The State of Onondaga Lake 2010

Onondaga Lake's Remarkable Progress

- Onondaga Lake is exhibiting a remarkable recovery and significant water quality improvements have been documented. Phosphorus, ammonia, and other major pollutants in the lake have decreased substantially.
- Phosphorus discharges to Onondaga Lake from the sewage treatment plant were reduced by approximately 86 percent between 1993 and 2009. Phosphorus levels in the upper waters are in the best condition in over 100 years.
- Chloride concentrations have decreased from 1,800 milligrams per liter in 1985 to 450 milligrams per liter in 2009. Lower levels benefit the lake by improving plant and animal diversity and habitat.
- Remediation projects were successful in reducing Tully Valley mudboil sediment loading to Onondaga Creek over the past 15 years, however the future of these efforts is uncertain.
- The Onondaga Lake watershed covers 285 square miles (738 square kilometers). Most of the land bordering the lake is parkland owned by Onondaga County. Over 1.3 million people visited Onondaga Lake Park in 2009 to enjoy recreational opportunities such as hiking, biking, fishing, boating, picnicking, and bird watching.
- Onondaga Lake fisheries are improving more quickly than anticipated and over 65 fish species have been documented in the lake. This is an impressive increase from the 9 to 12 species that were recorded in the lake during the 1970s.
- The Bassmasters Majors Tournament, involving the world's top 52 anglers, was held at Onondaga Lake in 2007, attracting bass fishermen from around the world.
- National sporting competitions and professional fishing events are scheduled each year, and local anglers use the lake on the regular basis during the summer months. In 2008, the North American Fishing Club named Onondaga Lake one of the top ten bass fishing destinations in the United States.

- Plant and animal diversity in and around the lake is exhibiting remarkable improvement. With the recent improvements in Onondaga Lake water quality, a nearly four-fold increase in aquatic plant cover was documented from 2000 to 2009. Plants provide valuable spawning and nursery habitat for the fish community.
- Bird diversity in and around the lake is exhibiting impressive changes, highlighted by sightings of bald eagles, great egrets, osprey, kingfishers, and numerous species of waterfowl.
- Successful remediation projects have reduced Tully Valley mudboil sediment loading to Onondaga Creek from an average of 30 tons (about three large dump trucks) per day to less than one ton (about a pick-up truck load) per day on average over the past 15 years.
- An underground barrier wall located on the western shoreline of Onondaga Lake diverts polluted groundwater to a state of the art treatment plant instead of flowing directly into the lake.

Federal, State, and local agencies, non-profit organizations, and citizen groups are working together to improve conditions in Onondaga Lake and its watershed. Additional information about the accomplishments of the Onondaga Lake Partnership (OLP) can be found at the following website: www.onlakepartners.org.

The State of Onondaga Lake
2010

Onondaga Lake Partnership

PRODUCED BY

The Central New York Regional Planning & Development Board
126 North Salina Street, Suite 200
Syracuse, NY 13202

WITH SUPPORT FROM THE ONONDAGA LAKE PARTNERSHIP

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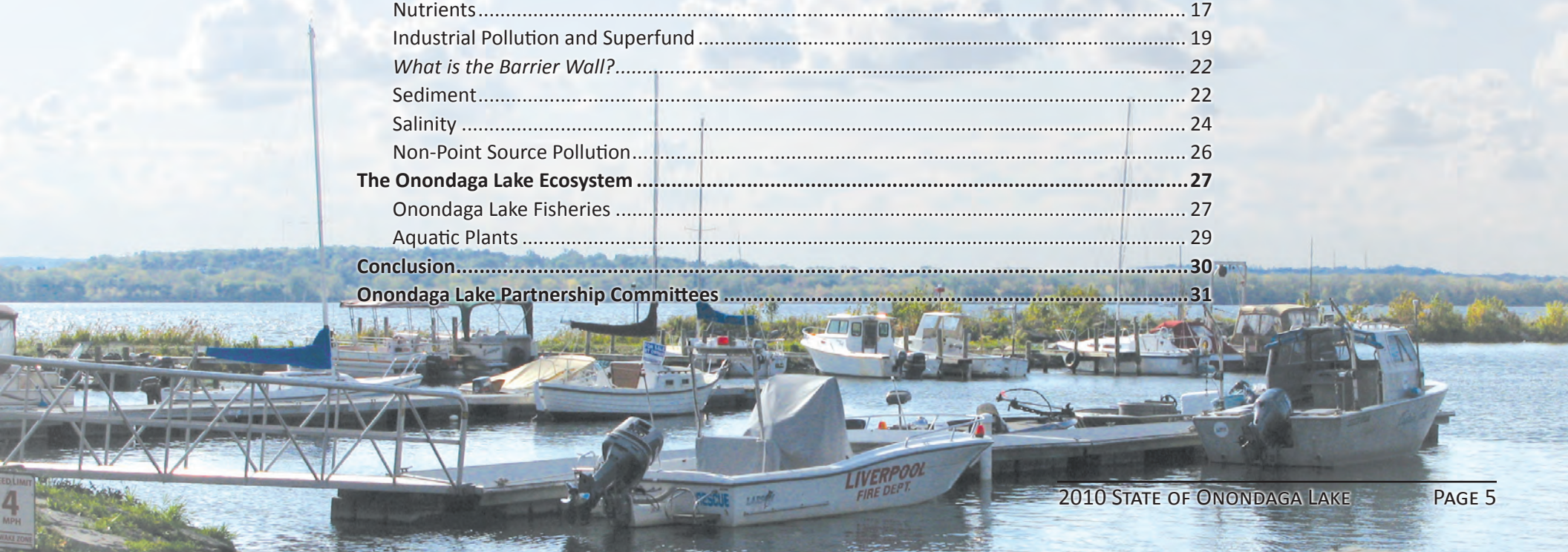
This report was reviewed by the individual members of the Onondaga Lake Partnership (OLP) and approved for release to the public for purposes of providing general overview information. Approval for release does not signify adoption or approval for purposes of regulatory, enforcement or other legal actions, of the factual, scientific or other assertions, characterizations or conclusions contained herein. Funding for this report was provided by the U.S. Army Corps of Engineers, Buffalo District in cooperation with the OLP, and included American Recovery and Reinvestment Act (ARRA) funds.

The report was adapted from: "*The State of Onondaga Lake, 2001*" (2nd ed), 1993 (1st ed), Onondaga Environmental Institute (formerly the Onondaga Lake Cleanup Corp)

Fish illustrations are provided by Peter Thompson.

Contents



Introduction

After many years of scientific research and restoration projects, Onondaga Lake is the cleanest it has been in over one hundred years and we are witnessing an extraordinary resurgence of this valuable local resource. Monitoring results are very encouraging and show that the lake is now supporting productive biological communities of plants and animals. Improvements in municipal wastewater treatment have contributed to decreases in nutrient concentrations, algal growth, and bacteria levels. Increases in the lake's dissolved oxygen levels and improved water clarity have resulted in greater fish species diversity and a renewed public interest in the lake as a valuable community resource. In addition to in-lake restoration initiatives, projects throughout the 285-square mile watershed are reducing sediment, nutrients, and other pollution runoff that enters the lake from industrial wastebeds, the Tully Valley mudboils, urban areas, and farmland. Based on these noteworthy improvements, Onondaga Lake now resembles other

What is the Onondaga Lake Partnership?

The Onondaga Lake Partnership (OLP) was authorized by an Act of Congress in Section 573 of the Water Resources Development Act of 1999. The Partnership and its Executive Committee are composed of six local, State, and Federal agencies: the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), New York State Department of Environmental Conservation (NYSDEC), New York State Attorney General's Office, Onondaga County, and City of Syracuse. Under the leadership of the USACE, the OLP Project and Outreach Committees work with representatives from the six Partnership agencies, other State and Federal agencies, and community interest groups. With the cooperative efforts of this diverse group of stakeholders, the OLP coordinates the environmental revitalization, conservation, and management of Onondaga Lake. The OLP is tasked with developing and implementing projects consistent with the Onondaga Lake Management Plan (OLMP) including implementation of the Amended Consent Judgment (ACJ) and the approved remedies for the Onondaga Lake Superfund process.

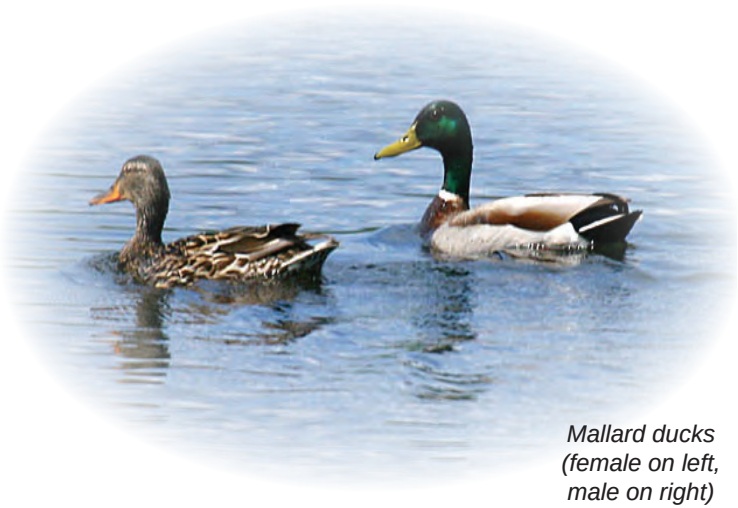
Through the OLP, millions of dollars have been invested in efforts to revitalize Onondaga Lake. Since the signing of the court-approved ACJ in 1998, over $140 million in Federal funds, along with approximately $135 million from New York State, have been secured specifically for Onondaga Lake. Onondaga County has paid the local share on all County projects and a substantial portion of the local share of other OLP projects.

similarly sized lakes in the region with respect to fish and plant abundance and diversity, and summertime water clarity.

The ongoing revitalization of Onondaga Lake has exceeded the expectations of many, but there is still work to be done. Under the leadership of the OLP, a comprehensive plan for the remediation of Onondaga Lake has been developed using a combination of well-established and innovative technologies. Unique partnerships between Federal, State, and local organizations, private corporations, residents, and lake users will ensure this vital resource continues to improve for years to come.

The 2010 State of Onondaga Lake Report documents the remarkable progress achieved in lake revitalization by the OLP. The report provides a concise summary of current lake conditions, the environmental setting, primary pollution issues, and progress made in reaching water quality goals.

Continued improvements in water quality and shoreline habitat are boosting the local economy while providing recreational opportunities for local and out of town visitors. In addition to the OLP, there are many agencies, organizations, schools, and individuals that are taking an active role in the lake's recovery. Building on these notable accomplishments, the OLP's long-term remediation goals for Onondaga Lake are clearly within reach.



Mallard ducks (female on left, male on right)

What is a Watershed?

A watershed refers to all the land that drains into a given body of water. The Onondaga Lake watershed covers 285 square miles (738 square kilometers) and encompasses portions of two counties (Onondaga and a small area in Cortland), the City of Syracuse, 18 towns, 6 villages, and the Onondaga Nation territory. Surface and groundwater from precipitation and snowmelt throughout this entire area drain into Onondaga Lake and influence water quality, aquatic ecology, and recreational opportunities such as fishing and boating. Land use activities within a watershed (such as development or agriculture) can produce pollutants that flow down the tributaries and into the waterbody. Efforts to protect and restore Onondaga Lake must therefore involve activities throughout the watershed, not just in the lake itself.

Figure 1. The Onondaga Lake Watershed

The Environmental Setting

Onondaga Lake is located along the northern border of the City of Syracuse in Onondaga County. The lake covers 4.6 square miles (11.9 square kilometers), has an average depth of 35 feet (10.6 meters) and a maximum depth of 63 feet (19.2 meters.) It is approximately one mile (1.6 kilometers) wide and 4.6 miles (7.4 kilometers) long.

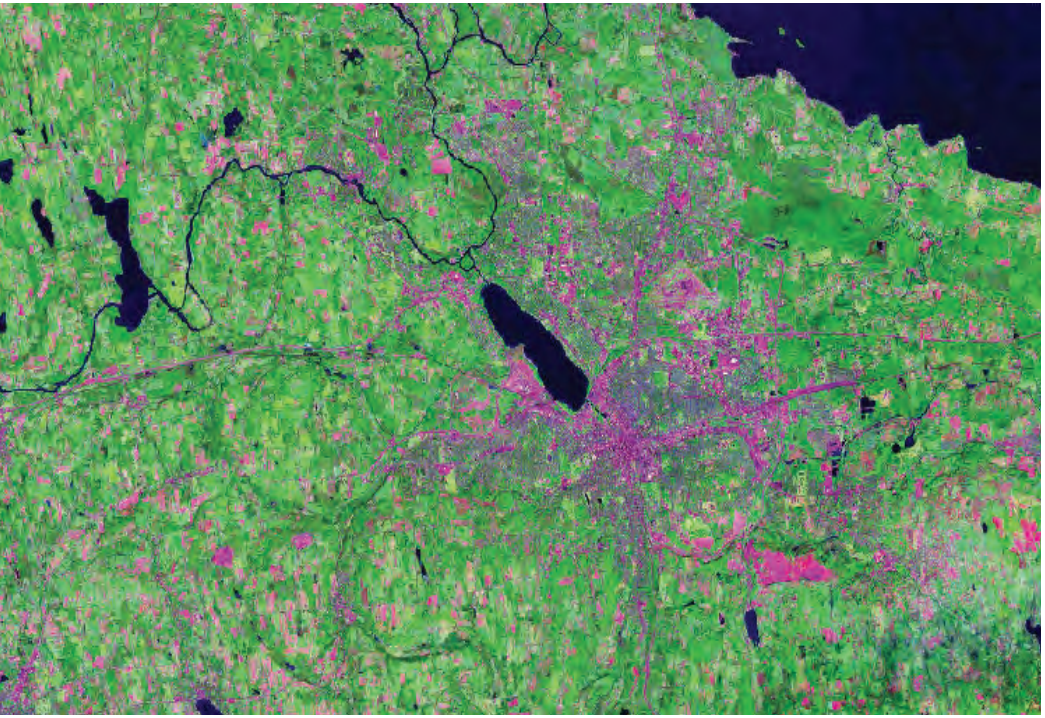


Figure 2. Satellite Image of Onondaga Lake
Photo credit: www.geology.com

Syracuse has the largest annual snowfall of any metropolitan area in the United States with a population over 200,000, and the seasonal weather patterns are influenced by Lake Ontario. The land surrounding Onondaga Lake is characterized by variable topography. The relatively flat, northern portion is within the Lake Plain region and the southern portion falls within the hilly, Appalachian Uplands. Characteristics of the limestone, siltstone, and shale bedrock commonly found in the Onondaga Lake region were shaped by glacial activity thousands of years ago.

Land throughout the Onondaga Lake watershed is primarily classified as agricultural, forest, and urban. The principal type of agriculture in the watershed is dairy farming. Most of the forest land is maintained for commercial use and its acreage exists primarily as small, scattered woodlots. Forests in the southern portion of the watershed are mostly owned by the county or State.

The northern portion of the Onondaga Lake watershed is more populated than the rural landscape to the south. The City of Syracuse is the county seat and serves as an important industrial and transportation center in Central New York.

Where Does the Lake Water Come From and Where Does It Go?

The major tributaries flowing into Onondaga Lake are Nine Mile Creek and Onondaga Creek which together account for about 70 percent of all the water that flows into the lake each year. The third largest contributor of water to Onondaga Lake is the Metropolitan Syracuse Wastewater Treatment Plant (Metro), supplying approximately 20 percent of the lake's annual inflow. Other tributaries that flow into Onondaga Lake include Ley Creek, Harbor Brook, Saw Mill Creek, and Bloody Brook. Water flowing from these sources helps to flush Onondaga Lake about four times each year. This rapid rate of flushing, compared to other lakes in the region, benefits the cleanup of Onondaga Lake because it responds relatively quickly to reductions in pollution loading.

Water flows out of Onondaga Lake to the Seneca River through a single outlet at the north end. The Seneca River combines with the Oneida River at Three Rivers Junction to form the Oswego River. The Oswego River then flows north to Lake Ontario, which is approximately 40 miles (64 kilometers) downstream from the Onondaga Lake outlet. Lake Ontario serves as a source of drinking water for many upstate New York and Canadian communities.

Historical and Cultural Influences

A Look Back

For centuries, the land surrounding Onondaga Lake was the homeland of the Onondaga Nation. Onondaga Lake was where the Peacemaker brought together the warring nations and formed the Haudenosaunee Confederacy, which is why the region is sometimes referred to as the birthplace of democracy. The meetings of the Grand Council of Chiefs, the governing body of the Haudenosaunee, are held at Onondaga still today. The lake continues to be a sacred place to the Onondaga Nation, one they believe must be cared for and respected.

The first European settlement was made by the French who established a fort and trading post on Onondaga Lake in 1655. European settlers inhabited the region in the late 19th and the early 20th centuries, drawn by the developing salt industry and the convenient transportation opportunities along the Erie Canal. By the early 1900s, the Onondaga Lake shoreline was a thriving community filled with tourist attractions, hotels, restaurants, and amusement parks.

Figure 3. Onondaga Lake Park
Photo credit: Anne Saltman

Use of the lake changed dramatically when the water and lake bottom sediments became polluted with municipal sewage waste and industrial pollution which resulted in low oxygen levels and elevated levels of nutrients, harmful microorganisms such as disease causing bacteria, and toxic contaminants. In addition, the Tully Valley mudboils and landslides have contributed elevated levels of sediment that impact the water clarity and aquatic habitat in Onondaga Creek and the lake. Swimming was eventually banned in 1940 and fishing was banned in 1972. Onondaga Lake and related upland sites were added to the Federal Superfund National Priorities List (NPL) in 1994. The lake and related upland sites are also on the New York State Registry of Inactive Hazardous Waste Disposal Sites.

Several events laid the groundwork for improved water quality in Onondaga Lake. Among them, the City of Syracuse started primary treatment of sanitary sewage waste in 1925; Onondaga County established a sewer district in the 1950s and later built Metro on the south shore of the lake in 1960; and in 1972, the Federal Clean Water Act was passed, setting national goals to make fresh water resources suitable for swimming and the propagation of fish and other aquatic life.

The Amended Consent Judgment

In 1988, a lawsuit was filed by Atlantic States Legal Foundation against Onondaga County, alleging that Metro and combined sewer overflow (CSO) discharges violated State and Federal water pollution control laws. The State of New York joined as a plaintiff, and the parties settled the litigation in 1989 through the Metro Consent Judgment. An agreement was reached in 1997 on collection system improvements and a schedule for attaining compliance with the Clean Water Act by 2012 (later amended to 2018). This agreement is part of what is known as the Amended Consent Judgment, or ACJ.

The 1997 ACJ and subsequent revisions contain strategies for engineering and scientific studies to evaluate the need for upgrading the Metro and for providing treatment of the CSOs that occur in the Metro service area. Abatement of CSOs would involve plans to either eliminate or capture and treat combined sewage collected during precipitation events, achieve water quality standards for bacteria in the northwestern half of the lake, and reduce floatable substances resulting from CSOs. The ACJ indicates effluent (or discharge) limits for both ammonia and phosphorus, which are required to be implemented in three phases. The final Phase III requirements for reduction of ammonia were met in 2004, eight years ahead of the schedule specified in the ACJ. Progress is also being made toward meeting phosphorus limits.

The former Onondaga Lake Management Conference, now the OLP, passed a resolution in 1998 amending the Onondaga Lake Management Plan (OLMP) to incorporate the ACJ and adopt its objectives as part of the OLMP. For additional information about the ACJ and water quality goals in relation to the New York State Environmental Conservation Law, refer to other sections of this report and check www.onlakepartners.org/cleanup_legal.htm#02.

Onondaga La

10,000 years ago

- Glacial activity carves out hills and valleys across Central New York, creating Onondaga Lake.

Over 1,000 years ago

- Earliest recorded date that Indian Nations come together at Onondaga Lake to form the Haudenosaunee Confederacy.

1613

- A treaty between the Haudenosaunee and the Dutch (the Two Row Wampum) establish relations.

1783

- Revolutionary War ends. European settlements develop in Central New York.

1784

- In the Treaty of Fort Stanwix, George Washington asks for peace between the USA and the Haudenosaunee to end fighting and re-establish relations.

1793

- Commercial salt production begins on the lakeshore.

1880s

- Onondaga Lake is a popular resort area with hotels, parks, and bathing beaches. Swimming, boating, and fishing are common activities.

1884

- Solvay Process Company begins production of soda ash.

1896

- City builds sewers and bans backyard privies. Sewage flows directly into Onondaga Creek and Harbor Brook.

1918

- Solvay Process Company begins production of organic chemicals.

1920

- Solvay Process Company merges with four other companies and forms Allied Chemical and Dye Corp.

1925

- City of Syracuse begins the removal of settleable solids from sewage (primary treatment).

1940

- Swimming is banned.

1946

- Allied Chemical and Dye Corp. begins discharge of mercury wastes into the lake.

1958

- Allied Chemical and Dye Corp. changes its name to Allied Chemical Corporation.

1960

- Onondaga County Metro is completed.

1970

- Fishing is banned. U.S. Attorney General sues Allied Chemical Corp. to stop mercury dumping.
- Onondaga County Department of Water Environment Protection establishes annual lake monitoring program.

1971

- Onondaga County bans the use of phosphorus in laundry detergents.

1972

- The Federal Clean Water Act is passed.

1973

- New York State bans phosphorus in laundry detergents.

1977

- Allied Chemical Corp. closes chlorinated benzene plant and Willis Avenue chlor-alkali plant.

1979

- Metro is upgraded to secondary and tertiary treatment.

1981

- Allied Chemical Corp. changes its name to Allied Corp.

1986

- Allied Corp. closes soda ash manufacturing operations.

1987

- Onondaga County implements best management practices for sewer interception.
- Allied Corp. merges with Signal Companies to form Allied-Signal Inc.

1988

- Atlantic States Legal Foundation, New York State Attorney General, and NYSDEC file complaint against Onondaga County alleging violation of its state discharge permit.

1989

- New York State Attorney General and NYSDEC file a lawsuit in Federal court against Allied-Signal Inc. for pollution violations and resource damage.
- A Consent Judgment is entered on February 1, 1989 requiring Onondaga County to perform studies to evaluate the need for upgrading Metro and for providing treatment of combined sewer overflows (CSO).

1990

- Onondaga Lake Management Conference is convened in Syracuse by U.S. Senator Daniel Patrick Moynihan.

1991

- Onondaga Lake Management Conference begins lake research and remediation projects.
- Pump stations at Liverpool and Ley Creek are modified to reduce raw sewage overflows to the lake.

1992

- U.S. Army Corps of Engineers completes the Onondaga Lake Water Quality Technical Report with lake remediation alternatives.
- The Onondaga Lake Management Conference funds study of the Tully Valley mudboils.
- A Federal court approves a consent order for study of industrial pollution and development of a cleanup plan.

1993

- The Onondaga Lake Management Conference (OLMC) drafts “A Plan for Action” which becomes the basis of the Onondaga Lake Management Plan (OLMP).
- The OLMC publishes the first State of Onondaga Lake report.

AKE TIMELINE

1994

- Onondaga Lake is added to the Federal Superfund National Priorities List (NPL).

1995

- The OLMC implements mudboil remediation projects to reduce flow of sediment to Onondaga Creek.

1997

- The State of New York, Atlantic States Legal Foundation, and Onondaga County reach agreement (Amended Consent Judgment [ACJ]) on municipal wastewater collection and treatment improvements, and a schedule to attain compliance with the Clean Water Act.

1998

- The ACJ is approved by Federal Court and replaces and supersedes the 1989 Consent Judgment.
- The Ambient Monitoring Program is implemented in accordance with the ACJ.

1999

- The OLMC approves a resolution to incorporate the ACJ into the OLMP.
- The NYS Department of Health (NYSDOH) lifts the ban on eating certain species of fish from Onondaga Lake and provides additional guidelines.
- Congressman James T. Walsh initiates legislation in the Water Resource Development Act of 1999 that replaces the OLMC with the Onondaga Lake Partnership (OLP).
- The OLP, led by the U.S. Army Corps of Engineers, is tasked with implementing lake improvement projects consistent with the OLMP and the ACJ.
- Allied-Signal, Inc. combines with Honeywell, Inc. and changes its name to Honeywell International, Inc.

2001

- Oil tanks are removed from "Oil City" and tenants begin site remediation.
- The second State of Onondaga Lake report is produced by the Onondaga Lake Cleanup Corp with support from the OLMC and the OLP.

2002

- The NYSDEC issues a report detailing the extent of contamination within the lake and assessing the risk to humans and the environment.

2004

- The final stage of the Metro improvements for ammonia treatment come on-line.

2005

- The Actiflo treatment system come on-line at Metro to reduce effluent total phosphorus (TP) concentration.
- NYSDEC and USEPA outline remediation plans for Onondaga Lake's industrial pollution concerns.
- Metro reaches ammonia limit goal eight years ahead of the scheduled deadline.
- Honeywell International, Inc. removes more than eight tons of mercury from the Linden Chemicals and Plastics property.

2006

- The NYS Attorney General's office files a motion to amend the ACJ with U.S. District Court. The amendments reflect changes since the original ACJ was signed in 1998.
- Honeywell International, Inc. completes a groundwater treatment plant at the former Allied Chemical, Willis Avenue site.
- Phosphorus release from Metro to Onondaga Lake is reduced from 200 pounds per day to 50 pounds per day with completion of an upgraded phosphorus removal facility.

2007

- NYSDOH modifies the fish consumption advisory for some species of fish.
- Wetlands restoration at former Linden Chemical and Plastics site is completed.
- Honeywell International, Inc. signs a Consent Decree to perform the Remedial Design and Remedial Action for the Onondaga Lake Bottom Site.

2008

- Honeywell International, Inc. begins construction of the groundwater barrier wall and trench collection system that will capture and transfer groundwater to the Willis Avenue treatment plant.
- Construction of Midland Avenue RTF is completed and addresses three CSOs.
- Atlantic States Legal Foundation, NYSDEC, and Onondaga County obtain a moratorium on construction of the proposed treatment facilities so that alternative methodologies, including green infrastructure, can be evaluated as part of the CSO abatement program.
- A Microbial Trackdown Program is implemented to identify dry weather sources of bacteria discharges to Onondaga Creek and Harbor Brook.
- Onondaga County proposes gray and green infrastructure as a component to its CSO abatement program.

2009

- The draft Onondaga Creek Conceptual Revitalization Plan is released for public review.
- NYSDEC issues the design work plan for the Onondaga Lake Bottom NPL Subsite and cleanup decision documents for the Geddes Brook/ Ninemile Creek Site.
- NYSDEC issues a Citizen Participation Plan designed to enhance public input and involvement in the Onondaga Lake Bottom cleanup project.
- A Fourth Stipulation to the ACJ is adopted and approved by the Federal court, incorporating green infrastructure methodologies into the CSO abatement program.

2010

- The OLP publishes the third State of Onondaga Lake report.

Timeline updated from "*The State of Onondaga Lake*" (OEI 2001)

The Road to Recovery

After many years of research and remediation, Onondaga Lake is now the cleanest it has been in over a century. Federal, State, and local officials continue to focus on restoration plans for the lake, upland sources of industrial contaminants are being addressed, and Onondaga County has made substantial improvements to its wastewater collection and treatment system. Since 2001, more than forty restoration projects have been completed and over twenty projects are currently being implemented.

Pollution, toxicity levels, and algal growth have decreased and water clarity has improved. These water quality changes have improved the aquatic community. Plant and animal diversity in and around the lake is exhibiting impressive progress, highlighted by numerous sightings of bald eagles, great egrets, osprey, kingfishers, mallards, and Canada geese along the shoreline. The National Audubon Society has designated the lake and its surrounding habitats (including deciduous woods and non-tidal wetlands) as an Important Bird Area. During fall migration, many thousands of waterfowl can be seen resting and feeding on the lake.

Onondaga Lake now supports a productive warm water fishery and a recovering cool-water fishery with several game species such as brown trout and smallmouth bass. In fact, over 65 species of fish have been documented in the lake and recreational opportunities have improved significantly. The Izaak Walton League in cooperation with the OLP host a popular family-oriented free fishing weekend each year. Carp fishing is becoming another popular event on Onondaga Lake and regional competitions for carp anglers are hosted each year by the Catch and Release Professional (CARP) Tournament Series.

Professional and recreational anglers enjoy an excellent largemouth and smallmouth bass fishery and several local and regional bass tournaments are held on the lake each year. World class fishermen competed in the Bassmaster Memorial Tournament at Onondaga Lake in 2007, and in 2008 the North American Fishing Club claimed that the lake is one of the country's top ten hotspots for bass. Three major sporting events were held on Onondaga Lake in 2008: the Toyota US Open of Watercross (a Jet Ski competition), Syracuse Hydrofest (for hydroplane enthusiasts), and the Junior Bassmaster World Championships with nearly 100 teens from the US, Canada, and South Africa. Onondaga Lake is on the road to recovery and anglers are taking notice.

Bald Eagle

Figure 5. Fishing on Onondaga Lake
Photo credit: Conrad Strozik

Lake Use

What are the Recreational Uses of Onondaga Lake and its Shoreline?

The public is taking note of the impressive recovery of Onondaga Lake. Water quality improvements are occurring more rapidly than expected and have led to increased public appreciation and use of the lake and its shoreline. Well over 1.3 million people visited Onondaga Lake Park in 2009 to enjoy popular recreational opportunities such as hiking, bicycling, picnicking, fishing, and boating. In addition to national sporting competitions and professional fishing events, community fishing, sailing, and rowing clubs use the lake on a regular basis and competitions are scheduled by high school and college crew teams throughout the spring and summer months.

Much of the land immediately surrounding Onondaga Lake is owned by Onondaga County. Seven miles (11.3 kilometers) of attractive, paved shoreline trails are currently used for walking, running, skateboarding, biking, in-line skating, picnicking, and bird watching. Plans to extend the trail by 2.1 miles (3.4 kilometers) along the western shoreline of Onondaga Lake are currently underway. In addition to the shoreline trails, two museums are located in Onondaga Lake Park: the Salt Museum and Sainte Marie Among the Iroquois.

How do New York State Water Quality Classifications Impact Water Quality Goals?

In 1972, the U.S. Congress passed the Clean Water Act requiring that all United States fresh waters should be suitable for swimming and the propagation of fish and other aquatic life. In response to the Clean Water Act, New York State classified its surface waters according to their best use. The best use classification for Onondaga Lake includes swimming, fishing, fish propagation, and secondary recreation. Onondaga County routinely monitors water quality conditions in the lake to determine if the designated uses are supported and compliance with water quality standards are achieved. Information about the ambient monitoring program is found at www.ongov.net/wep/we15.html.

NYSDEC developed and administers a system of discharge permits to control pollution and reduce violations of water quality standards. Enactment and enforcement of environmental laws such as the Clean Water Act, the Resource Conservation and Recovery Act of 1976, and State and Federal Superfund laws have brought about notable improvements to the lake. Ammonia concentrations, for example, now meet state standards developed for protection of aquatic life. In addition, recent improvements in dissolved oxygen concentrations in the lake surface water during the fall mixing period are now in compliance with regulatory standards, thereby providing better habitat for plants and animals.

Figure 6. Onondaga Lake Park
Photo credit: Onondaga County Parks

Are There Designated Swimming Areas in Onondaga Lake?

Great progress has been made in wastewater treatment at Onondaga Lake, especially with the construction of Metro in 1960 and upgrades at the plant in the 1970s and 1980s, and again in 2005. Onondaga County is involved in widespread efforts to separate and upgrade combined sewer overflows (CSOs.) This has resulted in a reduction in the number, frequency, and volume of sewage overflows into Onondaga Creek, Ley Creek, and Harbor Brook which flow into Onondaga Lake. Bacteria levels in some areas of the lake still increase after significant storm events, primarily in the southern end of the lake where tributaries receiving CSOs are located. Bacteria levels in the northern end of the lake are less impacted by rainfall events, but still increase after significant storm events and return to normal within a few days. According to the Special Event Water Quality Protocol developed by Onondaga County in 2009, these occasional high bacteria levels are among the reasons why swimming in Onondaga Lake is not encouraged. However, continued water quality successes in lake remediation may eventually lead to a change in this policy. For example, Onondaga County has recently begun a series of green infrastructure projects (such as permeable pavement and rain barrels) designed to intercept and redirect stormwater before it enters and potentially overwhelms the sewer system. These efforts are designed to reduce the volume of water entering the sewer system and the likelihood that CSOs and associated bacterial discharges will occur. The Water Quality Protocol is found at www.onlakepartners.org.

Figure 7. Fishing on Onondaga Lake
Photo credit: Onondaga County Parks

What is the Inner Harbor/Lakefront Development Project?

The Inner Harbor, a 42-acre area along the southern Onondaga Lake shoreline, is owned by the New York State Canal Corporation. The portion at the east end is operated and maintained by the Lakefront Development Corporation (LDC). The LDC was established in 1996 by the City of Syracuse and the Metropolitan Development Association of Syracuse to facilitate the redevelopment of the Syracuse Lakefront.

Remediation and redevelopment of the Lakefront neighborhood and adjoining areas began in the 1990s with the removal of contaminated soil and oil tanks from the area known as Oil City. The Carousel Mall was built, followed by upgrading of the vacant factory buildings in the Franklin Square area into residential housing, businesses, and restaurants. Additional improvements include construction of a 1,500-seat amphitheater and development of the Onondaga Creek Walk (connecting the Franklin Square area to the Inner Harbor) that provides opportunities for in-line skating, bicycling, and fishing.

Many see development of the Onondaga Lake waterfront as a way to boost tourism and expand recreational opportunities. The New York State Canal Corporation is currently seeking proposals to develop an additional 29 acres into a commercial, residential, and recreational attraction. Future development of the Syracuse Lakefront will be closely linked to water quality improvements in Onondaga Creek, the harbor and throughout the lake, and will be planned in accordance with the Syracuse Lakefront Zoning Code that outlines redevelopment goals.

What are Combined Sewer Overflows (CSOs)?

Sewers located throughout the City of Syracuse carry both sanitary sewage and stormwater. During dry weather, these sewers carry all sanitary sewage to Metro. However, during intense rainfalls, the amount of stormwater entering the combined sewer system exceeds the system's capacity, resulting in overflow and discharges of untreated wastewater (stormwater and sanitary sewage) into Onondaga Lake tributaries. The frequency with which CSOs actually occur varies from one CSO discharge location to the next, but generally ranges from only a few times per year to as many as 60 times a year.

CSOs are a major contributor of bacteria, floating trash, organic material, solids and grit to the lake and its tributaries. Elevated bacterial concentrations in Onondaga Lake can occur for up to three days following a storm event. Additional information about CSOs is available at:

www.onlakepartners.org/faqs.htm

Figure 8. The Inner Harbor
Photo credit: City of Syracuse

Priority Issues and Remedial Actions

Wastewater Pollution

Over the past two decades, Onondaga County has improved Metro's capacity to treat wastewater through projects such as advanced nutrient removal, odor control upgrades, an aeration system upgrade, digital system improvements, increased capacity for chemical storage and feed facilities, and digester modifications. As a result of the upgrades (especially the advanced treatment system that came on line in 2004), ammonia and phosphorus concentrations in Onondaga Lake have declined significantly. In recent years, phosphorus discharges to Onondaga Lake from the treatment plant were the lowest recorded since Onondaga County began monitoring in 1969. In 2009, ammonia concentrations were the lowest ever measured and remained at safe levels for even the most sensitive aquatic organisms. Overall, dissolved oxygen in the lake's upper waters has increased and the frequency of algal blooms is diminishing.

What is Metro?

Metro, built in the 1960s, is an advanced wastewater treatment facility that serves the City of Syracuse and several surrounding municipalities. It is the third largest source of water to Onondaga Lake, contributing 20 percent of the water entering the lake each year. During the summer, when the amount of water flowing into the lake from natural tributaries is low, the discharge from Metro represents the single largest source of water for Onondaga Lake. Recent Metro upgrades have resulted in significant water quality improvements and better habitat for aquatic plants and animals.

Figure 9. Aerial View of Metro
Photo credit: USACE

What Else is Being Done to Reduce Wastewater Pollution?

In addition to Metro upgrades, Onondaga County is implementing projects to control stormwater runoff and reduce the number of CSOs. In some areas, stormwater still mixes with sewage in underground pipelines during heavy rains, overloading pipes and overflowing into Onondaga Creek and other lake tributaries. The ACJ requires that by 2018, the County eliminate or capture for treatment, 95 percent of the CSO volume generated during precipitation events on a system-wide, average annual basis. Significant progress has been made to reach this goal. Of 70 total CSO discharges, 35 have been addressed to-date, resulting in an estimated 85 percent reduction in the volume of CSO discharges from rain and snowmelt on an annual basis.

Additionally, a skimmer boat collects floatable trash and debris from the Inner Harbor and the mouth of Onondaga Creek. Floatables Control Facilities remove trash from stormwater runoff with net bags and booms, while storage and treatment facilities remove and treat the waste. Storage facilities temporarily store stormwater to prevent it from contributing to CSOs.

The OLP is supporting projects designed to reduce wastewater pollution and improve water

Figure 10. Skimmer boat
Photo source: Onondaga County

quality in the lake and its tributaries through the following priorities:

- Completion of the Midland Regional Treatment and Storage Facility, which captures combined sewage from three major overflows that previously emptied directly into Onondaga Creek during storms. The facility stores 4.5 million gallons, and flows in excess of this amount are treated and discharged to Onondaga Creek.
- Installation of pipelines to convey combined flows for storage in the Clinton Street area.
- Completion of two additional sewer separation projects on the City's south side which closed two CSO discharges, and construction of new sewer lines that convey stormwater to Onondaga Creek.

What is the Microbial Trackdown Study?

An investigation called the Microbial Trackdown Study is being conducted to identify sources of fecal coliform bacteria during dry weather in two Onondaga Lake tributaries - Onondaga Creek and Harbor Brook. The study is identifying areas that are in need of further assessment or follow up by responsible jurisdictions or parties.

The Microbial Trackdown Study is funded by the Environmental Benefit Project fund provided by Onondaga County. The ACJ specified that the County provide the funds, and that the OLP select and approve the project to which the funds are being applied. The USEPA has also provided additional funds for the study. The NYSDEC and several other OLP member agencies participate on the project's work group.

The investigation has documented elevated levels of fecal coliform bacteria at urban areas of Onondaga Creek during dry weather conditions. Contaminated water from collapsed sanitary sewers and other sources of sewage flows to the creek through the sanitary and stormwater system. The sampling is helping to assess the impact that aging wastewater infrastructure has on the two tributaries. Although some dry weather contaminant sources have been addressed, the OLP continues to work to identify and eliminate such sources. Therefore, the OLP does not recommend engaging in activities which have the potential for immersion or ingestion of creek water.

Since the study began, the County has secured funding to replace the main interceptor sewer that parallels Harbor Brook. The upgrade is designed to help improve water quality. Additional information about this project and the ACJ can be found at www.onlakepartners.org.

How Does Green Infrastructure Benefit Water Quality?

Onondaga County officials, in cooperation with many community stakeholder groups, have taken a proactive approach to developing green infrastructure alternatives designed to reduce the amount of stormwater entering storm sewers and contributing to CSO discharges. Wastewater infrastructure refers to the pipes, concrete, pumps, and facilities that transport and handle sewage. Examples of these traditional methods, called "gray infrastructure", include Metro and the Midland Regional Storage and Treatment Facility. Green infrastructure helps reduce runoff by facilitating soil infiltration and the capture and reuse of stormwater before it enters the sewer system. The original ACJ has been amended four times, most recently in 2009. This fourth amendment authorizes a greater emphasis on green infrastructure (such as vegetated infiltration

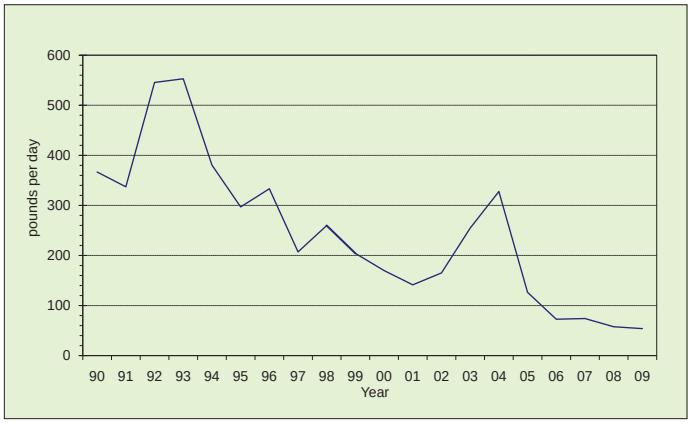


Figure 11. Phosphorus Discharged to Onondaga Lake from Metro
Data source: Onondaga County Department of Water Environment Protection

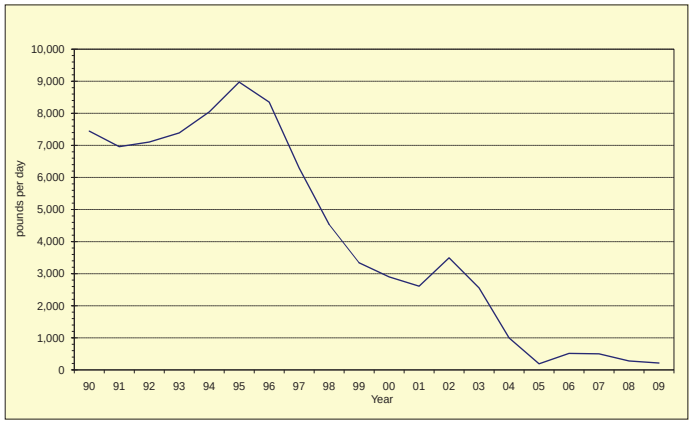


Figure 12. Ammonia-N Discharged to Onondaga Lake from Metro
Data source: Onondaga County Department of Water Environment Protection

Figure 13. Rain Garden Near Residential Sidewalk

basins, roof gardens, tree boxes, and rain gardens) in combination with traditional engineering practices (gray infrastructure) to reduce stormwater runoff and CSO volume during storm events. For additional information about the 2009 ACJ amendment, refer to www.onggov.net/forms/images/ACJ.pdf.

In March 2009, Onondaga County launched an innovative new "Save the Rain" campaign, designed to raise public awareness and help Onondaga Lake by reducing the volume of stormwater runoff that flows directly into the sanitary sewer system. Through this program, green technologies are also being promoted in order to reduce flooding and erosion and to cut down on pollution loading to Onondaga Lake and its tributaries. Additional information about this program is available at www.ongov.net/savetherain/greensolutions.html.

Onondaga County, in conjunction with the City of Syracuse and several other partner organizations, is also implementing a green infrastructure program on the City's Near West Side within the Clinton sewershed (an area drained by a network of combined sewers.) This program is designed to reduce CSO discharge rates by increasing soil infiltration. In 2009, nearly 400 trees were planted in order to shade streets and to provide vegetative cover in vacant city-owned lots. Rain gardens were also planted to absorb excess stormwater and to teach local residents about the benefits of green alternatives.

In 2009 the Syracuse Center of Excellence received over $3,000 in mini grant funds from the OLP for construction of a green roof and installation of permanent signage for a green infrastructure demonstration project in the Near West Side.

Additional green projects anticipated for the area will include installing porous pavement, green roofs, rain barrels, and expanding vegetated areas along Onondaga Creek.

Nutrients

Phosphorus

In recent years, the concentration of phosphorus dropped to the lowest level ever recorded in the lake's upper waters and reached an impressive average of 15 micrograms per liter (parts per billion) in 2008. This reduction can be attributed to upgrades at Metro. Between 1993 and 2009 phosphorus discharges from Metro were decreased by approximately 86 percent. In addition to the improved wastewater treatment, watershed projects supported by the OLP are reducing phosphorus loading from agricultural sources and urban-based stormwater runoff.

This notable change in phosphorus levels has resulted in widespread benefits for aquatic organisms and lake users through a reduction in the frequency and severity of algal blooms, improved water clarity, and increased oxygen levels. The New York State Department of Health standard for opening a beach requires water clarity reaching a depth of four feet or greater throughout the summer. In 2008, for the first time in many years, water transparency in Onondaga Lake averaged 14.7 feet and was greater than four feet each summer day. Improvement in water clarity is also attributed to the increased consumption of algae by small aquatic animals called zooplankton. In addition, abundant zebra mussels are effectively grazing the algae, providing greater lake water clarity.

Where Does Phosphorus Come From?

Phosphorus, an essential nutrient that influences plant growth, enters Onondaga Lake from point and non-point sources. Point sources can be traced back to a single origin, such as a sewage treatment plant discharge. Non-point sources of phosphorus include diverse land use activities such as lawn fertilization and agricultural runoff. Other sources of phosphorus to Onondaga Lake and its tributaries include CSOs that discharge untreated sewage and stormwater to Onondaga Creek and Harbor Brook during heavy rainfall. Once in the lake, phosphorus can continue to cycle between the bottom sediments and the overlying waters.

Belted kingfisher

Through efforts supported by the Onondaga Lake Partnership (OLP), Onondaga County is working to mitigate combined sewer overflows (CSOs) in Onondaga Creek and the Onondaga Lake Watershed. Sewage is normally treated at the County's Metropolitan Wastewater Treatment Plant. However, during periods of heavy rain or rapid snow melt, stormwater and sewage can overwhelm the system and be discharged directly in the Creek through a series of pipes and overflow points called CSOs. During these periods, the Creek may have high, rapidly moving water, and contain untreated sewage. As a result for safety and health reasons, one should not be in or come into contact with creek water at these times.

How Do Phosphorus and Dissolved Oxygen Influence Water Quality?

Lower phosphorus concentrations have contributed to a higher level of dissolved oxygen in the upper waters of the lake. Concentrations of dissolved oxygen (the amount of oxygen that is dissolved in water) typically vary with lake depth, season, and time of day. Oxygen levels have a major impact on the abundance and type of organisms found in a lake environment. Fish avoid waters with low dissolved oxygen levels, and anoxic conditions (no dissolved oxygen in bottom waters of a lake) can also trigger chemical reactions and the release of phosphorus and other pollutants from the lake bottom sediments.

Anoxia, particularly during the summer months, is a natural condition for some lakes. Evaluations to determine if anoxia could be a natural occurrence in Onondaga Lake are ongoing. Historically low oxygen levels in the upper waters had been one of the most significant water quality problems in Onondaga Lake. Oxygen levels in the upper waters of the lake, however, have improved significantly and are in compliance with water quality standards.

Ammonia

Ammonia and nitrite are forms of nitrogen that affect the type and abundance of aquatic life in lakes. As a direct result of Metro upgrades, ammonia and nitrite concentrations in Onondaga Lake have declined significantly and levels now consistently meet State standards developed for the protection of aquatic life.

Since 2007, the lake has been in full compliance with ambient water quality standards for ammonia and was officially de-listed for that parameter in the State's 2008 list of impaired waterbodies. The lower concentrations have improved conditions for young fish and other sensitive forms of aquatic life, and have enhanced fish spawning and migration patterns.

As with phosphorus, ammonia is supplied to Onondaga Lake from both point and non-point sources. The improvements to the Metro plant have reduced the point source loading of ammonia by an impressive 98 percent. Prior to completion of the upgrades to Metro in 2004, more than 90 percent of ammonia flowing into Onondaga Lake was discharged from Metro. In 2008, the Metro plant contributed only 44 percent of the ammonia flowing into the lake. The second largest source of ammonia to the lake is from Nine Mile Creek, which is bordered by several industrial wastebeds. In 2008, the contribution from Nine Mile Creek represented approximately 30 percent of the total ammonia load to the lake.

Figure 14. Summer Phosphorus Levels in Upper Waters
Data source: Onondaga County Department of Water Environment Protection

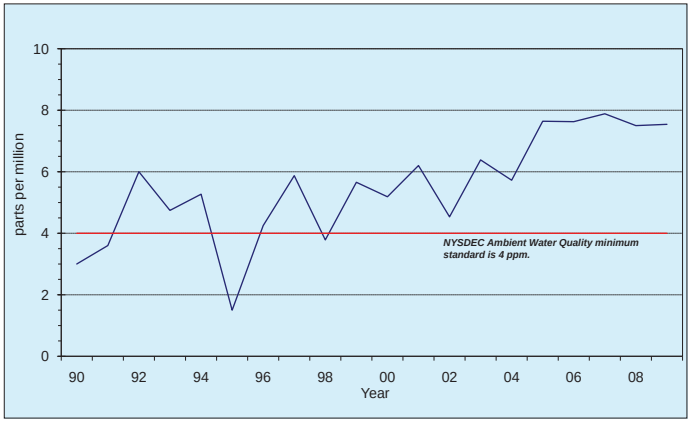


Figure 15. Minimum Oxygen Concentrations, Upper Waters in October
Data source: Onondaga County Department of Water Environment Protection

What is Being Done to Reduce Nutrient Levels in Onondaga Lake?

In addition to Metro upgrades, lower levels of ammonia and phosphorus in Onondaga Lake can be attributed to recent improvements and restoration projects that address CSO discharges, effective stormwater control practices, better management of agricultural runoff, successful regional partnerships established through the OLP, and a well-informed public. Additional information about the Ambient Monitoring Program and nutrient levels in Onondaga Lake is available at www.ongov.net/wep/we15.html.

Industrial Pollution and Superfund

For over 125 years, industrial and chemical manufacturing operations along the Onondaga Lake shoreline disposed of waste products on nearby land or by discharging waste directly into the lake. At one time industry discharged approximately 20 pounds of mercury to the lake per day. As a result of this activity, surface water was contaminated with mercury, and sediments were contaminated with polychlorinated biphenyls (PCBs); pesticides; creosotes; heavy metals including lead, cobalt, and mercury; polycyclic aromatic hydrocarbons (PAHs); and volatile organic compounds (VOCs) such as chlorobenzene. Ground water at many upland subsites has also been contaminated. The former industrial practices led to restricted recreational uses of the lake, reduced wildlife habitat, and elevated levels of toxic contaminants that still persist in fish and other aquatic life.

Figure 16. Water Quality Monitoring, Onondaga County Department of Water Environment Protection
Photo Source: Water Environment Protection

Figure 17. Annual Ammonia-N Levels in Upper Waters
Data source: Onondaga County Department of Water Environment Protection

As a result of the industrial pollution, Onondaga Lake was designated a Superfund site in December 1994. The Onondaga Lake Superfund site includes the lake bottom, and subsites around the lake and along the tributaries that are sources of contamination. Currently, 11 subsites have been determined part of the Superfund site:

1. Onondaga Lake Bottom
2. Geddes Brook/Ninemile Creek
3. Willis Avenue
4. LCP-Bridge Street – Operable Unit 1
5. Waste Bed B/Harbor Brook
6. Semet Tar Beds
7. Town of Salina Landfill
8. Lower Ley Creek
9. Ley Creek PCB Dredgings
10. General Motors – Inland Fisher Guide
11. National Grid- Hiawatha Boulevard

Waste Beds 1-8 are in the process of being named a subsite which would result in 12 areas included in the Onondaga Lake Superfund site (Figure 17). Additional information on the subsites can be found at www.dec.ny.gov/chemical/37558.html.

Due to the large size and complexity of the Onondaga Lake Superfund site, the basic approach that is being used for its remediation is to divide the site into manageable units which can be addressed on a focused basis. This

approach enables discrete remedies to move forward independently rather than waiting for the full suite of site remedies to be determined. Remediation is being addressed in two stages: 1) interim remedial measures (IRMs) and 2) long-term remedial actions focusing on cleanup of the subsites. IRMs undertaken at the site include: removing chlorobenzene from existing wells; altering existing on-site sewers; on-site demolition, removal, decontamination and recycling of former mercury cell processing buildings and building materials; cleaning storm drainage systems; investigation of berms surrounding the Semet Tar Ponds; design and construction of a lakeshore barrier wall and groundwater collection/treatment system; and removal of some contaminated sediments and floodplain soils from Geddes Brook and the East Flume. Investigations and long-term remedial actions at the various subsites are being performed by potentially responsible parties (PRPs), pursuant to enforcement agreements between the PRPs and the State. EPA has contributed over $16.5 million to the state for various activities at the site including investigations; coordination and management at subsites; implementation of a citizen involvement plan; creation of a site-wide database; and establishment of a comprehensive enforcement program.

Between 1998 and March 2010, eight Records of Decision (RODs) have been signed for cleanup plans at the various subsites. Selected remedies for contamination at the subsites include: dredging of sediments; excavation of soils; on and off-site treatment of contaminated materials; collection and treatment of contaminated groundwater; and capping of excavated soils and sediments.

In 2007, the Federal Court approved an agreement requiring Honeywell International Inc. (successor firm to Allied-Signal Inc.) to remediate the contaminated sediments in the bottom of the lake. The plan involves dredging contaminated sediments, capping approximately 580 acres of lake bottom sediments, and restoring habitat. Under the direction of NYSDEC (the agency responsible for overseeing the cleanup of industrial pollution), Honeywell is currently working in cooperation with a team of scientists, engineers, and Federal, State, and municipal leaders on designs for the restoration of the lake, including a dredging strategy, a sediment containment area, and wastewater treatment. Dredging is expected to begin in 2012 and

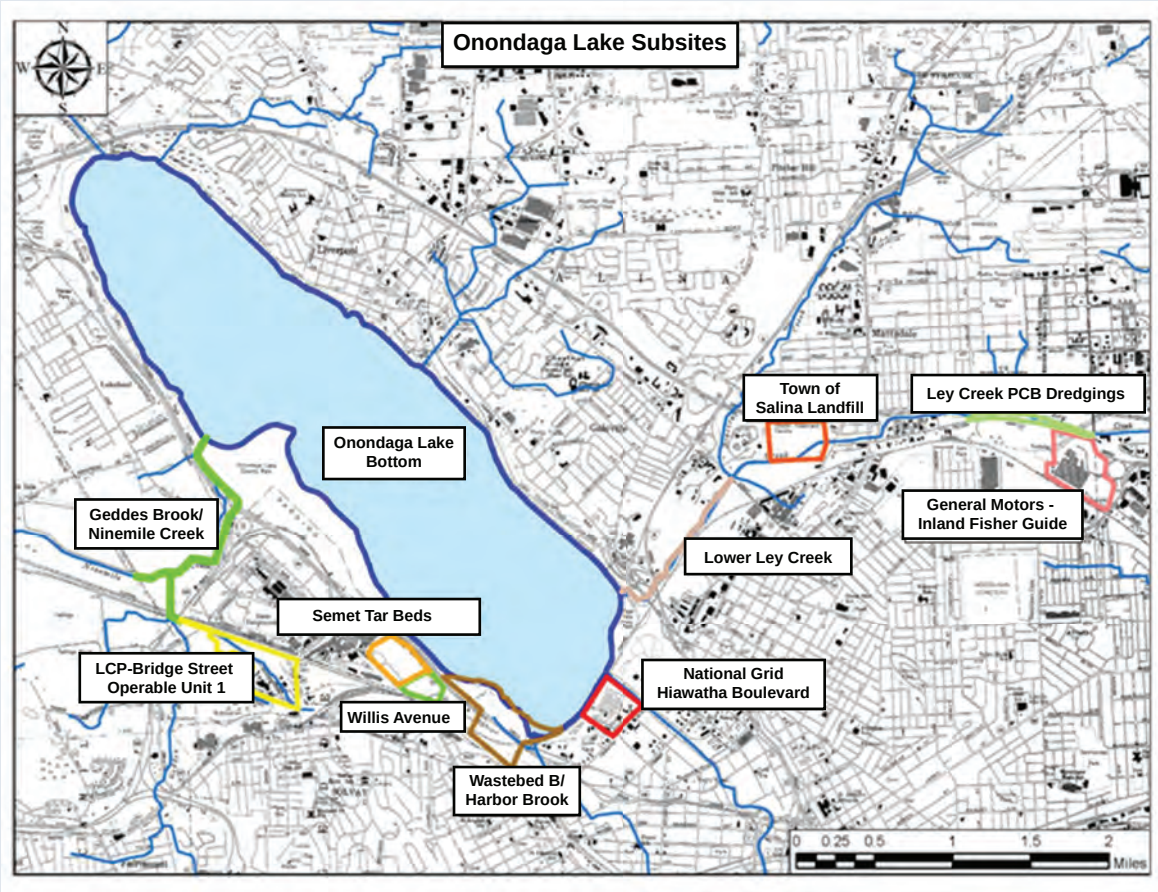


Figure 18. Location of Onondaga Lake Watershed NPL Subsites
Data source, NYSDEC

the cleanup program calls for sediments to be hydraulically dredged from the bottom of the lake and piped to a sediment consolidation area in Camillus, New York.

Honeywell is also remediating polluted upland sites that impact the lake. For example, the former Linden Chemical and Plastics (LCP) site was a major source of mercury contamination in Geddes Brook, Nine Mile Creek, and Onondaga Lake. As part of the site remediation, more than eight tons of mercury were removed from plant property through "soil washing." In addition to mercury removal, the cleanup program under direction of the NYSDEC involved excavation of contaminated sediments in surrounding areas; installation of an on-site groundwater collection system; and the construction of a five-story deep, underground cut off wall to prevent any future groundwater discharge.

In March 2009, the NYSDEC released a work plan outlining activities and schedules necessary to complete remedial design of the remedy selected in the Record of Decision (ROD) issued by the NYSDEC and the USEPA in 2005 for the Onondaga Lake Bottom Subsite. Additional information about Onondaga Lake remedial design work is available at the NYSDEC website at www.dec.ny.gov/chemical/34481.html.

Information about the Onondaga Lake Bottom Subsite, including information about the Sediment Consolidation Area is available at www.dec.ny.gov/chemical/37558.html.

What are the Chemical Restoration Objectives?

In 2005, the NYSDEC and USEPA, in cooperation with the NYS Department of Health, issued a Record of Decision (ROD) outlining remedial plans for Onondaga Lake's industrial pollution concerns. The ROD outlines plans to dredge and cap the lake sediments in order to remove the most polluted sediments from the lake and construct an isolation cap of layered sand, gravel, and other material to separate undredged material from the lake system.

Specific objectives in the ROD, called remedial action objectives or RAOs, are goals that were established for Onondaga Lake to protect human health and the environment. These objectives are based on information such as the nature and extent of the contaminants, the transport and fate of pollutants, baseline human health, and an evaluation of ecological risk. Although the sediments are the primary focus of the remediation, the degree of attainment of New York State's surface water standards and guidance values and site-specific fish target concentrations were also evaluated.

The RAOs for Onondaga Lake are:

- To eliminate or reduce, to the extent practicable, the release of mercury from the bottom waters;
- To eliminate or reduce, to the extent practicable, the releases of contaminants from the near-shore areas;
- To eliminate or reduce, to the extent practicable, releases of mercury from lake bottom sediments;
- To eliminate or reduce, to the extent practicable, existing and potential future adverse ecological effects on fish and wildlife resources and to eliminate or reduce, to the extent practicable, potential risks to humans;
- To achieve surface water quality standards, to the extent practicable, for chemical contaminants.

Additional information about the goals and objectives for Onondaga Lake are found at the following website: www.dec.ny.gov/chemical/34481.html.

What are the Habitat Restoration Goals?

In December 2009, Honeywell released a draft report titled Remedial Design Elements for Habitat Restoration. The plan is designed to restore wildlife habitat in areas surrounding the lake that are impacted by cleanup activities. Habitat restoration is an essential part of Onondaga Lake remediation efforts and serves as a significant component in the dredging and capping activities. Habitat

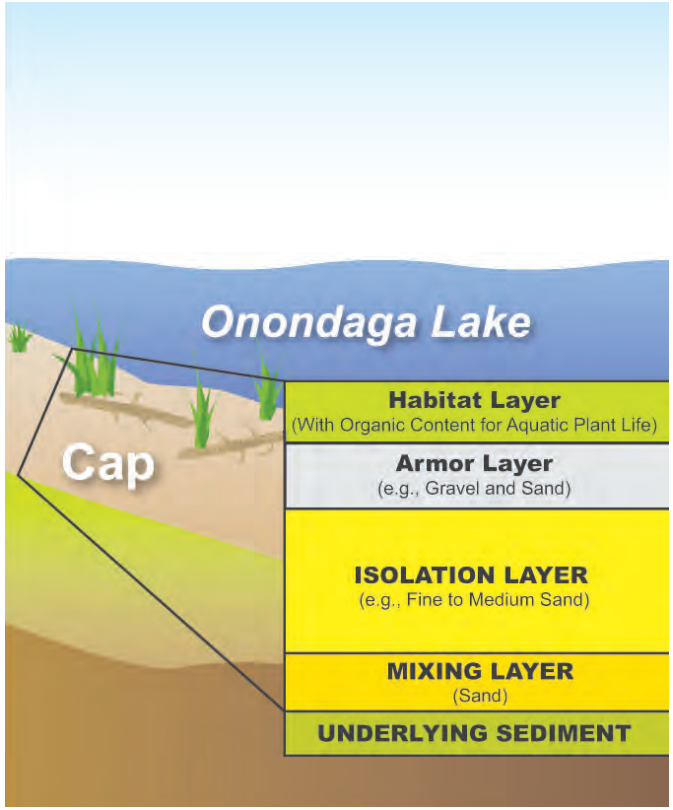


Figure 19. Proposed Lake Bottom Capping
Data source, USACE

What is the Barrier Wall?

In 2007, construction began on an impressive 1.5 mile long underground barrier wall along the southwest shore of Onondaga Lake. The purpose of the wall, ranging between 30 to 50 feet deep, is to divert polluted groundwater from several of the upland sites to a state-of-the-art treatment plant. The treated water is then pumped to Metro to undergo further treatment to meet New York State water quality standards. Approximately 80,000 gallons of clean, treated water is returned to Onondaga Lake each day as part of the first phase barrier wall groundwater diversion and collection system. Phase II of the wall construction was completed in 2009 and Phase III will be completed in 2011. Additional information about this project is available at www.onondaga-lake-initiatives.com.

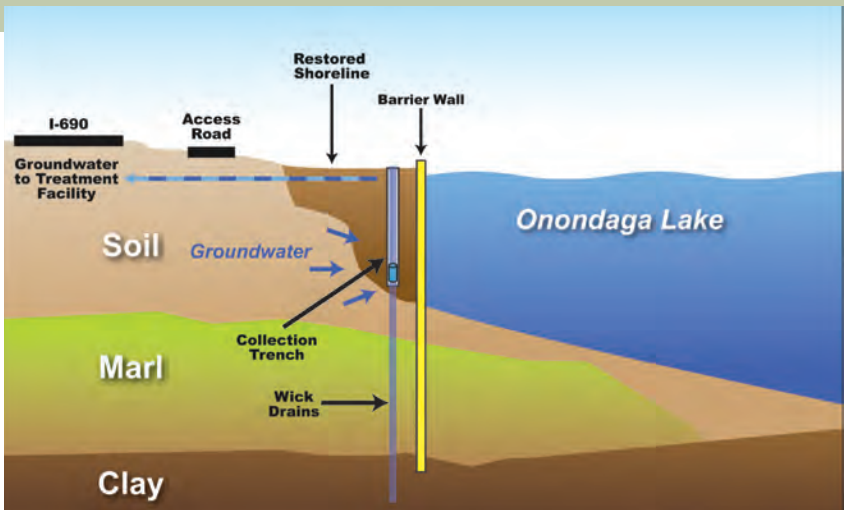


Figure 20. Barrier Wall Diagram
Data source, USACE

improvements presented in the plan will enhance the physical and biological setting for plants, mammals, fish, benthic macroinvertebrates, birds, reptiles, and amphibians, while providing public access along the lake shoreline. The draft report and related information are available at www.dec.ny.gov/chemical/61073.html.

Creation of new wetlands and habitats are important components of the Geddes Brook/Nine Mile Creek cleanup activities. Future activities are designed to restore forested wetlands, enhance wildlife habitat and species diversity, improve conditions for fish spawning and migration, control erosion, reduce pollution runoff, and provide opportunities for recreational use. Additional information about the Geddes Brook/Ninemile Creek Cleanup Actions is available at www.dec.ny.gov/chemical/37558.html.

What is Being Done to Encourage Citizen Participation?

Public involvement is an important component for the successful implementation and sustainability of Onondaga Lake cleanup efforts. Since 2004, the NYSDEC and Honeywell have encouraged citizen participation by informing and involving the public during the remedial design and construction phases of the Onondaga Lake bottom cleanup.

A report titled Citizen Participation Plan (CPP) for the Onondaga Lake Bottom Subsite Remedial Design Program provides a strategy for communicating with and soliciting feedback from the public during the remediation of the Onondaga Lake bottom. The report is available at www.dec.ny.gov/chemical/48761.html.

The CPP is a formal, yet flexible plan for two-way communication with the public during the multi-year dredging, capping, restoration, and monitoring project. It identifies specific community outreach and participation activities such as fact sheets, web sites, newsletters, annual reports, speakers, public meetings, and roundtable discussions. As part of the CPP, the NYSDEC formed a Community Participation Working Group. This volunteer group is comprised of citizens, public officials, and community and environmental leaders working independently of NYSDEC to provide a forum to inform, receive input, make recommendations, and discuss the Onondaga Lake bottom remediation program.

Sediment

What are the Impacts from Landslides and Erosion?

Landslides and other geologic features create additional non-point source pollution issues when the discharge of sediment causes gradual subsidence of nearby hillsides. Landslides in the Tully Valley contribute turbid (cloudy), saline water to Onondaga Creek. Landslides have occurred at the base of Bare Mountain for thousands of

Figure 21. OLP Tabletop Display
Photo credit: NYSDEC

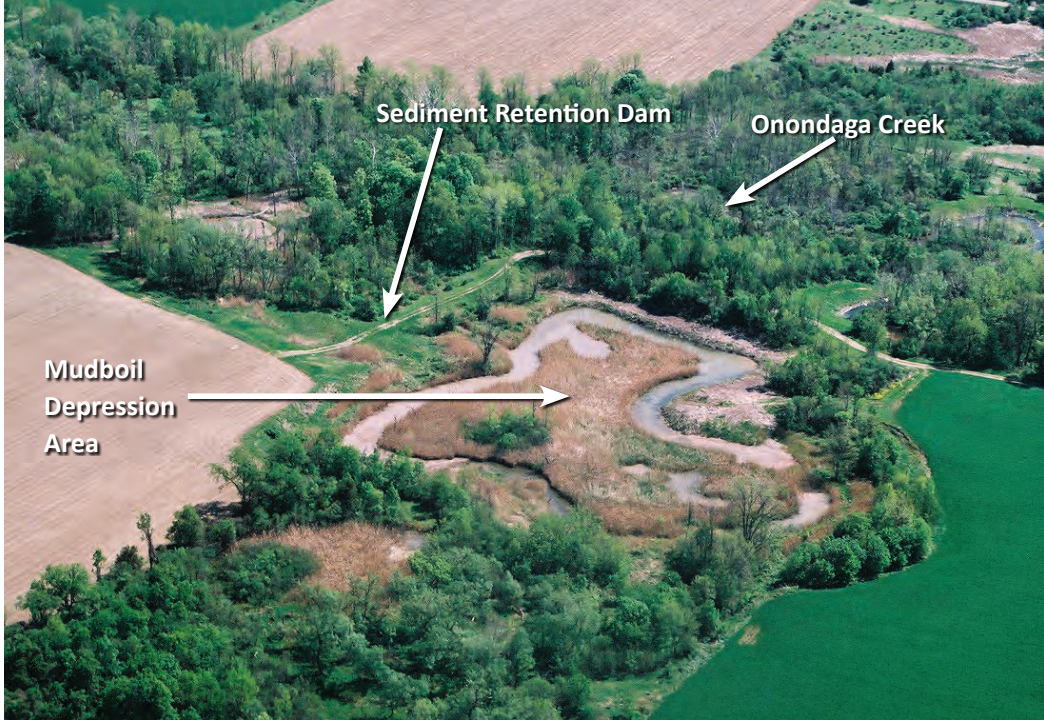


Figure 22. Tully Valley Mudboil Site
Photo credit: USGS

years, and two ongoing landslides are found in Rainbow Creek and Rattlesnake Gulf which are tributaries to the Tully Valley. Remedial efforts to stabilize the landslides in the two side valleys have not been possible due to difficult access and steep terrain. In addition to the mudboils and landslides, erosion along stream and road banks also contributes sediment to Onondaga Creek during periods of heavy rain and snowmelt runoff.

What are the Tully Valley Mudboils?

Mudboils are volcano-like cones of fine sand and silt found along the floor of the Tully Valley, approximately 18 miles (29 kilometers) south of Syracuse. They range in size from several inches to several feet high, and from several inches to more than 30 feet (9.1 meters) in diameter. Sediment from the mudboils enters Onondaga Creek which flows north into Onondaga Lake. Mudboil activity is a natural phenomenon that is influenced by seasonal variations in precipitation and groundwater recharge. They are more active during the spring and late fall when precipitation and recharge rates are high, and are less active during dry, summer months. Mudboils can erupt and form a large cone in several days. The flow might then continue for several years or stop as abruptly as it started.

Mudboils are caused by excessive artesian pressure in the valley that has existed since the retreat of glacial ice thousands of years ago and cannot be contained by the sediment layers that make up the valley floor. The reduction in artesian pressure is still occurring today in the form of water flowing from mudboils and water seepage through former mudboils. Mudboil activity may have been exacerbated by brine mining activities conducted in the Tully Valley during the first half of the 20th century.

What are the Impacts from Mudboil Discharges?

Sediment loading from the mudboils is a concern because it degrades water quality, decreases water clarity, and reduces habitat for aquatic insects, fish spawning, and plant growth along Onondaga Creek, the Inner Harbor, and to a lesser extent, in Onondaga Lake. Historically, Onondaga Creek has contributed more than 50 percent of the annual tributary sediment load to the lake. The discharge of sediment causes continuous

Figure 23. Tully Valley Mudboil
Photo credit: USGS

subsidence of the mudboil areas and nearby hillsides, which has resulted in the collapse of two road bridges.

Mudboil activity currently occurs primarily in two areas within the Tully Valley: the main mudboil depression area (MDA), and the rogue mudboil area located northeast of the MDA. After major mudboil remediation efforts in the MDA during the mid 1990s, the initial rogue mudboil appeared in early 1997. Over time this mudboil grew in size and in the early 2000s, a clay berm was constructed to contain the ever-growing mudboil. However, beginning in 2008, mudboil activity dramatically increased within and adjacent to the rogue mudboil area. Loss of a depressurizing well between the rogue mudboil area and Onondaga Creek in February of 2010 has lead to subsidence of the entire area around the former well, the berm that contained sediment inside the rogue area, and Onondaga Creek. This recent mudboil activity has increased sediment loading to Onondaga Creek and the OLP is currently working to address this issue to minimize negative impacts to the environment.

What is Being Done to Reduce Sediment Loading from the Mudboils?

The OLP is working with the Onondaga County Soil and Water Conservation District (SWCD), U.S. Geological Survey (USGS), and other regional partners to reduce sediment loading from the mudboils. Remediation projects have helped to reduce mudboil activity and to improve the ecological integrity of Onondaga Creek and Onondaga Lake. Remediation projects have included the following initiatives:

- Diverting the tributary flow that feeds the primary MDA to an adjacent tributary.
- Installing depressurizing wells at several locations near the MDA and along Onondaga Creek to decrease the artesian pressure.
- Constructing a dam and impoundments to control the flow of sediment. The impounded water allows the silt and sand to settle out before flowing into Onondaga Creek and downstream to Onondaga Lake.
- Modifying several geologic features that allow surface water to recharge the groundwater system in the southern Tully Valley (alluvial fans, losing stream reaches, and sinkholes).

OLP's remediation efforts resulted in dramatic reduction in sediment loading from the mudboils to Onondaga Creek from the 1990s through 2009. While the remedial activities implemented to date were successful in reducing sediment discharge to Onondaga Creek, controlling mudboil discharges will require continuous, long-term attention. Periodic maintenance activities, such as dredging of sediment-filled containment areas and repairing flow-measuring and flow-diversion structures, are necessary activities due to periods of high flow and excessive sediment accumulation. Depressurization wells also require constant monitoring and maintenance to assure continued well discharge and diminished mudboil activity. Ongoing land subsidence in the area around the mudboils will continuously affect mudboil activity and create new challenges to reducing sediment discharges to Onondaga Creek. The OLP's funding to maintain remediation efforts will expire September 30, 2012.

Salinity

Salinity refers to the concentration of dissolved salts in water. Salinity levels began to decrease in Onondaga Lake after Allied-Signal Inc. (a successor to the Solvay Process Company) stopped depositing salt waste into the lake. In recent years this has led to notable improvements in the lake ecosystem. Lower salinity levels improve the natural stratification (layering) of the lake water column, contribute to an increase in dissolved oxygen and aquatic diversity, and help to enhance near-shore habitats for plants and animals.

Improved water quality and habitat have also led to the presence of more pollution-sensitive fish species in Onondaga Lake, including brown trout, greater redhorse, and rainbow smelt.

Even with these changes, the salinity levels in Onondaga Lake remain high, which can be attributed to both natural and human influences. The levels are relatively high because salty wastes (containing by-products of soda ash production) are still entering Onondaga Lake from the Solvay wastebeds along Nine Mile Creek. In addition, naturally saline groundwater seeps into the lower reaches of Onondaga Creek.

Salinity is a priority water quality issue because of the high concentration of dissolved mineral salts (especially sodium chloride – common salt, and calcium chloride) in the waters of Onondaga and Nine Mile Creeks, and Onondaga Lake. High salinity levels can alter the natural stratification of a lake. Thermal stratification, a natural process commonly seen in many upstate New York lakes, is influenced by temperature and density differences. Chemical stratification, as seen in Onondaga Lake, is influenced by elevated salinity levels. Well-defined layers in a stratified lake do not mix until conditions change with air and water temperatures or chemical composition. Stratification contributes to a decline in the oxygen levels and impacts plant and animal health.

Figure 24. Onondaga Lake Park
Photo source: Gary Comins

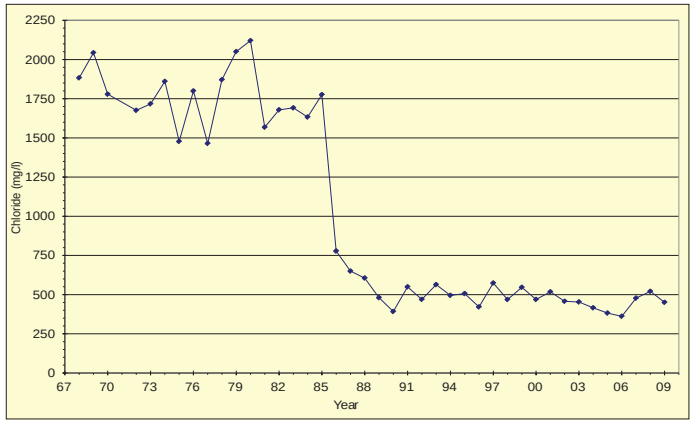


Figure 25. Average Annual Chloride Concentration
Data source: Onondaga County Department of Water Environment Protection

How Does Industrial Waste Impact Salinity Levels?

Salinity levels in Onondaga Lake declined after Allied-Signal, Inc. closed its chemical plants. Since then, the concentration of chloride, an important component of salinity in Onondaga Lake, has decreased from 1,800 milligrams per liter in 1985 to 450 milligrams per liter in 2009.

To extract the salt from the surrounding area, operators injected water into the salt layers through a series of wells 1,000-1,400 feet deep, and then pumped the dissolved salt (brine) to the surface. Brine from 167 wells was transported by pipeline from the Tully Valley area to the Solvay plant where it was used to make soda ash and chlorinated chemicals. Approximately 6 million pounds of salty waste, made up of chloride, sodium, and calcium, had been discharged daily to Onondaga Lake and nearby waste beds from the soda ash facility before it closed. At that time the salt content of Onondaga Lake was unusually high, averaging 0.30 percent. This was ten-times greater than nearby Otisco Lake that has a salt content of about 0.03 percent. By way of comparison, seawater in the world's oceans has a salinity level of about 3.5 percent. The salt content of the lake is presently about 0.10 percent by weight.

What are the Natural Sources of Salinity?

European immigrants settled in the Onondaga Lake region throughout the 17th and 18th Centuries due, in part, to the presence of salty springs. Numerous

salt springs referenced in historical documents have disappeared due to changes in lake level and land-filling along the shoreline, but one major salt spring in Onondaga Creek still remains and discharges brine to the Creek and Lake.

Tully Valley mudboils contribute water, and sediment, and some salinity to Onondaga Creek and Onondaga Lake. Saline discharges also originate from a series of salty springs within the older landslide areas along the foot of Bare Mountain (northwest of the mudboils) and from the 1993 landslide area. Within these landslide areas, salty springs discharge water to Onondaga Creek, which was a major reason why the Solvay Company explored Tully Valley in their quest for brine for the production of soda ash. Finally, the only major brine spring near Onondaga Lake is located just upstream of the Inner Harbor. It represents the concentration of brine which once discharged from these springs around the southern end of the Lake that made Syracuse the "Salt City".

What are Oncolites?

Much of the near-shore area of Onondaga Lake is covered with calcium carbonate stones called oncolites, believed to have formed from the calcium- and salt-rich waste discharges of the Allied-Signal soda ash facility. The calcium in the discharge water would precipitate and settle on the lake bottom, and the wave action then created nodules, or balls, called oncolites. Although oncolites are still present, the lake bottom is exhibiting greater stability due to increased plant growth.

Non-Point Source Pollution

Non-point source pollution occurs when stormwater and wind transport pollutants to waterbodies. Common non-point source pollutants within the Onondaga Lake watershed include sediment from the Tully Valley mudboils, salt from highway deicing operations, and fertilizers and pesticides from horticultural practices. Debris and floating trash enters Onondaga Lake and its tributaries through CSOs and storm sewers, and from nearby streets.

The OLP focuses on programs to reduce non-point source pollution loading to Onondaga Lake. For example, a litter vacuum truck is now used to remove floating trash from stormwater catch basins, and skimmer vessels are used to remove floating waste from the Inner Harbor. Trash removal helps to improve the aesthetics of the lake and reduces ingestion or entanglement hazards to wildlife.

Figure 26. Onondaga Lake Shoreline Wastebed
Photo credit: Onondaga Environmental Institute

Innovative OLP-sponsored watershed programs are reducing non-point source pollution by focusing on areas such as animal waste and pesticide management at farming operations, streambank and roadbank stabilization, increased use of phosphorus-free fertilizers, school education programs, and measures to control road and streambank soil erosion and stormwater runoff.

Agricultural Environmental Management (AEM) is a voluntary program where farmers work with a team of local resource professionals to develop comprehensive farm plans using a tiered process. The OLP provides funding to the Onondaga County Soil and Water Conservation District to deliver the AEM program in the Onondaga Creek and Ninemile Creek watersheds. The program helps to reduce agricultural sources of sediment and nutrient loading to Onondaga Lake. As of 2009, 57 of the 67 farms in the Onondaga Lake watershed had participated in the AEM program.

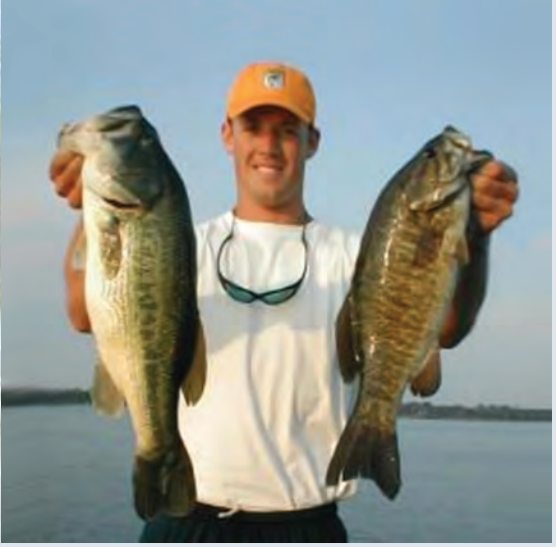


Figure 27. Fishing on Onondaga Lake
Photo credit: Craig Nels

The Onondaga Lake Ecosystem

Onondaga Lake Fisheries

The Onondaga Lake fish community is improving sooner than anticipated as a result of changes in water quality and aquatic habitat. Lower pollution levels have led to reductions in phosphorus, ammonia, and algal growth, which have had a positive influence on the health and diversity of the fish community. The lake now supports a warm-water fish community and a recovering cool-water fishery with several game species. Over 65 species of fish have been documented in the lake, reflecting an impressive increase from the 9 to 12 species that were recorded in the lake during the 1970s.

Warm-water fish such as sunfish and cool-water fish such as pike and smallmouth bass now reside in the lake year-round. Coldwater fish such as trout are transient and migrate to Onondaga Lake tributaries and to the Seneca River during the summer months based on dissolved oxygen levels and temperature.

Fish health and species diversity in Onondaga Lake are influenced by a variety of factors such as pollution levels, dissolved oxygen, water temperature, available food, and suitable spawning habitat. Decreased concentrations of ammonia, salinity, and mercury in recent years have contributed to healthier fish communities but the bottom waters of Onondaga Lake remain relatively uninhabitable to fish due to low levels of oxygen during the summer following thermal stratification (also known as temperature layering.) This condition also exists in nearby lakes, such as Otisco and Oneida.

Plant and animal communities in Onondaga Lake interact in complex relationships that are essential to overall lake health. The survival of each plant and animal is dependent on its relationship with other organisms, an interaction referred to as the aquatic food web. Fish are an important part of the food web and Onondaga County routinely monitors their populations and reproductive success. Fish data are also recorded on an annual basis from angler surveys. Additional information is located at www.ongov.net/wep/we15.html.

Table 1. Fish Species Documented in Onondaga Lake, Grouped by Relative Abundance, 2000 to 2008
Data source: Onondaga County Department of Water Environment Protection

Abundant Species

alewife, banded killifish, bluegill, brown bullhead, carp, channel catfish, gizzard shad, golden shiner, largemouth bass, pumpkinseed, shorthead redhorse, smallmouth bass, white perch, white sucker, yellow perch

Common Species

black crappie, bluntnose minnow, bowfin, brook silverside, brook stickleback, emerald shiner, fathead minnow, freshwater drum, longnose gar, logperch, northern pike, rock bass, tessellated darter, tiger musky, walleye

Uncommon Species

black bullhead, brown trout, goldfish, greater redhorse, green sunfish, johnny darter, lake sturgeon, longnose dace, northern hogsucker, quillback, rainbow trout, rudd, spotfin shiner, trout, perch, white bass, yellow bullhead

Largemouth bass

Common carp

Table 2. Chemicals in Sportfish and Game: 2010-2011 Health Advisories for Onondaga Lake
Data source: NYSDOH

Species	Advice*	Chemical(s) of Concern
Largemouth bass and smallmouth bass over 15” and walleye	Don’t eat	Mercury, PCBs
Brown bullhead and pumpkinseed	Eat up to four meals per month	Mercury, PCBs
Carp, channel catfish, and white perch	Don’t eat	PCBs, Mercury, Dioxin
All fish not listed	Eat up to one meal per month	Mercury, PCBs

**** Woman under the age of 50 and children under the age of 15 should not eat any fish from Onondaga Lake.***

Bluegill

White bass

What Types of Fish are Found in Onondaga Lake?

Onondaga County’s monitoring program has captured 46 different fish species since 2000. When combining the County’s species list with that of other recent studies, there have been 65 fish species identified in the lake in recent years. Fish species and their relative abundance are summarized in Table 1. As a further indication of the lake’s remarkable recovery, several new species have been caught in Onondaga Lake in the past few years such as lake sturgeon, quillback, green sunfish, and black bullhead. Additional information about lake fisheries is available at static.ongov.net/WEP/wepdf/FishFactSheet2007_2008.pdf.

Are the Fish Safe to Eat?

Fishing has become increasingly popular on Onondaga Lake over the past few years. National sporting competitions and professional fishing events are scheduled each year, and local anglers use the lake on the regular basis during the summer months.

Fishing on Onondaga Lake is a recreational sport and there are specific health advisories that provide recommendations regarding fish consumption. These advisories are for sport fish that people catch and are not for fish and game sold in markets. State advisories which apply to Onondaga Lake and other waterbodies in New York State are issued because fish may contain environmental contaminants such as mercury and PCBs that accumulate in fish and human tissues, and may pose health concerns if consumed. Fish advisories in New York State are primarily based on contaminant levels in fish tissue that are collected by the NYSDEC. The current health advisories for Onondaga Lake are listed in Table 2. The complete 2010-2011 health advisory is available at www.nyhealth.gov/environmental/outdoors/fish/fish.htm.

In addition to the continuing problem of elevated mercury levels in Onondaga Lake fish, PCB levels have increased in recent years in some fish species from Onondaga Lake. Based on these data, the health advisory issued by the New York State Department of Health (NYSDOH) recommends eating no carp, channel catfish, and white perch. In addition, the advisory for Onondaga Lake brown bullhead and pumpkinseed recommends eating up to four meals per month. The advisory states that no largemouth and smallmouth bass over 15 inches or walleye should be consumed. One meal per month can be consumed for all other fish species. However, women under the age 50 and children under the age of 15 are advised not to eat any fish caught in Onondaga Lake.

Aquatic Plants

With the recent improvements in Onondaga Lake water quality, nearly a four-fold increase in aquatic plant cover has been documented between 2000 and 2009. Lower phosphorus levels have led to fewer and less severe algae blooms. The water clarity has improved which means that sunlight can penetrate to greater depths. Aquatic plants in the lake are now growing at six meter depths.

The Onondaga Lake plant community has also become more diverse and abundant. Aquatic plants provide valuable spawning and nursery habitat necessary for fish communities. Plants also provide food and shelter for a variety of additional aquatic animals and insects, and their root systems help to reduce erosion by stabilizing the lake shoreline. Onondaga County monitors the plant communities through the use of aerial photographs and ground truthing. Ten plant types were identified during the 2008 sampling. Eurasian watermilfoil, coontail and elodea were the most widely distributed plant species found at most of the ten sites. Additional information about aquatic plant growth and the sampling program is available at www.ongov.net/wep/we15.html.

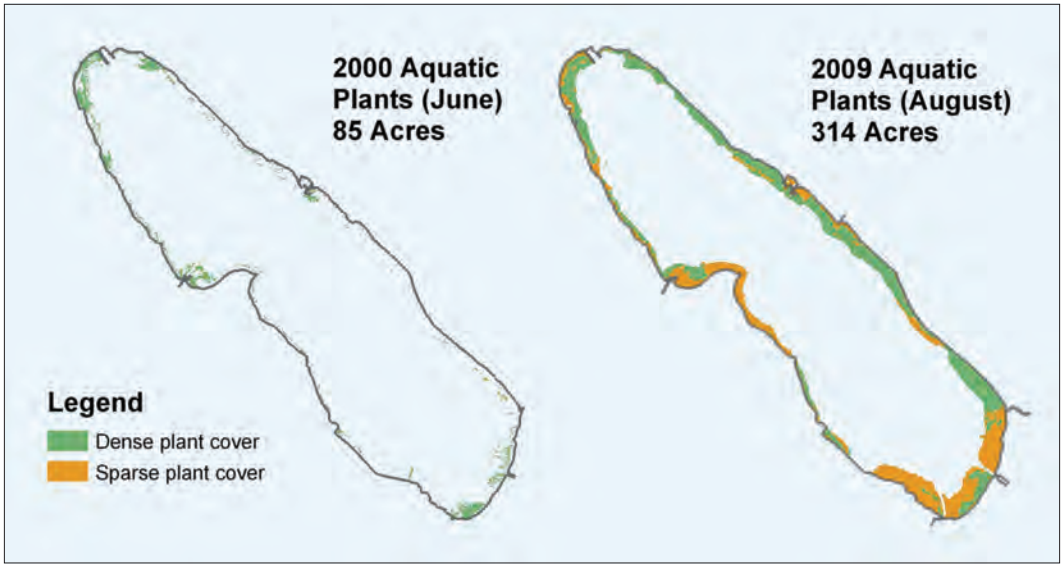


Figure 28. Aquatic Plant Coverage in Onondaga Lake, 2000 and 2009
Data source: Onondaga County Department of Water Environment Protection

Eurasian water milfoil

Conclusion

For the past several years, Onondaga Lake water quality has shown remarkable improvement and the lake is once again becoming a recreation destination point for outdoor enthusiasts while serving as a source of community pride. Following a long-term investment of funding, combined with strong regional partnerships and strategic restoration planning, the lake is now evolving into a valued local resource.

Because of continued water quality and biological improvements, public use of the lake is increasing, but there is still much to accomplish. Federal, State, and local organizations, residents, and lake users will continue to play a major role in the revitalization of Onondaga Lake for years to come. Projects will continue to be designed and implemented with measurable deliverables, well-defined goals, and timelines for completion. The following priorities have been identified for the next several years:

- Conduct a cleanup of industrial contamination from the lake bottom and additional sites to meet health standards and to improve conditions for the lake fishery;
- Maintain low phosphorus levels in the lake and continue to reduce phosphorus loading from Metro and other watershed sources;
- Reduce floatable solids and bacterial discharges from CSOs and control the volume of stormwater contributing to CSOs in order to meet water quality standards;
- Improve water quality in Onondaga Creek and Onondaga Lake by managing sediment loading from sources such as the Tully Valley mudboils and landslide activities; and
- Restore and maintain a healthy and diverse ecological habitat that is suitable for the growth of rooted aquatic plants and the maintenance of a sustainable fishery.

The plans for Onondaga Lake are designed to maintain water quality improvement trends that will support a healthy aquatic habitat for plants and animals, and that will continue to enhance recreation opportunities for the public. In addition, a water quality model is being developed as a predictive tool that, when utilized with models already developed for upstream and downstream of the lake, will simulate how the Onondaga Lake system will respond to changes in nutrient loading, source reductions, and wastewater treatment plant improvements.

As cleanup programs progress under the leadership of the OLP, future expectations are bright for continued improvement of Onondaga Lake resources. For additional information about the OLP and revitalization programs, visit the OLP website at www.onlakepartners.org.

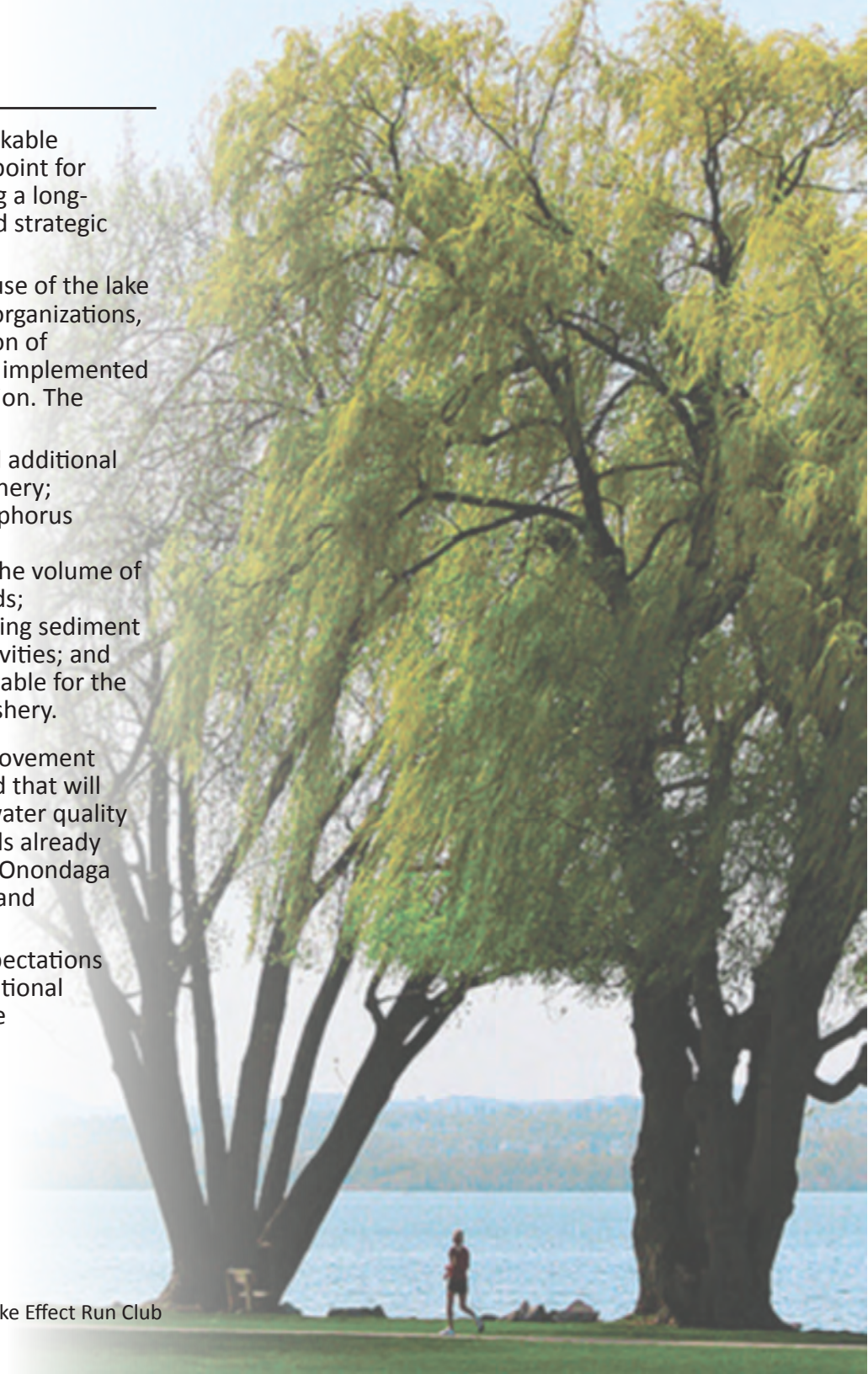


Photo credit: Lake Effect Run Club

Onondaga Lake Partnership Committees

The Onondaga Lake Partnership (OLP) promotes cooperation among Federal, State, and local governments, and other involved parties in the management of the environmental issues of Onondaga Lake and the Onondaga Lake watershed in the Syracuse, New York area.

Executive Committee

The Executive Committee, chaired by U.S. Army Corps of Engineers, establishes and maintains the mission of the partnership and the lake improvement effort. Committee members include:

- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- New York State Department of Environmental Conservation
- New York State Attorney General
- Onondaga County
- City of Syracuse

Project Committee

The Project Committee, chaired by the NYSDEC, provides technical expertise for OLP projects and develops and maintains funding strategies. Committee members include representatives of Executive Committee agencies, as well as the:

- State University of New York College of Enviromental Science & Forestry
- U.S. Geological Survey
- New York State Canal Corporation
- Onondaga County Soil and Water Conservation District
- Central New York Regional Planning & Development Board
- Metropolitan Development Association

Outreach Committee

The Outreach Committee, chaired by Onondaga County, works to enhance public knowledge and understanding of the partnership and the status of the lake improvement effort. Committee members include representatives of Executive Committee agencies, as well as the:

- Izaak Walton League
- Atlantic States Legal Foundation
- Cornell University Cooperative Extension, Onondaga County
- State University of New York College of Environmental Science & Forestry
- Onondaga Historical Association
- Citizens Campaign for the Environment

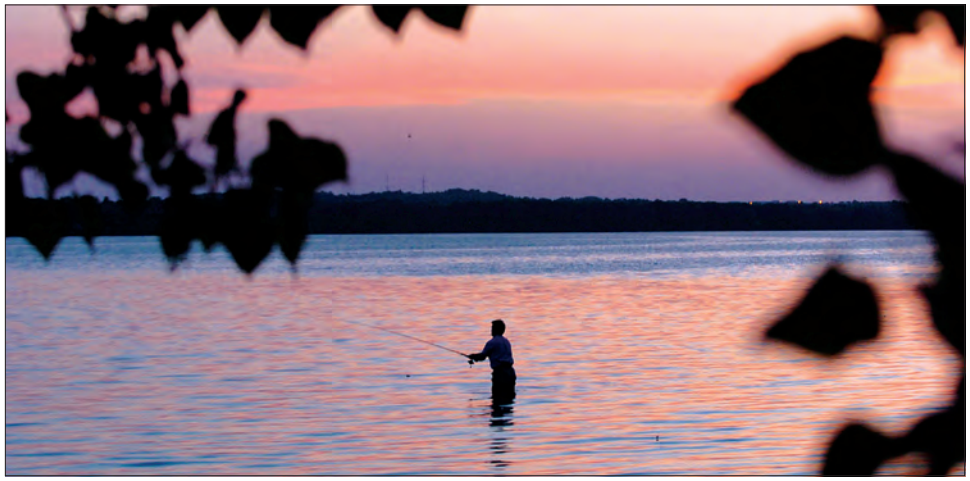


Figure 29. Fishing on Onondaga Lake
Photo source: Onondaga County Parks

ONONDAGA LAKE PARTNERSHIP

A clean lake reflects well
on all of us.

Federal, State, and local agencies, non-profit organizations, and citizen groups are working together to improve conditions in Onondaga Lake and its watershed. Additional information about the Onondaga Lake Partnership is available by calling (800) 833-6390, by submitting questions and comments to info@onlakepartners.org, or by visiting the Onondaga Lake Partnership web site at www.onlakepartners.org.