Mercury Emissions

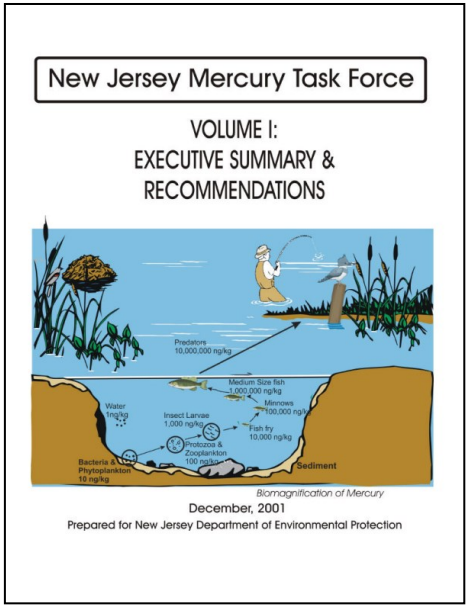
Background

Mercury is a volatile heavy metal that is toxic to humans at relatively low levels. Exposure to mercury can be due to acute and/or chronic inhalation of its toxic vapors, but more commonly comes from eating contaminated fish. Children and pregnant women are especially susceptible to health threats caused by mercury contamination, and exposure to even relatively low levels can cause permanent brain damage to the fetus, infants and young children. A small but significant fraction of the pregnant population already exhibits elevated levels of methylmercury in their system, most likely caused by eating fish contaminated with mercury. A New Jersey study found that 13% of pregnant women tested had levels above 1 ppm (detected in hair), which is considered evidence of exposure to an unsafe level of mercury.[1] In response, like every other state in the United States, New Jersey has issued consumption advisories for certain species of fish known to be contaminated with mercury.

Fish become contaminated with mercury when it is deposited directly or indirectly into the water. Once in an aquatic ecosystem, mercury can be biologically transformed into the toxic methylmercury, which in turn can be bioaccumulated by organisms in the food chain. Since they are higher on the food chain, fish can accumulate greater concentrations of methylmercury due to biomagnification (i.e., methylmercury concentrations increase up the food chain). Mercury-contaminated fish have been found in remote areas of the State, such as the Pinelands, as well as in industrialized areas (see "Fish: Concentrations of Key Contaminants" in the NJDEP Environmental Trends series). Studies have shown that under certain conditions, reducing mercury emissions can help reduce contamination in nearby aquatic ecosystems.[2,3]

Sources of mercury contamination in waterbodies include air pollution that deposits mercury directly to the water (i.e., air deposition), stormwater runoff from land surfaces (which contains mercury from air deposition and residuals from mercury-containing agricultural applications), and other direct inputs to waters such as point source discharges. Mercury falls to the land in precipitation ("wet deposition") and can be attached to particles or in a gaseous form that becomes adsorbed to land surfaces and foliage ("dry deposition").

Much of the mercury contamination in New Jersey is caused by air emissions from long-range sources (such as coal-burning power plants in China), as well as regional and local sources (such as coal-burning power plants in the central and western U.S and in-state power plants, incinerators, and industrial facilities). Elemental mercury is the predominant form of mercury emitted to the atmosphere and has an atmospheric lifetime on the order of 1-2 years, which results in long range transport and global dispersion.[4] During the atmospheric residency period, elemental mercury can be oxidized to divalent mercury. In contrast to elemental mercury, divalent mercury and mercury associated with particulate matter are more soluble and have shorter atmospheric lifetimes (days to weeks), resulting in these forms being the predominant types of mercury deposited, particularly in wet deposition and from local/regional sources.[4,5]



Mercury emission source sectors have been inventoried on global and national levels,[7,8,9] as well as on a state level (such as the emissions inventoried in the NJDEP Task Force Reports).[10] Common global sources of mercury emissions include natural events such as volcanic activity and forest fires, as well as anthropogenic activities such as gold mining, coal combustion, cement production, metal production, certain methods of chlor-alkali production, oil refining, refined fuels combustion, and waste incineration (municipal solid waste, sludge, and medical waste incineration). Other potential sources include crematoria (primarily due to mercury-containing dental amalgams), laboratory releases, improper disposal of mercury-containing light bulbs (including fluorescent and neon lights), and historic applications of some fungicides and/or insecticides. In comparing sources of mercury emissions from New Jersey with primary global sources, it is crucial to emphasize that there are a few sources that are not predominant within the State. Specifically, there is no known documentation of gold mining or cement production occurring currently in NJ. Also, the State has made efforts to limit reliance on coal combustion as an electricity source and continues to do so (see "Energy Use and Renewable Energy Sources" in the NJDEP Environmental Trends series).

The DEP has been working to better understand the impacts of mercury exposure on human health and the environment in New Jersey, and also to better quantify and control mercury emissions. These efforts began in the early 1990s with the establishment of the first Mercury Task Force, which identified municipal solid waste (MSW) incineration as a major source of mercury air emissions and recommended stringent controls. These controls were adopted by New Jersey in 1993, reducing mercury emissions from incinerators by more than 90%, and were considered a model for other states and the federal government. A second Mercury Task Force was convened in 1997 with the objectives of clarifying the impacts of mercury on the State, identifying additional significant sources of mercury contamination of New Jersey's environment, and recommending control, management, and monitoring approaches. The second Task Force developed an extensive body of information on sources of mercury, adverse impacts of mercury contamination, and various control strategies. The final reports were published in January 2002. In the years since the Task Force findings, the DEP has taken a number of steps to further reduce and understand the impacts of mercury releases to the environment, following many of the Task Force recommendations. These include:

- In March 2005, the Mercury Switch Removal Act of 2005 became effective in New Jersey.[11] This law requires automobile manufacturers to develop and fund a plan to remove mercury switches from end-of-life vehicles and requires all scrap yards and automobile dismantlers to remove mercury switches from end-of-life vehicles before sending the auto scrap metal to iron and steel mills. The mercury would otherwise be released into the air when the vehicles are melted down and recycled. Pursuant to this law, collection of mercury switches from end-of-life vehicles is now underway. Status reports of New Jersey collection efforts, as well as those of other states, are available online.[12]
- On July 14, 2006, DEP adopted new rules that require further reductions in mercury emissions from certain facilities.[13] The rules called for up to a 90% reduction of mercury emissions by 2008 from the State's 10 coal-fired boilers in power plants. The rules also required New Jersey's 5 MSW incinerator plants to reduce mercury emissions at least 95% below 1990 levels by January 3, 2012. The new rules also mandated a reduction of mercury emissions by 75% by 2010 from the State's iron and steel plants. The impacts of these efforts are illustrated in Figures 1–2 and further discussed in this report.
- On October 1, 2007, DEP adopted the Dental Amalgam rules and finalized a NJPDES Discharge to Ground Water General Permit for dental facilities that discharge to on-site septic systems. The new rules and permit were expected to significantly reduce the amount of mercury discharged to the environment.[14] The impacts of these efforts are supported by Figure 3 and further discussed in this report.
- The DEP has developed statewide Total Maximum Daily Loads (TMDLs) for watersheds that are impaired by elevated mercury concentrations. The TMDL was approved by the United States Environmental Protection Agency (EPA) on September 25, 2009 and was adopted into New Jersey's Water Quality Management Plans statewide in June 2010. The TMDL modeling indicates that to achieve TMDL targets, virtually all anthropogenic sources of mercury contamination must be eliminated. In addition, it shows that only 12.5% of the mercury contamination from air deposition originates from New Jersey sources. The TMDL document is available online.[15]
- To improve the ability to assess mercury trends in water and fish tissue, as of 2016, the DEP has implemented two key monitoring recommendations of the second Mercury Task Force. Analytical procedures to monitor mercury levels in rivers and streams were upgraded to state-of-the-art methods with detection limits adequate to detect most mercury levels in NJ waters, and fish tissue monitoring for mercury was incorporated into the State's routine water monitoring program for fresh and marine waters.

Status and Trends

The various recent actions to reduce mercury emissions at the federal and state level, especially the DEP rules noted above, have led to substantial reductions in mercury emissions from New Jersey sources. From 2005 to 2019, mercury emissions from coal-burning electricity-generating plants have decreased by 99% (see Figure 1 below). Similarly, from 1992 to 2019, there has been a 99% reduction in mercury emissions from MSW incineration (see Figure 2 below).

The reduction in emissions from the iron and steel manufacturing sector has been substantial. A portion of this reduction has been caused by the closing of four of the six plants in the state. The removal of mercury-containing switches from end-of-life automobiles through the implementation of the Mercury Switch Removal Act (as noted above) has also contributed. However, for the plants that are still in operation, the biggest portion of the reduction is due to the success of emissions control technology using activated carbon. Through the use of this method, the emissions of the historically highest mercury-emitting plant in NJ, Gerdau

Ameristeel in Sayreville, has reduced emissions by over 90% between 2005 and 2019. The other currently operating plant in New Jersey, McWane Ductile (formerly known as Atlantic States Iron Pipe) of Phillipsburg, has reduced its mercury emissions from approximately 80 pounds per year in 2005 to less than 1 pound per year in recent years.

Coal-burning electricity-generating plants have also shown significant reductions through the use of stack controls using activated carbon, reducing their overall emissions from over 500 pountds per year (lbs/year) in 2005 to less than 5 pounds per year in 2019 (see Figure 1).

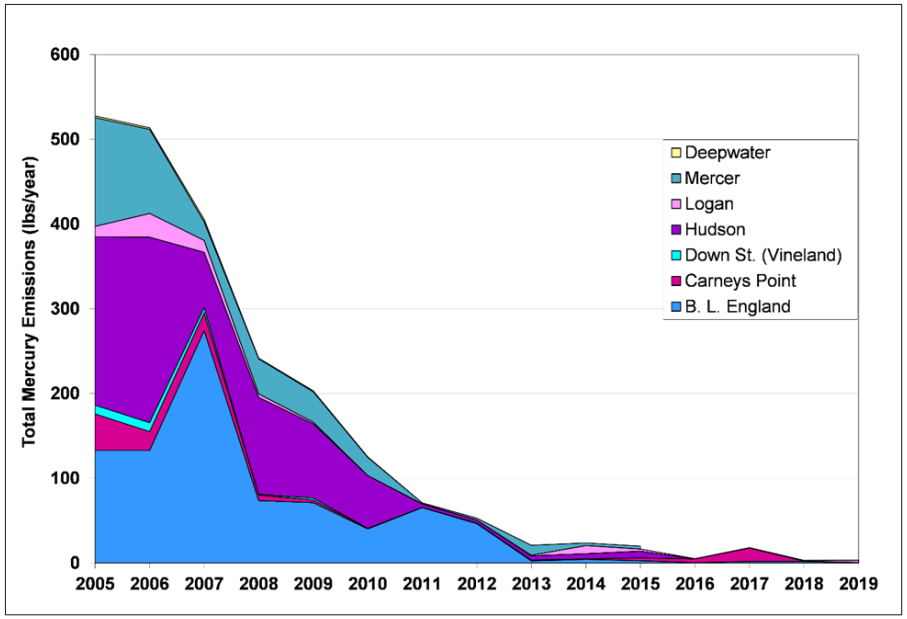


Figure 1: Annual mercury emissions from NJ coal-burning power plants (the key is divided by names of power plants).

The MSW incineration sector, which released over 4,000 pounds of mercury to the air per year in the early 1990s, achieved major reductions by the mid-1990s through the use of carbon injection emissions control, as well as through the removal of mercury from products such as dry cell batteries. This sector's total releases in 2019 were less than 52 pounds per year (see Figure 2).

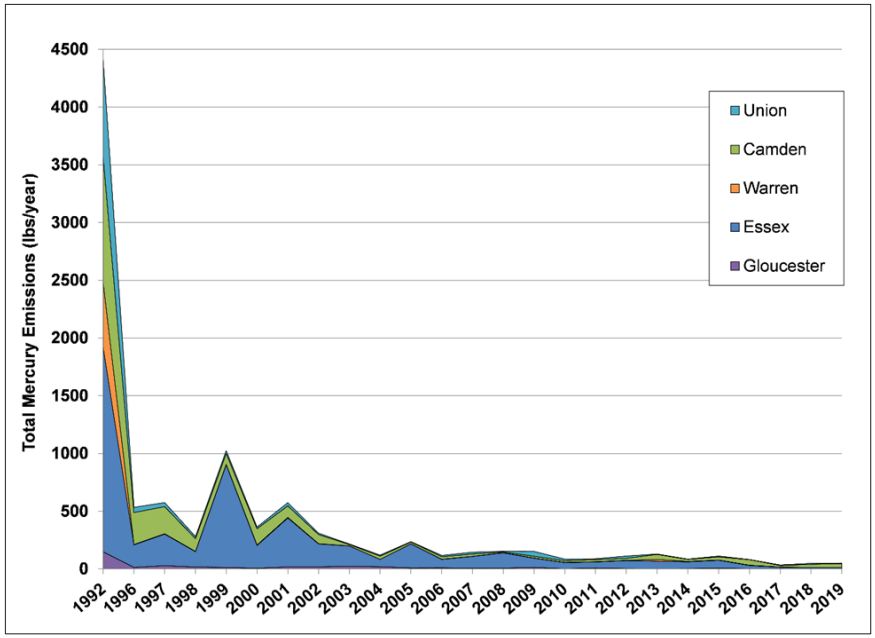


Figure 2: Mercury emissions for NJ's five county municipal waste incinerators.

As noted above, on October 1, 2007, DEP adopted the Dental Amalgam rules and finalized a NJPDES Discharge to Ground Water General Permit for dental facilities that discharge to on-site septic systems. The rules, under most circumstances, exempt a dental facility from the requirement to obtain an individual permit for its discharge to a Publicly Owned Treatment Works (POTW) if it implements best management practices (BMPs) for the handling of dental amalgam waste and properly installs and operates an amalgam separator. Dental facilities were required to implement the BMPs by October 1, 2008 and install and operate an amalgam separator by October 1, 2009.

DEP requires certain wastewater dischargers to report their effluent mercury concentrations. Ninety-three POTWs in New Jersey submitted baseline data in 2008 on mercury concentrations in their treatment plant effluent, which was followed by a period of sampling in 2011 to ascertain the initial impacts of the rule. These efforts to reduce the discharge of mercury from dental facilities resulted in decreases of about 36% in wastewater mercury effluent concentrations and 31% in sewage sludge mercury concentrations between 2008 and 2011. The

DEP continues to collect data on mercury concentrations in wastewater treatment plant sludge. Mercury concentrations in sludge from wastewater treatment plants (as measured in parts per million (ppm), dry weight) declined through 2017, before leveling out in 2018 and 2019 (see Figure 3).

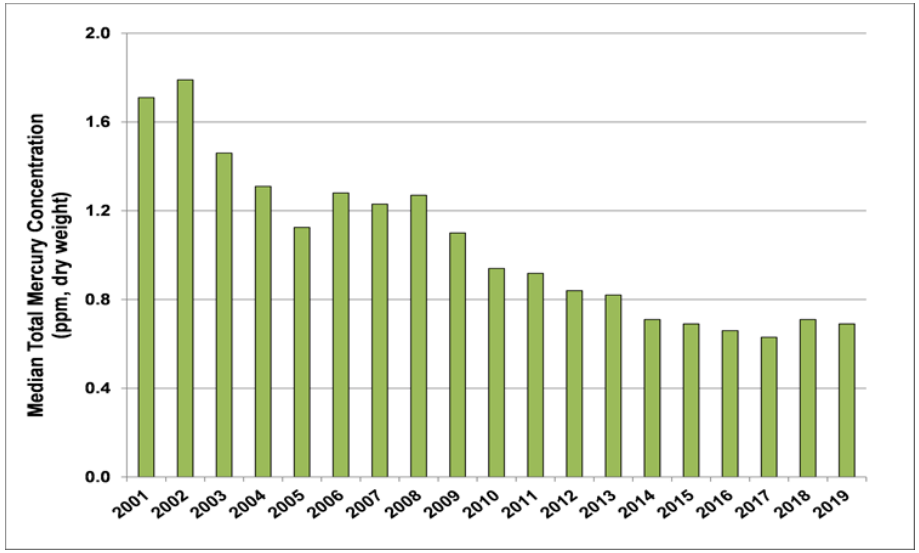


Figure 3: Median mercury content of NJ's wastewater treatment plant sludge.

Since most of the human exposure to mercury is from eating fish, it is important to estimate the contributions from primary sources of mercury contamination of waterbodies. Mercury enters the aquatic ecosystem through direct deposition from air, point source discharges of wastewater and stormwater, and indirectly from air deposition through overland flow of stormwater runoff into receiving waters. The second New Jersey Mercury Task Force reviewed data obtained through the NJ Atmospheric Deposition Network, which indicated that the mean wet deposition mercury concentration in the State was about 12 nanograms per liter (ng/L) in 2002.[17] More recent data collected by the National Mercury Deposition Network site,[18,19] show that the mercury concentration in precipitation and the total mercury deposition generally declined through 2010 and has been experiencing some fluctuations in the years since (see Figure 4). In 2017, the average mercury concentration and total mercury deposition were both higher than in the preceding and following years. This was largely based on the period of April 25 through May 2, when the concentration and deposition of mercury were recorded as 103 ng/L and 5,106 ng/m^2, respectively. These unusually high values were confirmed by the National Atmospheric Deposition Program (NADP) and consistent with values that were recorded in Pennsylvania during the same time period. The mercury emitting source that caused this spike has not been identified but could be a local intermittent source.

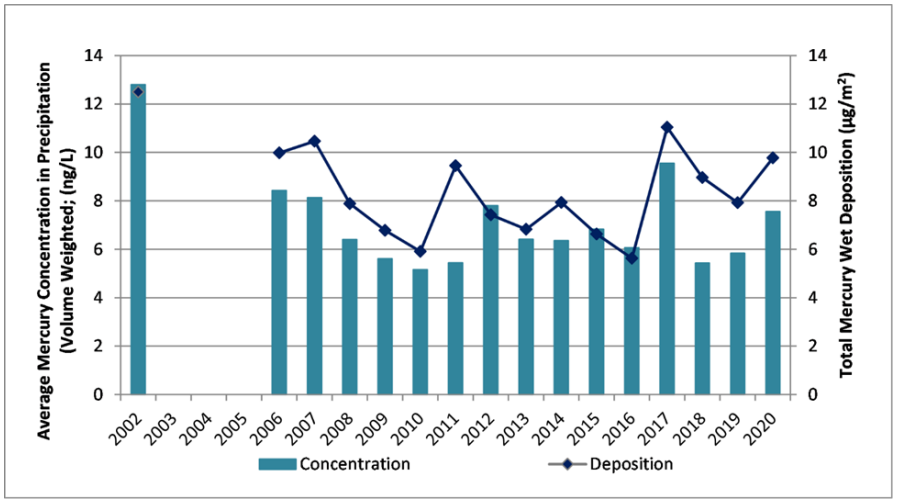


Figure 4: Mercury in wet Deposition for New Brunswick, NJ. (2002 represents 1999-2002 average; data not available for 2003-2005).

Outlook and Implications

The DEP continually evaluates sources of mercury in diverse media through permitting processes and other initiatives. The DEP also continues to utilize multi-phase monitoring (of groundwater, surface water, and air) to serve as an indicator of where the greatest potential reductions in mercury emissions can occur. The DEP expects to continue tracking mercury emissions and will continue to report levels of mercury in the environment.

With the reduction in the mercury concentrations in air emissions from coal-fired power plants and municipal waste incinerators, New Jersey has addressed some

serious local sources of mercury. However, regional and global sources continue to contribute mercury to the atmosphere, waters and lands of New Jersey. Continued monitoring will not only identify sources but will lead to a greater understanding of effects of this mercury contamination.

The DEP continues to promote awareness of the risks of mercury through fish consumption advisories and other outreach efforts, such as the "Fish Smart Eat Smart NJ" (www.FishSmartEatSmartNJ.org) educational campaign, and continues to support mercury research.

More Information

The second Mercury Task Force report finalized in 2002 and a variety of other mercury-related information is available at the DEP's mercury web site:

https://www.nj.gov/dep/dsr/mercury/

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