TAKING THE MERCURY INITIATIVE

state of louisiana
MERCURY RISK REDUCTION PLAN

PREPARED FOR LOUISIANA GOVERNOR KATHLEEN BABINEAUX BLANCO

PREPARED BY THE LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY | JULY 2007

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DEQ LOUISIANA

preface

The Louisiana Mercury Program began in 1994 when it was first funded by the Louisiana Legislature. Since then, the significant increase of mercury-related information has led to a better understanding of what mercury in the environment means to the residents of the state. This information has enabled us to review the program and adjust the direction so that the Louisiana Department of Environmental Quality (LDEQ) can continue to build on past findings. It has led to a clear understanding of mercury as a health threat, especially to young children and the unborn, because they are most susceptible to the neurological effects of mercury overexposure. Such a threat to our future generations warrants action on the part of the state to protect and preserve human health and the environment. That action is embodied in this Mercury Risk Reduction Plan. It is a plan to map the pathway for a cleaner environment and healthier future.

While mercury has very unique properties, it is not unique. Throughout history, there have been numerous substances that filled significant needs, but it was discovered later that the dangers associated with long-term use outweighed the benefits. You may remember how valuable DDT was as a pesticide, protecting humans from insect-borne diseases, or how valuable PCBs were for use as an electrical insulator, or how valuable asbestos was as a thermal insulator. Even though use of these materials ceased decades ago, the nation continues to be plagued by the effects of these substances in the environment today.

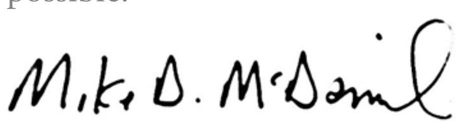
While mercury is a naturally occurring element, human activities have increased the availability of mercury to aquatic life and the fish we catch and eat. This threatens an aspect of Louisiana's culture that must be addressed. For many generations, Louisiana's family-oriented lifestyles have included social gatherings where local table fare is a significant component. At best, concern over the safety of seafood consumed by the younger generations at such events and in daily life casts a pall on the *joie de vie* that is so much a part of this wonderful state. At worst, we may be watching each subsequent generation suffer from potentially irreversible neurological damages that may impair our children for the rest of their lives.

Louisiana Governor Kathleen Blanco recognized this peril and created the Louisiana Mercury Initiative. State and federal agencies, businesses, industries, nongovernmental environmental organizations, and other interested members of the public were invited to participate in formulating the state action plan. This plan will chart the path for reducing risk to mercury exposure. Since mercury is used in so many products and processes, reducing mercury and associated risks will require a broad, comprehensive collaboration to be effective.

Recent actions by the Louisiana Legislature have illustrated the commitment that Louisiana lawmakers have toward protecting our children and environment from mercury. Senate Bill 615 was signed into law on June 2, 2006, and became Act No. 126 – the Louisiana Mercury Risk Reduction Act. This law, the first of its kind in Louisiana, gave authority to LDEQ to regulate mercury-added products and also provided the authority necessary to address unregulated mercury sources. Authorities within the federal Clean Air Act, Clean Water Act and Resource Conservation and Recovery Act give LDEQ the capability to address all other sources either through existing regulation or additional rulemaking.

In addition to granting these new authorities to LDEQ, the legislature continues to fund the Louisiana Mercury Program with annual allocations of state general funds. Even at a time when the state's economy was reeling from the effects of the 2005 hurricane season, the legislature agreed to fully fund the program in recognition of its importance to Louisiana.

On behalf of Governor Blanco, I want to personally thank all of you who have remained committed to protecting human health and the environment and have helped create the Mercury Risk Reduction Plan. Without your help this effort would not have been possible.



Mike D. McDaniel, Ph.D.
Secretary
Louisiana Department of Environmental Quality

acknowledgements

The Louisiana Mercury Risk Reduction Plan was developed with the assistance of many. Groups represented and participating with LDEQ in the Mercury Initiative workgroup meetings included representatives from the Louisiana Department of Health and Hospitals (LDHH), Louisiana Department of Wildlife and Fisheries (LDWF), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Attorney General's Office, United States Geological Survey (USGS), United States Department of Agriculture, United States Environmental Protection Agency (EPA) Region 6, EPA Gulf of Mexico Program, Southeastern Louisiana University, Tulane University, Delgado Community College, Louisiana State University (LSU) Wetland Biogeochemistry Institute, LSU Agricultural Center, LSU Sea Grant Program, LSU Hazardous Substances Research Center, LSU Department of Environmental Studies, Louisiana Forestry Association, Louisiana Association of Business and Industry, Louisiana Dental Association, Louisiana Chemical Association, Louisiana Mid-Continent Oil and Gas Association, Louisiana Oil and Gas Association, Louisiana Audubon Council, Louisiana Wildlife Federation, Louisiana Environmental Action Network, Sierra Club, Gulf Restoration Network, Coalition for Louisiana Progress, U.S. Public Interest Research Group, URS Corporation, Central Louisiana Electric Company, Southwestern Electric Power Company, Unocal Corporation, Citgo Petroleum Corporation, BASF Corporation, Chlorine Institute, Pioneer Americas LLC, PPG Industries Incorporated, Solutions Through Science, Entergy Gulf States Incorporated, Louisiana Generating LLC, Southern Scrap Material Company LLC, Bayou Steel Corporation and numerous individuals representing the public and other business interests. This list of participants also aided in editing the draft plan for production of the final document.

Numerous individuals at LDEQ contributed as authors of the plan. Co-authors of the plan include James Orgeron, Jennifer Mouton, John Rogers, Al Hindrichs, Bill Schramm, Timothy Bergeron, Linda Brown, Alice Fredlund, Aimee Killeen, Gary Aydell, Melissa Reboul, Chris Simms, Darlene Dosher-Collard, Frank Truesdale, Hall Bohlinger, Kimberly Cornelison, Rodney Mallett, Karen Gautreaux and Dr. Mike D. McDaniel.

Josh Carroll was responsible for layout, design and graphics. Marian Mergist was responsible for formatting. Chris Piehler was the coordinating author.

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Special thanks are offered to the members of Louisiana Legislature who enable the operation of the Louisiana Mercury Program through the annual disbursement of state general funds. Finally, congratulations are extended to Governor Kathleen Blanco, Secretary Mike D. McDaniel and the executive staff of LDEQ for the successful development of this state mercury action plan and the proactive desire to reduce risks to Louisiana citizens associated with mercury.

table of contents

table of contents

table of contents

list of figures

list of figures

FIGURE **PAGE**

list of tables

TABLE **PAGE**

acronyms & abbreviations

ABS .... Anti-lock Braking System
ACI .... Activated Carbon Injection
ADA .... American Dental Association
AHA .... American Hospital Association
BEP .... Beneficial Environmental Project
Btu .... British Thermal Unit
CAA .... Clean Air Act
CAAA .... Clean Air Act Amendments of 1990
CAMR....... Clean Air Mercury Rule
CANA .... Crematoria Association of North America
CDC .... Center for Disease Control
CERCLA .... Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR .... Code of Federal Regulations
CIU .... Categorical Industrial User
CWA .... Clean Water Act
EAF .... Electric Arc Furnace
EGU .... Electrical Generating Unit
EPA .... U.S. Environmental Protection Agency
ESP .... Electrostatic Precipitator
FDA .... U.S. Food and Drug Administration
FF .... Fabric Filter
FGD .... Flue Gas Desulfurization
g .... Gram
H2E .... Hospitals for a Healthy Environment
HAP .... Hazardous Air Pollutant
HDDV .... Heavy Duty Diesel Vehicle
Hg .... Mercury
HHW .... Household Hazardous Waste
kg .... Kilogram
LDAF........ Louisiana Department of Agriculture and Forestry
LDEQ........ Louisiana Department of Environmental Quality
LDGV .... Light Duty Gasoline Vehicle
LDHH .... Louisiana Department of Health and Hospitals
LDWF....... Louisiana Department of Wildlife and Fisheries
LOI .... Loss on Ignition
LPDES...... Louisiana Pollutant Discharge Elimination System
MACT....... Maximum Achievable Control Technology
MDN .... Mercury Deposition Network
mg .... Milligram
MMacf ..... Million Actual Cubic Feet
MOU .... Memorandum of Understanding
mV .... milli-volt
NADP .... National Atmospheric Deposition Program
NESHAP.... National Emission Standards for Hazardous Air Pollutants
ng/l .... Nanogram/litre
NPDES...... National Pollutant Discharge Elimination System
NRC .... National Research Council
OIG .... Office of the Inspector General
ORP .... Oxidation Reduction Potential
PAC .... Powdered Activated Carbon
PBT .... Persistent Bioaccumulative Toxin
PMA .... Phenyl mercuric acetate
POTW....... Publicly-owned Treatment Works
ppb .... Parts per billion
ppm......... Parts per million
ppt .... Parts per trillion
PRP .... Potentially Responsible Party
RCRA .... Resource Conservation and Recovery Act of 1976
RGHg .... Reactive Gaseous Mercury
SARA .... Superfund Amendments and Reauthorization Act of 1986
SCR .... Selective Catalytic Reduction
SIU .... Significant Industrial User
TAP .... Toxic Air Pollutant
TEDI .... Toxic Emissions Data Inventory
TGM......... Total Gaseous Mercury
TMDL....... Total Maximum Daily Load
TRI .... Toxic Release Inventory
USGS .... U.S. Geological Survey
WQBL....... Water Quality-Based Effluent Limitation

executive summary

Mercury in the environment poses a significant health threat to consumers of certain fishes. Whether obtained recreationally or commercially, consumption of too many of some species can result in neurological damage, especially in young children and a developing fetus. Mercury is present in fish tissue as a result of anthropogenic (human-influenced) contributions added to background concentrations of the naturally occurring element.

Since 1994, the Louisiana Department of Environmental Quality has received annual funding from the Louisiana Legislature to implement the Louisiana Mercury Program and works with the Department of Health and Hospitals and the Department of Wildlife and Fisheries in conducting program activities. The existing Louisiana Mercury Program focuses on sampling fish tissue, issuing fish consumption advisories when necessary, reporting findings, researching transport and fate of mercury and collecting data on mercury in surface water, rain water, sediment, epiphytic vegetation and human blood. Together the departments have issued 41 fish consumption advisories for mercury in the state including one in the Gulf of Mexico.

In October 2004 Louisiana Governor Kathleen Blanco announced the Louisiana Mercury Initiative. The initiative involved gathering many interested groups and individuals together to develop a plan to address risks to citizens from mercury and to work together to accomplish two goals:

1) Continual reduction in the use and release of anthropogenic mercury in Louisiana; and

2) Minimization of human exposure to mercury through improved communication, education, management, research, collection, recycling, and disposal.

The development of this Louisiana Mercury Risk Reduction Plan represents the combined involvement of government, business, industry and environmental advocacy groups to accomplish the governor's goals.

Reducing risks associated with mercury can be accomplished by reducing mercury releases that are controllable and by reducing exposures through behavior modification. To reduce mercury releases to the environment, the Louisiana Mercury Program will:

• Implement the Louisiana Mercury Risk Reduction Act of 2006 to regulate mercury in products and devices, and monitor development of required collection systems including convenience switches and anti-lock braking systems in end-of-life vehicles.

• Control emissions from coal-burning electrical generating units by implementing the federal Clean Air Mercury Rule, monitoring for effectiveness, and implementing further strategies if necessary.

• Study emissions from former mercury-cell chlorine manufacturers to ensure environmental protection is adequate during and after conversion to membrane-cell technology.

• Discourage waste incineration if mercury is a significant component of the waste and encourage waste minimization, pollution prevention, recycling, and beneficial reuse.

• Implement the Mercury Minimization Plan for the Louisiana Pollutant Discharge Elimination System (LPDES) to detect and address mercury releases through wastewater discharges.

• Scrutinize industrial landfills for controllable mercury releases. Establish requirements for best management practices to minimize off-site transport of mercury.

• Promote voluntary remediation of legacy mercury manometer sites and seek program continuation in the absence of volunteers.

• Support activities that reduce soil erosion and other nonpoint discharges to limit transport of background mercury in native soils to streams by rainfall. Support the Louisiana Nonpoint Source Management Plan as it applies to minimizing sediment in runoff.

executive summary

To reduce exposure to citizens of Louisiana, the Louisiana Mercury Program will:

• Continue to gather data on mercury levels in fishes and consumption habits of people to ensure that exposure levels are adequately understood. Risk assessment will be reviewed for adequacy and appropriateness. Adjustments to the process of issuing advisories may be needed and should balance risks from mercury and nutritional benefits of eating fish.

• Enhance risk communication efforts to maximize effectiveness and maintain a presence of information as a frequent reminder. Mercury awareness, in its many forms, involves numerous aspects of everyday life. Providing information that enables citizens to manage their risks is paramount. Numerous publications produced through the program have been successful and well received, creating recurring opportunities for mercury awareness when such reading material is brought home. Video development and public service announcements are tools used to reach target audiences.

• Bring understanding of mercury to science classrooms to teach children about practical applications to reduce risks of exposure and minimize pollution. Recycling taught to a youth may lead to a lifetime of environmentally friendly behavior.

• Continue to gather information on sources, transport, and fate of mercury to ensure that significant sources of exposure are known and addressed. Adjustment to existing sampling protocols may be required.

• Report every two years on program status and achievements which may be used to make recommendations and modify this plan. Reporting will focus on historic data availability, current data collection, detectable trends, and recent discoveries. The Mercury Program Steering Committee, consisting of representatives from LDEQ, LDHH and LDWF, with advice from the public, will review recommendations and consider program adjustments.

While the Louisiana Department of Environmental Quality and the state of Louisiana are working diligently to reduce the risk of mercury exposure to our citizens, it must be remembered that some sources of mercury to our environment are beyond local control. Because of mercury's long range transport in the atmosphere and cycling in terrestrial and aquatic environments, this toxic metal presents a global challenge. As evidenced by recent national programs established to address mercury exposures in the U.S. and Canada, as well as the United Nations Environment Programme, a truly multinational approach will be required to reverse the effects of mercury loading to our global environment. Recent scientific research provides some good news: levels of mercury in the environment will be expected to diminish if we can reduce the level of anthropogenic emissions.

section 1 goal statement/purpose of this document

The Louisiana Mercury Risk Reduction Plan has two primary goals supported by Louisiana Governor Kathleen Babineaux Blanco and LDEQ Secretary Mike D. McDaniel:

1. Continual reduction in the use and release of anthropogenic mercury in Louisiana; and

2. Minimization of human exposure to mercury through improved communication, education, management, research, collection, recycling and disposal.

The primary purposes of this document are: (1) to present a current assessment of the sources and potential means of exposure to mercury in our state's environment; and (2) to present strategies that have been mapped out for reducing the risk of mercury exposure to the citizens of Louisiana.

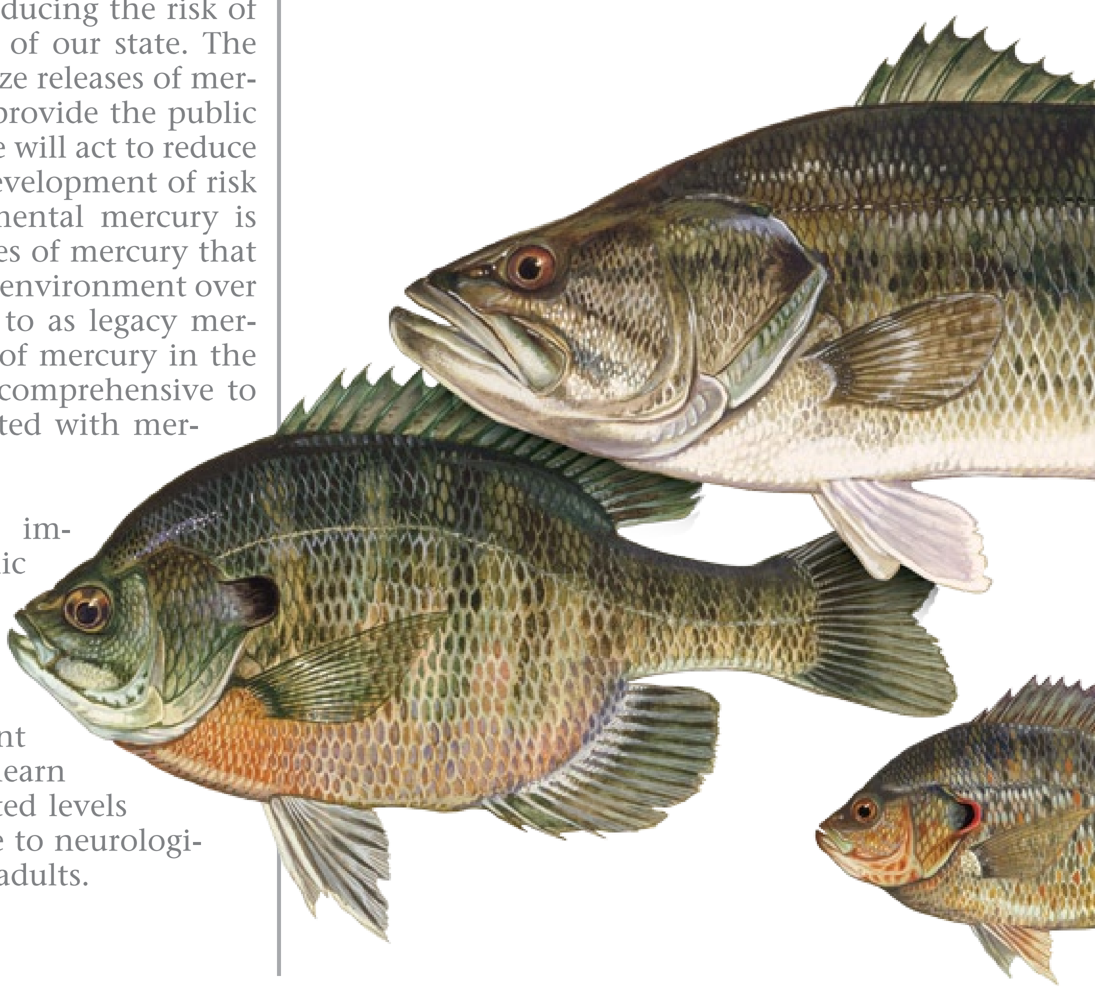
LDEQ, in cooperation with LDHH, LDWF, EPA, USGS, industry representatives, and nongovernmental environmental organizations, has developed this plan with the specific intent of reducing the risk of mercury exposure to the citizens of our state. The plan includes strategies to minimize releases of mercury to the environment and to provide the public with information on how the state will act to reduce their risk of mercury exposure. Development of risk reduction strategies for environmental mercury is complicated by the large quantities of mercury that have been released into the state's environment over the past century. This is referred to as legacy mercury. Given the pervasive nature of mercury in the environment, this plan must be comprehensive to address the many aspects associated with mercury use.

Preventing mercury exposure is important in the protection of public health. Pregnant women, the unborn and young children are most sensitive to mercury effects. Exposure to mercury during the early stages of human development can damage children's abilities to learn and control their behavior. Elevated levels of mercury can also cause damage to neurological and cardiovascular systems in adults.

Because of the dangers to human health and the environment, LDEQ developed this plan to reduce mercury mass transfers in the environment, to reduce or eliminate contributions from existing sources, and to remediate legacy mercury releases where possible.

The most significant risk of exposure to mercury by humans is from the consumption of fish. Reducing or preventing mercury releases to the environment is essential to reducing mercury uptake into the food chain and the subsequent exposure to humans from consuming fish.

Reducing consumer use of mercury-containing products can also aid in reducing opportunities for mercury exposures and releases to the environment as these products reach end of life and are discarded. Pollution prevention and waste minimization are key approaches to this endeavor and are applicable to residences and industry alike.



section 2 physical/chemical properties of mercury

Mercury (Hg) is a naturally occurring element found ubiquitously throughout the global environment, usually in trace concentrations. It has some unusual properties that distinguish it from other transition metals. It is a silver-white heavy metal and is the most dense element (specific gravity of 13.5 at 25 C) that exists as a liquid at room temperature (melting point is -38.9 C and boiling point is 356.7 C). It is slightly soluble in water (0.06 grams per liter of water at 25 C). Because of its substantial vapor pressure (2 x 10^{-3} mm Hg at 25 C), direct volatilization, even under normal pressures and temperatures, is significant.[1] Mercury vapors are odorless and colorless, but they can create a visible shadow when viewed between an ultraviolet light source and a fluorescent background.[2]

Mercury can exist in a variety of forms – elemental, inorganic compounds, and organic compounds. Elemental mercury does not conduct heat well, but is an extremely useful element as it conducts electricity and can be used to measure temperature and pressure. Mercury easily forms alloys with other metals. The unique properties of elemental mercury and mercury compounds have proven valuable for many uses, both historic and present day. However, it is also highly toxic to humans and other organisms depending on chemical form, amount, exposure pathway, and vulnerability of the person exposed.

As an element, mercury cannot be broken down or degraded into harmless substances. It may change between different states and species in its cycle, but its simplest form is elemental mercury, which itself is harmful to humans and the environment. Once mercury is liberated from natural sources or released from anthropogenic sources into the biosphere, it can be highly mobile cycling between the earth's surface and the atmosphere. The earth's surface soils, water bodies, and bottom sediments are thought to be the primary biospheric sinks for mercury.

Two characteristics of mercury, volatility and biotransformation, make it somewhat unique as an environmental toxicant. Its volatility accounts for atmospheric concentrations up to four times the level of contaminated soils in a given area. Also, inorganic forms of mercury can be converted to organic forms by microbial action. The most common organic mercury compound that microorganisms and natural processes generate from other forms is methylmercury. This is of particular concern, since methylmercury is especially toxic, and it can bioaccumulate and biomagnify in many edible aquatic species to levels that are many thousands of times greater than levels in the surrounding water.

section 3 mercury in the environment

3.1 Natural Sources of Mercury

Natural sources of mercury include volcanoes, volatization (evasion) from soil and water surfaces, degradation of minerals, and forest fires. Today's emissions of mercury from soil and water surfaces are composed of both natural sources and re-emission of previous deposition of mercury from both anthropogenic and natural sources. Measurement of relative contributions of these two sources is difficult and estimates often vary widely.

The most recent research provides an estimate of global natural mercury emissions of about 2,400 metric tons (5.28 million pounds) per year, of which 1,320 were emitted from land and 1,100 were emitted from oceans. It has become increasingly evident that anthropogenic emissions of mercury to the air rival or exceed natural inputs.[1]

In "Global Mercury Assessment," the United Nations Environment Programme (2002) presented a comparison of estimated pre-industrial and current global mercury emissions.[1] Pre-industrial annual emissions were estimated to be 1,800 metric tons per year and current annual emissions were estimated to be about 5,200 metric tons (11.44 million pounds) per year. EPA (1997) has estimated that annual amounts of mercury released into the air by human activities range between 50 and 75 percent of total yearly input to the atmosphere from all sources.[3]

Global Emissions of Mercury

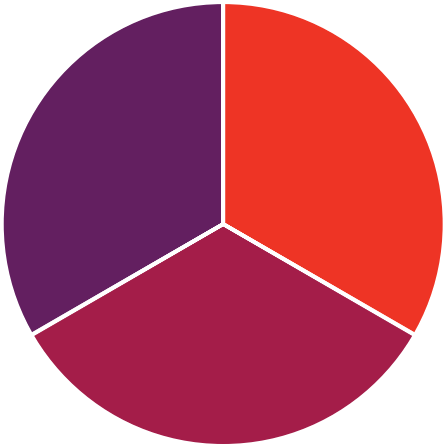


Figure 1 – Estimated relative global mercury mass transfers from natural, direct human, and indirect human sources.[4]

3.1.1 Volcanism

As mercury is an element present in the earth's crust, it is also volatilized to the atmosphere when volcanic magma is exuded to the earth's surface. Atmospheric measurements of mercury above Hawaiian and Icelandic volcanoes are orders of magnitude above normal background levels. Measurements of the gaseous plume from an active, but pre-eruptive Mount St. Helens in 1980 yielded estimates of 200 to 1,700 kg/day of released mercury.[5] Samples of volcanic ash, however, revealed mercury content below detection limits of 1.0 and 5.0 parts per million (ppm), seemingly supporting the theory that mercury in magma is released to the atmosphere before the magma cools and solidifies.[6] Although virtually nonexistent in many parts of the nation and world, the large volumes, high energy, and high temperatures associated with volcanic eruptions likely result in long-range transport of mercury, with deposition occurring at great distances from the source. Elevated mercury concentrations in ice cores from the Upper Fremont Glacier have been dated to correspond with historic volcanic eruption. (Figure 2)

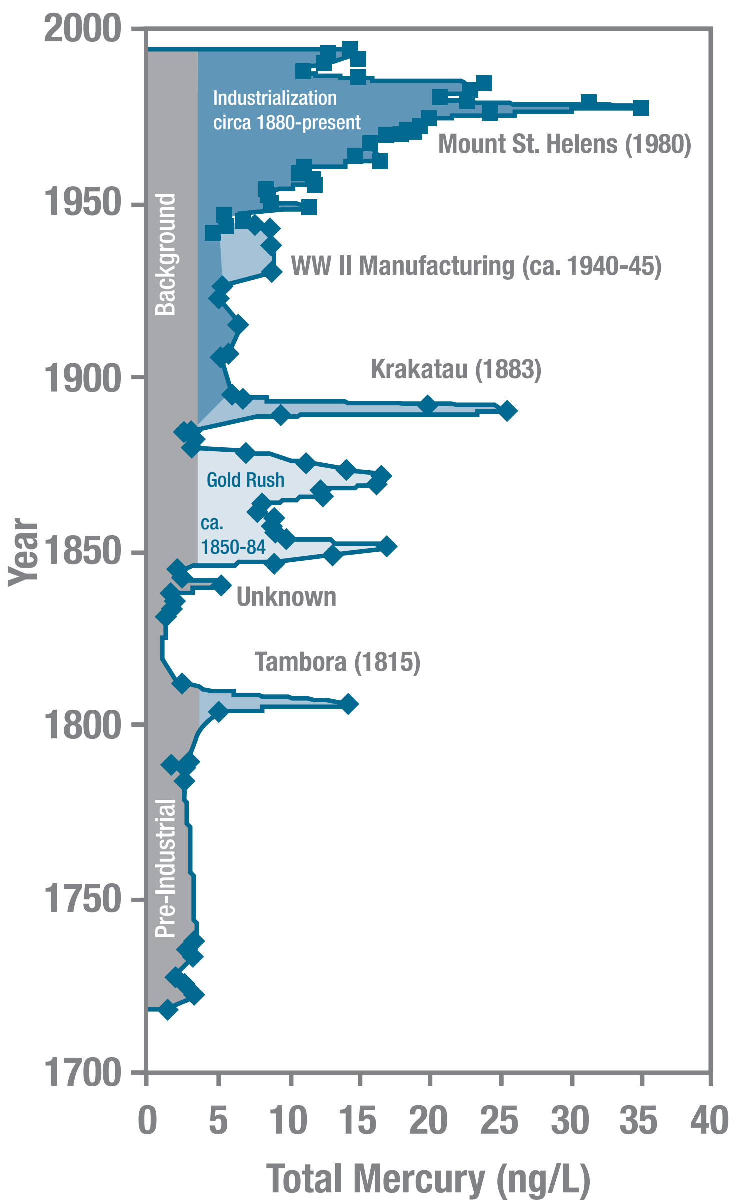


Figure 2 – Profile of historic concentrations of Hg in the Upper Fremont Glacier, Wyoming. A conservative concentration of 4 ng/L was estimated as pre-industrial inputs and extrapolated to 1993 as a background concentration. Age-depth prediction limits are ±10 years (90 percent confidence level); confidence limits are 2-3 years.[13]

3.1.2 Geothermal Systems

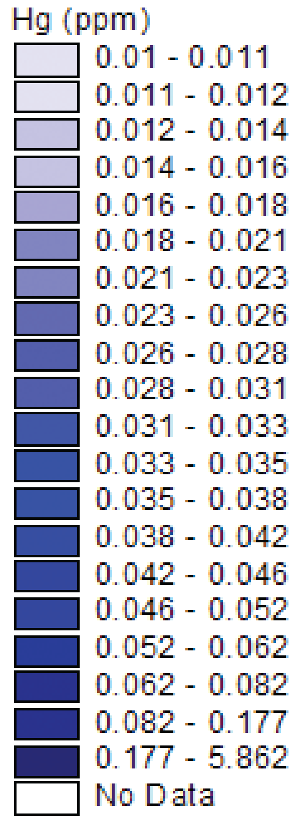
Atmospheric emissions of mercury and mercury-bearing deposits are associated with hot springs and geothermal areas. Globally, the emissions of mercury from geothermal systems are estimated to be less than 10 percent of those from volcanoes.[7] Additionally, mercury has been measured in geothermal spring water at values ten times and higher than those of ambient receiving waters in California.[8] Regional geothermal activity affecting Louisiana occurs near Hot Springs, Arkansas, within the watershed of the Ouachita River in the form of heated groundwater discharged to surface waters. This natural activity may represent a source of mercury to a watershed for which many fish consumption advisories in Louisiana and in Arkansas have been issued.[9]

3.1.3 Erosion of Mineral Deposits and Soils

Mercury is an element that occurs naturally throughout the earth's lithosphere. It is a trace component of many minerals. The important commercial ore is cinnabar, a mercury sulfide mineral, in which mercury content can reach 86 percent. Mercury is found in all classes of rocks including basalt, rhyolite, limestone, shale, sandstone, serpentine, chert, andesite and others. Continental rock averages about 80 parts per billion (ppb) of mercury.[10] Coal and lignite typically contain mercury at 100 ppb and higher.[11]

Emissions of mercury to the atmosphere from soils and minerals are a natural phenomenon, but the magnitude of emissions is uncertain and related to several variables.[12] Mercury transfers are likely influenced by sunlight, mercury speciation and concentration, temperature and other variables. Mercury emissions from land surfaces become greater with increasing mercury concentrations in soil and rock. Coastal areas of Louisiana have been shown to have naturally elevated levels of mercury in soils and other surficial materials (Figure 3).

Background concentrations of mercury in soils become available to aquatic life when erosion transports soil to surface waters. The concentrations of mercury may be low (as background) in most soil, but the amount represents an increase of mercury loading that would not occur to a water body except for the action of erosion. The state of Arkansas has identified black shale in the southern part of the state as the primary contributor of mercury to streams with mercury advisories.[15] Soil erosion probably contributes approximately 90 percent of mercury loading to Ouachita basin lakes.[9]



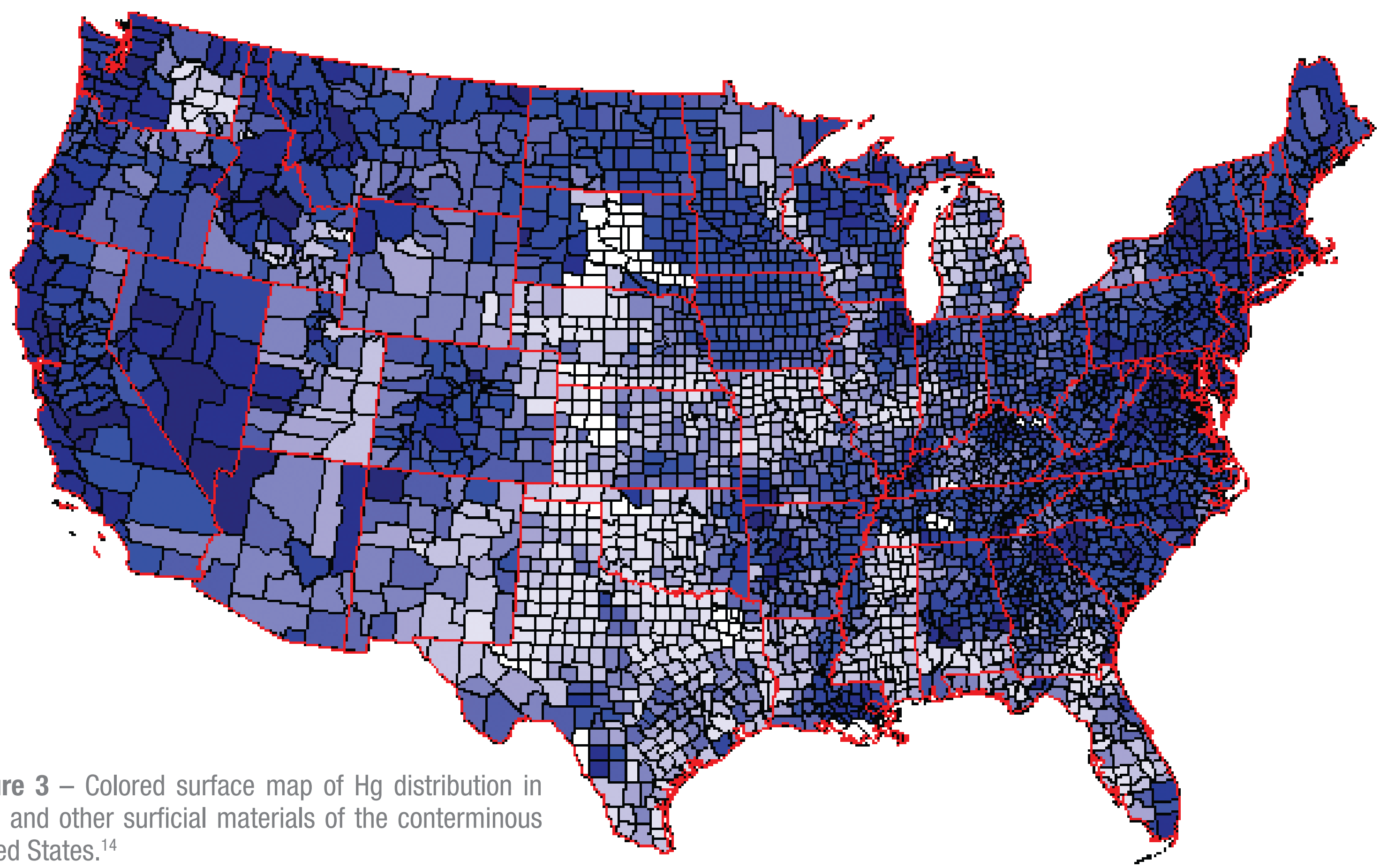


Figure 3 – Colored surface map of Hg distribution in soils and other surficial materials of the conterminous United States.[14]

3.1.4 Marine Waters

Oceans and the Gulf of Mexico may be thought of as sources of mercury or they may also serve as a pool of mercury fed by natural and anthropogenic sources through wet and dry deposition. Most mass transfer of mercury is to the atmosphere with less than two percent annually incorporated into ocean sediments and sequestered. It has been suggested that there is a net transfer of mercury from terrestrial environments to the oceans and that the concentration of mercury in oceans is increasing at a few percent per year (See Section 3.4 Re-emission of Mercury). This would characterize oceans as a net sink as opposed to a net source, but also may represent mercury sources to the marine environment.[16]

An estimated 55,000 pounds of mercury are annually deposited from the atmosphere to the surface waters of the Gulf of Mexico and an additional 48,000 pounds of mercury enter the northern Gulf of Mexico in the freshwater inflow from the Mississippi River.[17]

3.1.5 Forest Fires

Forest fires have been reported as a source of mercury. However, like oceans, forests also receive mercury by wet and dry deposition, which is then emitted in forest fires. Forest fires can also heat native soils to revolatilize background soil mercury.[18] Mercury is transferred from atmosphere to plants, with the net direction toward plants. Plant uptake appears to be through open leaf stomata.

The practice of control burning reduces forest floor material that serves as fuel for wildfires. Mercury volatilizes from soil, leaf litter and small plants during small-scale control burning.[19] However, as this practice reduces the likelihood of wildfire, it also reduces mercury releases associated with catastrophic wildfire events. Control burns help prevent largescale forest fires and may reduce soil erosion, which is a potential source of mercury loading to area waters.

3.2 Anthropogenic Sources of Mercury

3.2.1 Manufacturing Sources

3.2.1.1 Chlorine Production using Mercury-cell Technology

Chlorine is produced in the U.S. using a number of different production methods. In 2005, nine chlorine production facilities used mercury-cell technology (mercury-cell chlor-alkali) in the U.S. with two of these located in Louisiana. The mercury-cell technology that these facilities utilize was among the most current chlorine production technology available when the facilities were constructed. The industry was regulated under 40 CFR Part 61 Subpart E – National Emission Standard for Mercury. Regulation of facilities using mercury-cell technology is now regulated by EPA through 40 CFR Part 63 Subpart IIIII. The compliance date for the rule was reached on December 19, 2006.

A mercury-cell facility has many cells connected electrically in series. In the mercury-cell process, two distinct operations are involved. The electrolytic cell produces chlorine gas, and a separate decomposer produces hydrogen gas and caustic solution. One decomposer is associated with each cell. The cell and the decomposer are linked by an outlet end box and an inlet end box. A stream of liquid mercury flows in a continuous loop between the electrolytic cell and the decomposer. Elemental mercury flows into the cell at the inlet end box and flows down a slight grade to the outlet end box, where the mercury flows out of the cell and into the decomposer. After processing in the decomposer, the mercury is pumped back to the inlet end box of the electrolytic cell.

Saturated salt brine is fed to the electrolytic cell at the inlet end box and flows toward the outlet end box on top of the mercury stream. The brine and mercury flow under a metal anode, which contacts only the brine. The mercury forms the cathode. When electrical current is applied between the anode and the mercury cathode, the current produces a reaction that results in chlorine gas production at the anode and mercury:sodium amalgam production within the mercury cathode. The amalgam exits the cell from the outlet end box and flows to the decomposer with the mercury layer. The depleted brine is piped to a holding tank for resaturation and reuse. Chlorine gas is collected from the tops of the cells with a common header system.

In the decomposer, the amalgam is in contact with deionized water in the presence of a catalyst. The amalgam reacts with water, regenerating elemental mercury and forming sodium hydroxide (caustic soda) and hydrogen gas. The sodium hydroxide and hydrogen are transferred to auxiliary processes for purification and the regenerated mercury is recycled back to the cell. The sodium hydroxide produced in this process contains mercury as a contaminant. The maximum allowable concentration of mercury in sodium hydroxide is 1 ppm.

Mercury is emitted from permitted point sources associated with chlorine production – the end box ventilation systems, by-product hydrogen systems, and mercury thermal recovery units. In addition, there are fugitive mercury emissions from the cell rooms and the waste recovery and spill containment areas, generally associated with cell maintenance activities.[20]

Annual emission calculations for mercury-cell chlor-alkali facilities were initially developed in 1973 and were a summation of one-time measurements of point source emissions which came to represent an industrywide, EPA approved assumption of 1.3 kg/day of fugitive emissions from the cell room. Given the total of allowable mercury emissions was set at 2.3 kg/day, the fugitive emission assumption effectively set the emission limits for the combined point sources at 1.0 kg/day. The new Maximum Achievable Control Technology (MACT) rule, finalized in 2003 and effective in 2006, reduces point-source mercury emission limits approximately 1,500 pounds nationally. The rule also includes work practice requirements to reduce fugitive emissions throughout these facilities.

One of Louisiana's two mercury-cell chlor-alkali plants is located near Lake Charles and the other near St. Gabriel. Based on Toxic Release Inventory (TRI) reports for the last four years, these two facilities combined are estimated to emit more mercury and mercury compounds into the air in Louisiana than any other industrial sector. It is estimated that in 2004, more than 52 percent of the mercury and mercury compounds emitted in the state came from these two sites, totaling approximately 2,500 pounds (Figure 4).[21]

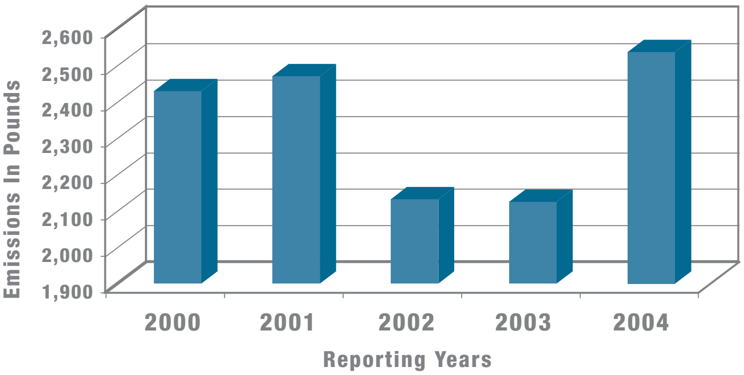


Figure 4 – Combined mercury releases from two chlorine manufacturing facilities using mercury-cell technology in Louisiana from 2000–2004 according to the Toxic Release Inventory. [21]

Both facilities have been taking steps to be in compliance with the newer MACT rule. Some examples include improvements to cell gaskets, sealed hydrogen coolers, seal-less mercury pumps, decomposer improvements, mercury removal using activated carbon, and overall cell technology upgrades. In addition, certain operational procedures that reduce the frequency of cell openings for maintenance have been employed. Together, these activities have contributed to reducing mercury emissions from these two facilities, although no quantification of this reduction has been made.

The new MACT rule will provide more stringent requirements for mercury-cell facilities nationwide. Point source allowable emissions (from vents) will be reduced from 1,000 grams per day to 60 grams per day on average. In addition, enhanced work practice standards will have an effect on fugitive emissions of mercury and also require detailed record keeping and reporting. Each plant will be required to report new mercury additions to the mercury cells and to report the added mercury to cells for the five years prior to the December 2006 compliance date. Some work practices subject to the new rule include specific equipment standards such as fixed end box covers or end box ventilation; smooth piping interiors; and tight-fitting lids on mercury storage containers. Operational procedures are improved in the new rule and include such practices as: allowing decomposers and electrolyzers to cool before opening; keeping liquid mercury spills under an aqueous layer to reduce opportunity for evaporation; and implementing a more stringent inspection requirement to find, repair, and document leaks in a timely manner.

The larger of the two mercury-cell chlor-alkali technology facilities in Louisiana announced on August 4, 2005, that by midyear 2007 the facility will have converted to membrane cell technology, thereby reducing its mercury emissions by approximately 1,600 pounds. This conversion will remove the single greatest source of mercury release to the air in Louisiana. The remaining mercury-cell chlorine producer in Louisiana, who reported in the 2004 TRI releasing 1,312 pounds and 15 pounds of mercury to air and water, respectively, also announced cessation of their mercury-cell processes. At this facility, chlorine production using mercury will cease by the end of 2008.

3.2.1 Manufacturing Sources

└3.2.1.2 Petroleum Refining

Crude oil is a complex mixture of hydrocarbon compounds that vary in percent composition depending upon the source. Crude oil refining involves several processes that result in gasoline, diesel fuel, and other separated petroleum fractions as product. When crude oil is extracted from the earth in exploration and production activities, it contains impurities and varying combinations of useable hydrocarbon substances. Different applications require different hydrocarbon mixtures, or blends, which must be refined from crude oil.

The first step in crude oil refining is to remove impurities. This process removes major contaminants, including water and salt, and is often referred to as desalting. After this step the oil is moved to an atmospheric tower for distillation. The hydrocarbons in crude oil have different boiling points according to the number of carbon atoms their molecules contain and how they are arranged. Fractional distillation uses the difference in boiling points to separate the hydrocarbons. The fractionating column, or tower, is cooler at the top than the bottom allowing vapors to cool as they rise. Vapors condense onto a tray when they reach the part of the column which is cooler than their boiling point.

As the last gases from the bottom of the column pass through holes in a tray, any lighter hydrocarbons still in the condensed liquid are boiled off and rise through the column. Heavy residues from the fractionating column are distilled again under a vacuum. This means that the heavier fractions can be further separated without high temperatures which would break them down. These are then passed on to the cracking unit, used to produce certain types of lubricating oils, or are blended into industrial fuels.

Mercury is present in crude oil as a contaminant and can be present in numerous forms. In liquid petroleum, mercury is present as elemental, dimethylmercury and diethyl mercury. In solid residues, mercury is present as mercuric chloride, mercuric sulfide and mercuric selenide. Mercury in liquids volatilizes in the distillation process and may be present in product streams and refinery fuel gas. Mercury in solid residues tends to fall out in waste streams or in petroleum coke.

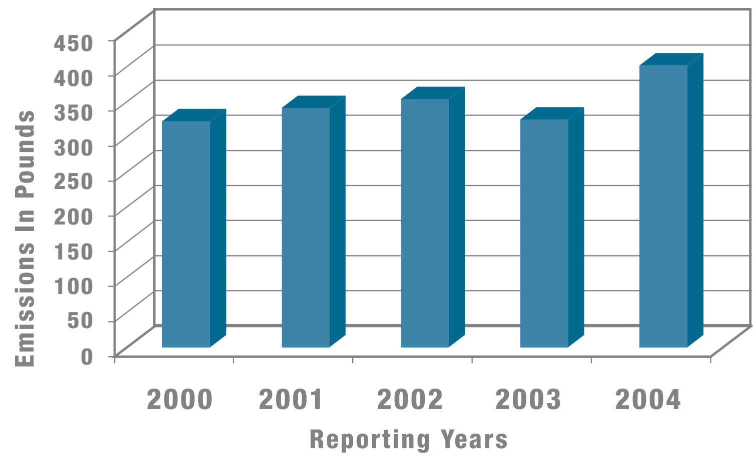


Figure 5 – Relative contributions from oil refineries to total mercury releases in Louisiana (TRI).[21]

In 2004, twelve crude oil refineries in Louisiana reported to the TRI, in total, more than 372 pounds of mercury in air emissions and approximately 33 pounds of mercury in wastewater discharges (Figure 5). As a contaminant, not an added substance, mercury reduces the quality of refinery products.

Industry and EPA are studying ways to better understand mercury in crude oil and to develop and improve technologies that will remove mercury from crude oil prior to refining. Current efforts to reduce fuel gas usage would have the co-benefit of reducing mercury releases. The use of wet gas scrubbers on air emission points would further reduce mercury in air emissions.

At present, controlling mercury in refinery emissions beyond the benefits of currently required controls would result in significant increases of refinery product costs (e.g., gasoline, diesel fuel, and other petroleum fuel products) but may not reduce total mercury emissions in the state significantly, given the low amounts emitted per facility. Reducing mercury at input would be a desirable approach to controlling mercury in refinery emissions, but technology to reduce mercury in raw crude oil has yet to be developed. Research into such technology should be promoted. This technology could also result in reducing emissions of the trace amounts of mercury in petroleum fuels consumed in transportation, manufacturing and other sectors.

3.2.1 Manufacturing Sources

└3.2.1.3 Electric Arc Furnaces

An electric arc furnace (EAF) is the principle furnace type for the electric production of steel. It is a metallurgical furnace used to produce carbon and alloy steels, typically using scrap steel. Cylindrical, refractory lined EAFs are equipped with carbon electrodes to be raised or lowered through the furnace roof. With electrodes retracted, the furnace roof can be rotated to permit the "charge," or addition of scrap steel by overhead crane. Alloying agents and fluxing materials usually are added through doors on the side of the furnace. Electric current is passed between the electrodes and through the scrap, generating arcing and enough heat to melt the scrap steel charge. After melting and refining periods, impurities (in the form of a slag) and the refined steel are poured from the furnace.[22]

The production of steel in an EAF is a batch process. Cycles range from about 1.5 to 5.0 hours to produce carbon steel and from 5.0 to 10.0 hours to produce alloy steel. Scrap steel is charged to begin a cycle, and alloying agents and slag-forming materials are added for refining. Stages of each cycle normally are charging, melting, refining (which usually includes oxygen blowing), and tapping.

Mercury emissions from an EAF can occur when the scrap metal charge includes mercury-containing devices (e.g., switches, relays, thermocouples, and other devices found in end-of-life automobiles, appliances, and other goods).

Approximately 60,000 end-of-life automobiles are melted at the single EAF in Louisiana each year. Some automobiles contain mercury switches in the hood and trunk in addition to the presence of mercury switches in some anti-lock brake system (ABS) devices. The amount of mercury in each switch ranges from 0.7 grams to 1.5 grams.

The single EAF in Louisiana emitted more than 450 pounds of mercury/mercury compounds to the air according to data in the 2003 TRI. Subsequently, the department requested that the facility complete a stack test to confirm the presence and estimate the amount of mercury emissions. Preliminary stack test results indicate emissions much lower than the TRI submittal; however, a revision to the TRI has not been submitted by the facility. The stack tests were performed at the primary dust collection point. In the facility's most recent permit application, no other emission points indicate the presence of mercury. Due to the facility process (how the scrap steel is charged) and the presence of mercury in the primary dust collection system, mercury emissions may also be present in the furnace house fugitive emissions and the secondary dust collection system. These emissions are not accounted for in the permit. Differences in the mass-balance calculations of the amount of mercury in vehicle switches and the amount of mercury emitted at the single EAF in Louisiana may be accounted for in losses upon vehicle crushing or shredding (a practice necessary for scrap vehicle transport), inaccurate account of which vehicles contain mercury switches, or as fugitive emissions from the EAF Furnace House and the Secondary Dust Collection System. According to the TRI report for 2004, the facility reported a marked decrease in mercury air emissions, from more than 450 pounds in 2003 to 20 pounds in 2004. The 2004 value is based on data gathered during stack testing.

The EAF facility is regulated under the state air toxics rule. However, when the EAF's air toxics compliance plan was submitted, the facility was not aware of mercury emissions so their compliance plan did not specifically address mercury emissions. The stack testing that resulted in the quantification of mercury in the facility's emissions was performed after submission of the compliance plan. The facility's air permit does not address controlling mercury emissions because the facility is allowed to emit 24 pounds per year before the state air toxics rule applies. The permit, as of November 2006, requires the facility to use scrap metal from which mercury switches have been removed.

Emissions are captured using canopy hoods and scavenger ducts whose vents are routed to the bag house unit. Current emission control consists of fabric-filter (bag house) type control intended to address particulate emissions from the EAF. Bag houses offer some co-benefit of mercury removal (see Section 3.2.2.1 on coal-burning electricity generation). Control of mercury in emissions would require approaches similar to those expressed in the section on electrical power generators.

Some states have used existing Resource Conservation and Recovery Act (RCRA) and Clean Water Act (CWA) regulations to promote removal of mercury-added products for recycling prior to their disposal. RCRA requires that hazardous wastes be handled in an environmentally sound manner. When crushing or shredding a mercury-added product, the hazardous material (mercury) becomes a hazardous waste, spilling uncontained from the scrap. Stormwater regulation within the CWA can also affect this situation, since spilled mercury from crushing or shredding operations may contaminate stormwater runoff during rainfall events. These represent resource intensive and costly approaches for a regulatory agency, as each site would require individual handling through traditional enforcement actions. Ensuring capture of mercury-added products for separate recycling, either voluntarily or through regulatory means, would reduce releases of mercury to the environment most effectively. This practice may only be necessary for a limited period of time. Automobile manufacturers discontinued use of mercury switches in automobiles after 2003, and as vehicles manufactured after that time reach end of use and are recycled, this control practice may be no longer needed.

3.2.1 Manufacturing Sources

3.2.1.4 Lumber, Pulp and Paper Mills

Current operations at pulp and paper mills may involve the addition of mercury as part of the paper manufacturing process if sodium hydroxide used in the process was manufactured using mercury-cell technology. This can contribute mercury to process wastewater discharges. Mercury is also present in timber as a naturally occurring contaminant and at some background level.

The mercury in wood pulp contributes to mercury in process emissions and discharges.[1] Pinebark is removed in preparation for pulp/paper processing and the bark is often used as fuel for the process equipment. The natural “background” level of mercury in bark is released to the air when the bark is burned as fuel.[23]

In the 2004 TRI, three Louisiana paper mills reported 46 pounds of mercury compounds released to the environment, of which 10 pounds were emitted through air emissions. Approximately 36 pounds of mercury were released to landfills, primarily as solid waste generated during the pulp/paper manufacturing process and also in the form of wood waste not suitable for fuel which may be landfilled on site.[21,23]

Since current lumber, pulp, and paper mill emissions include the re-release of "background" mercury contained within timber products, it is not likely that emission controls applied to these mills will represent a significant reduction in the amount of mercury in the environment. Reductions of trace amounts of mercury in air emissions could be realized if scrap timber (e.g., bark, sawdust) were landfilled or composted as opposed to being burned for fuel, but the beneficial use of an otherwise "waste" material as fuel instead of as another component of a landfill operation may be desirable. The use of clean burning fuels instead of wood waste would appear to lower mercury emissions by a maximum of 10 pounds per year in Louisiana.

Historic uses of mercury include use as a fungicide (or slimicide), herbicide, pesticide and microbiocide.[24] There are many mercurial formulations used for these purposes. In 1969, fish in the Saskatchewan River in Canada were found to contain up to 10 ppm mercury, resulting in a commercial fishing closure. An investigation traced the source of mercury to chlor-alkali plants utilizing mercury cells and to mercury slimicides used in the pulp and paper industry.[25] Mercurial slimicide use at pulp and paper mills was banned by EPA in the 1970s in response to the contamination of paper used in milk cartons. Subsequent monitoring of cormorant eggs near the coast of British Columbia revealed a three-fold decline in mercury burden from 1973 to 2000.[26] Legacy contamination of waterbody sediments from past pulp and paper mill discharges may occur in Louisiana.

The process of treating lumber with these compounds to prevent rot may have involved the use of vats, tanks, or open pits where lumber was submerged to be treated. Sawmill ponds were identified as legacy sources of mercury to area waters in Massachusetts.[27] Use of mercury fungicides in southern sawmills began in 1929 and quickly became widespread.[28] Elevated mercury levels in sediments of the Pearl River and a tributary were associated with a mill in Bogalusa, Louisiana in 1974.[29] Although this practice has been discontinued, the sites where this activity occurred may represent legacy contamination that continues to enter the food chain today. The process of closing these sites probably pre-dated most environmental regulation. Therefore, such sites may not have been closed in a manner that would prevent off-site migration of mercury compounds. Discovery of mercury-contaminated sites from legacy mill operations may prove difficult. Extent and accuracy of records on historic mill siting is unknown, but where available, could be supplemented with downgrade sediment samples for mercury to identify "above background" conditions that could indicate legacy contamination sites within the watershed. Remediation of such sites would depend upon site specific criteria, but may be functionally comparable to those associated with mercury manometer sites (see Section 3.2.3.1). Funding for the remediation of such sites, in the absence of a cooperative potentially responsible party (PRP), would likely require complexities similar to those stated for abandoned mercury manometer sites.

3.2.1 Manufacturing Sources

└ 3.2.1.5 Carbon Black Production

Carbon black consists of particles of carbon formed from the incomplete combustion of hydrocarbons. The most common use of carbon black is as filler in rubber manufacturing to add toughness and abrasion resistance to the final product, the most common of which is tires.[30]

Raw materials used in carbon black production include the feedstock, air and a fuel source, typically natural gas. The feedstock is generally a heavy petroleum fraction similar to No. 6 fuel oil, which has an average mercury content of 0.06 ppm.

The feedstock is heated to between 150°C and 250°C and introduced into an oxygen deficient zone with the auxiliary fuel in an atomized spray. The result is pyrolysis of the feedstock, producing fine carbon black particles that are captured using a fabric filter. Carbon black production in the U.S. occurs primarily in southern states. In 1995 Texas had eight of a total of 22 establishments. Currently five facilities in Louisiana produce carbon black. The industry release estimates nationwide are approximated at 560 pounds. The number of carbon black facilities in Louisiana represents 22 percent of the nation's total and approximately 127 pounds of potential mercury released based on 100 percent operating capacity and no mercury removal from existing air pollution control equipment.[31]

Three of the five Louisiana carbon black facilities reported mercury emissions in the 2003 TRI. The total reported mercury emissions from all three facilities was under 10 pounds.[21] Air emission controls on carbon black manufacturing facilities are not specific for mercury, but probably have the co-benefit of particulate mercury capture.

3.2.2 Combustion Sources

3.2.2.1 Coal-Burning Electrical Generating Units

The most common means of generating electricity is by using rotating turbines attached to electrical generators. Turbines may be driven using steam, water, wind, or other fluids as an intermediate energy carrier. The most common usage is by steam in fossil fuel power plants or nuclear power plants and by water through hydroelectric dams. The world relies mainly on the use of coal or natural gas to power steam turbines and generate electricity.

In the aggregate, facilities that burn coal to generate electricity are the largest emitters of mercury/mercury compounds in the U.S.[1] and the second largest emitters of mercury/mercury compounds in Louisiana.[21] Six coal-fired electrical generating units (EGUs) at four facilities reported 1,644 pounds of mercury/mercury compounds released to all media in the 2004 TRI report (Figure 6).[21]

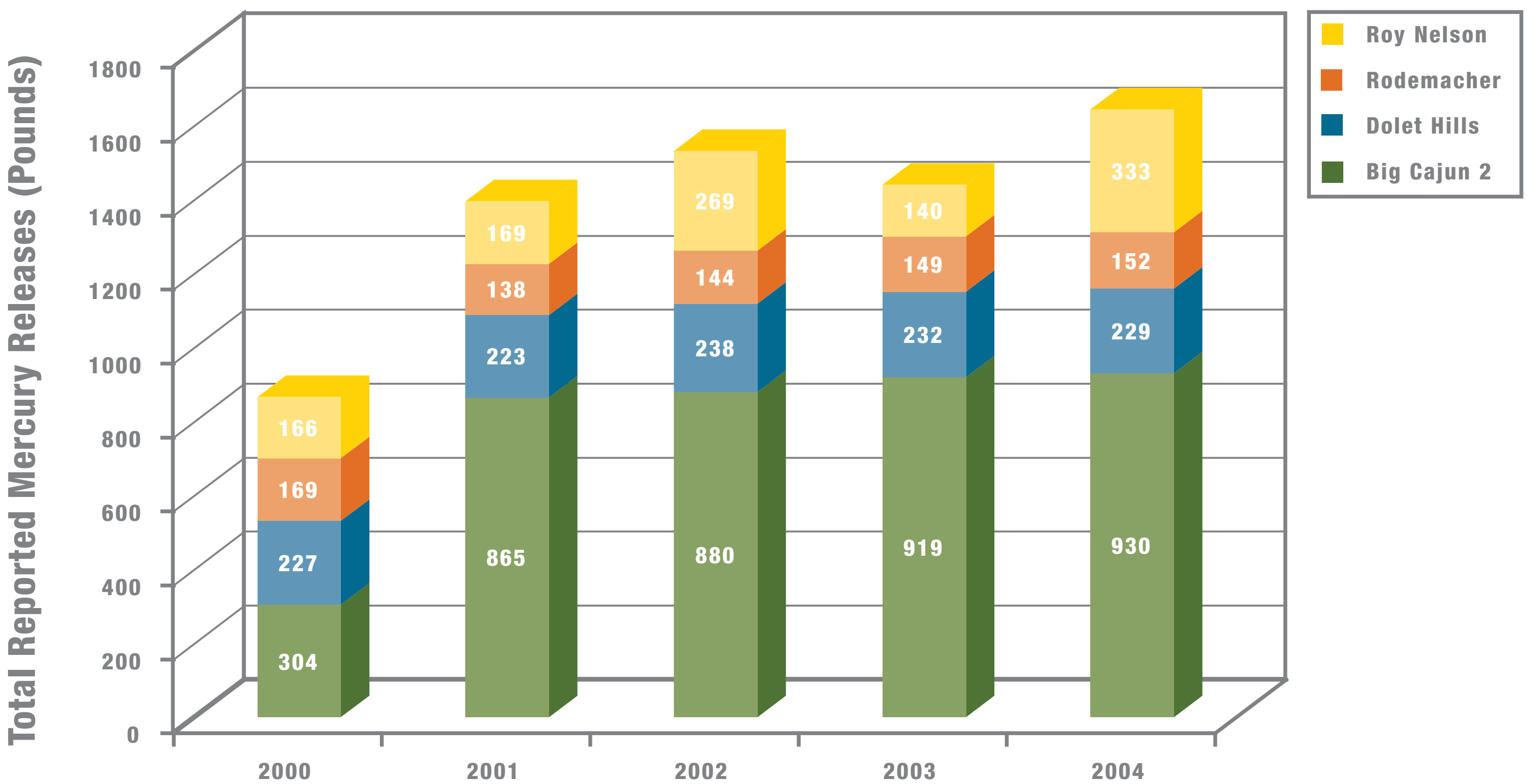


Figure 6 – Relative contributions to total mercury releases attributable to coal-burning EGUs in Louisiana.[21]

section 3 mercury in the environment

The effectiveness of mercury removal techniques is influenced largely by the type of coal burned at coal-fired power plants. Coal from different geologic formations and geographic locations will vary in mercury content, but also will vary in the content of sulfur and chlorine, which affects the form of mercury found in coal combustion gases. The concentration of mercury in coal samples compiled by the USGS revealed average mercury concentrations ranging from 0.07 ppm in samples from the Uinta Region in Utah/Colorado to 0.24 ppm in samples from the northern Appalachia Region in Ohio, Pennsylvania and West Virginia. However, when normalized on an equal-energy basis, Gulf Coast coal samples had the highest values (27.0 lbs mercury per 10^{12} British thermal unit [Btu]) and Green River samples from Wyoming had the lowest (6.5 lbs mercury per 10^{12} Btu).[32]

Mercury is difficult to control in stack emissions since it is commonly present as a vapor, either in its elemental form or in ionic form.[33] In general, the amount of mercury captured by a given control technology is greater for bituminous coal than for either sub-bituminous coal or lignite. Three of four Louisiana coal-burning facilities are currently using sub-bituminous coal and one facility mines native lignite coal deposits adjacent to the EGU. The effectiveness of present mercury removal using particulate matter control is less on these two coal types as compared to bituminous. Table 1 indicates reported mercury removal ranges for various coal types.[34] Results vary highly from test to test and facility to facility.

Table 1. Mercury removal rates measured for various coal types and two controls[34]

Coal Type	Control Type	Average Hg Removal	Observations
Bituminous	ESP	35%	Fair mercury removal at temperatures below 325ºF. Increased loss on ignition (LOI) carbon in coal correlates with higher mercury removal.
Sub-bituminous	ESP	9%	Poor mercury removal. Increased LOI carbon in coal correlates with higher mercury removal.
Lignite	ESP	2%	Poor mercury removal at temperatures above 330ºF.
Mixed Coals*	ESP	66%	*bituminous, sub-bituminous, pet coke mix
Bituminous	FF	84%	Good mercury removal at temperatures below 310ºF.
Sub-bituminous	FF	70%	Good mercury removal at temperatures below 310ºF.
Lignite	FF	0-34%	Poor mercury removal near 330ºF. Maximum 34% at 260ºF.

Current air pollution controls on Louisiana EGUs are not specific for mercury removal, but some mercury removal occurs as a co-benefit of particulate matter, sulfur dioxide, and nitrogen oxides control. Fabric Filters (FF) and Electrostatic Precipitators (ESP) are commonly used in particulate matter control. Flue Gas Desulfurization (FGD), also referred to as a "scrubber" is commonly used for sulfur dioxide control. Selective Catalytic Reduction (SCR) technology is used to reduce emissions of nitrogen oxides. In mercury removal tests in other states, SCRs have been found to increase the amount of oxidized mercury in flue gas and since "wet" scrubbers (wet FGD) are more effective in capturing mercury that is oxidized, the use of these two controls in tandem has resulted in mercury removal efficiencies of approximately 90 percent when bituminous coals are burned.[35]

The three coal-burning EGU facilities in Louisiana that burn primarily western U.S. sub-bituminous coals use ESPs to control particulates. The facility burning native lignite uses an ESP followed by a FGD unit to control particulates and SO_2 emissions, respectively. Mercury removal rates specific to these facilities, their respective operating conditions and air pollution control configurations have not been measured, but mercury emissions are estimated using emission factors for TRI reporting purposes.

Table 2. Mercury removal rates measured for various coal types and control configurations.[36]

Post-Combustion Controls			Average Mercury Removal		
Particulates	NOx	SO_2	Bituminous	Sub-bituminous	Lignite
ESP	None	Wet FGD	66%	16%	44%
ESP	None	Dry FGD	36%	35%	0%
ESP	SCR	Wet FGD	90%	66%	44%
ESP	SCR	Dry FGD	36%	35%	0%
ESP	None	Wet FGD	42%	30%	0%
ESP	None	Dry FGD	40%	15%	0%
ESP	SCR	Wet FGD	90%	51%	0%
ESP	SCR	Dry FGD	40%	15%	0%

New technologies for mercury control in stack emissions are currently being tested. Activated carbon injection (ACI) appears to have the potential to achieve moderate to high levels of mercury control. The performance of the ACI technology is related to physical and chemical characteristics of the carbon used. Surface area, pore size distribution, and particle size distribution appear to be the physical properties of interest. The selection of a carbon for a given application would need to take into consideration the total concentration of mercury, the relative amounts of elemental and ionic forms of mercury, the flue gas composition, and the subsequent method of carbon capture (e.g., electrostatic precipitator, fabric filter, or dry scrubber). A test using ACI at the Brayton Point Power Plant in Massachusetts resulted in a 94.5 percent mercury capture.[37] Testing of this technology across a complete range of operational parameters has not yet occurred, but initial results show this technology as effective. It is likely that the highest level of mercury reduction achievable would be through the use of more than one control technology. The use of low-sulfur coals (for which emission control for mercury is less effective) will likely increase in the future, thereby necessitating the need for advancements in mercury removal technologies specific to these coal types.

Table 3. Full-scale halogenated powdered activated carbon (PAC) testing. Particulate controls included cold-side electrostatic precipitators (CS-ESP), hot-side electrostatic precipitators (HS-ESP), and spray dryer absorbent with downstream fabric filter (SD/FF). PAC included brominated powdered activated carbon from Sorbent Technologies Corp. (B-PAC) and Norit America's halogenated powdered activated carbon (E-3). Injection rates measured in pounds per million actual cubic feet of gas (lbs/MMacf).[37]

Coal Type	Facility	Test Duration	Particulate Control	Sorbent/PAC Injection Rate (lbs/MMacf)	Percent Hg Removal
Sub-bituminous Blend	St. Clair	30 day continuous	CS ESP	B-PAC(3.0)	94
Sub-bituminous Blend	Holcomb	30 day continuous	SD/FF	E-3(1.2)	93
Sub-bituminous	Meramec	10 day continuous	CS ESP	E-3(4.0-4.5)	80-90+
High-S Bituminous	Lausche	Two 3-hour tests	CS ESP	B-PAC(4.0)	70
Low-S Bituminous	Cliffside	2 weeks parametric	HS ESP	B-PAC(6.4)	>80
Lignite	Stanton 10	2 hours parametric	SD/FF	B-PAC(1.5)	95
Lignite	Stanton 10	2 hours parametric	SD/FF	B-PAC(1.5)	70
Lignite	Stanton 10	2 hours parametric	SD/FF	E-3(1.5)	95

Electrical utility steam generating units were exempt from regulation under Section 112 of the Clean Air Act Amendments of 1990 (CAAA) for hazardous air pollutants until EPA determined regulation of emissions from such units were appropriate and necessary. The Clean Air Mercury Rule (CAMR), issued under Section 111 of the Clean Air Act (CAA), was proposed in 2004, initially promulgated on March 15, 2005, with final promulgation after reconsideration on May 31, 2006.[38] The rule provided for limiting mercury emissions using a "cap-and-trade" approach, the first such program for persistent, bioaccumulative toxins (PBTs). The first nationwide cap on mercury emissions from coal-powered utilities is proposed to become effective in January 2010 and the final cap in 2018. EPA believes that a nationwide cap-and-trade program between coal-fired utilities is the most cost effective way to reduce mercury emissions to the air. However, many states have opted out of the trading program, and through state rulemaking, require more stringent mercury reductions. Table 4 summarizes the provisions and timelines of some states that have opted to craft a state-specific mercury rule for existing coal-fired utilities and includes CAMR provisions for comparison. In order to comply with this federal rule, states were required to promulgate a state mercury rule and submit to EPA an emission guideline plan (CAA Section 111d) containing the rule by November 2006. The federal rule allows for two options: each state may adopt CAMR as it is written, with a number of options for mercury allowance distribution, or craft a state-specific mercury rule.

Table 4. Comparison of compliance dates and required Hg reductions in CAMR to some state alternatives.

	Phases	Phase I Date	Phase I Control Percentage	Phase II Date	Phase II Control Percentage
Federal CAMR	Yes	2010	21%	2018	69 %
Illinois	Yes	2009	75%	2013	90%
Michigan	Yes	2010	21%	2015	90%
Maryland	Yes	2010	69%	2012	75%
Minnesota	Yes	N/A	N/A	2015	90%
New Hampshire	Yes	N/A	N/A	2013	80%
Pennsylvania	Yes	2010	80%	2015	90%

Each state received a mercury budget for each year. Louisiana's budget is 0.601 tons of mercury for the years 2010-2017 and 0.237 tons of mercury each year thereafter. These statewide budgets are required whether or not Louisiana chooses to participate in CAMR. New coal-burning EGUs will have to meet stringent new source performance standards in addition to being subject to the caps. Other states (New Jersey, Georgia, Montana, Nevada, Colorado, Indiana, Massachusetts, Delaware, North Carolina, South Carolina, Florida, Oregon, and New Mexico), as alternatives to the federal CAMR, have announced being at various stages of developing state-specific mercury rules.

Adopting the federal CAMR, along with stabilizing electricity rates, is a cautious approach to mercury removal technology. One assumption in adopting the federal CAMR rule is that hotspots, where mercury deposition near-source is significant, do not occur. The EPA Office of Inspector General (OIG) has recommended that, "EPA develop and implement a mercury monitoring plan to (1) assess the impact of CAMR, if adopted, on mercury deposition and levels in fish tissue; and (2) evaluate and refine mercury estimation tools and models. Further, if CAMR is adopted after the rule reconsideration process is complete, the OIG recommends that EPA clarify in the final rule that the 'utility-attributable' hotspot definition does not establish a prerequisite for making future revisions to CAMR. In response to the draft report, EPA agreed that additional mercury monitoring is needed and explained that CAMR does not establish the 'utility attributable' hotspot definition as prerequisite for future changes to CAMR."[39]

LDEQ has chosen to adopt and implement CAMR. The state rule consistent with CAMR was proposed in the Louisiana Register on May 20, 2006. LDEQ is also developing measures to demonstrate whether near-source deposition from coal-burning EGUs is significant, providing evidence of the potential for mercury deposition "hotspots" to occur. Results indicating higher rates of near-source deposition than is protective of the environment will necessitate additional action on the part of LDEQ to reduce emissions and potential contamination of surface waters.

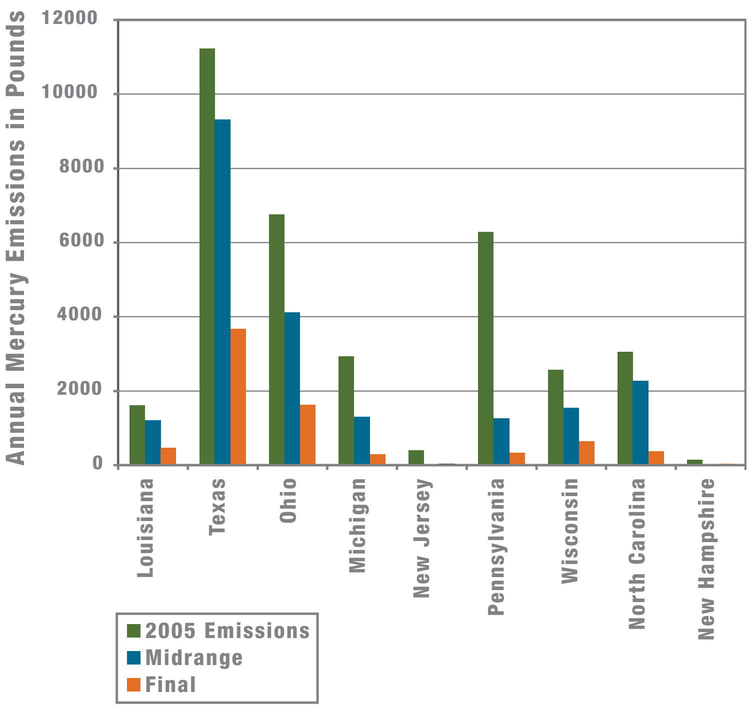


Figure 7 – Anticipated future trend of mercury emissions from Louisiana EGUs as compared to emission reduction methods chosen by other states.[40]

In addition to the use of CAMR as a source control strategy, energy production (and therefore coal burning) can be reduced using energy efficiency techniques. Supporting and promoting ideas and efforts that use less energy are sound environmental policy. Approaches may include supporting tax incentives for construction of energy efficient domestic and commercial buildings and "green development" techniques to establish and maintain shade trees in residential subdivisions to reduce home energy demand. Support for statewide building standards that achieve energy efficiency is a viable approach to reducing future energy demands.

There are alternatives to coal as fuel for electricity generation. Natural gas is a clean burning power source used by many power plants. Nuclear power plants can be operated safely and even though disagreements exist about nuclear waste disposal, the waste is contained and is not released to the environment. Hydroelectric power is nonpolluting but has limitations on scale and is geographically limited in suitability. Wind power can produce significant contributions to local energy needs in some locations but requires large amounts of space to safely operate mills and turbines. Solar power is gaining in affordability, but is currently, with a few exceptions, only cost-effective in relatively small-scale applications.

3.2.2 Combustion Sources

└3.2.2.2 Crematoria

Crematoria are facilities used to incinerate the physical remains of humans or animals after death. The primary chamber is typically charged with remains inside a casket and heated to an optimum range of 1,400 to 1,800 degrees Fahrenheit. Approximately two to two-and-one-half hours is required to incinerate the average corpse. The process results in vaporization of soft tissues of the body and collection of nonvolatile remains, such as bone fragments and ash.[41]

Statistics on crematoria indicate that there were about 1,971 crematoria in the U.S. in 2005 with 12 located within Louisiana.[42] The average mercury content of human corpses has been estimated to be 1.5g, with the vast majority of that from dental amalgam fillings.[43] An estimated maximum of 0.1g per corpse is from soft tissue contents, such as blood, hair and nervous tissue. This fraction is most likely the result of the consumption of fish or seafood with some level of methylmercury content.[44]

The projected estimation of cremations in 12 Louisiana crematoria for 2005 is 6,346.[42] Assuming the average content of 1.5g mercury per corpse and that 100 percent of mercury is emitted through the cremation stack, the estimated mercury emission from Louisiana crematoria is 9,519g or approximately 21 lbs for 2005. Nationally, an estimated 778,025 cremations occurred at 1,971 crematoria.[42] Using previous assumptions, in 2005 the estimated mercury emissions from crematoria in the U.S. were 2,571 lbs.

3.2.2 Combustion Sources

└3.2.2.3 Municipal Waste Incineration

Local governments and private operators handling domestic solid waste have in many places used combustion/incineration to reduce waste volume. In addition, when incinerators are properly equipped, the heat from incineration can be used to create steam for generating electricity. What may appear as an environmentally friendly practice to some, however, has some significant environmental drawbacks, largely due to the mercury-added products that can find their way into domestic solid waste streams.[45]

Reductions of mercury emissions from solid waste incineration can be realized through application of output controls, such as wet scrubbers and filters.[46] These controls can be costly to operate and maintain and may not be the most economical or environmentally friendly approach to handling municipal solid waste. Waste minimization programs that encourage recycling can reduce the amount of solid waste for which traditional disposal methods must be applied. However, recycling can be problematic if the infrastructure necessary for collection and handling is absent or underdeveloped.

Municipal waste incineration was discontinued as a solid waste handling practice in Louisiana in the 1990s. However, one exception is an incinerator in southeast Louisiana that incinerates biosolids waste from the municipal wastewater treatment system. Although control of this emission source of mercury is realized through use of traditional controls discussed above, an alternative approach to biosolids incineration would be to treat biosolids for beneficial reuse, as soil enhancement and soil conditioner, consistent with 40 CFR 503 and LAC 33:IX.6901 et seq. By promoting the development of the biosolids management industry within the state, and especially in the vicinity of this municipal sludge incinerator, a source of mercury emissions would be eliminated. The mercury within the treated sludge could be land applied or otherwise incorporated into soils, where mercury mass transfers are greatly reduced when compared to the practices of biosolids incineration.

The single sewage sludge incineration system in Louisiana has sludge throughput values of approximately 36 tons per day. A survey of the mercury content of biosolids in 40 Ohio publicly owned treatment works (POTWs) discovered a range of 0.001 to 510 mg/kg dry weight. A similar survey of 20 POTWs in New Jersey revealed mercury content of 1.6 to 4.1 mg/kg dry weight.[47] If an average mercury concentration of 2.0 mg/kg and a throughput rate of 36 tons (32,659 kg) per day are assumed, calculated mercury emissions from the subject municipal waste incinerator are approximately 144 pounds (65 kg) per year.

3.2.2 Combustion Sources

└3.2.2.4 Petroleum Fuel Combustion

Mercury is found naturally in crude oil and exists in low levels in refined petroleum products. Section 3.2.1.2 discusses mercury releases from crude oil refining. However, mercury releases through the use of petroleum products for fuel are recognized and occur. The EPA has estimated mercury emissions from burned fuel oil in the United States to be approximately 10,000 kg/yr.[3] Wilhelm (2001) reported a lower estimate of 1000-3000 kg/yr based on more recent data and improved analytical methods.[48]

The TRI includes reported mercury emissions from petroleum fuel consumed by industrial facilities, but the data is not distinguished from other point-source emissions not associated with fuel combustion, making the distinction of what levels are attributable to fuel combustion difficult. Emission factors are used to report the amount of mercury released from fuel combustion. Some example emission factors for mercury in petroleum fuel combustion include 1.2×10^{-6} lb/million BTU input for diesel fuel, 1.13×10^{-4} lb/1000 gallons for #6 fuel oil and 3×10^{-6} lb/million BTU input for #1 fuel oil.[49] Mercury emissions attributable to fuel combustion in the 2003 TRI in Louisiana range from 0.26 to 110 lbs/yr at major chemical manufacturing facilities.[21]

Petroleum fuels are consumed commonly in transportation. Other fluids and components used in motor vehicles, such as lubricating oil, engine coolant, brake rotors and brake pads, also contain detectable levels of mercury. The EPA reported mercury emission rates of 0.3–1.4 ng/mile for light duty gasoline vehicles (LDGV) and 6.4–11.1 ng/mile for a heavy duty diesel vehicle (HDDV). Contributions to these reported emission rates include mercury in fuel (52–189 ng/l in LDGVs and 4.2 ng/l in an HDDV), in lubricating oil (239–578 ng/l in LDGVs and 15 ng/l in an HDDV), and in engine coolant (0.2–2.5 ng/l in LDGVs and 6.9 ng/l in an HDDV).[50]

Using U.S. Department of Transportation data on the estimated number of highway vehicle miles traveled in Louisiana in 2000 (40.85 billion)[51] and an average mercury emission rate of 5 ng/mile, mercury emissions from transportation in Louisiana can be roughly estimated to be 204 grams, or less than one-half pound. This does not include "off-highway" consumption of gasoline and diesel fuels such as is consumed in farming, off-road recreation or marine applications.

Reductions in mercury emissions from industrial consumption of petroleum fuels and transportation are best achieved through sound conservation practices. The use of renewable fuels, such as those derived from annual crop production, is desirable from a conservation perspective, but would likely have similar mercury emission characteristics due to the trace levels of mercury found ubiquitously in the environment. Some fuels, such as electrical energy derived from hydraulic, wind, solar, and nuclear sources can be expected to be relatively mercury emission free.

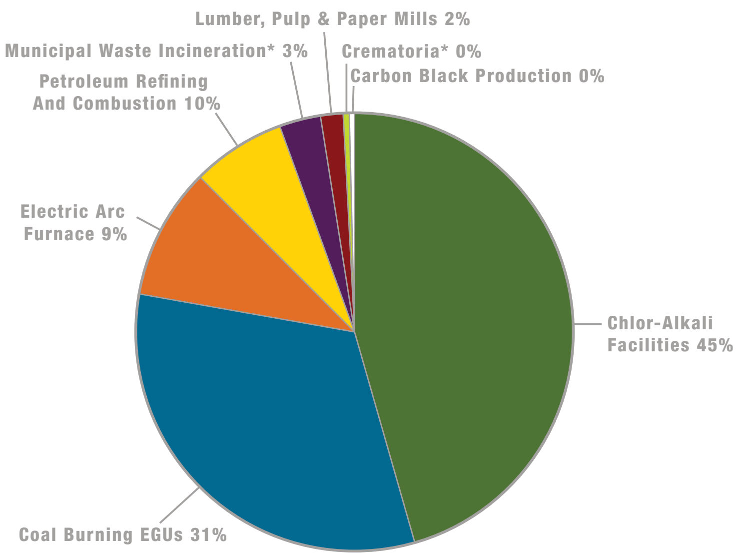


Figure 8 – Relative contributions to total annual mercury releases in Louisiana from manufacturing and combustion sources. Data from 2003 TRI, except for crematoria and municipal waste incineration, which were calculated using assumptions stated in text. Crematoria and EAF releases are potentially highly variable and dependent upon process inputs. Other sources are fairly steady.

3.2.3 Mercury Use in Products

3.2.3.1 Mercury Manometers Used in Natural Gas Production and Transmission

Oil and gas exploration, production and transmission in Louisiana began in the early 20th century. With its development, the oil and gas industry required a means of controlling, metering and measuring the gas during collection. The manometer proved to be a valuable tool, along with regulators and thermometers, in monitoring the flow of natural gas. These instruments were used beginning in the early 1920s on individual wells, pipeline junctions, pipeline manifolds, compressor stations, and distribution points. Although the use of manometers containing mercury has declined in the industry, some are still in use in Louisiana, and some are lost from earlier operations. Estimates of the number of sites where mercury manometers were used at one time or another range from 20,000 to 50,000.[52]

A mercury manometer contains approximately seven pounds of elemental mercury and is capable of accurately measuring the wide range of pressures encountered during natural gas production and collection. Meter readers would periodically visit metering sites to perform calibration and maintenance and collect natural gas transmission data. When onsite maintenance was not adequate, meters would be replaced, and those in need of repairs could be brought to a maintenance shop where the meters could be repaired, calibrated, and refilled with mercury as needed.

During use, a manometer was subject to pressure extremes, field repairs, calibration, and vandalism, all of which could result in the release of some or all of the mercury contained within. Releases may have occurred more than once at a single site. However, knowledge of the dangers of mercury in the environment and as a health threat was lacking, and legacy mercury spills were often not addressed.

The locations of spilled mercury are fairly predictable when the site is known. Directly beneath the meter site is a likely place to find free elemental mercury. When enclosed in buildings, spilled mercury was often swept outside, where it could be found in proximity to the building doorway. When these sites were located over water, as is common in Louisiana, spilled mercury went directly into surface waters and was not recovered.

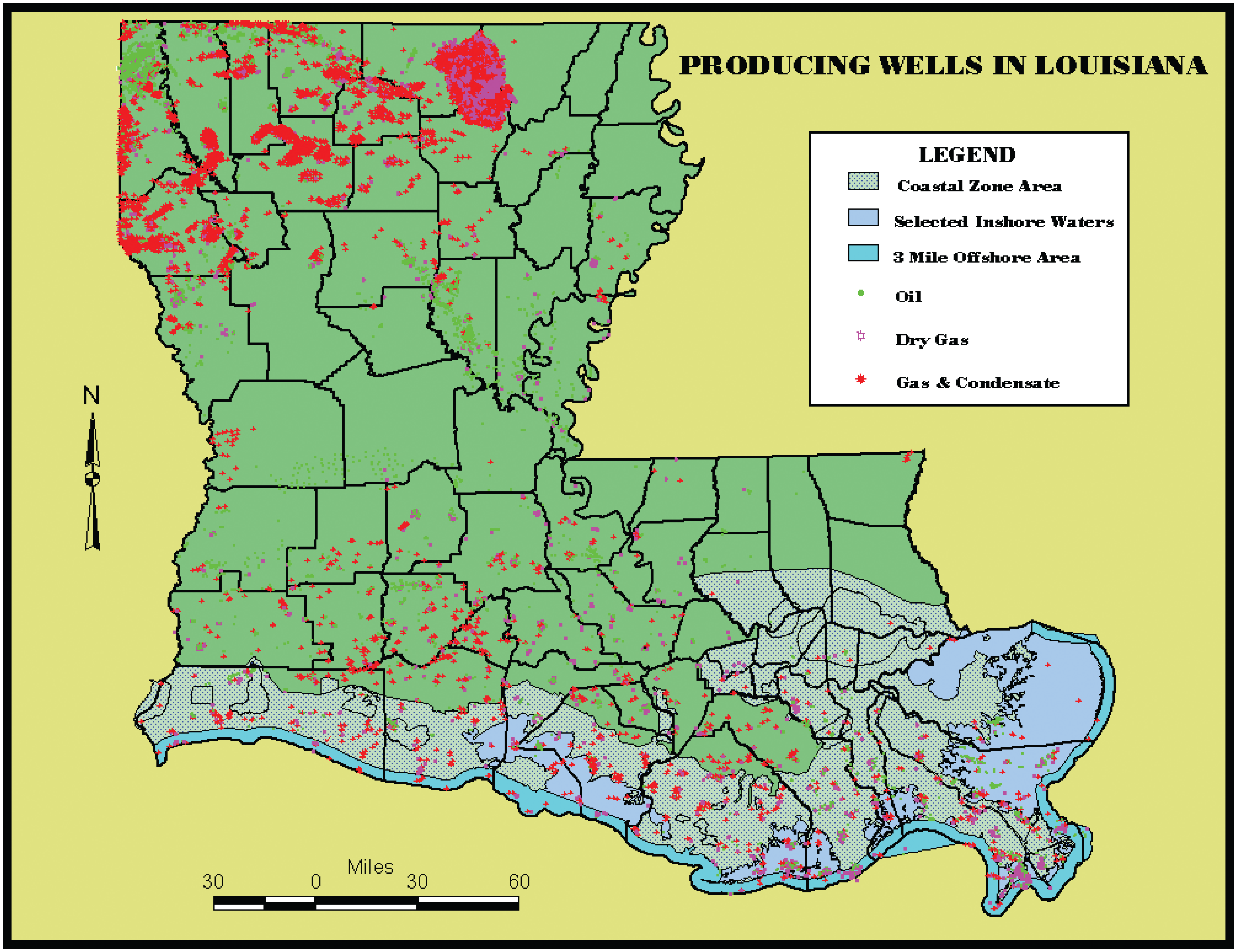


Figure 9 – Producing oil and gas wells in Louisiana. The largest natural gas fields are located in north Louisiana, from Ouachita and Morehouse Parishes west to Caddo and Desoto Parishes.[53]

Data collected by LDEQ from mercury manometer remediation efforts indicate that mercury spills associated with historic mercury manometer use may represent a significant source of mercury to the environment, especially if the manometer sites were in aquatic or periodically flooded habitats. Conservative assumptions from information collected to date on mercury manometer remediation are that the amount of elemental mercury unintentionally released into, and still remaining in, the environment may be as high as 20 tons. However, the successes of the voluntary mercury manometer remediation program are quantifiable, providing one of the few examples of activities through which mercury released into the environment can be effectively and efficiently remediated.

As the number of volunteer companies willing to participate in mercury manometer remediation declines, other approaches to accomplish this direct removal of mercury from the environment may be needed. A significant number of potential sites may still exist on state or federally managed lands. Personnel managing those lands should be encouraged to use their local knowledge to aid LDEQ in finding and remediating such sites. Canvassing of private landowners may also identify candidate sites. Sediment sampling of impaired watersheds may identify mercury contamination and pathways to sources at previously unknown manometer sites.

When unreported manometer sites are identified, and companies representing PRPs are absent, nonexistent, or unwilling to pursue remedial investigations voluntarily, a less desirable approach using CERCLA/RCRA laws and regulations to seek out PRPs for compliance with remedial requirements may be pursued. This approach will have added expense for both LDEQ and the PRP, and slow progress in site remediation. However, the magnitude of elemental mercury that appears to remain in the Louisiana environment from historical mercury manometer use warrants continuance of this program, whether done voluntarily or through a regulatory approach.

3.2.3 Mercury Use in Products

└3.2.3.2 Drilling Muds Used in Oil & Gas Exploration and Production

Mercury is also released to the environment through current and historic discharge of drilling muds during oil and gas exploration. Drilling muds are used during the drilling process to weight drilling fluids and move drill cuttings from the bottom of the bore hole and away from the drill bit. The geologic strata through which the drilling takes place contains background levels of naturally occurring mercury. Additionally, the barite which makes up a large percentage of drilling mud also contains low levels of naturally occurring mercury, which is sequestered in barium sulfate and zinc sulfide components of the mud. Formation water produced by the well from oil and gas formations may also contain low levels of mercury.[54]

Although the discharge of drilling muds, drilling fluids, and produced water to surface waters of the state was discontinued in Louisiana in 1996, these discharges still occur in the offshore Gulf of Mexico. Mercury in drilling fluids used in oil and gas exploration is currently regulated by maximum concentration limits placed on mercury content of drilling mud.[55] At an acceptable maximum of 1.0 ppm mercury in drilling mud, discharges of these substances do not pose a significant loading of mercury to aquatic biota and substrates. Mercury from offshore oil and gas exploration contributes less than 0.5 percent of the mercury loading to the Gulf of Mexico.[17] Most of the mercury from offshore production is in the barite in drilling mud where it is in an insoluble form not readily assimilated into the tissues of marine animals unless converted into a soluble form. Mercury concentrations in sediments near offshore oil and gas platforms are not significantly above background.[54]

In a synoptic survey of mercury in fish tissues from the Gulf of Mexico, no difference was found in the mercury concentration of fishes from Louisiana oil rigs and those collected from natural reefs in Florida Gulf waters.[56] These findings suggest that mercury coming from discharges at Louisiana offshore drilling platforms are not a significant source of mercury in fish tissues, and that existing regulations governing the allowable amount of mercury in drilling muds are adequate.

3.2.3 Mercury Use in Products

└3.2.3.3 Dentistry

The main source of mercury in a typical dental office is dental amalgam fillings, an alloy used to restore the soundness of teeth that have been damaged by decay. Other sources of mercury in dental offices include mercury-containing devices such as sphygmomanometers, thermometers, and thermostats.[3]

Dental amalgam represents a durable, versatile, and comparatively low cost tool in dental health care. Mercury in the form of dental amalgam is stable and consists of silver, zinc, tin, copper, and elemental mercury bound together chemically. The mercury content of dental amalgam is approximately 50 percent by weight.[57]

When existing dental amalgam fillings are removed during restorative work, or when unused portions of dental amalgam are disposed of, mercury can be added to the wastewater system. The discarded amalgam can provide a significant amount of the mercury that enters wastewater treatment facilities. An estimated 18,159 kg of noncontact mercury and 2,763 kg of contact mercury in dental amalgam waste is generated in the U. S. annually.[58] If not captured and collected, this material would be disposed of in solid waste streams or wastewater treatment systems. Upon entering a wastewater treatment system, most mercury from dental amalgam is likely trapped in piping and in sludge. However, contributions of mercury from dental facilities can affect the amount of mercury measured in the effluent of the utilized wastewater treatment system.

Dental amalgam waste is manageable in that the waste can be safely recycled.[59] The mercury can be recovered from amalgam wastes through a distillation process and safely reused in new products. The American Dental Association (ADA) has published best management practices for dental health practitioners that describe procedures that can affect the capture of dental amalgam and prevent its introduction into wastewater streams. These guidelines include best practices in handling waste amalgam, unused amalgam, and the collection of amalgam using chair-side traps and vacuum pump filters. With consistent implementation of these guidelines, and proper operation and maintenance of chair-side traps and vacuum pump filters, mercury discharges from dental care facilities can be reduced by an estimated 77.8 percent.[60] Periodic checks on the status and adequacy of implemented best practices are necessary to ensure that such waste minimization and pollution prevention measures continue.

3.2.3 Mercury Use in Products

└3.2.3.4 Laboratories

Mercury can be found in laboratories as elemental (bulk) mercury, in the chemicals used in testing and research, and in mercury-added products. While the more familiar mercury-added products (electrical switches, relays, fluorescent bulbs) are likely to be present, additional, more specialized products are commonly found in laboratories such as barometers, manometers, thermometers, thermocouples, thermo-regulators, vacuum gauges, and "U-tubes".[61,62] In 1996 a rough estimate was made that 7.3 short tons of mercury is used annually in mercury-added products in U.S. laboratories. [63]

Laboratory chemicals that contain mercury include mercury oxides, mercury chlorides, mercury sulfate, mercury iodide, mercury nitrate, Zenker's solution, Nessler's Reagent and others for specialized purposes.[3, 43] Spent chemical solutions may find their way into laboratory plumbing when sound handling/disposal practices for hazardous waste are not in place. Laboratories located in municipalities often discharge waste waters to the municipal sanitary sewage treatment system and can be a source of mercury to those systems.

In the U.S., mercury use in laboratory chemicals (reagents and catalysts) and laboratory equipment decreased from about 32 metric tons in 1990 to 20 metric tons in 1996.[63] It was estimated that roughly one third of the total was used in laboratory instruments, calculating the use of mercury-containing chemicals from laboratories in the U.S. to be 14.8 short tons in 1996. With an added assumption of Louisiana representing two percent of U.S. laboratories, a rough estimate of potential mercury usage in the state for 1996 is 592 lbs. It should be recognized that actual discharges of mercury would be less than this with sound waste chemical handling and disposal practices.

Mercury in air emissions from U.S. laboratories has been estimated at one metric ton (2,205 lbs) per year in 1994.[43] This was based on emission factors of 40 kg emitted per metric ton of mercury used in the laboratory. This emission factor was based on engineering judgment, not actual test data, and may have a high degree of uncertainty.

3.2.3 Mercury Use in Products

└3.2.3.5 Medical Facilities

Hospitals in the U.S. generate approximately 4.5 million tons of medical waste each year. About 15 percent of this waste is considered infectious waste.[64] Incineration of medical waste has the advantages of significantly reducing volume and of mitigating the infectious nature of the wastes. Disadvantages of incineration include its high costs and potential pollution hazards, among them releases of dioxins, furans, and mercury.

Incineration of wastes from medical facilities has the potential of introducing thermometers, batteries, other mercury-containing products, and unused pharmaceuticals to the solid waste stream to be incinerated. The EPA has identified medical waste incineration as the third largest source of dioxin air emissions and as the contributor of about 10 percent of the mercury from human activity.[65]

The CAAA reflected growing public concern about the large volume of toxic air pollutants released into the atmosphere and singled out waste incineration for special attention. Congress recognized a high level of public concern about the incineration of medical and other solid wastes. As a result, EPA promulgated nationally applicable standards and guidelines for hospital/medical/infectious waste incineration. These standards and guidelines were based on the use of add-on air pollution control systems and implemented the CAAA described above.[65]

This federal legislation had an economic effect on medical waste incineration. Nationally, hospitals and medical facilities have decreased usage of incineration as a waste disposal alternative. Until 1990, most hospitals in Louisiana operated medical waste incinerators. To date, medical waste incinerators subject to CAA permitting in Louisiana have ceased operations at all facilities previously permitted.

As the use of autoclaves for waste sterilization replaces medical waste incineration, a media shift occurs, resulting in increased release of mercury into sanitary sewers and solid waste streams as mercury emissions from medical waste incineration declines. Medical facilities, such as hospitals and clinics, may discharge their wastewater to existing community sanitary sewage treatment systems or they may discharge directly to surface waters through their own individual treatment systems. In some cases, facilities may pass their wastewater through an individual system and then to an existing community sanitary sewage treatment system. In all cases, at some point in the wastewater stream, the discharge is subject to permitting, monitoring, and parameter limits as per CWA and LPDES requirements. Dischargers may be required to implement a Mercury Minimization Plan consistent with LDEQ guidance. (See Section 8.2.3)

The use of non-mercury alternatives is, in many cases, a feasible approach to reducing mercury.There are numerous alternatives to many commonly used mercury-containing medical items. For example, digital devices to measure temperature and blood pressure have been developed and are effective, economical, and functional alternatives to mercury-containing thermometers and sphygmomanometers. Conversion to non-mercury products will effectively reduce mercury in any medical waste stream.[66]

Hospitals can also reduce volume in waste streams by separating waste materials from those suitable for recycling. This would affect the release of other pollutants as well, since polyvinyl chloride (PVC) is present in many materials consumed at medical facilities and, in some cases, is readily recovered.[64] By promoting operations within a facility that minimize waste generation, reductions in pollutants released through medical facility waste handling can be realized. In 1998, the American Hospital Association (AHA) and the EPA signed a memorandum of understanding (MOU) to virtually eliminate mercury in hospital waste streams by 2005.[67] This MOU led to the creation of Hospitals for a Healthy Environment (H2E): a partnership among the AHA, EPA, Health Care without Harm, and the American Nurses Association. Goals of the H2E include reduction of overall volume of hazardous waste by 33 percent in 2005 and 50 percent by 2010, and to identify hazardous substances, including mercury, for pollution prevention and waste reduction opportunities. A pledge program and voluntary measures to achieve these goals have been developed by H2E.

The H2E is promoting an approach that parallels the LDEQ Mercury Minimization Plan. With support from H2E, hospitals within the state are being asked to establish best practices to minimize hazardous waste in wastewater discharges. The success of these efforts, relative to the Mercury Risk Reduction Plan, is measured by the levels of mercury in discharged effluent, either at the health care facility discharge or at a subsequent discharge from the receiving community sanitary sewage treatment system.

If all best practices are implemented and the desired reductions in mercury in effluent are not achieved, then additional investigation of the subject waste stream will be necessary to discover and mitigate mercury sources. These efforts could include searching for places in wastewater collection/transmission lines where mercury may have become trapped and continues to contaminate effluent. Additionally, periodic checks on the status and adequacy of implemented best practices are essential to ensure that such waste minimization and pollution prevention behaviors continue.

3.2.3 Mercury Use in Products

└ 3.2.3.6 Mercury Manometers Used in Dairy Production

Manometers in dairy production are used in milking machines to quantify production. The number of dairies in Louisiana has declined significantly in recent years. Approximately 230 dairies are located

statewide, with 85 percent located in the parishes north of Lake Pontchartrain (the "Florida" parishes). Desoto Parish, south of Shreveport, also has a significant number of dairies.[68]

The use of manometers that contain mercury in active Louisiana dairies has ceased with preference given to dial or digital display manometers. However, because many dairy operations have closed or been abandoned, there is the potential for old equipment, including mercury manometers, to remain on site. Upon discovery, proper disposal of these pieces of equipment is necessary to prevent the release of the approximately 12 ounces of mercury that is contained within each manometer.

3.2.3 Mercury Use in Products

└3.2.3.7 Other Mercury-added Products

There are numerous products available to the public and industry that contain mercury added to provide a specific characteristic, appearance, or quality. The most commonly recognized include fluorescent lamps, "button-cell" batteries, thermometers, thermostats, electrical switches and relays, sensors, and barometers. Less obvious mercury-added products are switches associated with convenience lighting, anti-lock braking systems, and other devices in automobiles (See Section 3.2.1.3). These products become sources of mercury to the environment when broken or discarded, and are often introduced to municipal waste streams.

Estimates of mercury contributions to Louisiana municipal solid waste are depicted in Figure 10. These values are based on Florida's estimates adjusted by population. The values in the graph are 25 percent of Florida's reported values[69] as the Louisiana population in 2005 was 25 percent of Florida's.[70] Control of this source is best accomplished by reducing contributions to waste streams in two ways: (1) by eliminating nonessential uses of mercury and (2) by ensuring adequate capture of mercury-added products for recycling or sequestration.

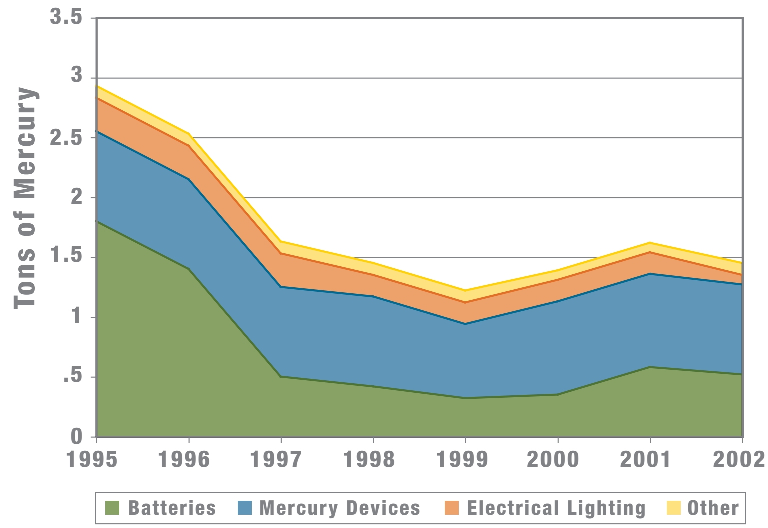


Figure 10 – Estimated discards of products containing mercury into Louisiana municipal solid waste (Adapted from Florida estimates[69] and adjusted by relative population).

3.2.4 Mercury in Waste

└3.2.4.1 Sanitary Sewage Treatment Systems

The process of treating sanitary wastewater through conventional methods is not of itself a source of mercury, although treatment facilities may be equipped with mercury-containing devices that, upon breakage, could introduce mercury into the waste stream. However, contributions to municipal wastewater collection systems from nontraditional industries such as dentists, hospitals, metal plating facilities, and laboratories (commercial and institutional), and also from domestic sources (households) can contain significant amounts of mercury. [71]

Mercury concentrations in effluent from municipal wastewater treatment systems nationwide have been measured at levels from 0.2 to 700 parts per trillion (ppt).[47] The presence of NPDES pretreatment programs at some municipalities has resulted in observable declines in effluent mercury as the practices are implemented over time.[47] In Louisiana, guidelines have been developed for mercury minimization plans (See Section 8.2.3).

Although technology is available to treat water to the desired goal of 12 ppt,[72] reductions in effluent can best be addressed by minimizing mercury in influent to the sanitary systems. Municipalities with categorical industrial users of their sewage treatment systems are subject to LPDES pretreatment regulations. Municipalities subject to pretreatment regulations are required to identify Significant Industrial Users (SIUs) and Categorical Industrial Users (CIUs), and to track their contributions to the system. Contributors to large municipal sanitary systems often include potential sources of mercury. Pretreatment regulations require CIUs and SIUs to sample and report on the composition of their contributions to the sanitary system, including mercury amounts if it is suspected to be a constituent of the contribution. If any contribution, such as mercury, exceeds a percentage of total loading of that parameter to the system, the contributor may be required to implement practices that will reduce contributions of that parameter to determined regulatory levels.

The implementation of a recently developed Total Maximum Daily Loading (TMDL) model for certain coastal waters of Louisiana requires certain discharges to test their effluent using ultra-clean methods (EPA Method 1631).[73] If the result exceeds 12 ppt, the discharger may implement mercury minimization practices as outlined in "Mercury Minimization Program Guidance for Permits Issued under the Louisiana Pollutant Discharge Elimination System" (See Section 8.2.3) and/or receive effluent limits for mercury.

The plan provides detailed guidance on approaches to reducing mercury in sanitary sewage system effluent. The mercury sampling of effluent described above is a requirement of the CWA and subsequently, the LPDES Program. It also serves the additional purpose of conducting mercury source identification, a key component of mercury reduction. Application of mercury minimization plan guidance within any given system is intended to seek out external sources to the wastewater treatment system and apply controls to minimize mercury-containing wastes.

While only dischargers within a certain geographic location may be subject to Mercury TMDL requirements, the practice is a sound approach to minimizing mercury in sanitary wastewater streams. Applying mercury minimization plan approaches to wastewater discharges which exceed 100,000 gallons per day statewide would continue the reduction of mercury released to surface waters throughout the state.

Additionally, facilities that treat sanitary wastewater may have mercury-containing devices as components of electrical circuitry or other aspects of the treatment process. Care should be taken to ensure that if these devices break that they do not result in spillage of mercury into the wastewater stream. Alternative locations for such devices are advisable when practical and if use of non-mercury alternatives are not feasible.

3.2.4 Mercury in Waste

└3.2.4.2 Landfills

Household hazardous waste (HHW) is a phrase that describes substances that would be regulated under RCRA if the waste came from commercial/industrial sources. RCRA contains a specific exemption for HHW, and as such, HHW is largely unregulated in the U.S. These substances may be just as hazardous, persistent, and toxic as materials derived from industrial processes, but due to the small volume (on a house-to-house basis) are exempt from RCRA regulation. Mercury-added products and materials used in the home eventually find their way to solid waste streams when they reach end of life.

An estimated 211 tons of mercury were used in products and devices (wiring devices, switches, measuring and control instruments, electric lighting and others, excluding dental uses) in the U.S. in 2001.[74]

A portion of these products are used in homes and are exempt from hazardous waste regulation. These products that are not recycled are discarded and generally added to municipal solid waste streams. This disposal practice peaked in 1989 nationally at 709 tons of mercury discarded to municipal solid waste landfills. The disposal of these products was predicted to decline to approximately 173 tons in 2000.[75] Mercury-added products and devices have been, and continue to be, placed in municipal landfills. These products and devices include fluorescent lights, pressure measuring devices, button cell batteries, electrical switches and relays, thermometers, thermostats and others.

That municipal landfills are known for the anaerobic generation of methane through bacterial activity suggests that these systems may function as bioreactors for methylated mercury compounds. In a Florida study, total gaseous mercury (TGM) was measured in the microgram per cubic meter (ug/m^3) range in landfill gas emissions, monomethylmercury was identified in landfill gas condensate and dimethylmercury was measured in landfill gas in the nanogram per cubic meter (ng/m^3) range.[76] A wide range of TGM was observed in the state of Washington's landfills, ranging from 25 to 8,000 ng/m^3. An estimate of the national average of mercury emissions from landfills is 350 mg/day.[77]

Mercury-added product disposal is relatively easily managed. With the establishment and support of effective end-of-life product collection programs that are accessible to all citizens, mercury within these devices can be diverted from municipal waste streams, safely collected, and recycled or otherwise sequestered from entering the food chain. Growing concern over solid waste management and future landfill capacity has many levels of government considering innovative ways to minimize waste and promote product recycling. Sound recycling programs not only extend landfill life, but minimize mercury contamination and subsequent emissions to the atmosphere.

Reductions in the use of mercury can also be achieved through phase out of nonessential mercury uses. There are uses of mercury for which there are no viable alternatives, but there are many for which cost effective and functionally effective alternatives already exist. By making conscious efforts to purchase non-mercury alternatives and to recycle essential mercury-containing products and devices, private citizens can have a measurable impact on the amount of mercury released to the environment and reduce risks of exposure to mercury through breakage in the home of these products and devices.

The 2004 TRI shows three significant sources of mercury released to the land.[21] The greatest volume (16,000 reported pounds) is handled at a hazardous waste disposal facility where microencapsulation procedures are used to prevent off-site releases of landfilled mercury-bearing materials. The two other facilities (reporting 1,576 and 228 pounds of mercury released to the land, respectively) are aluminum ore (bauxite) refineries. The mercury reported from these sites is associated with waste from the alumina extraction process. The waste is tailings from aluminum ore, commonly referred to as "red mud", and contains mercury as background; mercury is not added during the process. The air rule that regulates these operations, National Emission Standards for Hazardous Air Pollutants for Primary Aluminum Reduction Plants, does not include control for mercury.[78] All three facilities should be periodically evaluated to ensure that mercury is not released from these sites during volatilization, in stormwater runoff, or in seepage to groundwater.

3.2.5 Agricultural and Forestry Practices

Agricultural practices that involved the use of mercury include historical use of mercurial products as fungicides. The mercurial fungicides are among the most toxic biocides ever developed and were used primarily to treat seeds prior to planting.[79] The use of organic mercury compounds as seed treatments began in 1913 and continued until the 1960s when their use was banned.[80] During that time, seeds treated with mercurial fungicides were spread on croplands. In the U.S., 17 percent of 1,830 tons of mercury consumed per year was used for organic mercury compounds in the end of the 1950s, divided between slimicides using 3 percent (54.9 tons), antifouling paint using 4 percent (73.2 tons), and agricultural chemicals, including insecticides, using 11 percent (201.3 tons).[81] In Russia as recently as 2000, mercury-containing pesticides were still used, and about 50 tons of the product Granosan (at average Hg concentration equal to 2 percent) were applied, meaning that about 1 ton of mercury was released.[82] In New Jersey, approximately 318,000 lbs of mercury as an active ingredient could have been applied on approximately 150,000 acres of cropland and golf courses in the period 1921 to 1990. Based on crop recommendations, as much as 600,000 to over 1,000,000 lbs of mercury could have been applied.[83] The amount of cropland in Louisiana is approximately 9 times that stated for New Jersey in 2006 (2,757,000 acres in rice, corn, beans, cotton, wheat, and sugarcane[84] in Louisiana as compared to harvested acreage in New Jersey of 292,700 acres in barley, corn, potatoes, soybeans, sweet potatoes and winter wheat)[85], representing a potential historic total application of 5.4 to 9 million lbs of mercury in pesticides in Louisiana. In 1969, approximately 9,550 lbs of mercurial fungicides were applied to rice-growing areas in Louisiana.[86]

Whether applications were widespread or "spot", the use of mercurial agricultural chemicals appears to be a contributing factor to "background" mercury levels within arable soils. Widespread application of mercurial fungicides to standing crops in the U.S. may not have been a common practice, but such applications have historically occurred. Spot applications to areas of high fungal impact are more likely to have occurred than broadcast practices.

Since the historic use of such compounds involved spreading the material over relatively large areas, even in "spot" applications, the likelihood of finding areas treated with mercurial fungicides that may be feasibly remediated are unlikely. However, it is possible that locations where these compounds were mixed, stored and loaded, generally in areas of warehouses and work stations, may have been contaminated through accidental mishandling and may represent significant (local) legacy contamination.

Given that records needed to identify these historic sites may be nonexistent or inconclusive, the best approach to discovery of legacy mercury contamination from these practices may be systematic sampling within drainage pathways in impaired watersheds to locate "above background" mercury levels that would indicate potential legacy sites suitable for remediation.

The common practice of burning pre-harvest (after cutting, before removal) sugar cane contributes mercury to the atmosphere. Background mercury levels in soil can revolatilize when heated and can be re-emitted into the atmosphere. In a study in the Florida Everglades Agricultural Area (EAA) in 1991, mercury emissions from burning pre-harvest sugar cane fields were estimated to be 35 kilograms for the 174,000 hectare study area.[18]


Photo by John Wozniak, LSU AgCenter.

Forestry practices may mobilize and/or support re-emission of existing mercury in soils in several ways. First, control burning of timber producing lands for timber stand improvement allows for revolatilization of background mercury in soils to the atmosphere, as was demonstrated in the Florida EAA.[18] Control burning, however, is preferred (in the sense of mercury releases) to the wildfires they are intended to control since wildfire would consume more material and burn at hotter temperatures, resulting in higher levels of releases of mercury from terrestrial environments to the atmosphere.

Second, timber cutting practices that exacerbate soil erosion allow background levels of mercury in terrestrial environments to enter drainage patterns and surface waters. Further, trees may contain mercury due to incidental uptake from soils through root systems, or from wet and dry atmospheric deposition of mercury. When cut and removed, those portions of the tree (and the trace mercury levels found within) that are not used for lumber (tops, branches, bark, etc.) are either discarded as solid waste or burned for fuel. Burning these scraps would result in direct release of mercury to the atmosphere, although the quantity of the mercury in these releases is comparatively low.

Best practices demonstrated currently by agriculture and forestry industries intended to reduce soil erosion and to minimize the need for field waste burning (such as that associated with sugar cane production) or control burning (to reduce forest floor fuel accumulation and improve timber stands) will have the collateral benefit of reducing mercury mass transfer. Soils containing normal background concentrations of mercury have minimal impact on agriculture and forestry purposes when the mercury remains in place and is not transported to surface waters during rainfall events. By reducing the amount of soil that washes to surface waters, the amount of mercury introduced to those waters is reduced. Assuming average soil loss from erosion of agricultural lands to be 1,829 kg/ha/year[87] of soils averaging mercury concentration of 80 ppb,[10,14] annual transport of mercury from the 2,757,000 acres of cropland in Louisiana to off-site receiving media (e.g. surface waters) can be calculated to be approximately 359 lbs per year.

3.3 Atmospheric Deposition of Mercury

On a global scale, the atmosphere is the environmental compartment with the largest influence on mercury transportation and fluxes. Atmospheric mercury is primarily elemental mercury (between 90 and 95 percent), divalent mercury (3 to 4 percent) and methylated mercury (2 to 3 percent).[88] The average atmospheric concentration of gaseous mercury is about 0.2 ppt, but it can be much higher near emission sources. It is believed that the average atmospheric concentration is about three times that of pre-industrial times.[89] Mercury is emitted to the atmosphere from both natural and anthropogenic sources. It is removed from the atmosphere via wet and dry deposition, with an overall lifetime of 0.5 to 2 years.[90] Mason and Sheu estimate that since the pre-industrial age the atmospheric burden and deposition of mercury have increased by a factor of 3, while land and ocean emissions have doubled due to re-emission of anthropogenic mercury.[16]

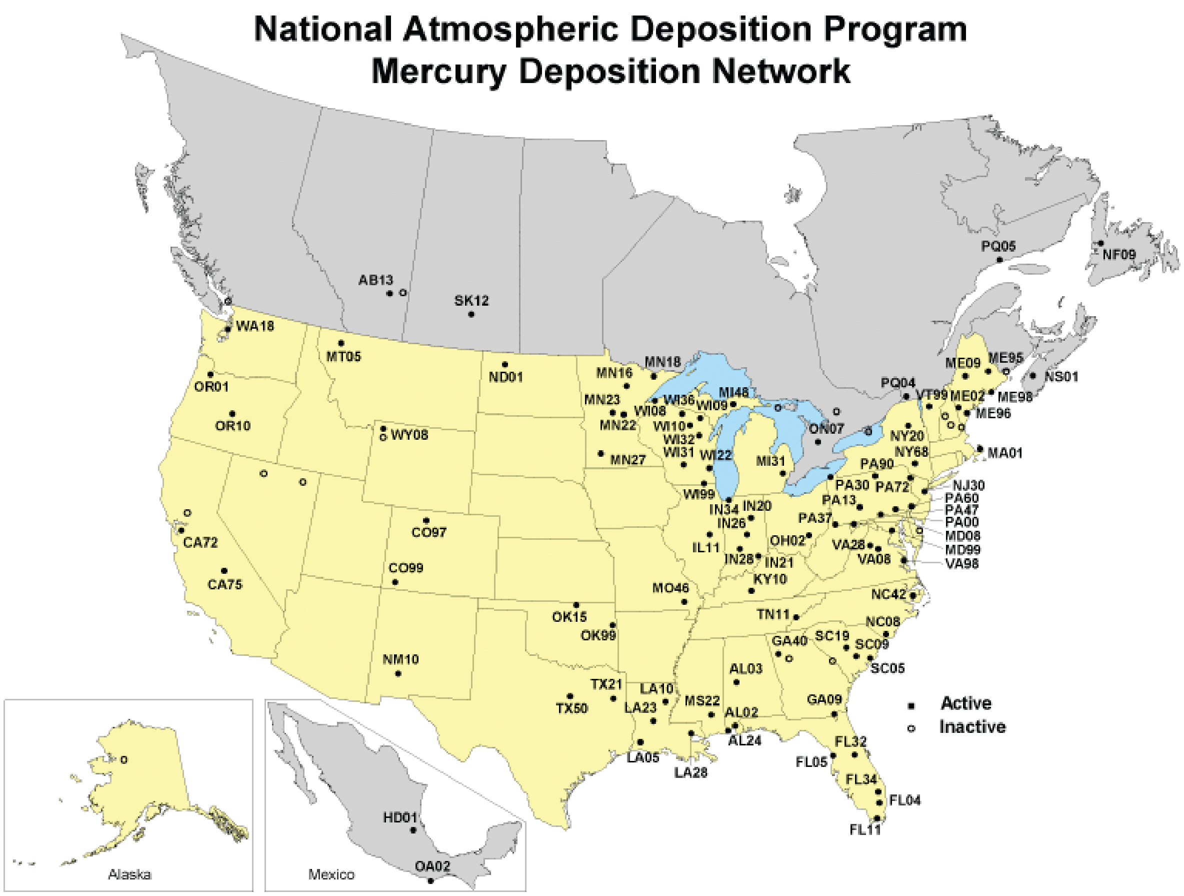
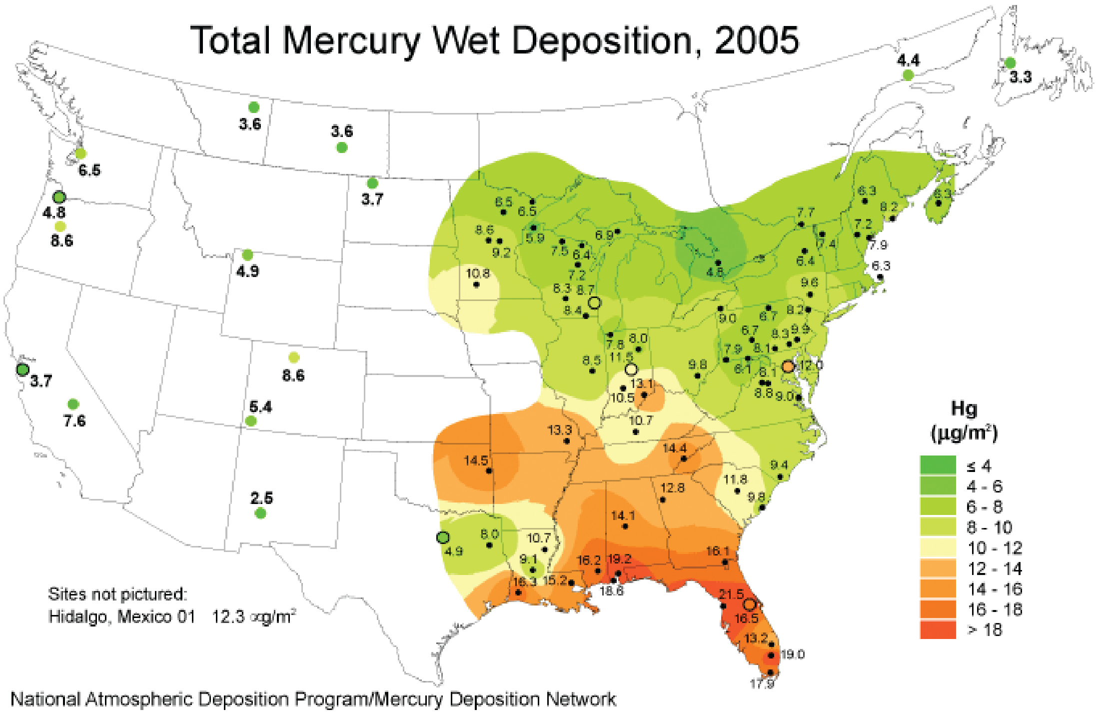


Figure 11 – Locations of wet deposition monitors associated with the Mercury Deposition Network in North America.

Recognizing the importance of atmospheric deposition and loading to surface waters, a national mercury deposition monitoring program was established to track mercury deposition patterns and trends. The objective of the Mercury Deposition Network (MDN) is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. Over 85 sites are currently in operation with four of them located in Louisiana (Figure 11). Wet deposition of mercury in 2005 was highest in the southeastern U.S. (Figure 12). But this is more a function of rainfall amounts than concentrations of mercury. Figure 13 shows rainfall concentrations of mercury to be mostly in the low to moderate concentrations except for south Florida and an area of SE Texas and SW Louisiana.

More detailed information on mercury deposition measured for the four Louisiana monitoring stations will be presented later in this text (Section 5.2.4).



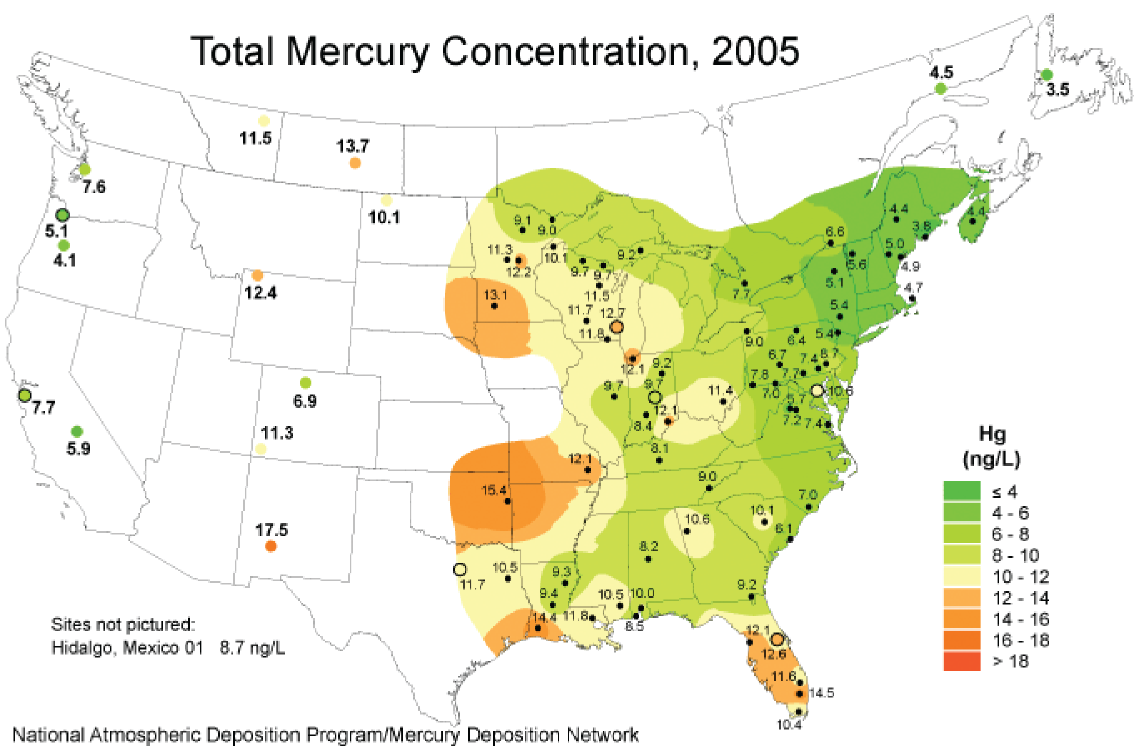


Figure 12 (Top) – Average mercury deposition in precipitation at various Mercury Deposition Network sites in 2005.
Figure 13 (Bottom) – Average mercury concentration in precipitation at various Mercury Deposition sites in 2005.

3.4 Re-emission of Mercury

Mercury fluxes between air, land, and water consist of contributions from natural and anthropogenic sources. The global mercury budget involves emissions from local and regional sources and re-emissions from land, fresh water, and evasion from the oceans (Figure 14). Re-emissions occur from previously deposited mercury reservoirs of either human or natural origin.

Although the magnitude of human emissions and resulting mercury deposition are greatly debated, evidence that mercury mass transfers have increased since the Industrial Age is readily available, largely based upon known increases in direct and indirect anthropogenic handling of the metal. Research attempting to describe and quantify the movement and distribution of mercury in the environment has been complicated due to the difficulty in separating new, natural sources from remobilized past and current human releases. It is thought that 95 percent of the estimated 200,000 metric tons of mercury emitted to the atmosphere since 1890 is currently in terrestrial soil stocks or part of the oceanic sink.[91]

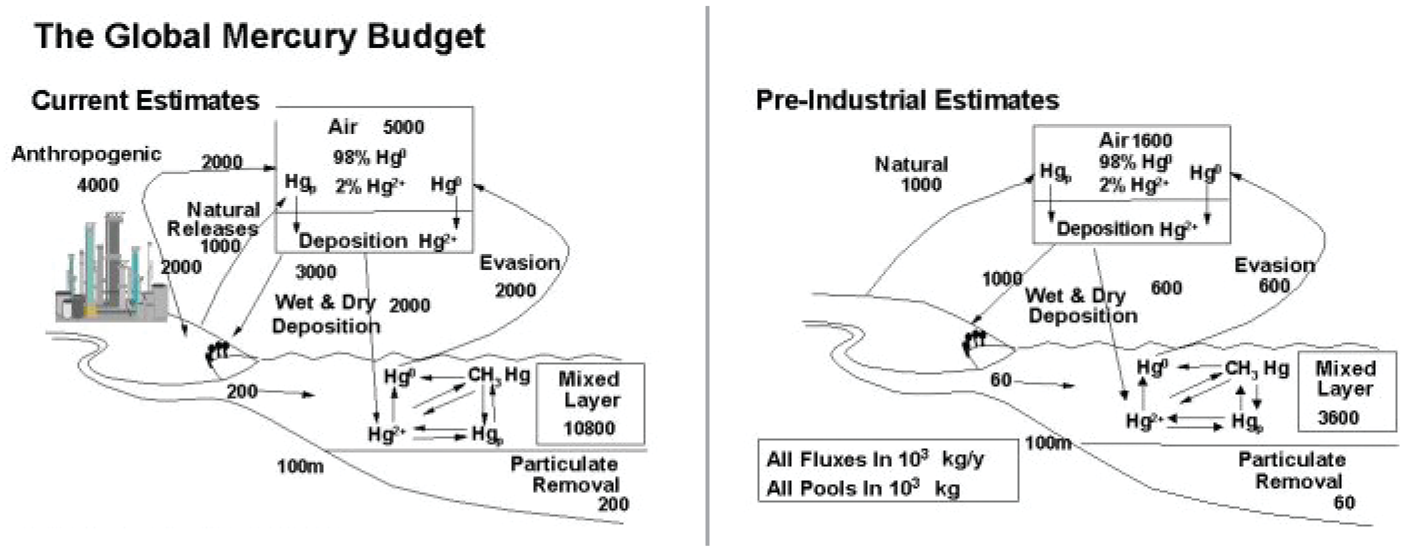


Figure 14 – Conceptual cycling of mercury between various pools and the transportation and transformation processes that are thought to occur.[92]

3.5 Summary of Mercury Sources in Louisiana

The following table provides a comparative summary of sources of mercury releases and transfers within the state of Louisiana.

Table 5. Mercury Releases and Transfers in Louisiana

Source	Receiving Media	Quantity	Comments
Current Human Activities			
Chlor-alkali	Primarily air, some water	2,558 lbs/year	Combined releases from 2004 TRI
Petroleum Refining & Combustion	Primarily air, some water	~550 lbs/year	Combined releases from 2004 TRI
Electric Arc Furnace	Air only reported	20-450 lbs/year	From 2004 & 2003 TRI respectively, release quantities highly variable
Lumber, Pulp, Paper	Air, Water	46 lbs/year	From 2004 TRI
Carbon Black	Air	8 lbs/year	From 2003 TRI
EGUs	Primarily air, some water	1,644 lbs/year	Combined releases from 2004 TRI
Crematoria	Air	~21 lbs/year	Calculated from 2005 CANA data
Municipal Sludge Incineration	Air	~144 lbs/year	Calculated using assumptions
Dentistry	Solid waste streams and waste water systems	~126 lbs/year	Calculated based on LA percentage of dentists nationally; entire quantity collectable
Laboratories	Primarily water (waste water systems), some solid waste	~592 lbs/year	1996 estimate; mainly from use of mercury-containing chemicals
Other product discards	Primarily solid waste streams/landfills/air	~1.4 tons/year	Calculated from Florida measurements, 2002
Industrial Wastes	Industrial Landfills	~17,800 lbs/year	From 2004 TRI
Natural Transport of Natural and Anthropogenic Mercury			
Wet Deposition (Mercury in rainfall)	Surface waters and soils	~3,945 lbs/year	Extrapolated from measurements at four Louisiana MDN sites
Soil Transport from Soil Erosion from Cropland	Surface waters	~359 lbs/year	Calculated from measured soil erosion,[83] 2006 extent of Louisiana croplands,[80] and average soils mercury content of 80 ppb[10, 14]
Legacy Releases			
Agriculture/Forestry	Soils/Ambient waters	~2,700–4,500 tons	Calculated from 1921 to 1990 uses of mercurial biocides
Manometers	Soils/Ambient waters	~20 tons	Calculated from current manometer remediation program

4.1 Hg Presence, Transport and Fate

Mercury can be found in several forms and in several media in the environment. It is found in the continental rock at an average concentration of 0.08 ppm.[10] As a metallic ore, mercury sulfide (cinnabar) is widespread, but economically significant deposits are rare. The most well known is in Almaden, Spain, with other viable deposits found in Germany, Slovenia, Italy, Peru, Bolivia, Venezuela, Russia, and China.[93] Significant deposits have been reported in North America, in British Columbia, California, Nevada, Texas, Arizona, and Arkansas, with economic factors affecting mining activities.[94,95] Commercially exploited deposits in the U.S. tend to be very small; the largest deposits rarely exceed 1 ton. Mercury mines have been operated in the U.S. as recently as 1992 in Nevada and 1971 in southwest Texas. Primary production from U.S. mines declined to 64 metric tons in 1992 from a historic high of 1,790 metric tons in 1943.[96] Typical mineable reserves contain ores ranging from 0.2 to 0.6 percent mercury.

Mercury is also a byproduct of gold mining. No mercury mining was occurring in Nevada in 1997, but byproduct mercury from gold mining was sufficient for Nevada to be the leading state in mercury production that year. Secondary production of mercury in the U.S. decreased to 389 tons by 1997.[96] Calomel (Hg_2Cl_2) is a mercury-bearing byproduct released during gold processing that may be captured by pollution-control devices at smelters.[94,95] See Figure 15 for information on historic U.S. mercury production.

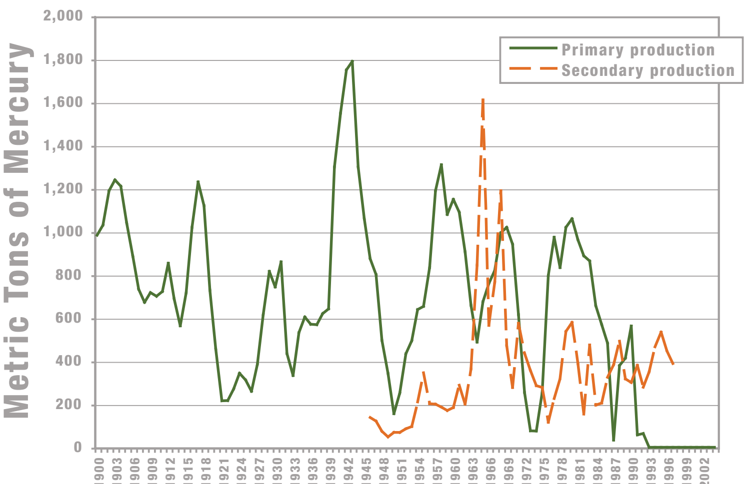


Figure 15 – U.S. mercury production in metric tons by year. Primary production indicated with a green line and secondary production by orange line.[94]

Smaller concentrations of mercury are found in coal deposits. The burning of coal results in the release of mercury to the atmosphere. The USGS has compiled a nationwide coal information database over a period exceeding 25 years. A subset of the data, called COALQUAL, contains analyses of over 7,000 coal samples that have been collected or calculated to represent the entire thickness of a coal bed in the ground. About 80 percent of the mercury concentrations in the database are less than 0.25 ppm and the highest value for mercury concentration in coal in the database is 1.8 ppm. Gulf Coast coal samples have the highest input load values (27.0 lbs Hg/10^{12} Btu) and Green River region (Wyoming) samples have the lowest values (6.5 lbs Hg/10^{12} Btu).[97]

Mercury naturally occurs in soils in small amounts (Figure 16) and can volatilize from soils to the atmosphere (See Section 3.4). Soil erosion, from wind or water, can transport these small amounts and contribute to mercury mass transfers. Mercury can be released from the earth's crust in much larger amounts during volcanic events. It may remain aloft in atmospheric currents for months or years or be deposited relatively near-source depending upon the form it is in. Figure 16 shows average mercury concentrations in Louisiana soils by parish.

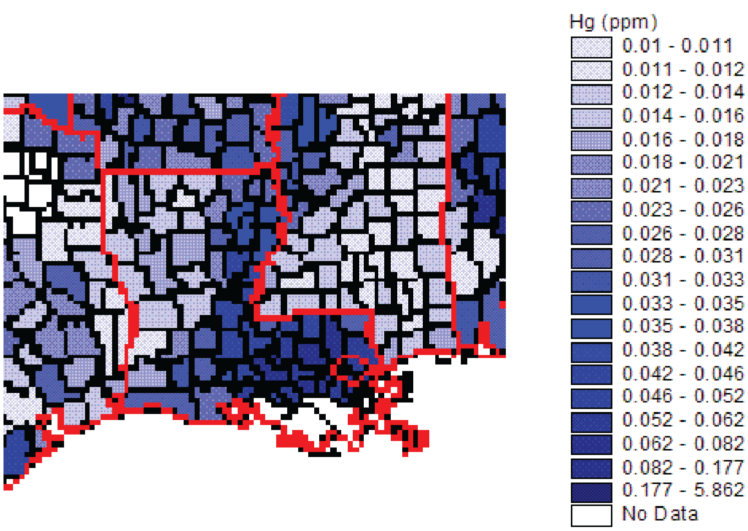


Figure 16 – Average mercury concentration in soils by parish.[14]

Wildfires and forest fires can contribute significantly to mercury mass transfers. Estimates of mercury flux from temperate forest fires in Canada are 3.5 metric tons annually, representing 30 percent of annual anthropogenic emissions in Canada during a normal fire year and perhaps as much as 100 percent during severe fire years. The emitted mercury resides in living plant material, leaf litter and in the soil and is volatilized when exposed to high temperatures of a fire. Fires within boreal forests are believed to emit approximately 22.1 tons per year due to the much larger areas affected.[98]

Deposition of airborne mercury can occur in rainfall (wet deposition) or as particulate matter (dry deposition). This broad-scale distribution process results in the ubiquitous presence of mercury, at least in trace amounts, across the surface of the globe. Depending upon the source of airborne mercury, near-source deposition can be added to the deposition that occurs from the "global background." Elemental mercury may remain airborne for long periods of time. Oxidized mercury may absorb onto particulates and be deposited more readily. Water-soluble forms wash out of the atmosphere in clouds, falling as wet deposition in rain to the earth's surface soils and water bodies.[99] Legacy industrial wastewater discharges may also account for elevated mercury levels found in some Louisiana water body sediments. Also, creation of surface water reservoirs can allow mercury in terrestrial areas to become inundated and available to aquatic environments.

Once added to surface waters and surface water sediments, a complex bacterial conversion of inorganic mercury to methylmercury can occur under certain natural environmental conditions. Factors that affect methylation rates include mercury availability, form and presence of sulfur, organic content of the sediments, acidity, oxidation reduction potential (ORP) of the sediment, and bacterial populations. Methylmercury is highly toxic and readily enters the food chain, particularly in aquatic systems. Bioaccumulation factors are high for methylmercury and concentrations tend to increase rapidly in the food chain as trophic levels increase.[100]

Mercury in soils and sediments, present either from atmospheric deposition or as redeposition from contaminated aquatic organisms at mortality, may eventually revolatilize and become airborne again, contributing to the global pool or "background" of mercury in the atmosphere. Factors that affect revolatilization are likely the same factors that affect the development of particular mercury forms, some of which are more volatile than others.[101]

Oxidized reactive gaseous mercury (RGHg) species are known to play a major role in the global mercury cycle.[102] RGHg species are water-soluble, exhibit a much shorter atmospheric lifetime than elemental mercury, and contribute to a large extent to atmospheric mercury deposition. In an attempt to quantify re-emissions of stable isotopes of mercury added to soils, wetlands and lake enclosures in Canada, researchers found that the "new" mercury added to soil was quickly measured in ground level ambient air and at above background concentrations. These re-emissions of the 'tagged' mercury declined over time to nondetect after 3 months. The re-emitted mercury from the soils was 5 percent of the total amount added to upland soils and 10 percent of the total amount added to the wetlands. This finding suggests that mercury in soils may eventually react to form less volatile compounds and be less reactive. This was supported by additional findings that a significantly larger fraction of newly deposited mercury was re-emitted from lake enclosures than from upland soils or from wetlands in the study.[101]

4.2 Exposures and Effects of Mercury

Exposure to mercury in all its forms can cause adverse health effects in humans. At high doses, exposure in the womb can cause such severe effects as mental retardation, cerebral palsy, deafness, and blindness. While high-dose poisonings are rare in the U.S., chronic low-dose exposure to methylmercury is widespread. EPA found in 2000 that "mercury is both a public health concern and a concern for the environment."[103]

Nationwide, most nonoccupational exposures occur through eating fish and shellfish obtained recreationally or commercially. Data on mercury concentrations in tissue samples associated with the Louisiana Mercury Program, which represent recreationally caught fish, are presented in Section 5.2.1. Data on commercial fish and shellfish associated with the United States Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition are presented in Attachment 1. Some overlap occurs between the two databases, notably with species such as shrimp, king mackerel, Spanish mackerel, catfish and tuna. While differences in the overlapping records within the two data sets can be expected, there appears to be overall agreement on which species contain mercury concentrations significant enough to be of concern. Exposures through fish and shellfish consumption are generally in low doses but at a recurring frequency, depending upon an individual's taste for fish. Low dose exposures can result in health effects that are difficult to detect. In recent years, evidence has emerged implicating increasingly lower doses of methylmercury in adverse human health effects.[104]

The most well documented health effects are neurotoxic. Extensive data reveal that methylmercury, when ingested in sufficient quantities, affects the development of the brain as well as the intact nervous system in humans and animals. Exposures have been linked to subtle neurodevelopmental effects in children, who are more vulnerable than adults because their nervous systems are undergoing rapid development and their exposure is higher relative to body weight. The developing child can be placed at risk when the mother is exposed before and after pregnancy because methylmercury can persist in the body for several months and is found in breast milk. Children who are exposed to methylmercury before birth as a result of their mothers' fish consumption may perform poorly on tests designed to measure verbal learning, vocabulary, attention, and motor functioning. They may also suffer IQ deficits. While the risk of these effects to the general population from methylmercury is low, the severity depends on the timing and concentration of exposure, with certain windows during fetal development being most critical. Moreover, studies reveal that the damage from methylmercury exposure, such as cognitive impairment, is likely irreversible. Sensory and motor impairments have also been documented in adults. [104, 105, 106]

In the 1999-2000 and 2001-2002 National Health and Nutrition Examination Survey (NHANES), the Centers for Disease Control and Prevention (CDC) sampled body burdens and found that almost 6 percent of women of childbearing age are exposed to levels of methylmercury that may put their babies at risk. Several recent studies have compared mercury concentrations in umbilical cord blood and maternal blood and have shown that cord blood on average has 70 percent higher mercury concentrations than maternal blood. Based on these studies, about 410,000 babies born each year – 10 percent of the national total – have been exposed *in utero* to mercury levels that exceed EPA's reference dose. The exposures are not uniform across the population, since freshwater fishes are consumed disproportionately in the families of sports anglers, certain ethnic groups, and subsistence fishers.[105]

Three large studies have examined the adverse neurological effects of methylmercury exposure. Two of these studies, in the Faroe Islands and New Zealand, found that *in utero* exposures produced later neurobehavioral deficits in development, attention, fine motor function, language, visual-spatial abilities, and memory. A third study in the Seychelles Islands found no association. But the results in New Zealand and the Faroe Islands are consistent with a broad body of research on the neurotoxic effects of methylmercury. More recent studies in exposed Amazonian villagers and Cree Indians in Northern Quebec also demonstrated reduced function on neuropsychological tests. Thus the weight of evidence indicates an adverse health association. A general agreement has emerged in the scientific community supporting the potential for moderate levels of methylmercury exposure to result in adverse health effects. The National Research Council (NRC), an arm of the National Academy of Sciences, recommended in 2000 that EPA use the findings from the Faroe Islands study to set its risk-based guideline for low-dose chronic exposure. In addition, NRC found that the magnitude of exposure reported in such studies was sufficient to be linked with increases in poor classroom performance, perhaps even requiring remedial or special education classes.[103]

Methylmercury exposure may also produce cardiovascular problems in adults and children. The strongest association for a link to heart attacks has been shown in studies of adult men. This is alarming, given that heart disease remains the leading killer of Americans. Methylmercury has also been linked to an increased risk of blood pressure problems and heart rate irregularities in exposed children and adults. Researchers suggest that methylmercury may interfere with the protective cardiovascular effects of fish oils but a specific mechanism of action is unknown. Methylmercury appears to have the potential to affect the immune system. Although evidence in humans is largely lacking, animal studies suggest that methylmercury exposure can weaken the immune system function.[103]

EPA, among other national and international health organizations, and consistent with the recommendations of NRC, has set a daily consumption standard of 0.1 micrograms of methylmercury per kilogram body weight per day. However, there is no evidence of a safe level given that health effects have been demonstrated at exposures below the reference dose. In the U.S., mercury contamination is so pervasive in the environment that at least 45 state health departments have issued fish consumption advisories. Experts agree that the only real remedy is to make fish safer to eat.[103]

The FDA has also recommended that expectant and nursing mothers and young children avoid swordfish, tilefish, shark, and king mackerel, and limit consumption of fishes and shellfishes that are lower in mercury, such as shrimp, salmon, and canned tuna, to two average sized meals or to 12 ounces a week on average[107] See Attachment 1 for mercury levels in commercial fish and shellfish. The FDA recommends consulting local fish advisories before consuming freshwater fishes. The risks posed by elevated levels of mercury in fish pose an additional public health problem because fish contain beneficial nutrients that are not easily obtained elsewhere, and reduction of fish protein consumption over concerns of exposure to mercury can result in decreased nutrition for some populations.

LDHH offered free mercury screening services to state residents in 13 Louisiana parishes in 1998.[108] Results were linked to a risk factor survey completed by the 313 screening participants. The study reported mercury concentrations by age, occupation, race, education, and fish consumption. Forty-eight of the participant's blood mercury levels were below the detection limit of 0.3 ppb and the range of the remaining 265 in whom mercury was detected was 0.5 to 35.1 ppb. The study observed a general increase in average blood mercury concentration with age and identified the subpopulation of commercial fishermen and their families as averaging over twice the blood mercury levels of the combined other occupations (6.65 ppb vs. 3.21 ppb, respectively). Six of the participants from Ouachita and Morehouse Parishes in northeast Louisiana had blood mercury levels between 19.6 ppb and 35.1 ppb and were advised to decrease the consumption of fish caught from waters covered by advisories. An investigation into the source of mercury exposure to a commercial angler in Morehouse Parish was conducted in 2002 jointly by LDHH and LDEQ.[109] The individual was reported to have elevated blood mercury levels and mercury poisoning-like symptoms by the treating physician. The investigation revealed the most likely source of exposure to be fish consumed that had been caught from a nearby water body with a limited consumption advisory in place due to mercury.

Debate has occurred recently on the potential link between the use of Thimerosal and the occurrence of autism in children.[110] Thimerosal is a preservative used in certain vaccines, including those for the early childhood diseases measles, mumps, and rubella. It is 49.6 percent mercury by weight and is metabolized or degraded into ethylmercury and thiosalicylate. As a vaccine preservative, Thimerosal is used in concentrations of 0.003 to 0.01 percent. A vaccine containing 0.01 percent Thimerosal as a preservative contains 50 micrograms of Thimerosal per 0.5 ml dose or approximately 25 micrograms of mercury per 0.5 ml dose. Under the U.S. Food and Drug Administration Modernization Act of 1997, the FDA carried out a comprehensive review of the use of Thimerosal in childhood vaccines. Conducted in 1999, this review found no evidence of harm from the use of Thimerosal as a vaccine preservative, other than local hypersensitivity reactions.

Still, the FDA is conducting efforts toward reducing or removing Thimerosal from all existing vaccines. Much progress has been made. The FDA has been actively working with manufacturers to reach the goal of eliminating Thimerosal from vaccines, and has been collaborating with other public heath service agencies to further evaluate the potential health effects of Thimerosal. In this regard, all vaccines routinely recommended for children 6 years old or younger and marketed in the U.S. contain no Thimerosal, or only trace amounts (1 microgram or less mercury per dose), with the exception of inactivated influenza vaccine, which was first recommended by the Advisory Committee on Immunization Practices in 2004 for routine use in children 6 to 23 months of age. [110]

Mercury is commonly used as an inexpensive form of tooth repair in the form of a dental amalgam ("silver cavity fillings") which contains approximately 50 percent mercury by weight.[111] For decades it was believed that a person's direct exposure to the mercury in amalgam was brief, occurring only while the dentist packed the filling into the tooth.

But with the arrival of more sensitive laboratory tools in the late 1970s and into the 1980s, scientists showed that dental amalgam continuously releases a mercury vapor into the mouth, which is inhaled and absorbed by the body. The rate at which mercury from dental amalgam may uptake to the human body is affected by several factors, such as breathing rates and excessive gum-chewing behavior. Measured levels of amalgam-derived mercury in brain, blood, and urine were shown to be consistent with low absorbed doses (1-3 micrograms/day). Published relationships between the number of amalgam surfaces and urine levels were used to estimate the number of amalgam surfaces that would be required to produce the 30 micrograms/gram creatinine urine mercury level stated by the World Health Organization to be associated with the most subtle, preclinical effects in the most sensitive individuals. Researchers estimate that 450 to 530 amalgam surfaces would be required to produce the 30 micrograms/gram creatinine urine mercury level for people without any excessive gum-chewing habits.[112] Whole body imaging of a monkey with dental amalgam fillings revealed the highest concentrations of mercury in the kidneys, gastrointestinal tract and jaw.[113] However, the levels of mercury in kidney tissue did not appear to be sufficient to cause renal damage.

Inorganic elemental mercury is used in more than 600 major industrial plants in the U.S. Exposure to inorganic mercury may occur in workers through inhalation of mercury vapor, mist, dust, or fume, by ingestion through hand to mouth activities, or by dermal contact through the skin, eyes, or mucus membranes. Inhalation is the most common form of exposure in the occupational setting. The National Institute for Occupational Safety and Health estimates that 70,000 workers may be exposed to mercury vapors.[114]

Elemental mercury is often found in schools, in laboratory reagents, thermometers, thermostats, switches and relays. Legacy uses of mercury in laboratories can include the inappropriate disposal technique of pouring spilled mercury into sinks. The density of mercury can result in long-term accumulations in laboratory plumbing. This represents a potential release to sanitary waste water systems and also a potential source of chronic exposures to those occupying such laboratories. Mercury spills and subsequent exposures are somewhat common.[115]

Spilled mercury (i.e., not recovered for disposal) that remains embedded in flooring presents an opportunity for school children and teachers, as well as their family members, to be exposed to elemental mercury vapors if mercury is brought into the home in contaminated materials. One particular incident of a significant mercury spill in Louisiana was reported to LDEQ. It required cleanup of numerous affected areas to reduce the potential of harmful exposure to the public.[116]

4.3 Hg in Fish, Wildlife and other Biota

Due to the ubiquitous presence of mercury in virtually all media in the environment, it is understandable that mercury can also be found to some degree in the plants and animals living in those media. Mercury has likely been present in the tissues of various biota throughout time. However, it is under conditions and situations when mercury in the tissue of various biota exceeds background to a level that may cause harm (either to the individual of a species, the population dynamics of the species or to the other species that interact with that species across trophic levels) that are of concern.

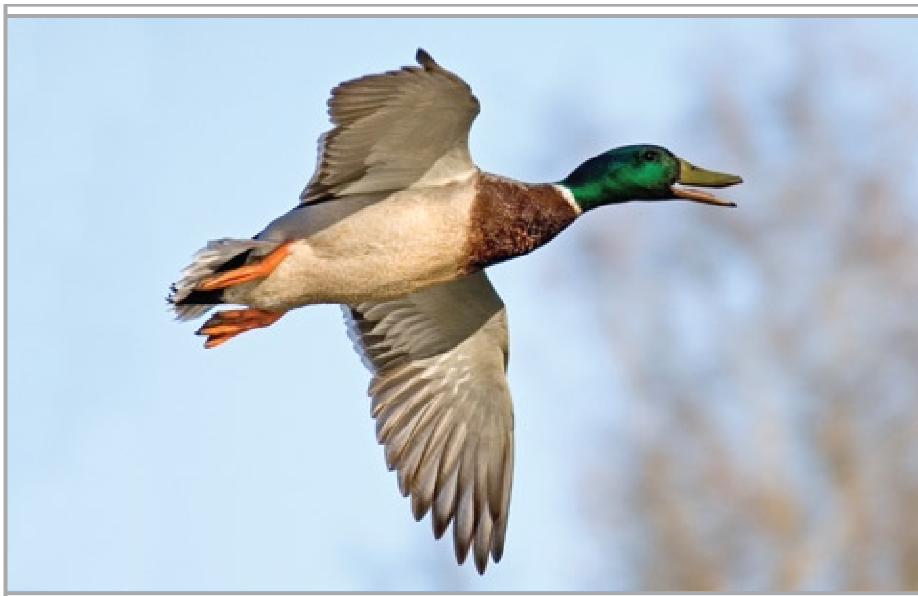
The presence of mercury in fishes has been well demonstrated as a source of exposure to humans.[117] The FDA data on mercury concentrations in commercial fish and shellfish is presented in Attachment 1. LDEQ data includes mercury concentrations in the edible tissues of fish and some nonfish species, such as American alligator (*Alligator mississippiensis*), red swamp and white river crawfish (*Procamberus* spp.), Eastern oyster (*Crassostrea virginiana*), and blue crab (*Callinectes sapidus*).[118] Mercury-related consumption advisories for these species have never been warranted in Louisiana, and blood and tissue data from the Louisiana Wildlife Hospital on Louisiana alligators (captive-hatched from wild eggs) confirms the low levels of mercury in American Alligator blood, liver and muscle.[119] LDEQ data does not include information on piscivorous animal species, such as raccoon and snapping turtle, used for food in some local human populations.

Such data could be useful in identifying overlooked exposures to some people.

A study of mercury in northern crayfish (*Oronectes virilis* (Hagen)) in the New England region of the U.S. indicated that due to the limited home range and the relative long-lived nature of this species (as compared to other invertebrates), they may be useful as indicators of local sources of pollution,[120] such as areas of historic natural gas manometer use. The use of crawfish tissue data as an indicator of local sources of mercury has not been pursued extensively in Louisiana, but the concept appears plausible and has potential as a local source indicator.

The effects of mercury on the general populations of many species are not well known. Mortalities due to mercury poisoning can be the result of reduced motor skills necessary for predation, but sub-lethal effects ultimately resulting in mortalities in the form of increased vulnerability to predation, decreased ability to feed or decreased fecundity may occur.[117,121,122] Mercury levels in tissue tend to increase in the food chain as trophic levels increase.[123]

Observations in Canada of wild mink (*Mustela vison*) and river otter (*Lutra canadensis*) carcasses indicate spatial trends of reduced liver mercury concentrations with increased distance from industrial centers.[124] The reproductive success of common loons (*Gavia immer*) may have suffered because of mercury exposure.[121] Egg survival in mallard ducks (*Anas platyrhynchos*) decreased with methylmercury exposures, but several fish-eating bird species, such as white ibis (*Eudocimus albus*), appear to be more sensitive than mallards to mercury.[125] In analyzing blood mercury data in belted kingfishers (*Ceryle alcyon*) and bald eagles (*Haliaeetus leucocephalus*) in the northeastern United States, mercury levels were found to increase based on the habitat of the individual, increasing from marine to estuarine to riverine, with lacustrine (lake) habitat showing the highest levels of blood mercury in kingfishers, averaging approximately 4 ppm.[122] This appears to support findings in Louisiana that mercury methylation appears higher in freshwater environments as opposed to brackish/saltwater areas, based on the mercury-in-tissue data collected by LDEQ.[118]



Some data on blood mercury in wildlife in Louisiana is available from the Louisiana Wildlife Hospital, mostly for captive-hatched and raised American alligator but also for wild bald eagle. One bald eagle was recently captured by private citizens after observations that the eagle was unable to fly. The bird presented as anemic and ataxic, but when fed ate readily. Blood mercury levels upon admittance to the hospital were 1.1 ppm. Chelation treatment reduced levels to 0.15 ppm, at which time the bird had recovered sufficiently from presenting symptoms to be released back to the wild after approximately two months. It has not been confirmed that mercury was the cause of the bird's ailment, but if so, a blood mercury level of 1.1 ppm in bald eagle would appear to indicate that a threshold of effect had been exceeded for that species. Mercury levels in eggs and blood are good indicators of short-term exposures of mercury to avian species, while mercury levels in liver and feathers provide better insight into long-term exposures.[119]

5.1 History

LDEQ first sampled for mercury in fish tissue in 1989 in the Ouachita River in northeast Louisiana. Notification from the state of Arkansas indicated elevated levels of mercury in fishes in the Ouachita River within Arkansas boundaries and raised concerns in the downstream waters in Louisiana. Subsequent data collection indicated elevated mercury levels, and the first fish advisory for mercury was issued in Louisiana for the Ouachita River in 1992.

With funding assistance from EPA Region 6 and cooperative efforts with the USGS, subsequent fish tissue sampling for mercury was conducted in 1993 at four additional sites on the Ouachita and in 12 freshwater lakes in northern Louisiana. Findings of that effort warranted further data collection. Given the labor-intensive nature of fish collection, sample handling, sample delivery, and the monetary expense of sample analysis, the need for a formalized, established program was realized. The mercury program was formalized in 1994, funded in part by existing LDEQ budget, but matched by general funds awarded by the Louisiana Legislature at the behest of nongovernmental environmental organizations. The program consisted of several LDEQ personnel who were certified to operate electro-fishing equipment, with assistance from various LDEQ field staff. Soon the program grew to include a full-time supervisor and two field scientists who conducted fish collection, rendering, and delivery for analysis. Additional LDEQ personnel were used to manage the data and report to the State Health Officer of the LDHH, Office of Public Health. To date, the Mercury Program has conducted sampling at 498 sites on approximately 300 water bodies. Current funding for the Louisiana Mercury Program is through annual allocations of state general funds at the discretion of the Louisiana Legislature. The program's annual budget is approximately $500,000.

In 1997, an interagency agreement between LDEQ, LDHH, LDWF, and LDAF was finalized. This agreement formalized the "Protocol for Issuing Health Advisories and Bans Based on Chemical Contamination of Fish/Shellfish in Louisiana," a document that clarified procedures for issuing mercury advisories, as well as advisories for other contaminants.[126]

To date, 40 freshwater advisories and one marine advisory, affecting 95 water bodies, have been issued in Louisiana relative to mercury.

When a mercury advisory is placed on a water body, signs are posted at area public boat launches warning potential anglers about eating fish from that water body. An advisory is broadcast by press release, listed on the LDEQ and LDHH websites and placed in the LDWF fishing regulations for public awareness. Technical compilations of mercury data and advisory status were published in annual reports and one document was prepared in layman terms in 2003 to enhance public understanding of mercury in the environment.

Louisiana joined the MDN in 1998. Mercury wet deposition monitors were sited near three Louisiana cities, Hammond, Chase, and Lake Charles to collect rainfall for analysis. A fourth was added in 2001 near Alexandria. These devices collect rainwater using a sufficiently clean protocol to allow for total mercury detection limits below 1.0 ppt. Rainfall volume data are gathered to allow calculations of mercury mass loading. Each site is serviced weekly (whether or not rain has fallen) to gather the sample and replace key parts of the equipment to ensure the cleanliness of the next sample.[127]

Programmatic sampling for mercury in the environment includes water, sediment (hydro-soils), and vegetation (epiphytes) samples in proximity to areas that are also sampled for fish species. Surface waters are collected as individual grabs using Kemmerer bottles and analyzed for total mercury, sulfate, alkalinity, and total organic carbon. Sediments are collected using a Ponar dredge and are analyzed for total mercury, methylmercury, macronutrients and micronutrients (phosphorus, potassium, calcium, magnesium, sodium, and sulfur), pH, ORP, texture, organic matter content, and percent composition of sand, silt, and clay. A minimum of three aliquots of sediment are collected and composited to provide one composite sediment sample per site visit. Vegetation is collected from areas that have living epiphytes. The dataset is comprised mostly of Spanish Moss (*Tilandsia usneoides*), but unspecified lichens are sampled on occasion. Epiphytes are analyzed for total mercury.

Behavior of mercury in the environment was poorly understood in the early years of the mercury program and necessitated research of its transport, fate and effects. Initial research funded through the program demonstrated that several physical, chemical, and biological factors can affect conversion to methylmercury, an organic form which is readily taken up in the food chain. These factors include the amount of sulfate and organic matter in sediment, and the ORP and pH of the sediment. As the methylation process became better understood, a shift in sediment data collection and analysis occurred. After 2001, sediments were analyzed for both total mercury and methylmercury, allowing data to be reported as ratios of the two parameters and serving as an indicator for in-situ mercury methylation rates.

Additional research was funded through the mercury program to conduct sampling of blood mercury in certain Louisiana residents. Personnel within the LDHH, Office of Public Health, offered free blood mercury screening services to residents in 13 parishes through local public health units. A written risk factor survey was linked to the blood mercury data. The intent of the study was to assess fishers and their families living near advisory water bodies for possible exposure to mercury from consuming fish. Screening residents for blood mercury provides data useful in determining mercury distribution in high risk populations and in determining baseline blood mercury in residents. The findings of this study are discussed further in Section 4.2 Exposures and Effects of Mercury.

The TRI Program began in 1986-1987, designed to provide citizens with information regarding the release and transfer of chemicals manufactured in their communities.[21] This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. The success of this program led to dramatic reductions in the amounts of toxic chemicals released into the environment. In an effort to continue to provide information to the public, EPA through the years has modified the reporting requirements. A major change to the program occurred in 1995 when the list of reportable TRI chemicals doubled to include additional chemicals of concern. Additionally, for reporting year 2000, the threshold was lowered for chemicals identified as PBT chemicals, one of which is mercury.

As a result of the lowered threshold, facilities were required to submit data previously not reported on mercury and mercury compounds. The TRI Program, along with the Toxics Emissions Data Inventory (TEDI) Program, has tracked emissions from facilities subject to specific reporting requirements. The TEDI is a Louisiana-specific program which began collecting data in 1991. The TEDI has different reporting criteria than the TRI, therefore data from the two programs may not always be comparable. However, the TEDI is another tool to use in tracking mercury releases to the environment, and as a state operated program is more easily modified to suit a specific need.

Another form of mercury monitoring occurs with the EPA's Chemical Speciation of PM2.5 Particulates. Since 2004, LDEQ has collected mercury data along with many other trace element analyses associated with two speciated PM2.5 air monitors, one in Shreveport and one in Baton Rouge. The media analyzed are airborne particulates smaller than 2.5 microns in size. The purpose of the data collection is to aid in source identification for mitigation should PM2.5 standards be exceeded. Currently there are no ambient air standard exceedances for PM2.5, therefore the data has not been scrutinized for implicated sources. This very small size of particulates is selected for analysis due to the ability of these particles to be inhaled deeply into the lungs, providing a potential pathway for human exposures to airborne pollutants.

5.2 Findings of the Hg Program to Date

Data collected under the Mercury Program has resulted in a large database, quantifying mercury in various media.[118] Fish tissue data are primarily used to develop fish consumption advisories. The latest fish tissue dataset of more than 11,000 records can also be useful in providing additional information about mercury in Louisiana's fish, such as length-to-concentration correlations, identification of species most likely to have high levels of mercury, and determination of areas of higher risk of exposure from fish consumption. The following is a discussion of some of these kinds of information.

5.2.1 Mercury in Fish Tissue

The most significant outcome of the fish tissue assessment has been the establishment of 41 fish consumption advisories affecting 95 water bodies throughout the state (Attachment 2) including one for the Gulf of Mexico. As of May 2006, of the 40 freshwater fish advisories in Louisiana, fish consumption limits are advised for bowfin (*Amia calva*) in 36, for largemouth bass (*Micropterus salmoides*) in 26, freshwater drum (*Aplodinotus grunniens*) in 19 and crappie (*Pomoxis* spp.) in 15 (Figure 17). Although some species, such as *Pomoxis* spp., occur frequently in advisories, individuals of that species with elevated mercury levels are often larger than what is commonly caught, based on LDWF creel surveys.[128]

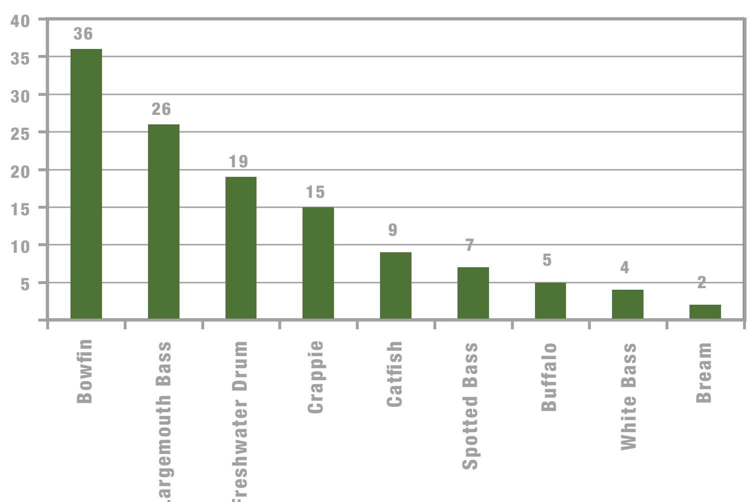


Figure 17 – Frequency of occurrence of freshwater fish species in 40 fish consumption advisories in Louisiana as of July 2007.

For coastal waters and the Gulf of Mexico offshore of Louisiana, average tissue concentrations in several species are indicated in Figure 18. The current Louisiana fish consumption advisory for the Gulf of Mexico includes king mackerel (*Scomberomorus cavalla*), blackfin tuna (*Thunnus atlanticus*), cobia (*Rachycentron canadum*) and greater amberjack (*Seriola dumerili*). In general, reef fish tissue concentrations were consistently lower than tissue concentrations in migratory pelagic species. No shellfish species are the subject of mercury advisories.

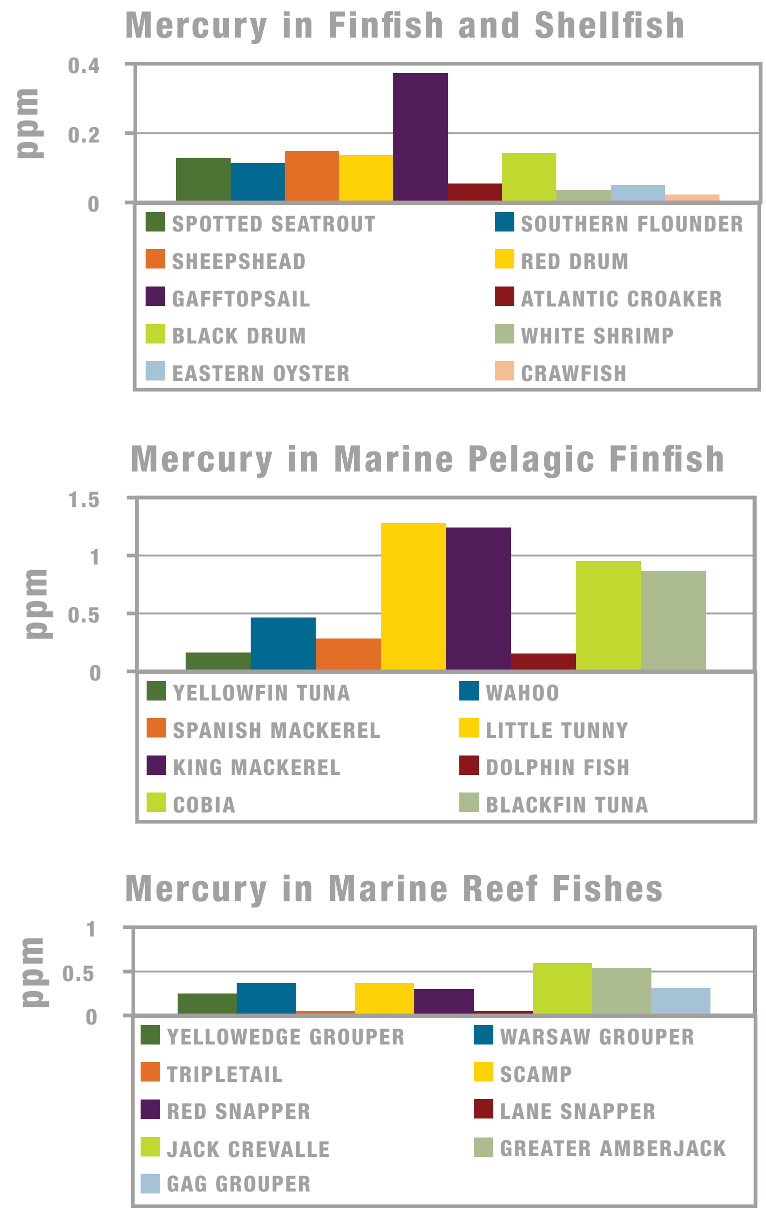


Figure 18 – Average tissue concentrations of coastal and marine finfish and shellfish in Louisiana and the near shore Gulf of Mexico. The "action level" for mercury advisory consideration is 0.5 ppm.

Although the database of mercury in fish tissue contains more than 11,000 records, the data are too broadly scattered over time and across the state for useful trend analysis by site and species. Trends in mercury uptake in fish by site could be identified and related to correlating factors for predictions and source identification were sufficient data available. Overall, data indicate that larger individuals of a species are more likely to have higher mercury concentrations in edible tissues than smaller individuals of the same species, especially when the assessment is site specific. This supports a standard advisory statement that recommends consumption of smaller individuals of a given species to reduce the risk of mercury exposure.

5.2.2 Mercury in Epiphytes

When present and feasible, epiphytes are collected during fish tissue sampling activities. Although lichens are occasionally collected, current practices focus on Spanish moss (*Tilandsia usneoides*) for long-term and spatial comparability purposes. Of the 555 total data points in the database for epiphytes, 13 represent lichens. The remaining data points represent mercury in Spanish moss.

Of the 555 epiphyte-related data points, 548 (98.7 percent) were below 0.5 ppm and 513 (92.4 percent) were below 0.2 ppm. The minimum reported detection limit (MDL) for this dataset was 0.0001 ppm and the data ranged from nondetect (<0.0001 ppm) to a maximum value of 0.973 ppm.

The 42 highest values were geospatially distributed throughout the state in no discernible pattern. Several of the sites with the highest values were sampled multiple times over a period of years. In those cases, high values were accompanied by values below 0.2 ppm. However, when all epiphyte data is graphed over time, most values over 0.2 ppm were found to occur in two fairly distinct time periods, one from May 1995 to May 1997 and the next from May 2001 to April 2003 (Figure 19). When mapping of these data is restricted to these time periods, again no geospatial pattern is discernible (Figure 20). The dataset may not be sufficiently robust in regard to the temporal and spatial coverage, to define geospatial patterns without further scrutiny and/or data collection.

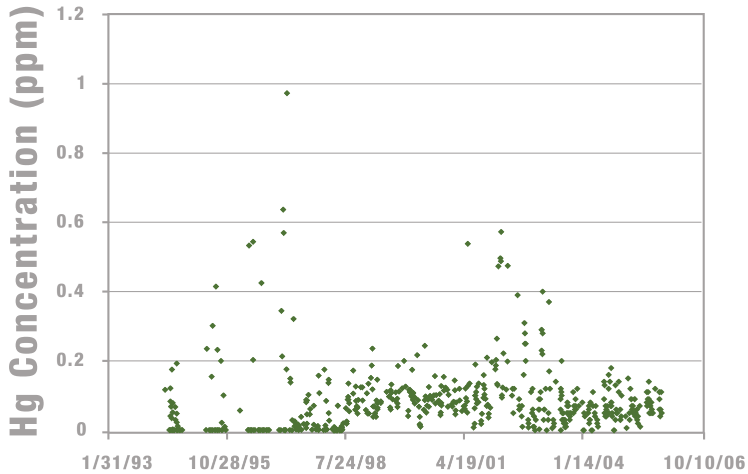


Figure 19 – Mercury concentration in epiphytes (primarily *Tilandsia usneoides*) in Louisiana relative to date of collection.

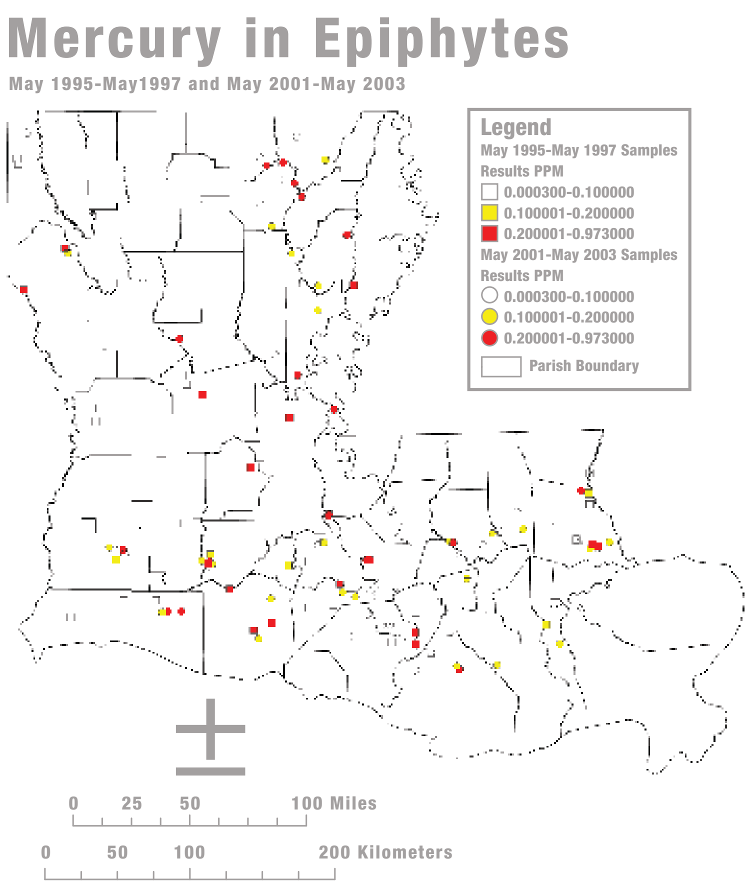


Figure 20 –Map showing epiphyte sampling locations in Louisiana and Hg concentration ranges.

5.2.3 Mercury in Sediment

Since 2001, both methylmercury and total mercury were measured in sediments where fishes were collected for total mercury analysis, but sediments have been analyzed for total mercury since 1993. A summary of data on methylmercury and total mercury in Louisiana sediments is presented in Table 6.

The ratio of methylmercury to total mercury may be used as an indicator of methylation rates within a given water body. Assessment of this aspect of the sediment data required the use of nonparametric statistics due to the non-normality of the data according to the Shapiro-Wilkes test for normality. At 84 percent confidence interval, the ratio of methylmercury to total mercury in water bodies with fish consumption advisories is higher than ratios in water bodies without fish consumption advisories. Additional data assessment would be needed to determine if other parameters collected as part of the sediment dataset (pH, ORP, macronutrients and micronutrients, organic matter content, and sand/silt/clay composition) relate to the methylation-rate indicator.

Table 6. Mercury in sediment data for all Louisiana sites

	Period of Record	Minimum	Maximum	Mean
Methyl Hg (n=365)	Oct 2001 to May 2005	ND	8.49ppb	0.82ppb
Total Hg (n=863)	1993 to May 2005	0.00005ppm	1.2ppm	0.105ppm

Research funded through the mercury program revealed that the methylmercury content of sediment increased tenfold when samples were spiked with a 2 ppm solution of mercury under laboratory conditions. However, the increase in methylmercury production was less in sediment when the water overlying the sediment was incubated under oxygenated (ambient air) versus nonoxygenated (nitrogen) conditions. Results suggest that methylmercury production would be less in waters containing an oxygenated water column. In parallel microcosm studies without added mercury, methylmercury decreased in sediment when the ORP of a sediment suspension was increased from -200 mV to +250 mV. Results of these studies demonstrate the importance of oxygenation or the oxidation-reduction condition of surface sediment on mercury methylation. Sediment conditions, which either reduce methylation or enhance demethylation in surface sediment, will limit the bioavailability of methylmercury to the aquatic environment.[129]

5.2.4 Mercury in Atmospheric Wet Deposition

The MDN sites in Louisiana collect rainfall volume data and mercury concentration in rainfall data on a weekly basis.[127] A weekly loading of mercury to the surface area of the state is calculated. These figures are available through the National Atmospheric Deposition Program (NADP) website http://nadp.sws.uiuc.edu/mdn/. Weeks with no rainfall are represented as a record in the database without valid volume or mercury concentration listed. Data that do not pass quality control are also listed, but flagged as invalid. For the purposes of data summary below, the invalid and dry-week (no measurable rainfall) MDN data records were excluded.

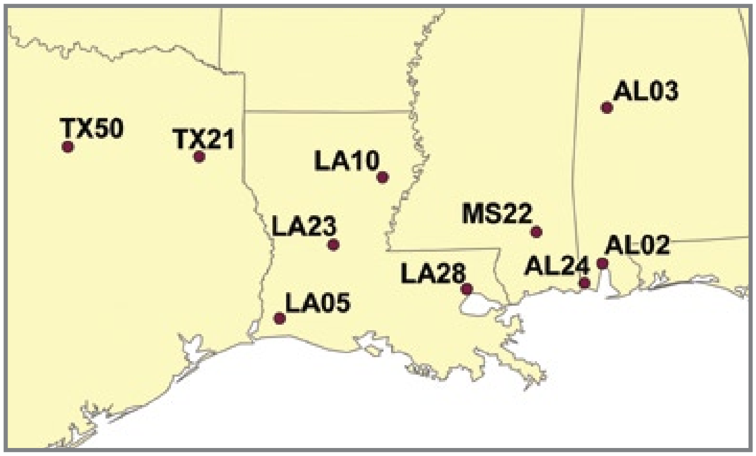


Figure 21 – Map of Louisiana showing the Mercury Deposition Network wet deposition monitoring sites.

The four mercury wet deposition monitors in Louisiana have produced 947 data points on mercury concentration in rainfall and weekly rainfall volume and the corresponding loading values. Table 7 below shows a summary MDN site data.

Table 7. Mercury data summary from four Louisiana MDN sites

MDN Site	No. of Data Points	Average Concentration (ppt)	Min-Max Concentration (ppt)	Average Loading (ng/m^2)	Min-Max Loading (ng/m^2)
Hammond	266	14.99	0.62 – 99.56	348.53	4.38 – 2747.53
Lake Charles	255	16.77	1.67 – 110.08	361.69	1.73 – 2744.15
Chase	263	15.17	3.01 – 337.92	404.19	7.17 – 2176.80
Alexandria	163	13.91	1.16 – 57.41	394.05	9.63 – 2223.60

The values in Table 7 show similarity between sites, but the data are highly variable. The loading rate values are important in assessing impact that rainfall is having as a source of mercury to Louisiana surface areas. Loading rates are a function of rainfall amount and concentration in rainwater. Loading rates from wet deposition nationwide are indicated in the NADP/MDN Total Mercury Wet Deposition contour map (Figure 12, Section 3.3) and compared to the NADP/MDN Total Mercury Concentration (Figure 13, Section 3.3). Average annual mercury loading to Louisiana through wet deposition is currently calculated as approximately 3,945 pounds, with approximately 631 pounds falling directly onto the 16 percent of the state that is open surface water. The remaining mercury either adds to "background" mercury levels in surface soils or adds to surface water loading via rainfall runoff.

Although mercury concentration in Louisiana rainwater is approximately midrange of nationwide values, wet mercury deposition is approximately twice as high in the Gulf Coast region when compared to other regions. This appears to correlate more closely to precipitation values than to mercury concentration values. Table 8 provides information from MDN sites in other geographic regions of the nation.

Table 8. Mercury data summary from four MDN sites within the U.S.

	No. of Data Points	Average Concentration (ppt)	Min-Max Concentration (ppt)	Average Loading (ng/m^2)	Min-Max Loading (ng/m^2)
Minnesota, MN27	316	16.65	1.13 – 112.20	237.50	0.42 – 1605.02
California, CA72	117	17.07	1.74 – 250.18	140.84	2.48 – 997.85
New York, NY20	272	8.41	0.71 – 53.97	148.91	4.39 – 1282.67
Florida, FL05	315	15.25	1.36 – 81.21	415.38	1.65 – 2055.36

Average concentration values in New York appear less than those in other parts of the U.S., but whether the values are statistically significant will require further statistical scrutiny. The apparent differences in average concentration values and the broad ranges of variation may imply that wet deposition mercury is not evenly distributed throughout the U.S., lending credence to the concept that local sources of mercury emissions may have local effects on wet deposition of mercury.

A recent study from Pennsylvania reported that data for an eight-year period from a wet deposition monitor located near a coal-burning EGU was 47 percent higher in average mercury concentration than data from a wet deposition monitor that was not located near a coal-burning EGU. Implications from the document are that near-source deposition from coal-burning EGUs may be more significant than previously believed.[130]

5.2.5 Toxic Release Inventory

LDEQ has been able to monitor mercury emitted by significant industrial sources through the inventory programs in the agency. Figure 22 shows Louisiana air emissions for mercury and mercury compounds by year for the four most significant source categories (chlorine manufacturing, steel recycling, crude oil refining, and electricity generating) subject to TRI reporting since 2000 when reporting thresholds were lowered. Overall, air emissions of mercury in Louisiana from these four source categories rose approximately 20 percent from 2000 to 2004. Mercury emission increases from 2000 to 2004 were reported for three of four source categories. Reported emissions from the single EAF are highly variable, likely due to differences in emission estimation procedures and differences in the mercury content of feed stock.

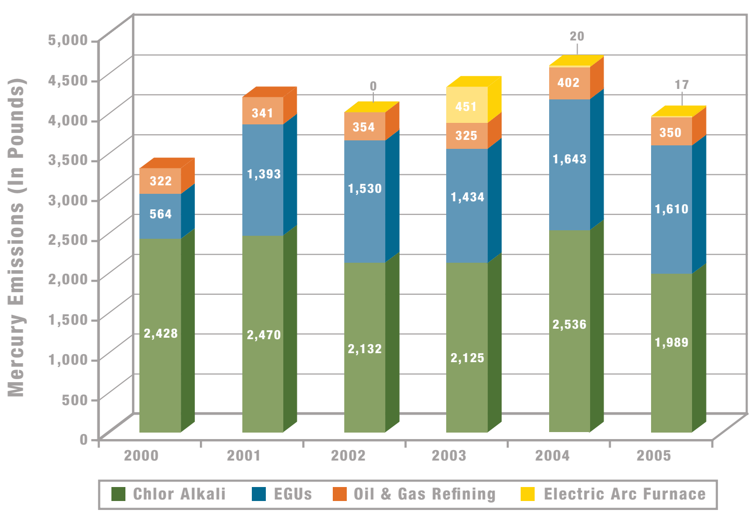


Figure 22 – Mercury released in air emissions from the top four Louisiana sectors from 2000-2004.[21]

5.2.6 Mercury Manometer Site Remediation

Remedial activities involving natural gas manometers became a practice of LDEQ in the early 1990s. Voluntary investigation and cleanup of contaminated sites is managed by LDEQ and continues today through cooperative agreements between the LDEQ Office of Environmental Assessment and responsible parties. A work plan is submitted to LDEQ for approval and is used to confirm the location and extent of contamination. A corrective action plan addresses the risk assessment and appropriate remedial activities needed to be protective of people and the environment. To date, over 5,200 sites have been assessed, resulting in the voluntary cleanup of over 2,300 sites.[52] The number of mercury manometer sites that have not been assessed is unknown, but estimates range from approximately 15,000 to 45,000.[52] Since records needed to track mercury manometers have not been required, identifying these legacy sites of mercury contamination is difficult. Programmatic needs for this aspect of the Louisiana Mercury Program include transition of hard copy information into a database for ease of access to records and the ability to interface with GIS. Additionally, as this activity continues, the need to discover orphan sites will arise as those sites with viable responsible parties are addressed. This will require new strategies for discovery and additional resources for program management.

5.2.7 PM2.5 Chemical Speciation

Data from the two PM2.5 Speciation Monitors in Louisiana include the concentration of total mercury in airborne particulates smaller than 2.5 microns (diameter) per cubic meter of air. At the Shreveport site from January 2003 to March 2007, the average mercury concentration was ~0.0040 micrograms per cubic meter (ug/m^3) and the values ranged from 0 to ~0.046 ug/m^3. At the Baton Rouge site for the same period, the average mercury concentration was ~0.0056 ug/m^3, with values ranging from 0 to ~0.0902 ug/m^3. Similar data exist for other regions of the country, but statistical comparisons to Louisiana data have not been developed.The analyses associated with the EPA program are on very small particulate-sized media (less than 2.5 microns). Particles of this size are more likely to remain airborne than PM10 or other larger airborne particulates. Therefore, this data may not be generally characteristic of dry mercury deposition and should not be used for that purpose.

6.1 Air

Before the CAAA, EPA listed eight substances as hazardous air pollutants: asbestos, beryllium, mercury, vinyl chloride, radionuclides, inorganic arsenic, benzene, and coke oven emissions. National Emission Standards for Hazardous Air Pollutants (NESHAP) were promulgated for these pollutants. The original standards for mercury emissions were promulgated in 1975. These standards are found at 40 CFR 61.50.

Frustrated with a lack of progress in attaining the air quality standards, Congress rewrote and strengthened the CAA. In addition to other requirements, the CAAA mandated the development of new control standards for sources of an expanded list of hazardous air pollutants (HAPs). The expanded list of 188 HAPs includes all of the 'original' NESHAP pollutants. The mercury compounds group includes "any unique chemical substance that contains [mercury] as part of the chemical's infrastructure." In the CAAA, the provisions of the Act have been restructured so that HAP sources instead of individual pollutants are now regulated. 40 CFR Part 63 Subpart IIIII, National Emission Standards for Hazardous Air Pollutants: Mercury Emissions From Mercury Cell Chlor-Alkali Plants, was promulgated on December 19, 2003.

In addition, Section 112(c)(6) of the CAAA requires EPA to list categories of sources within five years of the Act and promulgate standards within ten years for seven specific HAPs, of which mercury is one. The preamble to the federal rule for the control of mercury emissions in chlor-alkali plants includes Section 112(c)(6) as one authority for rule establishment.

The CAAA has special provisions for dealing with HAPs emitted from electrical utilities, including giving EPA the authority to regulate coal-fired power plant mercury emissions either by establishing "performance standards" or by MACT, whichever the agency deems most appropriate. On March 15, 2005, EPA issued the CAMR under the authority of Section 111 (performance standards). The rule creates performance standards for new applicable sources and establishes permanent, declining national caps on mercury emissions for new and existing applicable sources.

The authority to implement and enforce certain NESHAP promulgated by EPA at 40 CFR 61 and 63 has been delegated to LDEQ. With respect to delegated New Source Performance Standards (NSPS) and NESHAP, LDEQ is the primary point of contact and has the primary responsibility to implement and enforce the federal standards.

In addition to the federal programs mentioned above, LDEQ regulates mercury emissions through its Comprehensive Toxic Air Pollutant Emission Control Program which can be found in LAC 33:III.Chapter 51, promulgated in 1991. This rule requires "major sources" of toxic air pollutants (TAPs) to submit an air toxics compliance plan containing facility-specific state MACT controls for TAPs. To be classified as a major source, a facility must emit more than 10 tons per year of any one TAP or 25 tons per year of all TAPs combined. The rule also requires facilities to comply with Louisiana's ambient air standard for each TAP at their fence lines. Facilities are required to report approximately 200 TAPs, including mercury. Emission controls are required for mercury and for approximately 100 other TAPs. Although the rule applies to major sources of air toxics, it exempts electrical utility steam generating units. Thus, mercury and mercury compound reductions under the air toxics rule have not been as dramatic as those seen for other air toxic compounds.

6.2 Water

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act (CWA). The CWA established the basic structure for regulating discharges of pollutants into the waters of the U.S. It gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry. The CWA also contained requirements to set water quality standards for all contaminants in surface waters. It became unlawful for any person to discharge any pollutant from a point source into navigable waters, unless authorized in a water discharge permit. Subsequent enactments modified some of the earlier CWA provisions. Revisions in 1981 streamlined the municipal construction grants process, improving the capabilities of treatment plants built under the program. Changes in 1987 phased out the construction grants program, replacing it with the State Water Pollution Control Revolving Fund, more commonly known as the Clean Water State Revolving Loan Fund. This new funding strategy addressed water quality needs by building on EPA-state partnerships.

The Louisiana Water Control Law became effective in January 1980. This law gave the state the authorities and responsibilities for water-related pollution similar to those provided to the federal government by the CWA. Subsequent amendments to the state law resulted in Louisiana assuming the NPDES program of the CWA in 1996. The LPDES is consistent with NPDES provisions of the CWA and authorizes LDEQ to regulate discharges of pollutants to waters of the state through the issuance and enforcement of water discharge permits.

Provisions of the CWA that set water quality standards require action to reduce loading of a pollutant when that pollutant level exceeds the water quality standard. In the case of mercury, any water body with a fish-consumption advisory to protect human health is considered impaired. Actions required to address this impairment can be varied, but often involve the development of a TMDL strategy for a particular pollutant.

The TMDL approach typically includes reduction in the amount of a particular pollutant that can be discharged to surface waters as allowed by a wastewater discharge permit. Traditional TMDL strategies for reduction of mercury discharges to waters with fish advisories have become problematic since other significant sources of mercury exist in addition to point sources. For effective risk reduction of mercury, multiple strategies involving several authorities will be needed.

6.3 Solid Waste and Hazardous Waste

The RCRA, which amended the Solid Waste Disposal Act, was the first substantial effort by Congress to establish a regulatory structure for the management of solid and hazardous wastes. Louisiana created a Hazardous Waste Division in 1978 which was consolidated into the Office of Environmental Affairs in 1979. In 1980, Louisiana enacted the Hazardous Waste Control Law to align the state hazardous waste program with federal regulations. In 1985, Louisiana achieved "Authorized State" status from EPA to administer the RCRA program through rules codified in Title 33, Part V of the Louisiana Administrative Code (LAC).

Subtitle C of RCRA addresses "cradle-to-grave" requirements for hazardous waste from the point of generation to disposal. Most RCRA requirements are not industry specific but apply to any person that generates, transports, treats, stores, or disposes of hazardous waste. These requirements set up testing, notification, management, tracking, treatment, and disposal controls which LDEQ monitors through surveillance, permitting, and enforcement activities. For a hazardous material to be regulated as a hazardous waste it must first fall under the regulatory definition of solid waste and then within the definition of hazardous waste, both of which are described in 40 CFR 261 Identification and Listing of Hazardous Wastes in the federal rule and LAC 33:V.109 in the state code.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as Superfund) was enacted by Congress to address growing concerns about the need to clean up uncontrolled, abandoned hazardous waste sites and to address future releases of hazardous substances into the environment. Many states have state-level Superfund laws which complement and in some cases are more stringent than federal CERCLA requirements. Louisiana's "mini-Superfund" law is found in Louisiana Revised Statutes 30:II.2221-2290. The Superfund Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for Superfund, and created a free-standing law, SARA Title III, also known as EPCRA.

The term "Superfund" is based on the large fund of money that is collected by EPA to investigate sites and to pay for cleanups in cases where no responsible parties can be determined. If responsible parties can be found, they will be held liable for cleanup costs. The chemical industry pays about $300 million a year in Superfund chemical feedstock taxes. Under CERCLA, site cleanups are conducted under the procedures contained in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300), typically referred to as the National Contingency Plan (NCP). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as "removals."

A waste can be hazardous either by exhibiting a characteristic of a hazardous waste or by falling under a category of listed hazardous wastes. Hazardous waste characteristics are toxicity, corrosivity, ignitability, and reactivity. A solid waste exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure – Method 1311 (TCLP) outlined in EPA Publication SW-846, the extract from a representative sample of the waste contains concentrations greater than or equal to compound-specific values listed in LAC 33:V.4903.Table 5 (D-wastes). A waste yielding TCLP results at or above 0.2 mg/l mercury qualifies as a D009 hazardous waste under the toxicity characteristics.

Listed hazardous wastes include hazardous wastes from nonspecific sources (F-wastes), hazardous wastes from specific industries/sources (K-wastes), and discarded commercial chemical products (P-wastes or U-wastes). Examples: Multi-source leachate is classified as F039 if the TCLP extract contains at or above 0.025 mg/l mercury. Brine purification muds from the mercury-cell process in chlorine production are classified as K071. Wastewater treatment sludge from the mercury-cell process is K106. Wastewater treatment sludge from the production of vinyl chloride monomer using mercuric chloride catalyst in an acetylene-based process qualifies as K175. Mercury fulminate qualifies as a P065 hazardous waste due to toxicity and reactivity. Phenyl mercuric acetate (PMA) qualifies as P092, and discarded elemental mercury is classified as U151.

Mercury-containing hazardous wastes may also be managed under the Universal Waste standards in LAC 33:V.Chapter 38. This standard provides for safe handling and recycling of several specified hazardous wastes, including batteries, pesticides, mercury-containing equipment, lamps, electronics, and anti-freeze.

6.4 Consumer Products

Nearly all legislative activity in the U.S. intended to affect mercury-added products is at the state level. A federal effort to address mercury in products came with the passage of "The Mercury-Containing and Rechargeable Battery Management Act of 1996" which phases out the use of mercury in batteries, and provides for the disposal of used nickel cadmium batteries, used small sealed lead-acid batteries, and certain other regulated batteries.[131] The act establishes a nationwide labeling requirement for subject batteries, requires such batteries be manufactured in a way to be "easily removable" from consumer products, makes the collection, storage and transportation of subject batteries applicable to the Universal Waste Rule, requires EPA to establish a public outreach program and prohibits, or otherwise conditions, the sale of certain types of mercury-containing batteries in the United States. Other federal legislation specific to mercury has been developed under the scope of CERCLA/RCRA and CAA.

States and local governments have enacted various forms of legislation that affect mercury-containing products within their jurisdictions.[132] Of 16 states that have developed an overall mercury action plan or strategy document, the most commonly reported major elements are recycling, public outreach and education, small business and household mercury waste management, medical and dental mercury waste management, and reductions of mercury in consumer products. The following table lists the number of states to which a given category of legislation applies.

Table 9. Number of states with indicated activities legislated as of 2005.[132]

Activity	Number of States
Labeling mercury-containing products	12
Phase-out mercury-containing products	18
Mercury collection programs	37
Mercury vehicle switch removal	19

Until recently, state and local government approaches to address mercury contamination have not been part of a coordinated, comprehensive program. A growing trend toward developing comprehensive programs has emerged as states recognize the need for a broader commitment to phase out persistent toxic chemicals like mercury.[132]

States, through their respective legislative actions, have identified consumer product categories of concern for regulating mercury uses. These categories and their corresponding disposal masses are listed in the following table.

Table 10. Mass of mercury disposed annually in the U.S. by product category[133]

Product	Mercury in Tons
Electrical lighting	17 tons
Measuring devices	9-17 tons
Thermostats	15-21 tons
Switches and relays	36-63 tons
Dental preparations	34-54 tons
Batteries	Negligible

In addition to the categories in Table 9, mercury in vehicle switches is a category subject to activities in 28 states. As of 2005, 21 states have either proposed or enacted legislation or regulation addressing this category.[132] Although domestic automobile manufacturers ceased installation of mercury switches for convenience lighting, ABS and other systems such as ride control by 2003, estimates of the amount of mercury in "on-the-road" vehicles in 2005 was 150 tons.[134] This amount is expected to decline over time as older vehicles that contain mercury switches are retired and replaced with vehicles containing mercury-free alternatives.

Another category of consumer products is formulated mercury-added products. These are substances that are most commonly associated with laboratory, medical or dental uses. These substances are discussed in more detail in this document in Section 3.2.3. Seven states have passed legislation requiring notification to patients, handling restrictions and/or collection practices on the use of mercury in dental amalgam.[132]

Additional requirements are being developed by municipalities to aid in addressing their requirements for reducing mercury in domestic waste water treatment system discharges. Regulation of domestic waste water treatment system discharges often leads to regulation of dental amalgams, but may also include best management practices for laboratories and medical facilities using chemical compounds containing mercury.

In response to increasing awareness of mercury fate in the environment, LDEQ made an assessment of all associated departmental activities. This review highlighted many aspects of environmental regulatory and nonregulatory activities, some of which operate independently of each other. Activities included: issuing permits that limit the amount of mercury released in water discharges and air emissions; promoting programs to recycle certain waste products for environmental benefit; monitoring of mercury in ambient surface and groundwater; tracking reported mercury emissions; and the voluntary remediation of soils contaminated with mercury from natural gas manometers.

In 2004, Louisiana Governor Kathleen Blanco announced the Louisiana Mercury Initiative as a priority of her environmental agenda. The Secretary of LDEQ, Dr. Mike D. McDaniel, announced his intent to formalize applicable agency components into a comprehensive program that would reduce the risk of exposure to mercury in Louisiana's environment. A result of that announcement is this Mercury Risk Reduction Plan, which creates a comprehensive, statewide strategy for Louisiana to achieve the goals of reduced risks to humans from mercury in the environment.

7.1 The Kickoff Meeting

On September 13, 2004, a meeting was held at LDEQ headquarters in Baton Rouge announcing the Louisiana Mercury Initiative. Mercury in the environment was discussed in a media-specific format (i.e., as it is found in air, water, and land-related releases) including general and historical discussions. Activities associated with the existing mercury program and opportunities for program enhancement were also discussed.

Attendees were invited to join any of four "discussion workgroups" to gather information needed to develop the mercury program and to provide input to establish the program's direction. These groups focused on Industrial Processes, Medical/Dental, Mercury Products/Devices, and Public Outreach.

The groups were asked to address the following questions:

- How are the products or processes involved associated with mercury?
- What has been done to manage mercury handling and releases to the environment?
- What mercury handling/environmental releases remain within each given practice or product?

The information gathered from the workgroups was used to develop a Mercury Risk Reduction Plan that could be supported by the attendees and their representative organizations.

7.2 Industrial Processes

The Industrial Processes workgroup met on five occasions and discussed the following processes:

- Chlorine Manufacturing using Mercury-cell Technology
- Power Generation through Burning of Coal
- Lumber, Pulp, and Paper Mills
- Steel Recycling
- Auto Manufacturing/Dismantling
- Oil and Gas Exploration and Production
- Crude Oil Refining
- Agricultural Practices
- Forestry Practices
- Landfills (special request appearance)
- Medical Waste Disposal (special request appearance from the Medical/Dental workgroup)

Presenters of each topic were allowed 15 to 30 minutes to discuss the topic as it related to each of the three questions the workgroups were asked to answer. Other attendees were allowed to ask questions and bring up supplemental information for the group to consider. Questions were also accepted outside of the confines of each workgroup meeting and presented at subsequent meetings for discussion. Findings of the workgroups and subsequent research were used to develop the Louisiana Mercury Risk Reduction Act sections specific or ancillary to the above listed topics.

7.3 Mercury in Products and Devices

This workgroup met six times and began by identifying mercury-containing products and devices, including both fabricated and formulated products, and the amount of mercury found in them. Efforts were made to identify products and devices that may have significant amounts of mercury but may have been overlooked in lists developed through other groups. Mercury-added products were identified as a relatively unregulated source of mercury to waste streams. Consensus was reached on the need for adequate collection of devices and support for nonmercury alternatives where feasible. Disposal options were also a significant topic, including options for enhancing collection of mercury-containing products in residential settings. Roles for state and local government to initiate enhanced collection programs were discussed and tentative approaches developed.

7.4 Medical/Dental Uses of Mercury

Five meetings were held by the Medical/Dental discussion workgroup to review and comment on uses of mercury and the mercury-handling practices by this sector. Most prominent of topics included dental amalgam, mercury-containing devices associated with health care, and waste disposal. Guidance documents previously developed by the dental and hospital associations became the focus of discussion. Much of the findings of this workgroup centered on the utility and effectiveness of these guidance documents.

7.5 Public Outreach, Education and Awareness

This group was chaired by public relations/communications personnel from LDEQ. The workgroup differed from the others in that their focus was not on mercury source identification. This group focused on processes of providing adequate information to the public on risks associated with mercury, on how to lessen those risks, and on how to promote behavioral changes that can result in: (1) mercury risk reduction, (2) reduction in amounts of mercury as waste, and (3) proper management of mercury when spilled or at end of use.

Discussions took place on providing outreach to the general public and to private and commercial interests, and techniques for dissemination of information, such as PSAs, video production, speaking engagements, flyer publication, reports, workshops, and educational curricula development.

The group decided that to make the public aware of the dangers of mercury, especially those people most likely to come in contact with it, the messages should be recurring. This group developed three flyers on three specific topics of mercury – “Guidelines for Educators,” “Guidelines for Consumers and Heat, Venting and Air Conditioning Contractors,” and “Handling Procedures for a Mercury Spill.” PSAs on the importance of fish advisories were made on radio stations targeting various demographics. Also, LDEQ produced an award-winning mercury video available on DVD or VHS for distribution to schools, libraries, and the general public. The video is also available on the LDEQ website.

7.6 Mercury Risk Reduction Plan Approach

This document reveals the findings of these multimember workgroups and subsequent research to demonstrate the problem of mercury in the environment, options to mitigate those problems and action items that can be undertaken by government, industry, and the general public to reduce risks associated with mercury. This compilation makes clear the need to address mercury contamination in all sectors and to strive to provide a path forward for a Louisiana Mercury Program that will successfully address mercury sources in Louisiana and will promote similar approaches in other states and regions. By including representatives from various public and private sectors and using their efforts in plan development, the plan represents consensus on many items that will ultimately improve and protect the health and welfare of the citizens of Louisiana and the nation.

section 8 program enhancements for risk reduction

8.1 Existing Program Components

8.1.1 Fish Tissue Data Collection/Advisory Development

Fish tissue collection and subsequent advisory development are the longest running components of the Louisiana Mercury Program. The team of LDEQ environmental scientists conducting tissue sampling has an annual goal of 100 sample collection efforts. Over 1,120 tissue-sample collection efforts have been conducted since the program's official beginnings in 1994. These efforts have resulted in over 11,000 tissue samples submitted for total mercury analysis from 565 different sample sites. The sampling is representative of 356 different water bodies in the state. To date, 41 fish consumption advisories have been issued affecting 95 different water bodies.

Periodic review of sampling protocols is important to ensure adequate quality of data. The tissue sampling team operates according to written standard operating procedures and a quality assurance project plan. Meetings among the state agencies involved in advisory development have been, and continue to be, useful in identifying potential adjustments to existing protocols. These adjustments will enhance the quality of the fish tissue dataset and its use within the risk assessment process. Fish tissue data for advisory development purposes are intended to represent fish likely to be caught and consumed by recreational fishermen. Although the tissue sampling protocol calls for collection of multiple size classes within a given species, it is possible that certain size classes may not adequately represent fish commonly caught and consumed. To ensure that the fish tissue database is adequate for its intended purpose (human health risk assessments), consideration will be given in the future to revising the sampling protocol to collect only those size classes of fishes that represent 90 percent of size classes around a mean indicated in historic LDWF creel surveys throughout the state. The sampling protocol adjustments will ensure proper representation of those fish that are commonly caught and consumed and minimize collection of data that may be skewed toward specimens that are either too small (underestimating mercury exposures to consumers) or too large (overestimating exposure). Also, periodic review of risk assessment assumptions will help ensure that the assumptions are being met and supported with the data.

Fishes are necessarily collected from a portion of a given water body to be representative of the larger geographic extent. However, the validity of a given data set to be representative must be based on adequate dispersion of collection locations across the entire water body. Random sampling is not effective; fish do not exist randomly within a water body. Rather, their distribution reflects their habitat requirements. In order that fish tissue samples will be adequately representative of a water body, future collection protocols will be adjusted to provide tissue samples over a greater geographic extent of the represented water body. Adequate tracking of the actual sample area will also enhance the understanding of what waters a given set of data represents.

At the program's inception, water bodies had to meet specific criteria to be included in fish tissue sampling efforts. The water body had to be: popular for recreational fishing, significant in size, and of water quality believed to promote mercury methylation (e.g., high organic content, low pH, low ORP, sulfur). As the number of different water bodies sampled within the state increased over time, the selection process moved to any water body of size, frequented by recreational fishermen. Eventually, the LDEQ fish collection team sampled virtually all significant fishing locations throughout the state, and resampling priorities were developed by the LDHH to augment existing data for "borderline" water bodies where more evidence was needed to determine if a fish advisory was warranted. While some levels were obviously high enough to warrant advisory development and some were obviously low enough to be excluded from consideration, a number of data sets were close enough to the LDHH "action level" of 0.5 ppm to require additional data points for clarification as to whether action levels were exceeded. Future water body selection criteria should consider that sufficient data is available for some waters, thus eliminating the need to return for re-sampling, and preserving human and monetary resources for use in areas of greatest need. This would add a level of fiscal efficiency to this component of the Mercury Program and potentially enable funding of new components as needs arise.

8.1.2 Sediment Data Collection

In addition to fish tissue collection, the LDEQ tissue sampling team collects sediment from the water bodies where fish are collected. These sediments are analyzed for total mercury, total organic carbon, sulfur, grain size, pH and ORP. In 2001 methylmercury analysis was added. Collection of this additional data point allowed a sediment sample to be described in terms of the ratio of methylmercury to total mercury, and this ratio can be used as an indicator of methylation rates in a given water body.

A review of the sediment database has demonstrated that waters with fish advisories have significantly higher ratios of methylmercury to total mercury than those waters without advisories. This information, along with supplemental data, can be used in correlating increased mercury methylation with certain parameters such as high organic content, low ORP, and availability of sulfur/sulfate to sulfur-reducing bacteria.

Sediment data have other uses as well. Systematic sampling of watersheds and comparing data on site-specific total mercury concentrations to statewide averages or concentrations of other nearby tributaries can indicate whether a given sample is abnormally high, possibly indicating a local source of mercury. This is a tool for use in discovery of unknown local mercury sources. Subsequent remediation of a source in a watershed that contains a fish consumption advisory should lead to reductions in available mercury to that food chain. The subject watershed should be monitored for corresponding reductions in mercury content of fish tissue to verify the success of this approach in reducing risks of exposure from fish consumption.

Other parameters for which sediments are sampled (e.g., sulfur, organic content) are implicated in increased methylation rates. Detections of values that indicate sources of these exacerbating substances should also be investigated for compliance and whether permitted levels are protective of the environment. It is possible that poorly functioning sanitary sewage treatment facilities may discharge sufficient levels of sulfur compounds and organic material to increase mercury methylation. Adequate treatment of sanitary sewage not only protects the water body as habitat for aquatic life, but also may have the co-benefit of reducing potential contributions to mercury methylation.

8.1.3 Alternative Biota Data Collection

The LDEQ tissue sampling team routinely collects epiphytes, if present, for analysis from areas where fishes are collected. The predominant epiphyte sampled is Spanish moss (*Tillandsia usneoides*), although a small percentage of unidentified lichens are represented in the database. Consistent use of Spanish moss supports data comparability.

Sampling of mercury in epiphytes has been useful in demonstrating that atmospheric deposition of mercury contributes to mercury loading. The current protocol for collecting epiphyte data should be amended based upon information collected from the program. Rather than collecting epiphyte data solely from areas near fish collection, epiphyte collection from strategic points around known emission sources of mercury should be considered. Inexpensive but fairly direct reading of mercury deposition relative to emission sources could be achieved, providing valuable insight into the potential near-source deposition of mercury. Identifying significant mercury deposition near emission sources can be valuable in making future regulatory decisions affecting those sources.

8.1.4 Mercury Deposition Network

Louisiana subscribed to the MDN of the NADP in 1998 and is among many states across the nation gathering and submitting wet deposition (rainwater) samples for total mercury analysis. The samples are analyzed by Frontier Geosciences in Seattle, Washington, an "ultra-clean" laboratory, to detection levels below 1 ppt. These data are compiled, managed, and made available through the MDN website http://nadp.sws.uiuc.edu/mdn/. The information has proven valuable in quantifying mercury in rainwater as a source to surface waters and allowing comparisons of data from many areas of the nation.

Additional information could be obtained from the MDN sites in Louisiana with some adjustments to sample collection protocols. Currently only wet deposition samples are collected, but dry deposition can be a significant percentage of total atmospheric deposition. In May 2006 the NADP announced its intent to co-locate dry deposition monitoring with wet deposition monitoring facilitating capture of total and dry deposition for use in predictive-model evaluation, source-receptor assessments, and spatial-temporal trend analysis. The use of dry deposition data would be of particular use in Louisiana for source identification.

Another approach to the MDN would include trace metals analyses and mercury speciation with routine analysis of wet deposition samples. This would aid in identifying the source of mercury represented by a given sample. For example, mercury emitted from coal burning is in a different form than mercury emitted from mercury-cell chlor-alkali facilities. Mercury from burned coal will contain a higher proportion of ionic, or reactive gaseous mercury, to total mercury and is associated with certain trace metals, while mercury from mercury-cell chlorine manufacturing is primarily elemental mercury without other associated metals.

Event-based wet deposition monitoring may have greater practical application than current monitoring in which samples are collected on a set schedule regardless of rainfall events. By collecting rainwater samples immediately after a significant storm event and using meteorological data to determine air shed dynamics at the time of deposition, sources within the airshed may be identified.[135]

Information derived through the MDN may not be sufficient for mercury risk reduction in Louisiana, particularly if funding must be prioritized. Funds used for MDN may be more important for other aspects of Louisiana's plan. However, MDN data have not been assessed to their full potential and further scrutiny of this growing data set will help in making future funding decisions.

8.1.5 Mercury Manometer Recovery and Remediation

Activities associated with manometer remediation have been voluntary on the part of industry. The partnership between LDEQ and volunteer companies has been successful in removing some mercury from Louisiana's environment. However, LDEQ estimates that these efforts represent only 20 percent of sites where mercury manometers were used. LDEQ will solicit voluntary involvement, but without continued cooperation, site discovery and assessment will be more difficult and expensive than voluntary, cooperative participation.

In the absence of participating volunteer companies, LDEQ may seek site discovery through inquiry to landowners. The U.S. Fish and Wildlife Service conducted surveys of newly acquired properties in Louisiana in an effort to find, assess, and, where necessary, remediate sites of contamination. Other federal and state agencies that own or lease property within the state can be encouraged to conduct such surveys with LDEQ assistance. It is likely these surveys can easily be done given the knowledge local employees would have of their respective properties.

To aid in generating the necessary information, private landowners could be reached through landowner associations and workshops.

Site discovery can also occur through sediment sampling. Systematic sampling of a watershed subject to a fish consumption advisory could lead to the discovery of elevated levels of mercury in some hydrologic pathways to the advisory area. Such data collection, coupled with information gathered from geographic information systems, natural gas well data, historic tax records and other records, may help lead to the discovery of mercury contaminated sites in need of remediation.

Remediation of sites without cooperative PRPs would require funding if legal avenues to secure funding by historic site operators are unsuccessful. Although site-specific cleanup costs are low (on average approximately $3,000 per site), the sheer number of sites believed to be subject to remediation would yield significant costs. Given the availability of funds to the Louisiana Mercury Program, the LDEQ's pursuit of manometer site remediation would be limited and necessarily prioritized. As the most significant risk to humans is from fish consumption, those sites that would likely contaminate fishable surface waters would receive a high priority. High priority would also be placed on sites in proximity to schools or other places where people, especially children, congregate.

Considering the volume of sites in Louisiana, the state needs a database to track information gathered in past and future remediation efforts. Development and implementation of a manometer database could be accomplished with a one-time purchase or through in-house means. After database implementation, resource allocations for manometer remediation activities would be reduced since manometer data in hardcopy has made research into past activities time consuming. A manometer database with proper configuration and maintenance would also assist future site discoveries through its compatibility with geographic information systems.

Mercury manometers are no longer common in the dairy industry in Louisiana, but may still exist in dairies that have ceased operation. LDEQ will establish working partnerships with the LSU Agricultural Center to ensure that such devices are discovered and recovered in a manner that will prevent release to the environment and not adversely impact current manometer owners. Tracking dairy manometers will be accomplished through the same database discussed previously for use in tracking natural gas manometers.

8.1.6 Public Outreach, Education and Awareness

Mercury awareness is an activity that requires consistent effort to be effective. Frequent reminders keep the public constantly aware of advisories, health effects, and the roles they can play in risk reduction. These reminders can take many forms.

Past practices of issuing press releases on advisories, placing advisory signs at public boat launches, and maintaining current data and information on websites should be continued, but supplemented with other forms of outreach. The Public Outreach, Education, and Awareness workgroup of the Mercury Initiative identified target audiences for which published brochures on mercury issues would be helpful. These audiences included schools, hospitals, and private homes. The brochures present "timeless" information that does not become outdated quickly, which extends the lifespan of the brochure. Additional audiences for brochures should be identified. Brochures for the audiences should be created and distributed, broadening the scope of mercury awareness.

Brochures are informative, but properly placed "giveaway" items can also provide frequent reminders to people receiving and using them. Such items have been developed, distributed and are well received as they are informative and useful. Giveaway items have included refrigerator magnets with pertinent phone numbers and websites, pencils for school children, each labeled with a Mercury Initiative slogan, and waterproof, floating storage devices handy for fishermen to store boat registrations in their watercraft. LDEQ is a frequent participant at environmental events where booths may be setup for display purposes. These prove to be effective venues for mercury awareness and information dissemination.

PSAs have been written for radio airtime. The potential for reaching large numbers of people is significant, but cost for these PSAs can be high. There have been examples of successful PSA usage by other environmental programs, such as the "Coastal Minute" created through the Louisiana Department of Natural Resources (LDNR) to promote awareness of coastal land loss. Should radio or television PSAs be used, a helpful component would be follow-up surveys targeting audiences to gauge effectiveness of information transfer. Follow-up surveys would not only gauge effectiveness of limited program funding, but also provide additional mercury awareness to those surveyed.

A video was created through the Mercury Program in 2005 to reach the high school-age public. This video represents a one-time expenditure that can be used in many venues (classrooms, libraries, conferences) and is easily reproduced for large scale dissemination. The video "Mercury Awareness: Prevention & Protection" won an American Advertising Award (ADDY) in February 2006. LDEQ recognizes the usefulness of this video in raising mercury awareness and distributes the video free of charge in DVD format. The video can also be downloaded from the following website: http://www.deq.louisiana.gov/portal/tabid/287/Default.aspx.

Ultimately, instilling public behavior changes that reduce risks and prevent pollution are goals of this Mercury Risk Reduction Plan. These changes are most likely to be effective when the issues are presented to school-aged persons. Children growing up knowing the dangers of mercury are more likely to live a lifestyle that uses what they have learned, passing on their knowledge for generations to their children and grandchildren. To accomplish this, environmental education within standard curricula is vital.

The development of educational tools for use in classrooms can have a positive impact on the future of pollution prevention and risk reduction. Such tools can include projects that demonstrate the practicality of sound environmental behaviors and the positive outcomes that result. Further, while learning about dangers of mercury, awareness of activities crucial to other aspects of environmental protection, such as waste reduction, can broaden the positive effect.

In the absence of curriculum development, promoting the opportunity to have environmental scientists speak to school-aged children can have the desired effect of increasing mercury awareness and promoting risk reduction behaviors.

8.1.7 Environmental Excellence Through Project Recognition

Another approach to promoting environmentally friendly activities in schools and businesses is through the implementation of an environmental awards program that recognizes sound efforts to address particular issues. The Louisiana Environmental Leadership Program (LaELP) is a voluntary program sponsored by professional, environmental, industrial, and municipal associations. Financial support for the program is provided by LDEQ. Supplemental support for selected activities is provided by sponsoring organizations. Any industrial facility, federal facility or parish/municipal governmental unit committed to improving the quality of Louisiana's environment through pollution prevention is eligible to join the program as a participating member. By creating additional categories for educational institutions, schools would also be eligible to participate. An environmental awards program is an inexpensive and effective method to promote and reward activities that help protect and preserve Louisiana's environment, and should be pursued. It also fosters partnerships with agencies and the public toward common goals.

8.1.8 Reporting on the Louisiana Mercury Program

Annual reports on mercury in the environment, largely technical in nature, were produced by LDEQ until 2001. These reports were discontinued in favor of a publication produced in 2003 that was written in layman's terms. Both kinds of reports had merit and were favored by interested members of the public, but the resource intensive nature of producing these reports annually became a limiting factor in their development. Future outreach efforts of the Louisiana Mercury Program should include similar reporting, but may be reduced in frequency to once every two to three years. The reports should include discussion on the trend of mercury uses and releases in Louisiana as well as progress toward reducing risks to Louisiana citizens associated with mercury.

8.2 New Components and New Program Direction

8.2.1 The Louisiana Mercury Risk Reduction Act

Senate Bill 615 of the 2006 Louisiana Legislature created the Louisiana Mercury Risk Reduction Act (The Act). The Act gave authority to LDEQ to regulate the sale, disclosure, and disposal of mercury-added products. This authority provides for control over a largely unregulated group of mercury sources, i.e., in products which are not otherwise regulated through RCRA until and unless they are a hazardous waste. The Act creates comprehensive control of mercury-added products; requires notification by a manufacturer to the LDEQ of mercury-added products; phases out mercury-added products by requiring decreased levels of mercury over a specified period of time; bans certain products dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed; requires manufacturers to provide collection plans for mercury-added products; provides for labeling of mercury-containing products and public outreach on the danger of mercury; bans certain methods of disposal; and bans certain uses of mercury. The Act will result in reduction of mercury in solid waste streams, wastewater discharges, and certain air emissions.

Notification to LDEQ of the sale of mercury-added products in Louisiana will enable LDEQ to provide this information to the public in a readily accessible manner. The public can then make an informed decision on whether to purchase the alternative product and, if not, have viable prospects for recycling. This will reduce mercury in solid waste streams and municipal landfills.

The Act requires that a reasonable effort be made to remove mercury switches and certain other mercury-containing components from end-of-life vehicles and appliances prior to crushing or shredding. Removal of these components prevents mercury releases through spillage of mercury from broken switches upon shredding or crushing and through air emissions from EAFs that melt scrap metal to recoverable forms.

Louisiana will participate in the National Vehicle Mercury Switch Removal Program, which provides monetary incentive to automobile dismantlers for capturing mercury from convenience lighting switches and anti-lock brake systems. Consistent removal of mercury from these items across the nation is expected to reduce releases by up to 75 tons over the next 15 years.[136] Based on the estimate that Louisiana end-of-life automobiles comprise 1.6 percent of the nation's total, the program can be expected to reduce mercury releases in Louisiana by 1.2 tons during the same period.

The sale of nonessential mercury-added products will be phased out in Louisiana dependent upon the amount of mercury contained in the product. By 2014, all fabricated products containing greater than 10 mg of mercury and all formulated products containing greater than 10 ppm of mercury will no longer be offered for sale, unless the manufacturer receives exemption from phase out requirements from LDEQ. Exemptions are granted with consideration given to health, safety or homeland security requirements, availability of feasible nonmercury alternatives, and availability of nonmercury alternatives at a reasonable cost. In Louisiana, after July 1, 2007, mercury-added products containing more than 10 mg of mercury will not be offered for sale, use, or distribution for promotional purposes unless the manufacturer has submitted a plan for a convenient and accessible collection system for such used products, and such a plan has received approval from LDEQ. LDEQ will promote recycling of mercury-added products to minimize contributions to solid waste streams.

8.2.2 Enhancing Air Monitoring and Control of Emissions

A comprehensive survey of potential emission sources in Louisiana is needed to determine if some sources are operating without adequate control. The survey should include a file review of known air emission sources of mercury and may require stack testing at facilities to adequately characterize mercury emissions in terms of contribution. Acceptable thresholds below which mercury emissions are not believed to be significant may be lowered as new information becomes available on mercury levels that may cause environmental harm when reached.

The LDEQ recently acquired an uncommon air monitoring technology in the form of the Mobile Air Monitoring Laboratory (MAML). Modeled after the EPA Trace Atmospheric Gas Analyzer (TAGA), the MAML is a modified recreational vehicle (motor home) equipped with a series of air analyzers which include a total mercury analyzer. Anticipated projects using the MAML include ambient air monitoring around known and suspected mercury sources to determine if existing environmental regulations are being adequately applied and are protective of the environment. Data from the MAML can be used to discern ground level ambient air concentrations of mercury in proximity to chlor-alkali facilities, coal-burning EGUs, "red mud" lakes, and other industrial sources. The enhancement of LDEQ's mercury air monitoring is essential to measure baseline mercury and progress in mercury emissions reduction.

The two most significant sources of industrial mercury emissions in Louisiana are chlorine manufacturers using mercury-cell technology. Both facilities have now announced pending conversion to membrane-cell technology, a nonmercury alternative. Using TRI data averages from 2000 to 2004, the cessation of mercury-cell technology operation will result in a reduction of 1,222 pounds of mercury annually beginning in the summer of 2007. An additional release reduction of 1,116 pounds will occur in the winter of 2008.

Once the proposed CAMR is final and implemented, mercury emissions from coal-burning EGUs will be controlled for the first time. Louisiana has chosen to participate fully in the new federal rule which employs a cap-and-trade approach to ultimately reduce mercury emissions nationwide. This is the first time a cap-and-trade approach has been used in the control of a PBT. At this time, the proposed rule is the subject of a lawsuit filed by 16 states. Should excessive delay in the implementation of CAMR occur and subsequently result in delays in reducing mercury emissions from coal-burning EGUs, Louisiana-specific legislation will be considered to ensure the state's environment is adequately protected.

An important assumption of CAMR is that significant deposition of mercury from coal-burning EGUs does not occur near the source and instead is broadly distributed before deposition. The lack of data on near source deposition relative to EGUs leaves concern as to whether "hot spots" of mercury deposition will occur without facility-specific emission control requirements. Until CAMR goes final, LDEQ will proceed with projects to gather facts on the fate and transport of mercury from Louisiana coal-burning EGU facilities to ensure that the environment is adequately protected. These projects will involve ambient air monitoring for mercury at fixed sites and use of the MAML. The projects should also incorporate aggressive direct collection of data from emission sources through stack testing which includes the speciation of mercury forms where applicable. Speciation of mercury from stacks involving combustion is important, since ionic, or reactive, gaseous mercury may deposit near source much more readily than elemental form. If future information gathering demonstrates significant near source mercury deposition from coal-burning EGUs, LDEQ may opt to develop state rules that will improve upon the environmental protectiveness of CAMR. This would be accomplished through legislation to ensure that LDEQ authorities require more stringent controls on coal-burning EGUs.

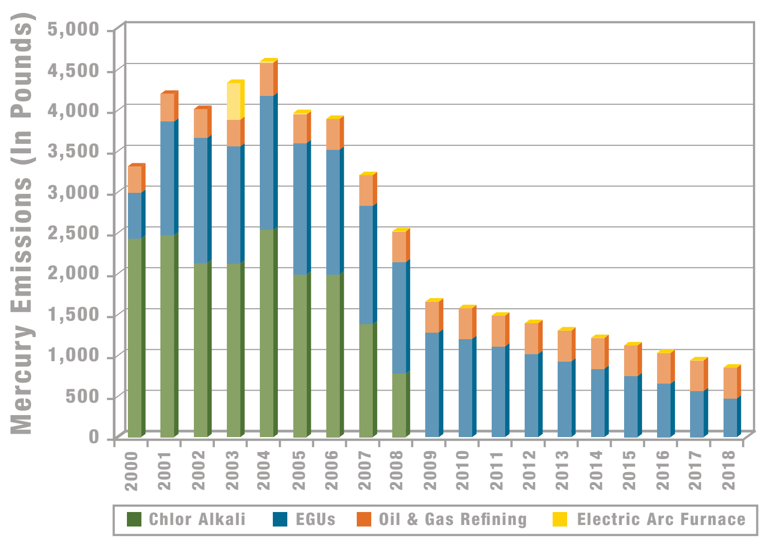


Figure 23 – Anticipated future trend of mercury releases from four significant sectors in Louisiana

Additional energy sources should be promoted that do not involve mercury releases. Nuclear technology has provided power to much of the U.S. and Louisiana for decades. Although disagreement exists on waste disposal, nuclear energy appears cost effective when compared to coal-burning technology, especially when health, social and environmental costs are considered.[137] Sound energy policies should include a variety of power sources, such as natural gas, nuclear, hydroelectric, wind, and solar. Promotion of passive solar energy practices can conserve energy consumption and reduce the total amount of coal burned to meet the electrical needs of portions of the state and nation.

Energy conservation is a staple of sound environmental policies and sustainable development. Support for energy-efficient development, perhaps in the form of statewide building codes for energy efficiency, can reduce energy consumption and, therefore, coal burning at area EGUs. Conservation of heating, cooling, lighting and other energy-related needs can have a dramatic effect of reducing overall energy consumption, thus reducing the amounts of coal burned (and mercury emitted) to support those needs. LDEQ will promote the use of energy-efficient technologies, such as low-power light sources, reuse of otherwise waste materials and "green building" designs, consistent with the EPA "Energy Star" Program.[138]

Promoting energy efficiency can also include fuel-efficient behaviors that reduce consumption of fossil fuels. Although efforts to reduce consumption of petroleum fuels would lead to decreased emissions of mercury and sulfur compounds from petroleum refining and transportation, the reductions in mercury releases in comparison to overall sources of mercury emissions would probably not be high. On the other hand, programs to encourage fuel conservation and alternative fuel options are a part of sound environmental policy and will be included among LDEQ activities.

The mercury emissions from the single EAF in Louisiana will be reduced per requirements in The Act (See Section 8.2.1), particularly by the requirements to remove and capture mercury switches in end-of-life automobiles and appliances.

As stated previously, the potential reduction of mercury released to the Louisiana environment from automobiles alone, considering automobile crushing, shredding and metal smelting, could be 1.2 tons over a 15 year period.

8.2.3 Enhancing Water Monitoring & Control of Discharges

The CWA requires the development of a TMDL strategy for water bodies found to be impaired for any number of designated uses. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards for the designated uses of that water body. The TMDL calculations allocate to each discharger an allowable amount per pollutant for release to the subject water body, with consideration given to seasonal water quality variation. Point source and nonpoint source contributions are included in the calculations as well as a margin of safety.

Because of the ubiquitous nature of mercury in the environment and in association with human activities, recognizing all contributions to a water body can be difficult. Some discharges are reasonably expected to contain mercury due to the nature of the processes involved. Others, such as sanitary sewage treatment systems, may contain mercury as a result of industrial contributions to the collection system (See Section 3.2.4.1). Operators of the treatment systems may or may not be aware of mercury from industrial collection systems. To ensure detection of all significant contributions to any water body, the LDEQ currently applies a complex decision tree to ensure that permits are issued in a manner that addresses the potential for mercury in discharges. This strategy requires "clean metals" analysis of waste water effluent, i.e., use of EPA Method 1631.

Currently, 100 surface water sub-segments are listed as impaired for mercury. Where TMDLs have been finalized, the TMDL will be implemented by requiring the development of a Mercury Minimization Plan consistent with the plan guidance provided in Mercury Minimization Program Guidance for Permits Issued Under the Louisiana Pollutant Discharge Elimination System, available at www.deq.louisiana.gov/portal/tabid/287/default.aspx. For water bodies listed as impaired, but where TMDLs are not finalized, or for water bodies that are not listed as impaired, an application to discharge will be scrutinized for the reasonable potential to discharge mercury.

The "reasonable potential" scrutiny is based on presence and/or use of mercury at the facility, contributions of mercury to the collection system, the requirement to sample for mercury in the past, size of the discharge, and other considerations. If a reasonable potential to discharge mercury does not exist, the facility will not receive mercury-related requirements in the LPDES permit. If reasonable potential exists, the facility will be required to sample the effluent using Method 1631. Should the sample results exceed 12ng/l in freshwater bodies or 25ng/l in marine water bodies, the discharge will be modeled for adverse effects outside the mixing zone. If modeling indicates adverse impacts outside the mixing zone, water quality-based effluent limitations will be included in the LPDES permit and a Mercury Minimization Plan may be required. Otherwise, the facility will not receive mercury-related requirements in the LPDES permit.[139] Figure 24 depicts the LPDES permit application process as stated above for the discovery and control of significant surface water sources of mercury.

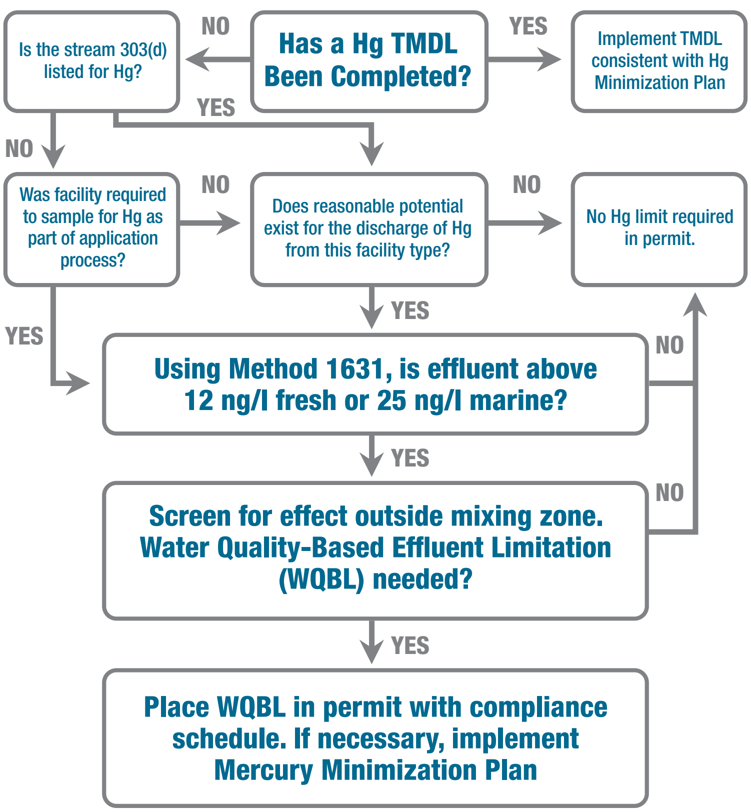


Figure 24 – Decision tree for discovery and control of mercury in LPDES discharges.

Stormwater discharges cannot be overlooked as potential sources of mercury. Facilities that handle end-of-life metallic products, such as automobiles and appliances, may contribute mercury as a pollutant in stormwater runoff as a result of leakage of mercury-containing components. The current version of the Louisiana Multi-sector General Permit (MSGP) does not authorize mercury as an allowable component in effluent for such facilities. Adjustments to the affected sector within the MSGP could result in additional requirements. These would most likely be in the form of best management practices, such as mercury switch removal prior to crushing or shredding, to ensure reductions of mercury from metal reclamation facilities. This will be consistent with the requirements of the Louisiana Mercury Risk Reduction Act.

Soil erosion to water bodies imparts mercury loading that otherwise would not occur due to the background mercury content of soil. Existing regulations and voluntary efforts at the state and local level that minimize transport of ambient soils to water bodies during rainfall events provide a direct benefit of minimizing eroded soils as a source of mercury. Compliance assurance efforts by LDEQ can contribute to the reduction of mercury in aquatic systems and should be pursued as a priority. This is consistent with EPA national priorities concerning wet weather regulation enforcement and the Louisiana Nonpoint Source Management Plan.

8.2.4 State and Local Government Participation in Mercury Reduction

The state of Louisiana and local governments can lead by example to reduce mercury by initiating an inventory of mercury-added products in state and municipal buildings coupled with plans to replace mercury-added products at end of life with nonmercury alternatives. The plans should include procedures for ensuring the proper handling of the waste products in an environmentally sound manner. This approach should result in an increase in the number of mercury-added products sent for recycling. Several large metropolitan areas have established an infrastructure, even if only for one day annually, to accept spent mercury-added products along with other household hazardous wastes.

Expanding the capacity of these programs to allow for more frequent, or even continuous, collections will make recycling easier for the general public and is critical to a recycling program's goal of pollution prevention. Given the provisions of The Louisiana Mercury Risk Reduction Act (See Section 8.2.1) relative to collection system requirements, local governments may find opportunities to partner with manufacturers of mercury-added products to provide a "convenient and accessible recovery system" for users of these products. The LDEQ will promote, as is practical, the location of collection points for mercury-added products in areas that will serve not only larger municipalities but also in the more rural portions of the state as is practical.

The Act requires state agencies to give priority and preference to the purchase of equipment, supplies, and other products that do not contain mercury-added compounds or components, unless an economically feasible non-mercury-added alternative that performs a similar function is not available. In circumstances where a non-mercury-added product is not available, preference will be given to the purchase of products that contain the least amount of mercury added to the product as necessary for the required performance. The Louisiana Division of Administration is authorized by The Act to give a price preference of up to twenty percent for products that do not contain mercury or contain less mercury than comparable mercury-containing products.

LDEQ will continue to promote the inventory and replacement of mercury-added products in schools and other places where children and child-bearing aged women (the most sensitive subpopulations) congregate. LDEQ has used nontaxpayer funds through Beneficial Environmental Projects (BEPs) to conduct this type of activity. A BEP is a project that provides environmental mitigation for which a party subject to an enforcement action is not otherwise legally required to perform, but to which the party agrees to undertake as a component of a settlement agreement stemming from an environmental violation(s) or penalty assessment.

This activity, when available, will result in the direct removal of potential exposures of mercury to sensitive populations at no cost to the taxpayers or the Mercury Program budget. Funds made available through BEPs can also be used to promote mercury-added product inventory and replacement activities in local government-owned buildings.

section 9 mercury risk reduction plan action item summary

The following action items are summarized here and may be pursued dependent upon available funding and resources. The need to modify action items may occur as additional knowledge of specific risk reduction approaches is gained. Periodic review of these approaches for inclusion or exclusion, depending upon priorities, is recommended.

9.1 Source–specific Strategies

9.1.1 Chlorine Manufacturing Using Mercury-cell Technology

The two chlorine manufacturing facilities in Louisiana that use mercury-cell technology have publicly announced they will convert to membrane-cell technology, which does not use mercury. The cessation of existing processes will take place in the summer of 2007 and the winter of 2008, respectively. LDEQ will use the MAML to conduct ambient air monitoring in proximity to the facilities, and anticipates the oversight of site closure, remediation and acceptable disposition of associated mercury.

9.1.2 Petroleum Refining and Combustion

The 13 crude oil refineries in Louisiana reported to the TRI a combined total of 402 pounds of mercury emitted in 2004 for an average emission rate of 30.9 pounds of mercury per facility. Considering that the mercury emitted is the result of background mercury levels in crude oil, attributing control strategies is difficult. LDEQ has interest in technology that can remove trace mercury from crude oil prior to refining and will review and consider those technologies as they develop. Once developed, controls at input will likely be the most cost effective method. However, the LDEQ will also consider whether current technologies for controlling air emissions (wet scrubbers, fabric filters, electrostatic precipitators, selective catalytic reduction, activated carbon injection, volatile compound burners) can be enhanced or used in series to address this mercury emission source.

Mercury releases from petroleum combustion associated with industrial manufacturing and transportation are currently best addressed through continued application of energy efficient technologies.

The development of technologies to remove mercury from crude oil would have a co-benefit of reducing mercury emissions attributable to petroleum fuel combustion, but until that technology is proven, reductions in mercury releases will be most readily realized through reductions in petroleum usage. LDEQ will support and promote energy conservation measures within industrial manufacturing and transportation sectors, which will support reductions of other emissions as well, such as sulfur dioxide, nitrogen oxides and volatile organic compounds.

9.1.3 Electric Arc Furnaces

The single EAF in Louisiana will be subject to a new federal Area Source Rule that is currently under development; however, the most practical method of controlling mercury emissions from EAFs is to reduce or eliminate mercury in the scrap metal stock obtained for smelting. The Louisiana Mercury Risk Reduction Act requires removal of mercury-containing switches prior to rendering scrap materials for metal recovery. Ensuring compliance with this requirement for all parties handling scrap metals, including the EAF facility, will be the most cost effective and successful method of reducing mercury from this source.

9.1.4 Lumber, Pulp and Paper Mills

Mercury emissions and discharges from pulp and paper mills are low in concentration because only trace amounts of mercury are found in the fuels and chemicals used; however, releases can be significant due to the large volumes of fuel and chemicals consumed in processes. Process efficiency and mercury-free (or mercury-reduced) chemicals as inputs to the processes are the most cost effective method of addressing these low mass releases. Trace amounts of mercury in scrap wood that is landfilled represent background levels that are returned to the earth, which also has background levels of mercury. Regulating the scrap wood in landfills does not represent a significant source to control. The cost effectiveness of treating pulp and paper mill effluent for mercury will be considered by LDEQ, but promoting the use of mercury-free or mercury-reduced fuels and chemicals is preferred.

Of greatest significance is the historic use of mercury to treat wood and wood products to prevent fungal decay. PMA was widely used in the industry and may still represent localized legacy sources at historic locations of lumber, pulp and paper mills. LDEQ will use record searches and ambient data collection to discern such locations and their contributions of mercury to the environment. If discovered, these locations would represent one opportunity to locate mercury in the environment and remediate down to protective levels. Discovery of significant contamination from legacy discharges will also lead to consideration of remedial opportunities.

9.1.5 Carbon Black Production

The release of mercury from carbon black facilities in Louisiana is very low, and a result of trace amounts of mercury in fuel used in their processes. Existing controls are currently believed to be the most cost effective and further control does not appear to be warranted at this time. To maintain adequate source tracking, LDEQ will ensure that mercury releases from carbon black production facilities are appropriately reported according to TRI requirements.

9.1.6 Coal-burning Electrical Generating Units

In Louisiana, with the cessation of chlorine manufacturing using mercury-cell technology, coal-burning EGUs will represent the most significant source of industrial mercury emissions. LDEQ will participate in the federal CAMR to support a consistent nationwide approach to reducing mercury emissions from coal-burning EGUs. LDEQ will use enhanced air monitoring capabilities to collect area-specific data to determine if CAMR is adequately protective of Louisiana's environment. Should data indicate that CAMR is not sufficiently protective, LDEQ will pursue legislation to apply facility-specific controls for the most technologically and cost effective reductions of mercury from coal-burning EGUs.

In addition, given the challenges from some states and nongovernmental organizations currently being heard in federal courts on the legitimacy of CAMR, should CAMR requirements be rescinded in a manner that would negate the effectiveness of the rule, LDEQ will pursue legislation to apply facility-specific controls for the most technologically and cost effective reductions of mercury from coal-burning EGUs.

9.1.7 Crematoria

At this time, LDEQ does not believe that control of these sources of mercury emissions is warranted. LDEQ will ensure that mercury emissions from crematoria are properly characterized and, if deemed necessary, will consider imposing industry practice requirements to reduce mercury emissions.

9.1.8 Municipal Waste Incineration

Incineration of municipal waste does not occur in Louisiana except for a single incinerator in southeast Louisiana serving the city of New Orleans. That facility, which burns dried sewage sludge, was rendered inoperable as a result of the 2005 hurricane season. LDEQ is presently working with the responsible entity to pursue a nonincinerating alternative for sewage sludge handling, such as beneficial reuse by treating to Class A biosolids standards. LDEQ policy is to discourage incineration of municipal waste.

9.1.9 Mercury Manometers Used in Natural Gas Production and Transmission

LDEQ recognizes the significance of the potential quantities of elemental mercury that may be in Louisiana soil and water as a result of legacy operation of manometers in natural gas transmission. LDEQ will create and utilize a database of past and future manometer remediation activities for adequate tracking. LDEQ will aggressively pursue partnerships with responsible industry members to provide for the voluntary identification and recovery of mercury manometers currently in use. Discovery of active and historic locations of manometer usage will continue using the most cost effective means available. Remediation of discovered sites will be accomplished with the cooperation of PRPs or through alternative legal avenues such as those contained within existing CERCLA/RCRA laws and regulations. LDEQ will, in consultation with LDNR, examine the feasibility of implementing a collection and replacement program for natural gas manometers, including technical and monetary assistance to operations that once contained mercury manometers.

9.1.10 Drilling Muds Used in Oil and Gas Exploration and Production

The discharge of drilling muds is prohibited within the state of Louisiana. The discharge of drilling muds in U.S. Territorial Seas beyond three miles of the Louisiana coast is allowed, but EPA regulation requires discharged mud to contain no more than 1 ppm mercury. LDEQ does not anticipate the need for further control of this source given the insoluble nature of the mercury typically found in drilling mud and given that marine fish data taken from oil and gas exploration and production facilities indicate mercury levels below those of concern for reef fishes found there.

9.1.11 Dentistry

The authority for the LDEQ to regulate handling and disposal of mercury used in dentistry was granted with the passage of Act 126 of the 2006 Louisiana Legislature. Regulations will be promulgated to require practices within the industry to capture unused dental amalgam product and waste dental amalgam removed from fillings. Additional requirements may be imposed by responsible entities of municipal waste water treatment systems that are required to implement mercury minimization plans consistent with the LPDES Program.

9.1.12 Electric Lighting

Electric lighting products that are mercury-added products according to the definition in Act 126 of the 2006 Louisiana Legislature are subject to a phase out of allowable sales in the state. Banning the sale of such products is dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed. Fluorescent lamps are exempt from phase out until July 1, 2014, at which time either the mercury content of fluorescent bulbs must not exceed 10 mg or an administrative exemption must be granted. Any electric lighting product containing more than 10 mg of mercury will be subject to a requirement of the manufacturer to provide a convenient and accessible collection system for recycling.

9.1.13 Batteries

Batteries that are mercury-added products according to the definition in Act 126 of the 2006 Louisiana Legislature are subject to a phase out of allowable sales in the state. Banning the sale of such products is dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed.

9.1.14 Laboratories

Formulated and fabricated mercury-added products, according to the definition in Act 126 of the 2006 Louisiana Legislature, which are used in laboratories, are subject to a phase out of allowable sales in the state. Banning the sale of such products is dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed. If the laboratory discharges to a municipal waste water treatment system, additional requirements may be imposed by responsible entities of municipal waste water treatment systems which are required to implement mercury minimization plans consistent with the LPDES Program. Individual waste water discharges from laboratories will be scrutinized through the LPDES Program for allowable mercury discharges.

9.1.15 Medical Facilities

Formulated and fabricated mercury-added products, according to the definition in Act 126 of the 2006 Louisiana Legislature, which are used in medical facilities, are subject to a phase out of allowable sales in the state. Banning the sale of such products is dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed. If the medical facility discharges to a municipal waste water treatment system, additional requirements may be imposed by responsible entities of municipal waste water treatment systems which are required to implement mercury minimization plans consistent with the LPDES Program. Individual waste water discharges from medical facilities will be scrutinized through the LPDES Program for allowable mercury discharges. Medical facilities are encouraged to participate in waste minimization and pollution prevention activities such as those advocated by H2E.

Incineration of medical waste will be discouraged. Currently, medical waste incinerators are not known to be operating within Louisiana. Future proposals to conduct such activities in the state will be met with the strong suggestion that consideration be given to alternatives that are less likely to result in mercury emissions.

9.1.16 Dairies

After July 1, 2007, mercury manometers will not be legally offered for sale in Louisiana. Current active use of mercury manometers in dairy operations is believed to be negligible/nonexistent. LDEQ will, in consultation with LDAF, examine the feasibility of implementing a mercury manometer collection and replacement program for dairy operations, including technical and monetary assistance to operations that once contained mercury manometers.

9.1.17 Other Mercury-added Products

Formulated and fabricated mercury-added products, according to the definition in Act 126 of the 2006 Louisiana Legislature, are subject to a phase out of allowable sales in the state. Banning the sale of such products is dependent upon the amount of mercury contained within the product and whether administrative exemptions are allowed. Industries affected by Act 126 not previously mentioned include, but are not limited to, facilities conducting photography and X-ray development activities.

9.1.18 Sanitary Sewage Treatment Systems

Waste water discharges from sanitary sewage treatment systems will be scrutinized through the LPDES Program for potential mercury discharges. When warranted, implementation of a mercury minimization plan and/or effluent limitations for mercury will be required. Act 126 of the 2006 Louisiana Legislature prohibits the installation of mercury switches or mercury-containing devices in any waste water treatment system. Effective July 1, 2009, all mercury devices must be removed from wastewater treatment systems where the installed switch may release mercury into the water if damaged, broken or otherwise malfunctions. Mercury-added devices external to wastewater systems are exempt from this provision.

9.1.19 Landfills

Implementation of the requirements of Act 126 of the 2006 Louisiana Legislature should reduce the amount of mercury-added products in solid waste streams destined for municipal landfills. LDEQ will partner with manufacturers of mercury-added products to establish convenient and accessible collection systems for as many areas of the state as is feasible to further this goal.

Industrial landfills will be scrutinized by LDEQ with enhanced air and water monitoring to ensure that certain facilities, such as "red mud lakes" and hazardous waste disposal sites, are not contributing levels of mercury emissions that are deemed unacceptable. Future permitting of these landfills will consider best available technology to ensure that mercury in waste placed there is not re-emitted to the air or lost to stormwater runoff.

9.1.20 Agriculture and Forestry Practices

Legacy uses by agriculture and forestry-related industries of fungicides and slimicides containing mercury may have resulted in broad distribution of mercury to soils, contributing to elevated "background" in certain areas. Remediation of this source of mercury is likely not feasible, but erosion control practices that keep soils out of area surface waters reduce additional mercury loading to aquatic systems. Sound management of nonpoint source discharges, consistent with the LDEQ Nonpoint Source Management Plan will be encouraged and supported.

Legacy sites where mercury-containing fungicides and slimicides were used in bulk, and where such materials were mixed, stored and potentially spilled during handling, may represent areas where localized remediation can result in direct removal of mercury from the environment. LDEQ will pursue discovery of such potential locations, and subsequent remediation, where necessary, through the most cost effective means available.

Fuels consumed by lumber, pulp and paper mills re-emit mercury in trace amounts. Existing controls on the air emissions of these facilities is believed to be sufficient at this time. Enhanced air and water monitoring will be conducted to ensure that adequate characterization of the mercury in these emissions and discharges is understood and tracked.

9.2 Enhancing Public Awareness

LDEQ will enhance mercury risk communication efforts. Many citizens are unaware of the potential health hazards from mercury exposure and sources of mercury exposure. Past practices of issuing fish consumption advisories jointly with LDHH and LDWF will be continued but reviewed periodically for effectiveness, using surveys and questionnaires. Enhancement of risk communication may include periodic review and release of new or revised pamphlets, flyers, PSAs, publications, videos, and other means of distributing information to target individuals and groups.

LDEQ will pursue mercury-specific education elements appropriate for various secondary and high school grade levels that can be delivered in classrooms. The assistance provided to science teachers will focus on "practical learning" of environmental mercury issues and will emphasize the effects that behavioral changes have on reductions of mercury handling, use and release. Assistance may include guest speakers from the Governor's Office of Environmental Education, LDEQ, LDHH or LDWF presenting material and information that can be used at school and at home to generate mercury awareness and reduce mercury pollution. Effective teaching of the nature and risks of mercury to students will enable them to practice environmentally friendly behaviors throughout their lives, helping to protect the environment now and in future generations.

New and existing information gathered through the program will be disseminated once every two years and will be presented in technical and nontechnical terms to satisfy the information needs of both technical and nontechnical members of the public. This reporting may occur in a single or in multiple documents, depending upon advice from communication/public relations staff and program participants. Periodic reviews of this Mercury Risk Reduction Plan will be conducted to provide modifications as necessary and ensure Mercury Program activities are consistent with the Governor's Initiative to reduce risk to Louisiana citizens from mercury exposure.

Adequate resources will be allocated to ensure that the LDEQ Mercury Initiative internet web site is developed, is user friendly, and is maintained to maximize information availability and transfer. All data collected through the program will be kept current and be easily accessible. Data and documents will be made available in various formats to accommodate the needs of the public.

9.3 Administrative

LDEQ will continue to jointly administer the Louisiana Mercury Program with LDHH and LDWF. Activities that are the specific responsibility of each agency will be updated and formalized in the *Protocol for Issuing Health Advisories and Bans Based on Chemical Contamination of Fish/Shellfish in Louisiana* (1996)[126] or the associated Interagency Agreement. Representatives from each agency will comprise the Louisiana Mercury Program Steering Committee and will meet periodically with stakeholders, including business and industry, academia and the general public, to solicit input and involvement, exchange information, and get feedback on mercury-related issues.

The Secretary of LDEQ is the head of the Louisiana Mercury Program and will designate one individual to administer and direct Mercury Program activities and funding. The Secretary's designee will represent LDEQ on the Louisiana Mercury Program Steering Committee and answer to the Secretary relative to programmatic activities. LDEQ will establish clear organizational lines within the various offices in the Department to ensure effective implementation of program activities. Such organizational oversight will be exercised using concepts of co-management that have been developed within LDEQ for other issues. The designee will track progress of the Mercury Program relative to this Risk Reduction Plan and interface with regulated entities affected by the provisions of Act 126 of the 2006 Louisiana Legislature.

LDEQ will support and promote energy efficiency in new and existing residential and commercial buildings and other developments to reduce consumption of electricity from coal-burning EGUs. Approaches may include promoting tax incentives for energy efficient equipment and conducting outreach to homeowners with cost saving methods that reduce energy consumption. Support for Energy Star and "green building" activities will be included in the LDEQ policy. The agency will also encourage fuel efficiency in vehicles. These are sound approaches for any environmental agency and should reap the benefits of mercury release reductions from coal-burning EGUs and crude oil refining.

The Louisiana Mercury Program will apply resources to adequately assess the large volume of mercury data generated from sampling various media. Limited scrutiny of the data indicates that trends may be demonstrable under specific parameters and criteria. Although the mercury database contains many records, site-specific characteristics make broad comparisons difficult for certain circumstances, necessitating site-specific assessments. Current data gathering does not provide for sufficient statistical degrees of freedom by site for trend determination. Adequate assessment of the existing database will lead to recommendations on data collection activities.

LDEQ will continue to gather information on sources, transport, and fate of mercury to ensure that significant sources of exposure are known and adequately understood. The fish, water, sediment, and epiphyte sampling will continue, with sampling protocols subject to modification to ensure that data collected are sufficient to address specific issues. Special monitoring projects will be undertaken with multiple objectives, e.g., source identification and identification of trends that can lead to source control or exposure reduction. Such monitoring will follow LDEQ protocols for quality control, documentation and reporting. New protocols may require development and will be formalized in Standard Operating Procedures and Quality Assurance Project Plans.

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United States Food and Drug Administration Mercury Levels in Commercial Fish and Shellfish

May 2001; Updated February 2006

Table 1. Fish and Shellfish With Highest Levels of Mercury

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
MACKEREL KING	0.730	N/A	N/A	0.230	1.670	213	GULF OF MEXICO REPORT 2000
SHARK	0.988	0.830	0.631	ND	4.540	351	FDA 1990-02
SWORDFISH	0.976	0.860	0.510	ND	3.220	618	FDA 1990-04
TILEFISH (Gulf of Mexico)	1.450	N/A	N/A	0.650	3.730	60	NMFS REPORT 1978

Table 2. Fish and Shellfish With Lower Levels of Mercury†

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
ANCHOVIES	0.043	N/A	N/A	ND	0.340	40	NMFS REPORT 1978
BUTTERFISH	0.058	N/A	N/A	ND	0.360	89	NMFS REPORT 1978
CATFISH	0.049	ND	0.084	ND	0.314	23	FDA 1990-04
CLAM *	ND	ND	ND	ND	ND	6	FDA 1990-02
COD	0.095	0.087	0.080	ND	0.420	39	FDA 1990-04
CRAB [1]	0.060	0.030	0.112	ND	0.610	63	FDA 1990-04
CRAWFISH	0.033	0.035	0.012	ND	0.051	44	FDA 2002-04
CROAKER (Atlantic)	0.072	0.073	0.036	0.013	0.148	35	FDA 1990-03
FLATFISH [2*]	0.045	0.035	0.049	ND	0.180	23	FDA 1990-04
HADDOCK (Atlantic)	0.031	0.041	0.021	ND	0.041	4	FDA 1990-02
HAKE	0.014	ND	0.021	ND	0.048	9	FDA 1990-02
HERRING	0.044	N/A	N/A	ND	0.135	38	NMFS REPORT 1978
JACKSMELT	0.108	0.060	0.115	0.040	0.500	16	FDA 1990-02
LOBSTER (Spiny)	0.09	0.14	‡	ND	0.27	9	FDA SURVEY 1990-02
MACKEREL ATLANTIC (N.Atlantic)	0.050	N/A	N/A	0.020	0.160	80	NMFS REPORT 1978
MACKEREL CHUB (Pacific)	0.088	N/A	N/A	0.030	0.190	30	NMFS REPORT 1978
MULLET	0.046	N/A	N/A	ND	0.130	191	NMFS REPORT 1978
OYSTER	0.013	ND	0.042	ND	0.250	38	FDA 1990-04

attachment 1 mercury levels in commercial fish & shellfish

Table 2. Fish and Shellfish With Lower Levels of Mercury†

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
PERCH OCEAN *	ND	ND	ND	ND	0.030	6	FDA 1990-02
POLLOCK	0.041	ND	0.106	ND	0.780	62	FDA 1990-04
SALMON (CANNED) *	ND	ND	ND	ND	ND	23	FDA 1990-02
SALMON (FRESH/FROZEN) *	0.014	ND	0.041	ND	0.190	34	FDA 1990-02
SARDINE	0.016	0.013	0.007	0.004	0.035	29	FDA 2002-04
SCALLOP	0.050	N/A	N/A	ND	0.220	66	NMFS REPORT 1978
SHAD AMERICAN	0.065	N/A	N/A	ND	0.220	59	NMFS REPORT 1978
SHRIMP *	ND	ND	ND	ND	0.050	24	FDA 1990-02
SQUID	0.070	N/A	N/A	ND	0.400	200	NMFS REPORT 1978
TILAPIA *	0.010	ND	0.023	ND	0.070	9	FDA 1990-02
TROUT (FRESHWATER)	0.072	0.025	0.143	ND	0.678	34	FDA 2002-04
TUNA (CANNED, LIGHT)	0.118	0.075	0.119	ND	0.852	347	FDA 2002-04
WHITEFISH	0.069	0.054	0.067	ND	0.310	28	FDA 2002-04
WHITING	ND	ND	‡	ND	ND	2	FDA SURVEY 1990-02

Table 3. Mercury Levels of Other Fish and Shellfish†

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
BASS (SALTWATER, BLACK, STRIPED)[3]	0.219	0.130	0.227	ND	0.960	47	FDA 1990-04
BASS CHILEAN	0.386	0.130	0.364	0.085	2.180	40	FDA 1990-04
BLUEFISH	0.337	0.303	0.127	0.139	0.634	52	FDA 2002-04
BUFFALOFISH	0.19	0.14	‡	0.05	0.43	4	FDA SURVEY 1990-02
CARP	0.14	0.14	‡	0.01	0.27	2	FDA SURVEY 1990-02
CROAKER WHITE (Pacific)	0.287	0.280	0.069	0.180	0.410	15	FDA 1990-03
GROUPER (ALL SPECIES)	0.465	0.410	0.293	0.053	1.205	43	FDA 2002-04
HALIBUT	0.252	0.200	0.233	0.050	1.520	46	FDA 1990-04
LOBSTER (NORTHERN/ AMERICAN)	0.310	N/A	N/A	ND	1.310	88	NMFS REPORT 1978

Table 3. Mercury Levels of Other Fish and Shellfish†							
SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
LOBSTER (Species unknown)	0.169	0.182	0.089	ND	0.309	16	FDA 1991-2004
MACKEREL SPANISH (Gulf of Mexico)	0.454	N/A	N/A	0.070	1.560	66	NMFS REPORT 1978
MACKEREL SPANISH (S. Atlantic)	0.182	N/A	N/A	0.050	0.730	43	NMFS REPORT 1978
MARLIN *	0.485	0.390	0.237	0.100	0.920	16	FDA 1990-02
MONKFISH	0.180	N/A	N/A	0.020	1.020	81	NMFS REPORT 1978
ORANGE ROUGHY	0.554	0.563	0.148	0.296	0.855	49	FDA 1990-04
PERCH (Freshwater)	0.14	0.15	‡	ND	0.31	5	FDA SURVEY 1990-02
SABLEFISH	0.220	N/A	N/A	ND	0.700	102	NMFS REPORT 1978
SCORPIONFISH	0.286	N/A	N/A	0.020	1.345	78	NMFS REPORT 1978
SHEEPSHEAD	0.128	N/A	N/A	0.020	0.625	59	NMFS REPORT 1978
SKATE	0.137	N/A	N/A	0.040	0.360	56	NMFS REPORT 1978
SNAPPER	0.189	0.114	0.274	ND	1.366	43	FDA 2002-04
TILEFISH (Atlantic)	0.144	0.099	0.122	0.042	0.533	32	FDA 2002-04
TUNA (CANNED, ALBACORE)	0.353	0.339	0.126	ND	0.853	399	FDA 2002-04
TUNA (FRESH/FROZEN, ALL)	0.383	0.322	0.269	ND	1.300	228	FDA 2002-04
TUNA (FRESH/FROZEN, ALBACORE)	0.357	0.355	0.152	ND	0.820	26	FDA 2002-04
TUNA (FRESH/FROZEN, BIGEYE)	0.639	0.560	0.184	0.410	1.040	13	FDA 2002-04
TUNA (FRESH/FROZEN, SKIPJACK)	0.205	N/A	0.078	0.205	0.260	2	FDA 1993
TUNA (FRESH/FROZEN, YEL-LOWFIN)	0.325	0.270	0.220	ND	1.079	87	FDA 2002-04
TUNA (FRESH/FROZEN, Species Unknown)	0.414	0.339	0.316	ND	1.300	100	FDA 1991-2004
WEAKFISH (SEA TROUT)	0.256	0.168	0.226	ND	0.744	39	FDA 2002-04

attachment 1 mercury levels in commercial fish & shellfish

Source of data: FDA 1990-2004, "National Marine Fisheries Service Survey of Trace Elements in the Fishery Resource" Report 1978, "The Occurrence of Mercury in the Fishery Resources of the Gulf of Mexico" Report 2000.

Mercury was measured as Total Mercury except for species (*) when only Methylmercury was analyzed.

ND - mercury concentration below detection level (Level of Detection (LOD)=0.01ppm)
N/A - data not available

†The following species have been removed from the tables:

- Bass (freshwater) – not commercial
- Pickerel – not commercial

‡ Standard deviation data generated for new data 2004 or later only.

[1]Includes: Blue, King, Snow
[2]Includes: Flounder, Plaice, Sole
[3]Includes: Sea Bass/ Striped Bass/ Rockfish

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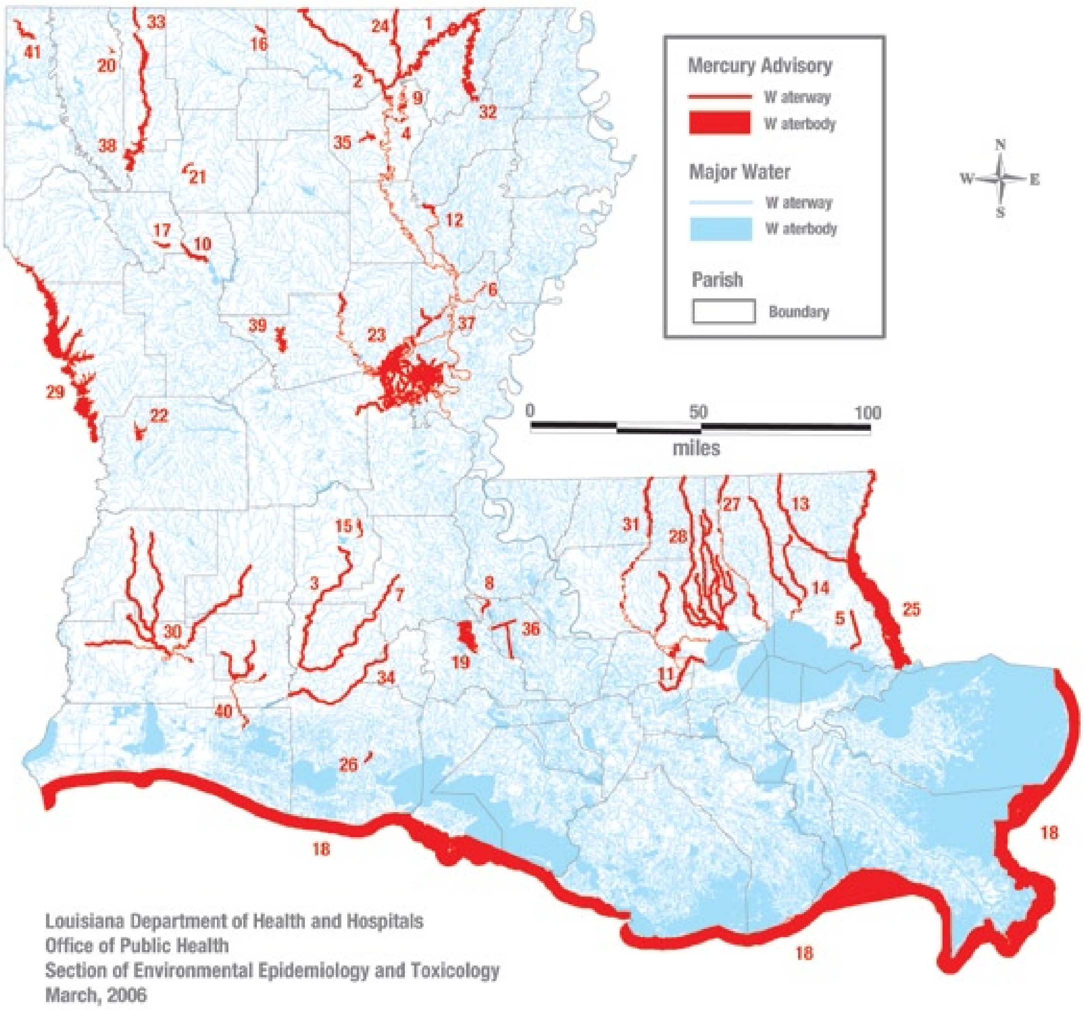
USFDA, 2006. *Mercury Levels in Commercial Fish and Shellfish*. United States Food and Drug Administration, Center for Food Safety and Applied Nutrition, College Park, MD. Available at website: http://www.cfsan.fda.gov/~frf/sea-mehg.html.

Louisiana Mercury Fish Consumption Advisories



The Louisiana Department of Health and Hospitals/Office of Public Health/
Section of Environmental Epidemiology and Toxicology (SEET) cannot guarantee the accuracy
of the information contained on this map and expressly disclaims liability for errors and omissions in its contents.

LOCATION	NUM
Amite River Drainage Basin	31
Bayou Bartholomew	1
Bayou Bonne Idee	32
Bayou Chene and Bayou Lacassine	40
Bayou De Loutre and Associated Lakes	2
Bayou des Cannes	3
Bayou DeSiard	4
Bayou Dorcheat	33
Bayou Liberty	5
Bayou Louis and Lake Louis	6
Bayou Plaquemine Brule	7
Bayou Queue De Tortue	34
Big Alabama Bayou	8
Black Bayou Lake (Caddo)	41
Black Bayou Lake (Ouachita)	9
Black Lake	10
Blind River	11
Boeuf River	12
Bogue Chitto River	13
Bogue Falaya and Tchefuncte Rivers	14
Calcasieu River Drainage Basin	30
Cheniere Lake	35
Chicot Lake	15
Corney Lake	16
Grand Bayou Reservoir	17
Gulf of Mexico	18
Henderson Lake Area	19
I-10 Canal and Work Canal	36
Iatt Lake	39
Ivan Lake	20
Kepler Creek Lake	21
Lake Bistineau	38
Lake Vernon	22
Little River/Catahoula Lake Area	23
Ouachita River	24
Pearl River	25
Seventh Ward Canal	26
Tangipahoa River	27
Tew Lake	37
Tickfaw River Drainage Basin	28
Toledo Bend Reservoir	29

notes

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