the 91 kg total of mercury which went to the MSW stream, 9.08 kg or 20.02 lbs were released to the air during the storage, transit and transfer as MSW per the Waste Disposal section of Table 1. 0.58 kg or 1.28 lbs were released to the air from MSW landfills. 2.47 kg or 5.45 lbs were released from disposal of waste in burn barrels. The EPA Mercury Flow Diagram estimated 8.06 kg of Hg released from mass burn and refuse derived fuel, but as this category has been addressed in the point source inventory, this estimate has not been included in the inventory.

The EPA Mercury Flow Diagram estimated 2.56 kg from sludge incineration but this category has been addressed under the point source inventory and therefore not included. 1.28 kg or 2.82 lbs were released from air releases from land application of sludge, and another 0.18 kg or 0.40 lbs from the landfilling of sludge, with 0.13 kg or 0.29 lbs released by other means. Land application of sludge has been estimated as a separate area source, so these values have not been included in the 2005 mercury report.

Therefore, 12.13 kg or 26.75 lbs of mercury were estimated to have been released to the air in 2005 from this category.

Non-fluorescent lamps

Emissions from non-fluorescent lamps were estimated by substituting Michigan data for United States data in the USEPA Flow Diagram.

High intensity discharge (HID) lamps include mercury vapor lamps, metal halide lamps and high pressure sodium lamps, and are used for streetlights, floodlights, parking lots and industrial lighting. Mercury is an essential ingredient in HID lights and in other energy efficient lighting ["Promoting Mercury-Containing Lamp Recycling: A Guide for Waste Managers," Lamp Recycling Outreach Project (Solid Waste Association of North America, Association of Lighting and Mercury Recyclers, National Electronic Manufacturers Association-NEMA)].

Using national estimates for the production of HID lamps in the US, and assuming that that HID lamps make up 75% of all non-fluorescent, mercury-containing lamps, the model suggests that 1,360,000 non-fluorescent, mercury-containing lamps were sold in Michigan in 2005. Population data were used to derive the proportion of lamps likely sold in Michigan. This number was increased to account for an additional 0.5% broken at retail locations (for 1,366,800 lamps), and an additional 5.0% broken at production locations (production total of 1,435,140 lamps). The amount of Hg released at production is assumed to be the same as for fluorescent production (0.08 kg or 0.18 lbs). The quantity of lamps in retail and the quantity of lamps purchased by consumers were then multiplied by release factors to estimate the amount of mercury emitted when a fraction of these lamps were broken. The release factor for breakage during retail was 0.002, and the release factor for consumer breakage was 0.01. It was assumed that each lamp contains 0.03 g of Hg. Retail breakage likely contributed 0.08 kg (0.18 lbs) of emissions based on a release factor of 0.2%. Consumer breakage likely contributed 0.41 kg (0.90 lbs) of emissions based on a release factor of 1%.

Lamps disposed of in 2005 were assumed to have an average mercury content of 0.04 g Hg/unit. This is a conservative assumption. Lamps disposed of in 2005 are assumed to have been manufactured in 2003. An estimate for 2003 was unavailable. Per NEMA, lamps

manufactured in 2000 were estimated to contain 0.4 g of Hg and lamps manufactured in 2005 were assumed to contain 0.3 g of Hg, therefore 0.4 g was chosen as the most protective number.

It was assumed that 50% of lamps were recycled and 50% of lamps were sent to the solid waste stream. Lamps that were handled as MSW likely emitted 2.80 kg (6.17 lbs) of Hg during storage, transit, and transfer, using a 10% release factor. Storage for recycling is estimated to have released 0.28 kg (0.62 lbs) of mercury emissions. Two percent of the lamps that were handled as MSW were assumed to have been burned in a burn barrel, releasing 90% of the mercury contained in them. Burn barrels contributed 0.38 kg (0.84 lbs) of mercury emissions to the atmosphere due to non-fluorescent lamps. Lamps disposed of in landfills released an estimated 0.20 kg (0.44 lbs) of mercury. Lamps burned in mass burn/RDF were estimated to have released 1.64 kg (3.62 lbs) of mercury, but this value was not included in the report since incineration was included under point sources.

Lamp recycling was estimated to have released a total of 0.37 kg (0.82 lbs) of emissions. These emissions will be added to the 1.26 lbs from retail and consumer losses.

A total of 4.60 kg (10.15 lbs) of mercury emissions is estimated from non-fluorescent lamps in 2005.

Bulk Mercury

Clean Sweep Household Hazardous Waste collection sites collected 684 lbs (310 kg) of elemental free-flowing mercury in 2005. The EPA Flow Model estimates that 1% or 7 lbs (3 kg) of this Hg was released to the air. A total of 728 lbs (330 kg) of bulk mercury were transported as waste in 2002. One percent or 7 lbs (3 kg) this mercury was expected to be released during waste transport. Approximately 9,693 lbs (4,393 kg) of Hg was calculated as the total consumer input by extrapolating from the total waste estimates. It was assumed that bulk mercury disposed of as waste comprised 7.5% of total consumer input. Mercury from consumers had an expected release factor of 0.2%, resulting in emissions of approximately 20 lbs (9 kg) of elemental Hg in 2005. Hence, approximately 34 lbs of mercury was likely released from all aspects of the bulk mercury category in 2005.

Volatilization during solid waste collection and processing

The estimate for volatilization during solid waste collection and processing was based on the assumption that 1.5% of the mercury in solid waste is volatilized during collection, transportation, and mechanical processing (MPCA, 2001). To estimate the quantity of municipal solid waste (MSW) composted in Michigan, a Michigan specific figure from the MDEQ Waste and Hazardous Materials Division was utilized (Fletcher, 2009). The quantity of solid waste combusted was calculated using EI Toolkit throughput values (See [Municipal Waste Incineration](#)). 2005 landfill data was obtained from the MDEQ WHMD ([MDEQ, 2009](#)). For this estimate, only Type II in-state waste (33,343,053 cubic yards) was considered and a weight of 0.333 tons per yard was assumed. Since out-of-state waste is not likely to be transported to a transfer station in Michigan, it was not included in this estimate. It is assumed that the mercury concentration of municipal solid waste is approximately 0.004 lbs of Hg/ ton of solid waste (van Veizen, 2002). Approximately 731 lbs of mercury were likely emitted due to volatilization during the collection and processing of MSW in 2002.

Table 38. Calculations for volatilization during solid waste collection & processing:

Fate of Municipal Solid Waste	Amount	Reference
MSW Compost	400,000	Fletcher, DEQ (2008 value)
Resource Recovery (tons)	674,567	See MSW incineration above
Landfill Type II In-State Waste (tons)	11,114,349	MDEQ, Waste & Hazardous Materials Division
Total landfill, combusted, composted (tons)	12,188,916	
Calculated Mercury Content (lbs/ton)	0.0040	van Veizen (2002)
Mercury content (lb) of SW (excluding recycling)	48,756	
Volatilization during handling and transport (lb)	731	
(1.5% of landfill, combustion, composting)		
MI population	10,120,860	http://www.census.gov/popest/states/tables/NST-ES
US population	295,895,897	http://www.census.gov/popest/states/tables/NST-ES
% of population that is in MI	3.42%	

Landfill volatilization

The estimate for volatilization during solid waste collection and processing was based on the assumption that 0.1% of the mercury in landfilled solid waste is volatilized per year based on studies of MSW emissions in Florida ((Lindberg and Price, 1999).

To estimate the quantity of municipal solid waste (MSW) landfilled in Michigan in 2005, a Michigan specific figure from the MDEQ Waste and Hazardous Materials Division was utilized (MDEQ, WHMD, 2009). For this estimate, total landfilled Type II (in-state and out-of-state) waste (49,882,921 cubic yards) was considered and a weight of 0.333 tons per yard was assumed. It is assumed that the mercury concentration of municipal solid waste is approximately 0.004 lbs of Hg/ ton of solid waste (van Veizen, 2002). Approximately 67 lbs of mercury were likely emitted due to volatilization during the collection and processing of MSW in 2005.

Table 39. Calculations for volatilization during solid waste collection & processing:

Fate of Municipal Solid Waste	Amount	Reference
Total Landfilled Type II Waste (tons), 2005	16,627,640	MDEQ, Waste & Hazardous Materials Division
Calculated Mercury Content (lbs/ton)	0.0040	van Veizen (2002)
Mercury content (lb) of SW (excluding recycling)	66,511	
Volatilization from landfilled MSW (lb)	66.51	
(0.1% of mercury in landfilled MSW volatilizes)		Lindberg and Price (1999)

Burn Barrels

For the category of burn barrels (open burning of MSW), the USEPA's methodology from Appendix A of *Documentation for the Final 2002 Nonpoint Sector (Feb 06 Version) National Emission Inventory for Criteria and Hazardous Air Pollutants* was followed. The ratio of urban to rural population was obtained from 2000 U.S. Census data, then multiplied by a 2005 U.S. Census Bureau estimate of the county population in Michigan to obtain an estimate of rural population in 2005. The estimate excluded those counties where the population was greater than 80% urban under USEPA's presumption that open burning of MSW would not occur there. Based on 2005 population and 2000 Census data, it is estimated that 78% of Michigan's 2005 population lived in the counties which had greater than 80% urban population. USEPA's estimate of 3.37 lbs of solid waste per person per day was used. It was assumed that MSW has a mercury content of 0.0040 lb/ton (van Veizen, 2002). Per an estimate by Minnesota Pollution Control Agency (MPCA, 20008), 2% of MSW was assumed to be disposed of in burn barrels. 111.18 lbs of mercury was estimated to have been emitted from burn barrels in Michigan in 2005.

Human Cremation

According to Kathy Humphreys of the MDCH, there were 31,973 bodies cremated in Michigan in 2005 (MDCH, 2007). Estimates of the amount of mercury released per body cremated vary greatly. One literature review concludes that a release of two to three grams of mercury per body cremated seems most well-supported (Reindl, 2005). This yields a total emissions estimate between 140.98 and 211.46 pounds of mercury from this category in Michigan. However, a more recent study estimated that the average mercury amalgam in place contains 51.6 mg (Takaoka, Oshita, Takeda and Morisawa, 2010). This estimate, with an assumption of four fillings per body, yields a total estimate of 14.61 lbs of mercury emitted in 2005 from the human cremation category. Using the study's conservative estimate of a maximum of 231 mg of mercury per filling, a high range emissions estimate of 65.20 lbs is obtained. Therefore between 14.61 and 65.20 lbs of mercury were likely emitted to the atmosphere from human cremations in Michigan in 2005.

Volatilization: land application of sewage sludge

88,616 dry English tons of sewage sludge were land applied in Michigan in 2005 according to estimates from the Sewage Sludge Program of the Water Bureau of the MDEQ (Water Bureau, 2009). According to MDEQ Water Bureau, sewage sludge had an average concentration of 1.96 ppm Hg in 2005. Assuming 1% of mercury applied to the surface of the land volatilized within a year (MPCA, 2004), but not taking into account any carryover from previous years, 3.47 lbs of Hg were likely emitted via volatilization from surface-applied sewage sludge in 2005.

Contaminated Site Remediation

The only known source of atmospheric mercury emissions from the clean-up of a contaminated site in Michigan, is the future dredging of the BASF site in Detroit. The dredging of this site is likely to emit 9.00 lbs of mercury to the atmosphere in 2006 (Sadoff, 2006).

MOBILE SOURCES

ON-ROAD

U.S. Environmental Protection Agency and University of Michigan Air Quality Laboratory collaborated on a pilot project in 2002 to investigate motor vehicle mercury emissions ([Hoyer et al., 2004](#)). This pilot project produced significantly different emission factors than those previously used to estimate mobile source mercury emissions from on-road vehicles. Michigan's 1999 mercury emissions inventory estimated on-road mobile source emissions using emission factors that were the detection limit cut in half from Coordinating Research Council (CRC) data. The emission factors produced by the USEPA/U of M pilot project were several orders of magnitude lower than previously-used emission factors.

Table 40. Comparison of 1999 (CRC) and 2002 (USEPA/UM) Emission Factors

Vehicle Type	1999 Emission Factor	2002 Emission Factor
Light-duty Diesel	6,579 ng/mi	6.4-11.1 ng/mi
Heavy-duty Diesel	86,577 ng/mi	6.4-11.1 ng/mi
Light-duty Gasoline	875 ng/mi	0.3-1.4 ng/mi
Heavy-duty Gasoline	839 ng/mi	0.3-1.4 ng/mi

The Light Duty Gasoline Vehicles emission factor from USEPA/UM was applied to all gasoline vehicles for 2005 and the Heavy Duty Diesel Vehicles emission factor from USEPA/UM was applied to all diesel vehicles. Based on data from the Michigan Department of Transportation (MDOT) [MDOT \(2005\) and Weidner \(2009\)](#), 92,216,446,425 miles were driven by various gasoline vehicles in 2005. The number of miles estimated to be driven by diesel vehicles was 8,938,942,091. The 2005 estimate suggested that <1 lbs of Hg was emitted from on-road vehicles (0.19 to 0.50 lbs).

It should be noted that the USEPA/U of M pilot project did not measure reactive gaseous mercury and since this was a pilot project, few vehicles were studied. Further research is needed to estimate emissions from mobile sources with the desired degree of certainty. This pilot study tested light-duty gasoline vehicles (LDGV) and heavy-duty diesel vehicles (HDDV). These estimates only include Hg from tailpipe emissions and do not address other potential mercury sources from on-road vehicles such as mercury in brake pads. Break wear was identified as a potentially significant source of mercury emissions from mobile sources during the pilot study ([Hoyer et al., 2004](#)).

NON-ROAD

There are 19 ferries in Michigan. A preliminary estimate of between 0.2 and 10 pounds of mercury emitted per year was generated for Michigan's only coal-burning ferry, the Badger. The Badger operated ~157 days in 2005 and burns 71.2 tons of bituminous coal per day on average. Using the range of mercury concentration in bituminous coal of 0.01-0.45 ppm ([MMEUW, 2005](#)), the preliminary range of emissions was created. Efforts to estimate other emissions from this source sector and other non-road mobile sources have not been conducted to date.

REFERENCES

Advanced Environmental Management Group. Nov. 1, 2007. *Assessment of Mercury Emissions Impacts for Lafarge Midwest, Inc., Alpena, Michigan*, pp-20-21.

Air Compliance Testing, Inc. 2002. *North Star Steel Company-Michigan Division: Compliance Stack Emission Test Report*, p. 7.

AP-42 Compilation of Emission Factors, U.S. Environmental Protection Agency (U.S. EPA). Ch. 12.5, Iron and Steel Production, pp. 1-19.
<http://www.epa.gov/ttn/chief/ap42/ch12/final/c12s0501.pdf>

Charley, Mary. 2010. Personal communication via writing on 8/18/2010 to Dennis McGeen. Charley is a retired Environmental Engineer Specialist and is the incineration expert for Air Quality Division, MDEQ.

Dictionary.com. Gray Iron. Accessed: Feb 2005. Available from:
<http://dictionary.reference.com/search?q=gray%20iron>. Originally from *Webster's Revised Unabridged Dictionary*, © 1996, 1998 MICRA, Inc.

Ecology Center & Great Lakes United. 2001. *Toxics in Vehicles: Mercury*, p 35, 38. Accessed: Dec 2004. Available at: <http://www.great-lakes.net/lists/enviro-mich/2001-01/msg00125.html>

End-of-Life-Vehicle Solutions Corporation. 2006. 2006 Annual Report, p 7. Accessed Dec. 2009. Available at <http://www.seas.columbia.edu/earth/RRC/documents/End-of-Life%20Vehicle%20Solutions%20Corporation,%20annual%20report%202006.pdf>

Energy International: Metals Processing Advisor. Electric Arc Furnace: Process Description. Accessed: Feb 2005. Available at:
http://www.heattreatconsortium.com/MetalsAdvisor/iron_and_steel/process_descriptions/raw_metals_preparation/steelmaking/electric_arc_furnace/electric_arc_furnace_process_description.htm

Environmental Test Report. 2005. Detroit COV Report No. 3086, Volume 1, Appendix A.5 pp. 23-25, Appendix A.13 pp. 57-59, Appendix A.21, pp. 91-93. Copies from TPU File "Michigan Waste Energy-Greater Detroit RRF, MWC 11 - 13. Detroit Multi-Pollutants September 12-22, 2005."

Fletcher, Matt. 2009 Personal communication via 12/15/2010 email to Dennis McGeen. Matt Fletcher is the Recycling and Composting Coordinator for the Waste and Hazardous Materials Division, Michigan Department of Environmental Quality (MDEQ).

Foy, Joanne. 2010. Personal communication via 8/03/2010 email to Dennis McGeen. Joanne Foy is an Environmental Quality Specialist with the Lansing District of the Air Quality Division, MDEQ.

Grinstern, Eric. 2010. Personal communication via 8/19/2010 email to Dennis McGeen. Grinstern is an Environmental Quality Analyst with the Grand Rapids District of the Air Quality Division, MDEQ.

Great Lakes Commission. 2009. 2005 Inventory of Toxic Air Emissions for the Great Lakes Region: Appendix C: Michigan Toxic Emissions Inventory. Accessed Dec. 2009. Available at: <http://qlc.org/announce/2009-regional-emission-inventory-documents/>

Hoyer, Marion, Baldauf, Richard W., Scarbro, Carl, Barres, James, and Gerald J. Keeler. Mercury Emissions from Motor Vehicles. 2004. Paper from the 13th International Emission Inventory Conference: "Working for Clean Air in Clearwater." Accessed: April 2006. Available at: www.epa.gov/ttn/chief/conference/ei13/toxics/hoyer.pdf

Indiana Department of Environmental Management (IDEM), Office of Air Quality. *Summary of Mercury Emissions from Non-Electric Generating Units (Non-EGUs)*.

Jiang, Hongming. 1999. Personal communication via 4/8/1999 email to Joy Taylor Morgan. Jiang Hongming is with the MPCA and based this value on a 1995 stack test from Empire.

Humphreys, Kathy. 2005. Personal communication via 8/30/2006 email to Dennis McGeen. Kathy Humphreys is with the Division for Vital Records and Health Statistics, Michigan Department of Community Health.

Lindberg, S. E.; Price, J.L. Airborne emissions of mercury from municipal landfill operations: a short-term measurement study in Florida. *J. Air & Waste Manage. Assoc.* 1999, 49, 520-532.

Maillard, Michael. 2009. Personal communication via telephone with Dennis McGeen, MDEQ, on Sept. 8, 2009. Michael Maillard is an Environmental Engineer with the MDEQ, AQD.

McGeen, Dennis. 2009. Dennis McGeen is an Environmental Quality Analyst with the Emissions, Reporting & Assessment Unit of the Air Quality Division.

McLemore, Wilhemina. 2010. Personal communication via 8/03/2010 email to Dennis McGeen. McLemore is the District Supervisor of the Detroit Office of the Air Quality Division, MDEQ.

Michigan Department of Consumer and Industry Services: Bureau of Health Services (now MI Dept. of Labor & Economic Growth). 2002/2003 Annual Report of the Bureau of Health Services. Accessed: March 2005. Available at: http://www.michigan.gov/documents/mdch_bhs2003AnnualReport_117627_7.pdf

MDEQ, Air Quality Division. *EI Toolkit*. Version: 2008.0.0. Accessed Dec. 2009.

MDEQ, Environmental Sciences & Services Division. TRI Query Tool. 2009. Accessed August 2009. Query tool has since been replaced by link to EPA's TRI Explorer tool (<http://www.epa.gov/triexplorer/>).

MDEQ, Waste and Hazardous Materials Division. 2006. *Report of Solid Waste Landfilled in Michigan: October 1, 2004-September 30, 2005*. Accessed Dec. 2009. Available from: http://www.michigan.gov/dec/0,1607,7-135-3312_4123-47581--,00.html

MDEQ, Water Bureau. *Mercury Trends*. Accessed Dec 2009. Available from: http://www.michigan.gov/documents/deq/wrd-biosolids-state-avg_556253_7.xlsx

MDEQ, Air Quality Division. 2010. *Jackson County RRF, Unit #1, Metals/Mercury, February 16, 2005, and Jackson County RRF, Unit #2, Metals, February 8, 2005*. Copies from TPU File "Jackson County RRF, MWC 1 + 2 (Subpart JJJ testing). Jackson, Various Pollutants May 2-4 + June 21-22, 2005."

MDEQ, Pollution Prevention Program. 2010. *Memorandum of Understanding Between the Michigan Department of Environmental Quality and the Alliance of Automobile Manufacturers Establishing the Michigan Mercury Automotive 'Switch/Sweep' Program*. July 1, 2004. http://www.michigan.gov/deq/0,1607,7-135-3307_29693_4175---,00.html

MDOT (Michigan Department of Transportation). 2005. *Statistics: Michigan Average Vehicle Miles Traveled-2005*. Accessed Dec 2009.

Metals Processing Advisor. Energy International, with support from Southern California Gas, Gas Research Institute and others.

http://www.energysolutionscenter.org/heattreat/metalsadvisor/iron_and_steel/process_descriptions/raw_metals_preparation/steelmaking/electric_arc_furnace/electric_arc_furnace_process_description.htm

Michigan Mercury Electric Utility Workgroup (MMEUW). 2005. *Michigan's Electric Utility Workgroup Report on Mercury Emissions from Coal-Fired Power Plants*. Accessed: Nov. 2009. Available from: http://www.michigan.gov/documents/deq/deq-agd-air-aqe-mercury-report_272074_7.pdf

Minnesota Pollution Control Agency (MPCA). 2004. *Estimated Mercury Emissions in Minnesota for 1990, 1995, & 2000: March 2004 Update*.

Minnesota Pollution Control Agency (MPCA). 2008. *Estimated Mercury Emissions in Minnesota for 2005 to 2018*. Accessed January 2010. Available at: <http://www.pca.state.mn.us/air/mercury.html>

Minnesota Pollution Control Agency (MPCA). 2001. *Substance Flow Analysis of Mercury in Products*. Accessed: Jan 2005. Available at: www.pca.state.mn.us/publications/hg-substance.pdf

NEMA (National Electrical Manufacturers Association). 2000. *Environmental Impact Analysis: Spent Mercury-Containing Lamps*.

Office of Highway Policy Information, Federal Highway Administration. *Highway Statistics 2005. Section II: Motor Vehicles. State Motor Vehicle Registrations – 2005*. Accessed: December 2009. Updated: Oct. 2006. Available at: <http://www.fhwa.dot.gov/policy/ohim/hs05/xls/mv1.xls>

Pilgrim, Wilfred. 1998. Chapter VIII. New Brunswick Department of the Environment. Fredricton, New Brunswick in Northeast States for Coordinated Air Use Management, Northeast Waste Management Officials Association, New England Interstate Water Pollution Control Commission, and the Ecological Monitoring and Assessment Network. 1998. *The Northeast*

States and Eastern Canadian Provinces Mercury Study. Accessed: Feb 2005. Updated: Sept 2000. Available at:

<http://www.eman-rese.ca/eman/reports/publications/mercury/contents.html>

Reindl, John. 2005. Summary of References on Mercury Emissions from Crematoria. Copy available from John Reindl, P.E., reindl@co.dane.wi.us. John Reindl, P.E., is with the Dane County Department of Public Works in Madison, Wisconsin.

Sadoff, Margaret. 2006. Personal communication via 5/26/2006 email to Joy Taylor Morgan.

Schleusener, Paul. 2005. Personal communication via 3/30/2005 email to Leah Granke.

Takaoka M., Oshita K., Takeda N., and Morisawa, S. Mercury emission from crematories in Japan. *Atmospheric Chemistry and Physics*. April 20, 2010. www.atmos-chem-phys.net/10/3665/2010/.

Taylor Morgan, Joy. 2010. Personal communication via writing on 8/09/2010 to Dennis McGeen. Taylor Morgan is an Environmental Quality Specialist and is the mercury expert for Air Quality Division, MDEQ.

Tibbetts, Mark. 2009. Personal communication via 12/15/2010 email to Dennis McGeen. Mark Tibbetts is the Executive Director of Thermostat Recycling Corporation. Re: 2005 Estimates for Mercury Thermostat Recycling.

Tilden stack test. 2002. Received via 12/04 email from Conrad Chin, EPA.

URS Corporation. 2004. Final Report: Risk Burn Test of the 32 Rotary Kiln Incinerator. The Dow Chemical Company. Midland, Michigan.

US Census Bureau. Population estimates: states. Accessed Aug. 2008. Available at: http://www.census.gov/popest/data/historical/2000s/vintage_2007/

United States Environmental Protection Agency (USEPA). 1986. *AP 42, Fifth Ed., Volume 1, Chapter 12: Metallurgical Industry*. Accessed: Jan 2005. Available at: <http://www.epa.gov/ttn/chief/ap42/ch12/index.html>

USEPA. 2009. *WebFIRE database*. Available for download at: <http://cfpub.epa.gov/webfire/index.cfm?action=fire.main&CFID=56736798&CFTOKEN=76744429>

USEPA. 2002. TRI Explorer. Accessed: May 2005. Available at: <http://www.epa.gov/triexplorer/facility.htm>

Van Veizen, Daniel, Langenkamp, Heinrich & Georg Herb. 2002. Review: Mercury in waste incineration. *Waste Manage. Res*: 20, p 556-568.

Weidner, Joan. 2009. Personal communication via 12/28/2010 telephone call to Dennis McGeen. Joan Weidner is Senior Planner for the Transportation Department of the Southeast Michigan Council of Governments (SEMCOG).

Weiss, Laura & Sandy Wright. 2001. *Mercury: On the Road to Zero: Recommended Strategies to Eliminate Mercury Releases from Human Activities in Oregon by 2020*, p 59. Accessed: Dec 2004. Available at: <http://oeconline.org/wp-content/uploads/2014/12/roadtozero.pdf>

Wisconsin Department of Natural Resources (WDNR). *Fate of Mercury in Products in Wisconsin*. Flow model developed by Barr for WDNR. First modified with 2002 Michigan data by Leah Granke, MDEQ, in 2006. Modified with 2005 Michigan data by Dennis McGeen, MDEQ, in 2009.

Yanochko, David. 2006. Personal communication via 6/06 email to John Vial, Catherine Simon, and Randy Telesz. David Yanochko is a senior engineer with Fishbeck, Thompson, Carr & Huber, Inc. in the Environmental Services Group.

Prepared by Dennis McGeen, MDEQ, November 2011. This inventory represents the best information available at the time of the last update. The inventory will continue to be updated as better information becomes available.