Industrial Waste Contamination: Past, Present, and Future

by Sandra Lizlovs

Onondaga Lake has seen many uses over the centuries, from a sacred site of the Iroquois to a recreational resource for lakeside resorts to a source of industrial activity. The advance of the industrial age caused many long-lasting impacts. This article examines some of the historical uses of the lake, the sources of industrial contamination, and the status of the cleanup of the many hazardous waste sites and subsites that adjoin the lake.

Historical Background

In the late 1800s and early 1900s, Onondaga Lake supported a thriving resort industry. The lake was viewed as a source of recreation, including swimming, boating, and fishing. The lake also had a plentiful cold-water fishery, which supported a commercial fishing industry until the late 1800s. However, from the late 1800s through the 1960s, Onondaga Lake lost its status as a recreational and fishery resource and became primarily a receptacle for both industrial and municipal wastes.

Salt springs in the vicinity of Onondaga Lake supported a major salt recovery industry throughout the 1800s and were associated with the development of railroads and the Erie Canal in the region. This infrastructure supported the growth of additional industries, including the former Allied Chemical (now Honeywell) operations, petroleum product storage, fertilizer production, a steel foundry, a vehicle accessory manufacturing facility, manufactured gas plants, and pottery and china manufacturing.

Allied Chemical Company operated manufacturing facilities in Solvay, New York, from 1881 until 1986. These facilities were known collectively as the Syracuse Works or "main plant." Manufacturing processes were based on four major product lines:

- At the main plant (two processes): soda ash and coke, benzene, toluene, xylene, and naphthalene production
- At the Willis Avenue plant: chlorinated benzenes, hydrochloric acid, and chlor-alkali products
- At the Bridge Street plant: chlor-alkali products and hydrogen peroxide

These product lines resulted in releases of a variety of contaminants including the following:

- From the soda ash process, the primary waste product was known as "Solvay waste." Solvay waste is a white, chalky, calcite-related material containing calcium carbonate, calcium silicate, magnesium hydroxide, and smaller amounts of other carbonates, sulfates, salts, and metallic oxides. Some of the metals present at elevated levels include aluminum, copper, iron, lead, zinc, and mercury.
- The primary wastes from the coking process were benzene, toluene, ethyl benzene, and xylene (BTEX), chlorinated benzenes, and polycyclic aromatic hydro-

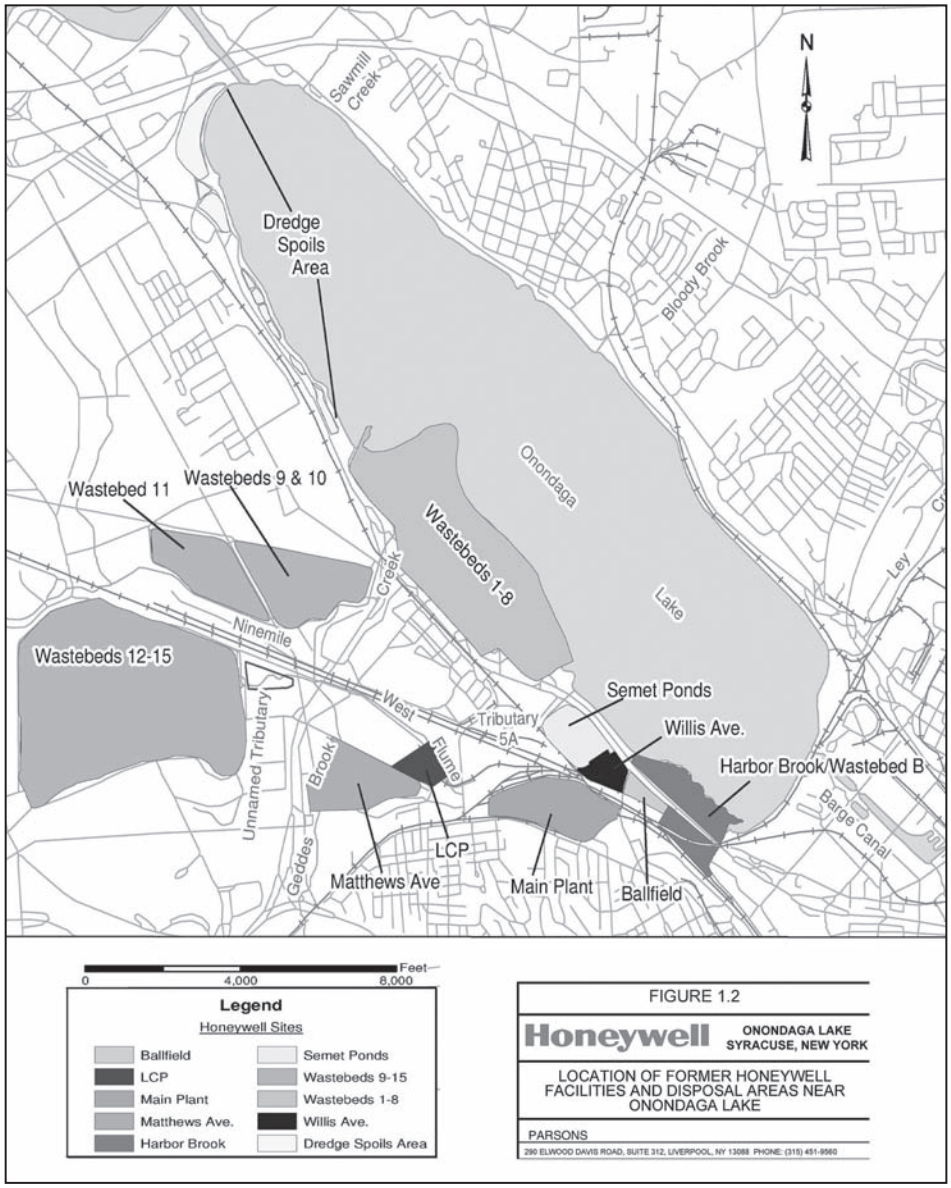

Figure 1. Map of Honeywell area

carbons (PAHs), primarily naphthalene.

- The waste products associated with the Willis Avenue chlorinated benzene process included BTEX, chlorinated benzenes, and PAHs, especially naphthalene.
- At the Bridge Street plant, chlor-alkali products, including chlorine, caustic potash, and caustic soda were produced by an electrolytic cell process. Related products such as potassium carbonate, hydrogen gas, and hydrogen peroxide were further produced, reacting chlor-alkali byproducts with other chemicals. As part of the electrolytic cell process, mercury was used as a sacrificial anode, and waste mercury subsequently was discharged into Onondaga Lake. Another waste/contaminant associated with this product line was PCB.

Former Allied Chemical Operations: Waste Management and Disposal

Waste was generated by most manufacturing processes at the Syracuse Works. Waste streams were discharged from the three plants to at least four different destinations: the Semet Residue Ponds (coke byproduct recovery only), Geddes Brook, and Nine Mile Creek (via the West Flume), the Solvay waste beds, and Onondaga Lake (via the East Flume). The Solvay waste beds are located in the towns of Camillus and Geddes, and in the City of Syracuse. From approximately 1881 to 1986, these waste beds were the primary means of disposal for the wastes produced by the Syracuse Works. Initial Solvay waste disposal practices consisted of filling low-lying land adjacent to Onondaga Lake. Later, unlined waste beds designed specifically for Solvay waste disposal were built using containment dikes constructed of native soils, Solvay waste, and cinders, or by using bulkheads made with timber along the lakeshore. Syracuse Works also had a landfill in the center of Solvay waste bed 15.

The discharge of Allied Chemical waste through the East Flume caused the formation of a large in-lake deposit from all of Allied Chemical's product lines, including Solvay waste, mercury cell waste, and chlorobenzene production waste. This deposit extends approximately 2,000 feet into the lake, approximately 4,000 feet along the lakeshore, and is up to 45 feet thick. Discharges of waste material to Geddes Brook and Nine Mile Creek through the West Flume, as well as overflows from Solvay waste beds 9 through 15, resulted in the development of waste deposits in the Nine Mile Creek delta in the lake. Seepage overflows from Solvay waste beds 1 through 8 contributed additional waste loads to the lake itself.

Two additional sites (the Mathews Avenue Landfill and the Willis Avenue Ballfield sites) were used for disposal of industrial wastes and construction and demolition debris from the Syracuse Works. A site known as the Dredge Spoils Area, located on the lakeshore northwest of the mouth of Nine Mile Creek, was used for disposal of dredged material from the Nine Mile Creek delta and nearshore areas north of Nine Mile Creek.

In 1970, the Syracuse Works' main plant ceased production of benzene, toluene, xylene, and naphthalene. Furthermore, releases of mercury from the Willis Avenue plant and the Bridge Street plant were reduced. In 1977, when the Willis Avenue plant closed, the production of chlorinated benzenes and chlor-alkali products at the plant ceased. In 1979, the Bridge Street plant was sold to Linden Chemicals and Plastics (LCP), which operated the plant until it closed in 1988. In 1986, the main plant ceased production of soda ash and related products, marking the end of manufacturing at the Syracuse Works.

Current loads of contaminants to the lake are primarily derived from residuals associated with Allied Chemical sites, with tributaries

and groundwater delivering much of the contamination. Dense non-aqueous-phase liquid (DNAPL) plumes at the Willis Avenue and waste bed B/Harbor Brook sites convey pollutants to the lake. While other parties have contributed to the wastes in the lake, empirical evidence for the Allied Chemical contributions can be found in the water, sediment, and biota of the lake and in the sediment of selected wetlands, indicating the dominance of these sources to historical and current lake contamination.

Onondaga Lake Clean-Up Projects: Sites and Status

The lake is a sink for essentially all contaminants. Some of the contaminants of concern due to industrial activity include the following:

- mercury and methylmercury
- low molecular weight organics such as benzene, toluene, ethyl benzene, xylene, chlorinated benzenes
- high molecular weight organics, such as naphthalene, anthracene, and PCBs

These contaminants are present at elevated levels at various locations in the lake sediments, reflecting their resistance to biodegradation as well as the extended period of discharge to the lake by Honeywell and other sources.

Several of the various subsites are shown in figure 1. The current status of some of these subsites and ancillary projects is summarized below. Several of the sites discussed in this article are being investigated to determine the appropriate way to remediate them. At the conclusion of the investigation for a given site, the New York State Department of Environmental Conservation (NYSDEC) will release a proposed clean-up plan for public comment. The NYSDEC Division of Environmental Remediation's Onondaga Lake Unit may be contacted for further information.

Onondaga Lake Bottom: Pollutants of Onondaga Lake include mercury, chlorinated benzenes, naphthalene, PCBs, and various metals including cadmium, chromium, and lead. The November 2004 Onondaga Lake Proposed Plan recommended remediation activities including dredging of as much as an estimated 2,653,000 cubic yards of sediment from the lake, the use of isolation capping over an estimated 425 acres of the lake bottom, and the construction of a thin layer cap over an estimated 154 acres of the lake bottom. The majority of the dredged material will be disposed of within a sediment containment area to be located near Onondaga Lake, and the water from the dredge spoils will be treated for mercury and other contaminants.

An in-lake aeration demonstration project has also been proposed as part of the Proposed Plan. Oxygenation of the lake's hypolimnion is expected to reduce the methylization of mercury in the water column. NYSDEC expects that the oxygenation project, together with removal and capping of sediments and remediation of upland sites, will eventually reduce the levels of mercury in fish flesh.

At the time of writing this article, the public comment periods on the project ended, and the NYSDEC is preparing a responsiveness summary to the comments as well as a Record of Decision.

West Flume/LCP Bridge Street: Since the mid-1800s industrial processes included manufacturing salt, ammonia, caustic soda, and chlorine gas using the mercury cell process. Between 1972 and 1975, two lined surface impoundments were constructed. These impoundments were used to settle suspended matter and mercury from process wastewaters and equalize the wastewater discharged to the chlor-alkali facility's wastewater treatment plant. Treated wastewater was subsequently discharged to the West Flume. The major contaminant in this site is mercury, with maximum concentrations of elemental mercury up to 11,500 milligrams per kilogram (mg/kg) found in the soil. Volatile organics such as xylene are also present.

In 2000–2001 the plant buildings were demolished and the mercury from the mercury cell building was removed. In 2004 the final cleanup began with excavation of approximately 4,500 cubic yards of contaminated soil from the area of the former mercury cell building. The mercury is being washed from the soils, and the soil will eventually be disposed of at the LCP site. Figure 2 illustrates how much free mercury is present in the soil at the site. Additional work will include excavation of approximately 19,000 cubic yards of sediment from the West Flume, excavation of approximately 31,000 cubic yards of sediment from two nearby wetlands, and excavation of approximately 3,200 cubic yards of brine mud. The soils will be disposed of in an 18.5-acre on-site capped landfill. A cut-off wall will be installed around the entire site to prevent groundwater from migrating off-site. Groundwater pumping and monitoring wells will also be installed.

Geddes Brook and Nine Mile Creek: Nine Mile Creek has been and continues to be the single largest external source for total mercury. It has also been a source of other contaminants to the lake.

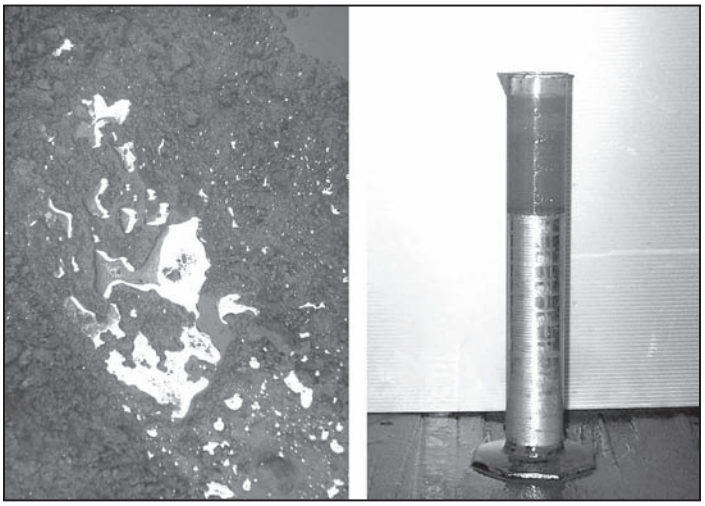

Photo credit: Honeywell construction photograph, Parsons 2004

Figure 2. Clay under the mercury cell building at the former Linden Chemicals and Plastics facility in Solvay, New York, before the removal of 6,000 tons of mercury-contaminated soil. To date, 400 pounds of mercury have been recovered from the soil washing treatment process.

An evaluation of alternatives for remediating channel and floodplain soils is under way through the Remedial Investigation and Feasibility Study (RI/FS) for Geddes Brook and Nine Mile Creek. The remediation of both streams and associated floodplains, in conjunction with remediation of the LCP Bridge Street subsite, is expected to result in a significant reduction of loadings of mercury and other contaminants to Onondaga Lake. In July 2002, Honeywell entered into an administrative consent order with NYSDEC whereby it committed to perform Interim Remedial Measures (IRMs) for Geddes Brook. The IRMs will include removal of all sediments down to the underlying clay layer in the reach of the brook from the West Flume to the confluence with Nine Mile Creek. Impacted soils and sediments within the floodplain along lower Geddes Brook will also be remediated. IRM design is under way.

Willis Avenue Groundwater Treatment Plant: A wastewater treatment plant will be built during 2005 for treatment of contaminated groundwater from various sites and liquid waste from the Semet

Ponds. The plant will treat groundwater collected in an approximately one-mile-long trench along the shore of Onondaga Lake.

Photo credit: NYSDEC

Figure 3. Beginning construction of the Willis Avenue groundwater treatment plant

The treatment plant will be designed to accept a wide variety of waste streams, which will require treatment over the next several years. Pollutants that must be treated include metals such as lead, iron, and mercury, as well as BTEX, chlorinated organics (chlorobenzene, dichlorobenzene), and polycyclic aromatic hydrocarbons (PAHs) such as naphthalene and anthracene. As a result, the plant will contain metals precipitation, filtration, air stripping operations, and activated carbon. Water flow rates will vary considerably, so the design will be flexible enough that treatment units can be added and removed as necessary. Some of the anticipated sources of contaminated water are described below:

- **Waste Bed B/Harbor Brook:** In November 2003, Honeywell entered into an administrative consent order with the NYSDEC whereby it committed to implement an IRM for the waste bed B/Harbor Brook subsite. The project consists of construction of a hydraulic containment system along the shoreline from the Willis Avenue site to Harbor Brook and along the lower portion of Harbor Brook. The project is intended to isolate and collect contaminants including mercury, chlorinated benzenes, BTEX, naphthalene, and other PAHs, and nonaqueous phase liquids (NAPLs) from groundwater before they enter Onondaga Lake and Harbor Brook. A similar project is under way to collect groundwater from the Semet/Willis site.
- **East Flume:** The East Flume sediments contain metals, chlorinated benzenes, and PAHs. The IRM for the East Flume includes the excavation of approximately 19,000 cubic yards of sediment from within the upper and lower East Flume, the abandonment of an existing 72-inch concrete pipe that discharges to the upper East Flume, and the extension of an existing 60-inch concrete pipe into Onondaga Lake.
- **Semet Ponds:** The Semet Ponds cover approximately 20 acres and were used for disposal of tarlike waste materials. Honeywell is currently pursuing a Beneficial Use Determination (BUD) for the Semet Pond material, which could result in this waste material being reused. The plant will treat wastewater associated with remedial activities at this site.
- **LCP Bridge Street:** The groundwater extracted from within the onsite cutoff wall/cap system is scheduled to be sent to the Willis Avenue treatment plant.

Waste Beds

One of the most easily seen sources of contamination to the lake are the hundreds of acres of Solvay waste material located in the Towns of Geddes and Camillus. The beds average 50 feet in height and are unlined. Hundreds of drainage pipes are located within these beds. As the waste material disposed of in the beds was a liquid that was pumped over from the manufacturing facilities, these pipes were used to dewater the material. These pipes still exist, allowing leachate and contaminants to flow out of the beds and into the lake and its tributaries. The beds are discussed below:

- **Waste Beds 1–8:** Waste beds 1–8 extend along Onondaga Lake for approximately one-and-a-half miles. They have a surface area of 315 acres and rise over 50 feet in some locations. The beds were in use from at least 1926 until 1944 when a dike failed, flooding the local area. Leachate from the beds continues to seep into Onondaga Lake. The leachate itself is very high in chlorides. Some samples taken from the leachate show 7,900 milligrams per liter (mg/l) of chlorides as opposed to fresh water chloride levels, which are less than 50 mg/l. Other contaminants found in the leachate are BTEX, phenol, and naphthalene. An additional concern is the direct erosion of this waste material into the lake. The high chloride content as well as the erosion of material leads to formation of oncolites in the lake bottom. Oncolites are small calcium carbonate spheroids that form in highly saline waters. Much of the nearshore sediment in Onondaga Lake is covered with oncolites, limiting the growth of aquatic plants. These beds are currently being sampled and evaluated.
- **Waste Beds 9–11:** Waste beds 9–11 cover approximately 73.5 acres and contain over 14 million cubic yards of Solvay waste material. The beds were active from 1944 until 1968. In addition to Solvay waste, the beds received brine purification wastes, boiler bottoms, and fly ash. Leachate from these beds is very high in chlorides, and solids have precipitated into Nine Mile Creek. Over the years, the beds have developed natural vegetation. Recently, due to flooding of nearby properties with leachate, Honeywell constructed a pumping system to pump stormwater contaminated with leachate underneath Nine Mile Creek to a storage lagoon at waste beds 12–15. From there, the leachate is pumped to Onondaga County's Metro plant for treatment.
- **Waste Beds 12–15:** These beds cover 536.3 acres of land and have an average waste depth of 55 feet. The beds were in use from approximately 1951 until Allied Chemical closed in 1986. Bed 15 is now operated as a construction and demolition landfill. Leachate from the beds is very high in chlorides, with an average concentration of approximately 8,100 mg/l, and a typical pH of approximately 11 to 12 SU. Other contaminants such as calcium, benzene, dichlorobenzene, and phenols, have also been detected. Leachate from these beds is presently collected and pumped to Onondaga County's Metro sewage treatment plant. Several projects are planned for these beds. According to the Onondaga Lake Proposed Plan, bed 13 as well as other waste beds will be evaluated as potential sites for the construction of sediment containment areas. Further, Honeywell, together with the State University of New York College of Environmental Science and Forestry, is using the waste beds to pilot a biofuel project using willow trees.

Non-Allied Chemical Sites

The area surrounding Onondaga Lake was historically heavily industrialized, including such diverse uses as oil storage tanks, scrap

yards, landfills, and manufacturing. A few of the sites are discussed below to show what is being accomplished.

General Motors Inland Fisher Guide Subsite

The former General Motors Inland Fisher Guide (GM-IFG) facility that manufactured various automotive components, most recently plastic moldings, also contributed pollutant loadings to the Onondaga Lake drainage basin. Remediation work is well under way. Confirmed hazardous wastes at this subsite include PCBs, solvents, copper, nickel, and chromium. Wastes from the plant were formerly discharged to Ley Creek, a tributary of Onondaga Lake.

At the GM-IFG subsite, three significant projects have been performed to prevent offsite migration of PCBs into Ley Creek. An on-site industrial landfill, which contained chromium- and PCB-contaminated material, has been capped. Second, over 26,000 tons of soil containing hazardous waste levels of PCBs have been removed from the site. The third significant project, completed in 2003, was the construction of a retention basin and associated water treatment system. The treatment system collects all water that accumulates on-site in any of the storm sewers or groundwater recovery wells. The water is then treated using multimedia sand filtration and granular activated carbon filtration to meet permitted discharge limits prior to discharge to Ley Creek. The purpose of this project was to stop the intermittent discharge of PCBs and other contaminants.

General Motors Ley Creek Dredgings Subsite

GM's Ley Creek dredgings subsite includes areas along the banks of Ley Creek where PCB-contaminated dredge spoils removed from the creek were placed. An RI/FS was completed by GM for the site, and a Record of Decision (ROD) was issued by NYSDEC in March 1997. A 4,000-foot stretch of the stream bank containing the dredged spoi ls has been remediated. Activities included the excavation and off-site disposal of PCB-contaminated sediments exceeding 50 parts per million and site capping.

Town of Salina Landfill Subsite

The Town of Salina landfill subsite, which borders Ley Creek, received domestic, commercial, and industrial wastes from the 1950s to the 1970s. An RI/FS was completed by the Town of Salina and a Proposed Plan was issued by NYSDEC in January 2003. It is anticipated that a ROD will be issued in 2005. The proposed remedy includes construction of a multilayer cap over the landfill areas north and south of the creek and construction of a groundwater and leachate collection trench north and south of the creek.

Additional sites in the vicinity of Onondaga Lake that are being addressed by various parties are in various stages of investigation or remediation but are not discussed here. Information regarding these sites is provided in the Onondaga Lake Remedial Investigation Report.

Conclusion

Decades of pollution have resulted in severe problems in Onondaga Lake and its tributaries. Demonstrable progress is being made to remediate the causes and results of this contamination. Over the next several years, work will continue, resulting in Onondaga Lake once again becoming a valuable resource for central New York.

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Sandra Lizlovs, PE, is an engineer at the NYSDEC's Region 7 office in Syracuse. She can be reached at smlizlov@ gw.dec.state.ny.us.

Photo credit: NYSDEC

Figure 4. Allied Chemical waste beds lining the shore of Onondaga Lake